Futures of automobile industry and challenges on sustainable development and mobility

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FUTURES OF AUTOMOBILE INDUSTRY AND CHALLENGES ON SUSTAINABLE DEVELOPMENT AND MOBILITY

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1 Introduction

Some programs and research networks are dealing with topics associated with automotive sector, observing one of the most significant sectors of modern economies. It represents the key-sector where the more important and intense changes (technological, business, conception, organisational) have take place in the last decades. It also represents one of the most important cultural elements in modern societies. That is why is so interesting predicting some of the possible changes in the sector for the next 10 to 20 years. But this exercise can not be focus only on the technical aspects of the automobile construction, design aspects or mobility systems. It should mainly focus on the integrative dimension of these technical aspects (construction, design and mobility) and on socio-cultural aspects, such as consumers' behaviour, urbanisation tendencies, multi-modular transport, values and infrastructures of communication and also attitudes in what concern mobility. All these aspects will have a major influence in the future of what we call 'self-mobility'. In fact a bigger importance than aspects related with technical obstacles or virtues. Nevertheless these dimensions are missing on the economic debate about the future of the automobile industry, on the steps that should be taken and on the visions about technological needs. The organisational aspects (production cells, team works, flexible systems of production) are also important elements that can represent an improvement on the outputs (productivity, quality, competitiveness) of the industry, although they are systematically put aside in relation to the major trends of the sector.

How can this problem be faced and how can it be decisively important is what we will try to answer in this paper, that resume some of the debates about prospective exercises in Germany (Futur) and also about the automotive sector in Portugal (WorTiS). More recently we are developing these issues once one of the most important outcomes of the WORKS project will be the development of some

scenarios about the future of work below global restructuring processes, which may be used by policy stakeholders and researchers interested in the future of work in the knowledge-based society.

2 Conceptual framework

In the begin of 2001, Yannick Lung wrote in bulletin *La Lettre du Gerpisa* that "the automobile have been subject to an enormous process of change (in project and production methods) since 1968 [1] - even the product itself, beyond design changes, it kept basically the same appearance; the principles of motorisation are the same; and it still being produced in factories, organised in production lines" (Lung, Yannick: 2001, p.1). In fact, the technical dimension of this industrial sector it is one of the major obstacles for the imagination. Designers, information technology specialists and production engineers are those who "pull" the more innovative ones in automobile industry.

The sector is developing its own production structures with new *marketing* relations, with quick answer systems to economic demand and international alliances based in complementariness of markets, products and skills. Because of this, the majority of companies think that the scenarios construction is very important, giving them the possibility and tools for decisions that facilitate and allow the anticipation of market trends for some future decades. For a close future this foresight capacity will be understood as a competitive business tool.

In fact, a large number of assumptions about the trends of automobile industry are based in "visions" related with technical features of production systems (flexible systems, robotic, etc.) or models of work organisation (chain work, semi-autonomous teams, job rotation). These trends are also based in visions related with market trends (in what concern relations with suppliers and subcontractors, but also with the emergence of e-business or the modular organisation systems). But all these visions are based in common or traditional aspects of the use of the automobile and urban structures. It is clear that we can support the fact that these aspects will not change in its structural dimension in the next, say, 30 years.

Even if this "generational law" (that corresponds to the time that is need to a radical change of the "family" product or of an industrial sector) is accepted, the foresight is still necessary as a business tool and it is frequently useful to initiate a process of rebuilding or restructuring based in those change process. This process includes the development of regional politics and urban planning, or the development of financial institutions, social and demographic structures. It is not necessary to emphasise the importance of political and economic sciences to recognise the emergence of new social actors and their integration in institutionalisation.

In this sense, foresight exercises with this type of time horizon needs the in-put of the majority of social sciences. These scientific areas can be more decisive than technical specifications. Begin to "function" after the main patterns have been constructed and established, or when the main trends are identified, as well as the key factors of support. Nevertheless, a vision about the development of technical features related to automobile industry should at the same time include these aspects and remain isolated from them.

