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## THE EVOLUTION OF THE CAR-MAKING INDUSTRY

Mass-production, cars, pollution – they all have long become well known and well connected phenomena of the modern life. Nowadays the people can also add to the list such items like awareness, scientific approach, long-term thinking, and environmental responsibility. They are surrounded by a multitude of consumer goods, most of which are produced in a scientific manner, and all of which will more sooner than later end up in the garbage. Cars are the most noticeable – both by size and by numbers – and also the most expensive of all the mass products in people’s view. For many of them they are a clear target for reprimand and regulation, and, as a result, the automotive industry is being increasingly brought under bureaucratic control, together with its whole supplier and distributor network. The author started writing this article in an attempt to place the above process under scrutiny, because it is his firm belief that similar measures, similar tough governmental control will inevitably spill over to other industries, which at the moment are producing more inconspicuous, but still polluting products. The present paper shows the relationship between car-making, supply chain management and the efforts of public administration to protect the environment – a connection with clear practical implications.

**Keywords:** car industry, supply chain management, environmental protection

*“Man made the cars to take us over the road”  
James Brown and Betty Jean Newsome*

The complexity of the modern production processes requires coordination of highest precision. An industrial entity without detailed logistics will simply never survive. Moreover, plain internal logistics is not enough for survival any more. The processes of design, production, delivery to customers, then after-sales maintenance and servicing become more and more complicated, and, as a result, involve more and more independent organizations into the planning and effectuation beside the core “brand builder”. These points beyond the boundaries of a single company, and demands strategic cooperation between producers, suppliers and service providers. In this regard it is far from surprising that in the theatre of industrial thinking the concept of Supply Chain Management (SCM) has become a prima donna. The significance of broad long-term approach is further enhanced by another factor – national and international regulation. Administrative measures – the basic attributes of human development – can influence company strategies for years ahead.

### Car-Making and Supply Chains

The automotive industry has been providing an excellent research field for all SCM-addicted scholars for decades. Toyota Motor Corporation, which after years of steady development finally toppled General Motors from the top global sales position, is baking in the limelight of business attention, and it has become scientifically fashionable to examine its success. Interestingly, the most famous product of Toyota is not a car model, but a business model, a production concept with the slick name of TPS.

If you decide to Google search for Toyota Production System, you will receive more than a million results in a fraction of a second. Those fellow Googlers who would try to check the more popular “Just In Time” phrase, attributed to Kiichiro Toyoda, shall be ready to sift through millions of results, even if linked together with words like “production”, “manufacturing” or “automotive”! Studying the evolution of Toyota’s concept, some authors, including Keith Oliver, the person who introduced the term of “Supply Chain Management” back in 1982, may point out

non-automotive roots: “Taiichi Ohno, the father of the Toyota Production System, was inspired by the modern grocery store in the 1960s.” (Laseter – Oliver, 2007). Others, like Toyota Motor Manufacturing Kentucky, Inc. ([www.toyotageorgetown.com](http://www.toyotageorgetown.com)) definitely and proudly put the “blame” on a fellow American, the first automotive mass producer. Reading the following lines we cannot deny the “Just-in-time feeling”:

*We have found in buying materials that it is not worth while to buy for other than immediate needs. We buy only enough to fit into the plan of production, taking into consideration the state of transportation at the time. If transportation were perfect and an even flow of materials could be assured, it would not be necessary to carry any stock whatsoever.*

*The carloads of raw materials would arrive on schedule and in the planned order and amounts, and go from the railway cars into production. That would save a great deal of money, for it would give a very rapid turnover and thus decrease the amount of money tied up in materials. With bad transportation one has to carry larger stocks.*

*Ford (1922)*

Whatever other roots the TPS might have, the American automotive genealogy is undisputable. Toyota’s engineer Taiichi Ohno in his book “Toyota Production System: Beyond Large-Scale Production (Ohno, 1988) openly acknowledges the influence of Henry Ford. His editor later similarly confirms, “When I subsequently asked Mr. Taiichi Ohno, ‘How did you discover the Toyota Production System?’ His answer was, ‘I read Henry Ford’s book Today and Tomorrow’ (Bodek, 2006). It is ironic, that Toyota started to really perfect its lean manufacturing system approximately at the same time, when Ford Motor Company really abandoned it (see Figure 1). “The comfortable maturity into which American industry drifted during the 1950s and 1960s disrupted the evolutionary progress of the American System. Confident that the age-old ‘problem of production’ was firmly in check, American managers redirected their efforts away from the shop floor and towards marketing and finance (Abernathy – Corcoran, 1983). The time proved the Japanese car-maker to be right. It is not the objective of this paper to analyze in detail the development of internal processes within Toyota, that is why I turn directly to the activities outside the company.