The integration of some of these questions in the debate about mobility and transports interface is crucial to understand the emergency of such patterns.

These questions are related not only with automobile industry, but are also embedded in discussions on aeronautics sector, railways sector and on development of new information and communication technologies. The main reason is the fact that the interface and multi-modularity of

[1] The author was refering the visions including on S. Kubrick film 2001 A Space Odissey that was in theatres in 1968 for the first time. In fact, the majority of those visions didn't happen in the pretending year (2001).

transports are becoming crucial, once this concept leads to the need of solving new architectural problems, and also new urban solutions to take advantage of the different transport networks. Another reason is related with growing financial integration of different sectors mentioned above (aeronautic, railways, logistics, communication systems, construction and, of course, the automobile industry). But, the coordination of development strategies in which of this sectors is crucial for those interests.

As published in the GERPISA bulletin *(La Lettre du GERPISA*), another aim for future investigation will be the seizure of interaction between organisational dynamics of enterprises and socio-economical models of development. This seems to be the key of any construction of prospective analysis related to the automobile and mobility structures.

It is also possible to analyse a set of foresight exercises in Europe, in USA or in Japan about automobile industry. If we take in account the German exercise that start recently in the scope of FUTUR framework program (with the construction and assessment of "orientation visions" to 2020, with the purpose of development research programs), one of the main themes that emerge from the first discussions was exactly "Mobility: individually attractive and socially sustainable". Within this thematic three sub-topics were considered important:

Individual mobility versus public mobility

- ✓ "Tele-office in the backpack": mobility in movement?
- ✓ Germans "favourite child" - the new role of automobile

As we can see clearly the issue of mobility it is very important when we develop social and economic visions to the next 20 years, including the emergent concept of sustainability. The same way, automobile functionality is also discussed. This seems to be the essential problem that the industry will have to deal with and must find solutions in next years.

Also IMVP program from MIT is dealing with these questions in the topic "Visions of a sustainable future". This topic includes three themes: the global reach, enabling and disruptive technologies and the organisational learning and knowledge management. These themes will be analysed in relation with the following items:

- ✓ "Green" drive train technology
- ✓ New materials, recycling and environment management
- ✓ Mobility solutions

3 New themes about mobility

Mobility has been one of the more important social needs. We can mention the needs of individual mobility and also the needs to transport goods and services. We also can integrate here cultural questions related with the possession and exhibition of individual mobility goods (the automobile), but also questions related with the orientation to social isolation of individuals that resort to this kind of personnel's valorisation instruments. In all this aspects there is a marginalisation of the importance of collective use of transport, or the decisive importance of planning urban and leisure spaces, that integrating also labour, cultural, familiar, consumption dimensions, among others.

This process develop traffic systems related with the principles of social division of labour, which means, distribution of specialised activities, localisation of production places, localisation of design and production units, as well as financial units, commercial activities organisation, commuting movements, ect. As been demonstrated through different researches, the JIT techniques, as well as e-market are the main reasons for traffic increase, though initially there was the idea that the result would be the opposite!

But, the need of a bigger mobility is, somehow, in an inverse proportion with the disadvantages of load transports and traffic. Once there is a greater need of mobility, the increase of negative impacts in the environment and in psychological conditions is easily understood. Examples can be found taking into account the increase of noise and air pollution, land price, or the transformation of landscape with the construction of roads in mountains, valleys or plains. Traffic will increase, despite tended to move slowly. This have a clearly impact on time allocation, causing psychological constraints.

If the principle of "roads provoke traffic" is usually accepted, the individual dependency of automobile will reduce the choice of alternatives patterns of mobility. So, what could have be seen as an improvement in life style with more individual mobility, will be turn into an obstacle to social relations in a near future. This doesn't happen just because of some reduce on specific individual freedom, but also due to an increase of urban or metropolitan congestion and their correspondents' environmental damages.

Sustainability is then a very important concept, but only recently has been taking into account, both by policy makers as by engineers, researchers and scientists. These aspects will be study not only by engineers and environmentalists but also by social scientists. New problems in social relations, urban structures, behaviours, social needs and acceptability degrees will be taken into consideration.

It is worth stressing that in Delphi 98 exercise in Germany, about the theme "Mobility and transport", the most recognise themes are related with these dimensions, once 23,5% of respondents think that "the progressive diffusion of communication systems will reach an intelligent distribution of traffic and transport between the different systems of traffic and transport routes, in way to use the existent transports infrastructure more effectively and efficiently, to support the elimination of problematic traffic and periods of traffic peaks and to encouraged or allow the use of flexible ways of transport." (Cuhls, K.; Blind, K.; Grupp, H.: 2002, p. 129).

In the same foresight exercise (Delphi 98), have been noted that the main innovations in mobility field will still, according to 55% of the specialist panel, be oriented to the resolution of ecological problems. This was considered as one of the major problems. Therefore, mobility will not be associated mainly to time reduce or economical efficiency. It looks like that the main effect will be felt in environmental scope, once from the cultural point of view there is a large resistance to find and accept alternatives to traditional mobility systems.

In this sense, system's traffic organisation will use the results form research to understand clearly the whole systems conditions and the new organisational concept involved. In most cases, new technical concepts will also emerge to organise those traffic systems with the support of information and communication technologies.

Such discussions were the ground for organisation of a series of scenario themes that were presented to a panel of experts in Portugal in order to study the possible trends of evolution of the automobile industry, as well the increase the knowledge on the conditions and problems for that evolution. The next chapter presents those results.

4 The Delphi exercise in Portugal on the automobile sector

This foresight survey was done under the WorTiS project, developed in 2003 and 2004 by IET – Research Centre on Enterprise and Work Innovation (at FCT-UNL), and financed by the Portuguese Ministry of Science and Technology.

The majority of experts considered having an average of less knowledge in almost all the scenario topics presented. This also means that the information on the automotive industry is not spread

enough among academics or experts in related fields (regional scientists, innovation economists, engineers, sociologists) in Portugal. Some have a good knowledge but in very specialised fields. Others have expertise on foresight, or macroeconomics, or management sciences, but feel insecure on issues related with futures of automobile sector. Nevertheless, we considered specially the topics where the experts considered themselves to have some knowledge. And these were the ones that we analyse here.

There were no "irrelevant" topics considered as such by the expert panel. There are also no topics that are not considered a need for co-operation. The lack of technological infrastructures was not considered as a hindered factor for the accomplishment of any scenario. The experts' panel considered no other international competence besides US, Japan or Germany in these topics.

We present here only the results that are related with the topics of sustainable development, mobility and the socio-economic issues of the sector.

The scenario topics are decisive for the assessment made by the expert's panel on the possible trends in this productive sector. The themes were elaborated having in consideration not only proposals already discussed under other similar research projects, but also considering the discussions developed in the WorTiS project.

After some meetings and seminars was possible to build up a group of 40 scenario topics. According to the experience of other already done exercises, the organisation of themes scenario themes does not allow a larger number, once the response tendency of the panel members diminishes with the increase of the number of situations that they would assess in terms of its importance and impact.

Less themes could be more interesting, while the panel members could concentrate themselves on the hipotheses that were presented. But the scenario situations could then not cover the needed fields, not even those that could be needed to assess relations of concepts or conceptual dimensions.

4.1 Results related with sustainability and trends of mobility

4.1.1 Topics better known by the experts

All the experts member of the panel were asked which topics would correspond better to their knowledge. This can be important once the other responses involving these topics should be over-evaluated. In contrast, those topics where the expert's knowledge is not clear should be under-evaluated. If a quantitative analysis would take place the different topic should have a weight to clarify their dimension in a comparative relation with each other and under the same framework.

T1. 25% of the fuel cells that exist in the national automobile park are produced by companies located in Portugal

The experts considered also that for the accomplishment of this future topic the institutional collaboration would be determinant. The main international competence related with this topic is Japan. In this theme are implied three main tendencies: 1) there will be a strong change from the point of view of this type of vehicle consumption; 2) there will happen a growing market (and economically stronger) in the field of service delivery on fuel cells; 3) vehicles that are assembled in Portugal will use more the fuel cells as a energy source. In any case, it is possible to occur some lateral effects like the increased need of entrepreneurial activities oriented for this type of product.

T8. 50% of passenger automobile vehicles have systems of hybrid propulsion (electrical and gasoline or diesel fuel)

This future situation would only take place on the very-long range according to the expert's estimation. The co-operation is very important to accomplish it. Japan is also the most competent country in this field. With the continuous oil crisis and the increase lack of resources (together with the environmental effect due to the automobile pollution) led to the development of hybrid propulsion technologies. The public acceptance of this type of engines and its growing diffusion (especially in Japan and US) point out to the possibility of an enlarged automobile park. This process will be, however, relatively long because of cultural reasons (more than economical ones)

T9. 25% of running light transport vehicles incorporate fuel cells (hydrogen)

Also should take place on the long run. As the previous cases, co-operation is very important and Japan is the most competent country. With the expansion of hybrid systems and the development of scientific research, several solutions were find and applied to prototypes with fuel cells [2]. It can be forecasted that ¼ of the total light passenger vehicles will use this kind of energy source.

4.1.2 Topics considered important from the point of view of "quality of living"

The entire panel was asked on their opinion about the given importance on all the topics. Those that could be included in the field of "quality of living" [3] and received larger amount of references were the following.

T7. 75% of all transport passenger automobile vehicles have automated driving systems (at least, automatic steering systems or satellite navigation)

The panel didn't show a clear common opinion on the implementation period, neither the main international competence (only a smaller majority pointed US). It is considered as very important the cooperation between companies and other institutions. The technological development in this sector is being more evident in the field of autonomous vehicles. Particularly, one can mention the experience in the field of aeronautics and aviation, and on the railway transport. In the sequence, the road transport can also apply these new driving automated systems, adapted from the other experiences. In such situation, this scenario topic assumes an almost usage of elements of these systems.

T28. All factories of the automobile industry have environmental management systems working (efficient usage of energy resources, residuals, emissions)

All members of the expert panel mentioned these topics, and the above-mentioned T8. On T7 a majority mention that US can be the international competence in the field. Special mention can be done to T28 once the topic is considered to be implemented in the short or medium term, and Germany is the reference country. Although this is an important requisite, and even compulsory from the legislative point of view, several companies still limit themselves to the minimum legal actions. It is although possible that companies in this sector consider the growing importance of these environmental management systems.

But other topics received also a meaningful reference on this area (quality of living).

T2. There is international competence in Portuguese companies for the development of technological systems that can be ecologically efficient in the automobile industry (equipments and products)

This topic can be implemented in the short-term (until 2011). The panel considered the US as the international competence. Co-operation is fundamental in this future topic. Portugal has no explored

[2] Just some Japanese car manufacturers are producing in larger scale this type of engines (to mention Honda and Toyota).

[3] This definition was taken by the research team.

resources in the field of carbon hydrates (oil and coal), neither of natural gas, and have no tradition in the field of nuclear energy. One should then consider that it exist a technical competence in the field of ecologically efficient systems (to a certain extent this is true). And as exists a strong exporting specialisation in the field of automobile industry, the articulation of these two competencies is logically possible.

T14. The manufacturing of ecological vehicles (engine, bodies, and interiors) has costs only 10% higher than the conventional vehicles

To be implemented in the medium or long range. Japan and Germany were considered to be the international competences. In this moment, the development of vehicles that apply ecological criteria are still too much expensive, which represents a market limit. However, the expected technological development, and the increase of quality in the customer's choice criteria, can increase this market segment. This can occur even if the costs are slightly higher (10%?) than the other vehicles.

T15.Telematic and control systems will be largely used in order to be possible a traffic distribution over the different transport systems, to use infrastructure in a rational way

Will take place only in the long term. The cooperation is very important and is not clear for the panel where the main international competence in the field is. The usage of these systems is seen only from the point of view of transport comfort. Nevertheless, these systems allow – always in communication with the traffic management systems – a rational usage of road transport (individual or collective). This is already done today in the air and rail transports and, as a tendency, in the maritime transport.

T35. The increase of individual mobility implies the existence of intermodal networks of public transport that integrate the road transport (car and motorcycle in a car-sharing system, buses), railways (trains and trams), fluvial transport (boats and hovercrafts)

To be implemented in the short-term, and France is pointed as one of the main international competences in the field, with whom such collaboration should be improved. This scenario represents a new field where automobile sector can play an important role: the one of the intermodality in the public transport oriented towards the individual mobility. Individual needs are not normally taken into consideration by the public transport services. The present phase of technological development allows a larger versatility and flexibility in the usage of the different transport means. There is an increasing market in this area. This can imply a decrease in the consumption of vehicle for private usage, but will increase largely the volume of vehicles for collective usage. It can become an interesting proposal, but it depends again on the cultural character aspects. More than on the technological or economical aspects.

T38. The entire automobile fuel commercialisation network will be re-structured and integrates also the supply of alternative fuels.

To be implemented in the long run. The panel mentioned most US as the main international competence. One of the main problems on the development and trade of vehicles with alternative fuels (natural gas, vegetable derivates, electricity, etc.) is the network of fuel commercialisation. Such networks can be a hindering factor. But they restructure to supply these fuels, they can be a supporting factor for the development of such less polluting vehicles and with alternative fuels.

Possible terms of implementation

The already mentioned topics T2, T28 and T35 were those that were pointed as to have a possible implementation the short term (until 2011)

T2. There is international competence in Portuguese companies for the development of technological systems that can be ecologically efficient in the automobile industry (equipments and products)
T28. All factories of the automobile industry have environmental management systems working (efficient usage of energy resources, residuals, emissions)

T35. The increase of individual mobility implies the existence of intermodal networks of public transport that integrate the road transport (car and motorcycle in a car-sharing system, buses), railways (trains and trams), fluvial transport (boats and hovercrafts)

The long term implementation will only be possible for the following topics, which means that the expert's panel considered those topics much more difficult to be achieved. They are presented next:

T8. 50% of passenger automobile vehicles have systems of hybrid propulsion (electrical and gasoline or diesel fuel)
T9. 25% of running light transport vehicles incorporate fuel cells (hydrogen)
T10. Light automobile vehicles with a group electric motion-propeller of local generation (fuel cell) reach speeds up to 200km/h (actually, 150 km/h – Toyota and Honda), and has autonomy of about 750 km (actually, about 300 km)
T14. The manufacturing of ecological vehicles (engine, bodies, and interiors) has costs only 10% higher than the conventional vehicles
T15. Telematic and control systems will be largely used in order to be possible a traffic distribution over the different transport systems, to use infrastructure in a rational way
T22. The implementation of "working group" concept extends to about 50% of all automobile components manufacturers, while all the assembling companies use it (100%)
T38. The entire automobile fuel commercialisation network will be re-structured and integrates also the supply of alternative fuels.

4.2 Results related with the future of the industry

4.2.1 Topics better known by the experts

As with the results related with sustainability and mobility, here all the experts member of the panel were also asked which topics would correspond better to their knowledge. As mentioned above, those topics where the expert's knowledge is not clear should be under-evaluated. If a quantitative analysis would take place the different topic should have a weight to clarify their dimension in a comparative relation with each other and under the same framework.

The next two topics were also considered as been the most important from the economical point of view (all the experts revealed such opinion).

T11. Manufacturing companies (assemblers and suppliers) have electronic business systems (e-business) that allows them to order, to design, to manage production and delivery using internet communication (C2B e B2B)

The US and Germany were considered the most important countries with competence in this field. Although for Portugal it would be only implemented in the medium-term. The first experiences in this area were recognised and successfully evaluated. The US company Saturn (from the GM group) was the first more important example. However other companies tried to apply some e-business and simultaneous engineering principles to the automobile sector (examples from Smart and VW are clear, also in Portugal). Although these systems are not still quite generalised, is possible to anticipate a growing application.

T32. The creation of "automobile cluster" (assemblers, components, services) increases the national competitive capacity, that would produce about 350 thousand vehicle per year (60% for export)

There is no clear position on the period for occurrence of this topic. The large majority mentions the need for co-operation and again Germany is considered as a reference country for the organisation of an "automobile cluster". The increase of the cluster activity implies the attraction of more FDI in the sector. This produces indirect effects on the international increase on competition capacity of the all cluster in Portugal. A final effect is the increase of production volume. In this scenario a large amount of that volume stays in the internal market (40%), which means an increase of the national income with clear effect in the consumption structure.

Other mentioned topics:

T17. The expansion of the national automobile industry creates the "automobile cluster" that integrate about 500 thousand jobs (assembling companies, components, services)
T29. Each assembling company in national territory will be associated at least one research centre and one product engineering centre in co-operation with Portuguese Universities and/or Polytechnic Institutes
T31. Few assembling companies will be located in Portugal. The total production will be around 50 thousand cars/year (it was about 240 thousand in 2001)
T37. There is technical capacity, in the chain client-distributor-manufacturer-distributor-client, to produce a vehicle specially ordered in only 3 days.

Considered also as very important from the economical point of view by most of experts in the panel

T13. Generalised usage of security systems that guaranty the integrity of the occupants in frontal and/or lateral collisions at 80 km/h
T18. The development of international levels of competitivity demands for the increased number of average schooling level in the sector (9.3 years in 1999) for about 15 years
T40. The labour relations systems in the automobile sector is the national reference for the negotiation with higher levels of productivity and social peace

4.2.2 Topics considered important from the economical point of view

Beside those that were already mentioned above, there are also others considered as very important by the members of the expert's panel.

T6. Annually are registered patents of products associated to the automobile sector which corresponds to about 35% of total national patents

Topic considered as such by all the experts. US are the country clearly considered to be the international competence in the field. This topic can be implemented in the medium range, according to panellist's opinion. The increase of the productive activity, mainly of foreign investment (vehicle assembly and component manufacturing), this implies evident innovation processes. To these processes it corresponds not only technology transfer processes, but also R&D activities at the company level or in co-operation with universities. In this scenario such activity corresponds to more than 1/3 of the national patents, which position this sector as one of the most innovative in the country (alongside with the pharmaceutical or electronic sectors).

T3. The production of aluminium and other light metal leagues components represents about 50% of the business volume in the sector (metal components) in Portugal

To be implemented in the medium range period and Germany is largely considered as the main competence in the field. Co-operation is not considered to be so important. The automotive components industry is a very important sub-sector in the Portuguese manufacturing structure. With more usage of aluminium components or other components in other light metal leagues, it is possible (and desirable) that the metal products industry (that includes pressing and metal injection) can renovate and integrate the automobile cluster.

T10.Light automobile vehicles with a group electric motion-propeller of local generation (fuel cell) reach speeds up to 200km/h (actually, 150 km/h – Toyota and Honda), and has autonomy of about 750 km (actually, about 300 km)

Already commented above. In this topic are presented some examples that allow the justification for substitution of conventional engines for the fuel cell ones. And even this can be done in a similar condition of automobile usage. The technological development of these systems allows the forecasting of such possibility of implementation. Especially in a situation where there are more large automotive

companies interested on the development of prototypes. The majority of cases are Japanese (Honda and Toyota), but Ford, GM, VW and Daimler are also doing experiments. Until now, only the Japanese are producing in larger scale and selling their fuel cell products.

T16.1/3 of the automobile vehicles produced in Portugal include light materials in their construction (composites, structures-sandwich, metal foam), therefore they are not produced by the conventional monococke method.

The members of the panel considered that this topic can be implemented until 2020. Undoubtedly is Germany the main country in the field. This innovative production capacity comes with a larger FDI in this sector using this kind of new materials. Such possibility will occur if the Portuguese companies that are already component suppliers become prepared for those materials, which means a stronger investment from their side on applied research on new material.

T34.7% of the total business volume of the automobile industry in Portugal is due to the R&D activities

Only in the long-term can this topic find its implementation. Is very important the co-operation and France is pointed as the main international competence. This scenario topic implies an increase and up-grading in the value chain. This would increase also clearly the R&D activities in the assembling companies, as well in the suppliers. The side effect would be the increase of similar activity in services and engineering companies.

4.3 Major obstacles

The main technical problems for the implementation of different scenario themes deals with the difficulty of application of autonomous driving systems of vehicles in the main road paths of metropolitan areas, with production problems (fuel cells, light construction materials and information systems) and with the working group concepts.

4.3.1 Technical problems

T5. The main road communication ways in the metropolitan areas are equipped with vehicle autonomous driving systems (without need for human intervention)

The technical problems are related with the construction and application of sensors in the driving ways, as well of systems of remote control.

T10. Light automobile vehicles with a group electric motion-propeller of local generation (fuel cell) reach speeds up to 200km/h (actually, 150 km/h – Toyota and Honda), and has autonomy of about 750 km (actually, about 300 km)
T16. 1/3 of the automobile vehicles produced in Portugal include light materials in their construction (composites, structures-sandwich, metal foam), therefore they are not produced by the conventional monococke method.
T22. The implementation of "working group" concept extends to about 50% of all automobile components manufacturers, while all the assembling companies use it (100%)

Some panel members said that it would unrealistic to forecast 100% for assembling companies.

T24. The time necessary for the development of new vehicles is less then 18 months, due to ICT and to the advanced design and flexible manufacturing systems, and to the standardisation of large components in vehicles
T37. There is technical capacity, in the chain client-distributor-manufacturer-distributor-client, to produce a vehicle specially ordered in only 3 days.

Was mentioned that exists "postponement platforms" (like "Intersat", "Stifa", "Trive", etc.) that can do client personalisation of car models.

4.3.2 Legislation and rules problems

T1. 25% of the fuel cells that exist in the national automobile park are produced by companies located in Portugal
Obstacle deal only with rules and legislation. Is not clear the position of the panel on this issue, but this can mean that some legislation can oblige the national incorporation of such elements in the vehicles in circulation (either assembled in Portugal, or imported).
T11. Manufacturing companies (assemblers and suppliers) have electronic business systems (e-business) that allows them to order, to design, to manage production and delivery using internet communication (C2B e B2B)
The main obstacle can only be the existing legislation.
T21. The normal working time of 35 hours is been used by 75% of the employed population in the automobile industry (assemblers, suppliers and services)
T23. With the implementation of vehicle autonomous driving systems, the employment in this specialised sector (telecommunication, control and navigation systems, software, electronic maintenance, development and adaptation of products) represents about 15% of total employment in the "automobile cluster"
T28. All factories of the automobile industry have environmental management systems working (efficient usage of energy resources, residuals, emissions)
T38. The entire automobile fuel commercialisation network will be re-structured and integrates also the supply of alternative fuels.
T40. The labour relations systems in the automobile sector is the national reference for the negotiation with higher levels of productivity and social peace
No comments for these topics.

4.3.3 Lack of capital

T4. 25% of traffic control systems and satellite navigation are associated to the vehicle autonomous driving
The lack of capital in the area of telecommunication can be an obstacle to its implementation
T5. The main road communication ways in the metropolitan areas are equipped with vehicle autonomous driving systems (without need for human intervention)
The expert's panel mentioned the unavailability of investment in this are in Portugal.

T7. 75% of all transport passenger automobile vehicles have automated driving systems (at least, automatic steering systems or satellite navigation)
Again the lack of capital in Portugal for this area can be the main problem. This type of automated driving system needs major sophistication of assembling (or maintenance) companies from the technical point of view. Not all are prepared in Portugal to do it. Mainly for a so much large number of vehicles (75% of all cars).

T8. 50% of passenger automobile vehicles have systems of hybrid propulsion (electrical and gasoline or diesel fuel)
Also here is a similar problem. But one should add the possible lack of interest from the consumption side. Traditionally Portuguese automobile consumers are not particularly interested on hybrid propulsion systems, but more on issues related with price and design or power performance. Thus, the available money for such products is larger for the traditional ones (conventional fuelled) than the modern ones (hybrid or electric propulsion).

T32. The creation of "automobile cluster" (assemblers, components, services) increases the national competitive capacity, that would produce about 350 thousand vehicle per year (60% for export)
The panel members mentioned the difficulty to implement this scenario once Portugal is a peripheral country in relation to the larger European centres of automobile production. The fewer

success cases (VW-AutoEuropa or Opel) are rather exceptions and not rules of a manufacturing structure [4].

T30. 30% of the R&D investment from the Portuguese entrepreneurial sector is dedicated to the automobile industry and its components
T34. 7% of the total business volume of the automobile industry in Portugal is due to the R&D activities
T35. The increase of individual mobility implies the existence of intermodal networks of public transport that integrate the road transport (car and motorcycle in a car-sharing system, buses), railways (trains and trams), fluvial transport (boats and hovercrafts)

No comments on these issues

4.3.4 insufficient qualification and training

26. New forms of work organisation (task enlargement, task rotation, job enrichment) implies an average increase of 15 to 20% of labour productivity (GVA/employee)
T29. Each assembling company in national territory will be associated at least one research centre and one product engineering centre in co-operation with Portuguese Universities and/or Polytechnic Institutes

No comments on these issues

4.3.5 cost factors

T12. 50% of automobile vehicles (light and heavy passenger transport) in circulation are platforms of telecommunication and information technologies services (navigation, entertaining, individual productivity)

Members of the expert's panel mentioned that the cost factors for the consumer are the main obstacles for implementation of this scenario topic. Such type of integration would turn the vehicles too much highly priced. And then 50% is a very high rate.

T14. The manufacturing of ecological vehicles (engine, bodies, and interiors) has costs only 10% higher than the conventional vehicles

Precisely this increased cost could become the major obstacle to a dissemination of this type of vehicles. Nowadays these costs are much higher, but the consumer's option is normally of cultural character. More than just economical one.

4.3.6 other obstacles

T17.The expansion of the national automobile industry creates the "automobile cluster" that integrate about 500 thousand jobs (assembling companies, components, services)

There is still a lack of critical dimension in Portugal for such cluster, was mentioned in the expert's panel.

5 Some conclusions

The foresight exercises have a strategically importance for the automobile sector. For that reason was held a Delphi survey held in Portugal on the automotive sector. One conclusion is that information on the automobile industry is not spread enough among academics or even experts in related fields (regional scientists, innovation economists, engineers, and sociologists). They are much specialised in their own specific fields. Other experts have advanced knowledge on foresight, or macroeconomics, or

[4] An example of that was the recent closure of the GM-Opel Portugal assembling factory in Portugal (Azambuja).

management sciences, but feel insecure on issues related with futures of automobile sector. In general this discussion should involve more the academics and the industrial experts to build a "strategic knowledge" for the Portuguese cluster of the automobile industry.

It was interesting to know that there were no "irrelevant" topics considered as such by the expert panel. There are also no topics that are not considered a need for co-operation. The lack of technological infrastructures was not considered as a hindered factor for the accomplishment of any scenario. These are clearly aspects to be considered as policy dimensions for this sector. These policies related with the different transport systems with implies further relations and connections that influence the environment, the safety issues, energy supply systems, and the mobility strategies.

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