With the introduction of lean manufacturing, with the stock of supplies reduced to the minimum, quality requirements became tighter – there was no room for faulty parts, everything had to be perfect. To make that possible, Toyota needed appropriate suppliers. This was exactly the domain where Toyota’s uniqueness became clearly evident – the Japanese car-maker with an unprecedented supportive attitude shaped its suppliers in its own image! In 1943 Toyota officially founded Kyohokai – a voluntary organization of its parts suppliers ([http://www.kyohokai.gr.jp/khktowa/kyohokaioutline/e\\_outline.htm](http://www.kyohokai.gr.jp/khktowa/kyohokaioutline/e_outline.htm)). The next similar association was established in Japan only eleven years later, by Nissan. More than half a century later these Japanese associations remained strong examples of mutually beneficial partnership, as evaluated by the members themselves in a paper by Sako (1995), who examined 11 such organizations. Among them Toyota suppliers are standing out – they have the highest opinion about the benefits of their membership: “Toyota’s association, with its longstanding history and its concerted effort to diffuse the Toyota Production System, is different both in the magnitude of benefits it brings to its members and the function it fulfills.” (Sako, 1995). It is worth noticing that the subjects of the research were really important partners of Toyota, as they were taking up to 98% of its Total Parts Purchasing Cost.

Source: Timeline of Manufacturing Excellence, 2007 (extract)

Figure 1

- 1947 - 1949: Ohno promoted to machine shop manager. Area designated model shop.
  - Rearrangement of machines from process flow to product flow
  - End of one man one machine. Start of multi process handling
  - Detail study of individual process and cycle times
  - Time study and motion analysis
  - Elimination of "waste" concept
  - Reduction in work in process inventory
  - In-process inspection by workers
  - Line stop authority to workers
  - Major component sections (Denso, Aishin etc.) of Toyota divested
- 1946: Ford adopts GM management style and abandons lean manufacturing

The fastest technology transfer is again linked to Toyota. Lieberman et al. (1997) demonstrate a significant correlation between Toyota Association membership and the supplier's productivity (cited by Dyer – No-beoka, 2000). We are witnessing a deliberate production technology transfer, which is the result of Toyota's long-term thinking. This example is another proof that Supply Chain Management is a successful strategic approach to

intercompany cooperation. From reducing redundant stocks and eliminating inefficient movements, through removing unnecessary actions, improving processes and, finally, coordinating and developing suppliers we arrive to the end-users, as shown on Figure 2. The evolution of the Supply Chain Management concept has led to the present state, where we do not speak about competing companies any more, but about competing Supply Chains (Vonderembsea et al., 2006). In this regard Figure 2 already seems too simple and outdated compared to Figure 3.

As evolution never stops, if we closely examine the next figure – Figure 4, we can discover further development in the automotive supply chain management. Namely, beside mergers and acquisitions (M&A) there are the strategic alliances between automotive manufacturers. In the following diagrams I am splitting the process into three steps. The first step shows the formation of independent supply chains (Figure 5a). Later coordination between the core brand builders be-

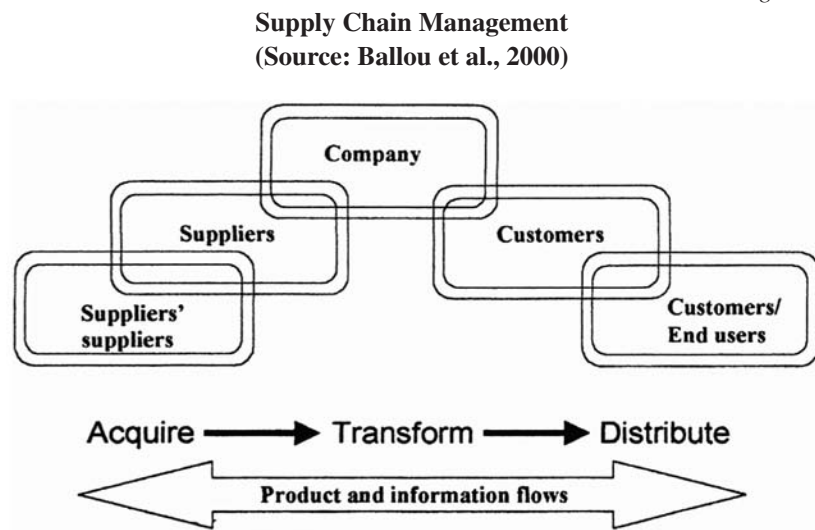


Figure 2

Types of intercompany business process links  
(Source: Lambert and Cooper, 2000)

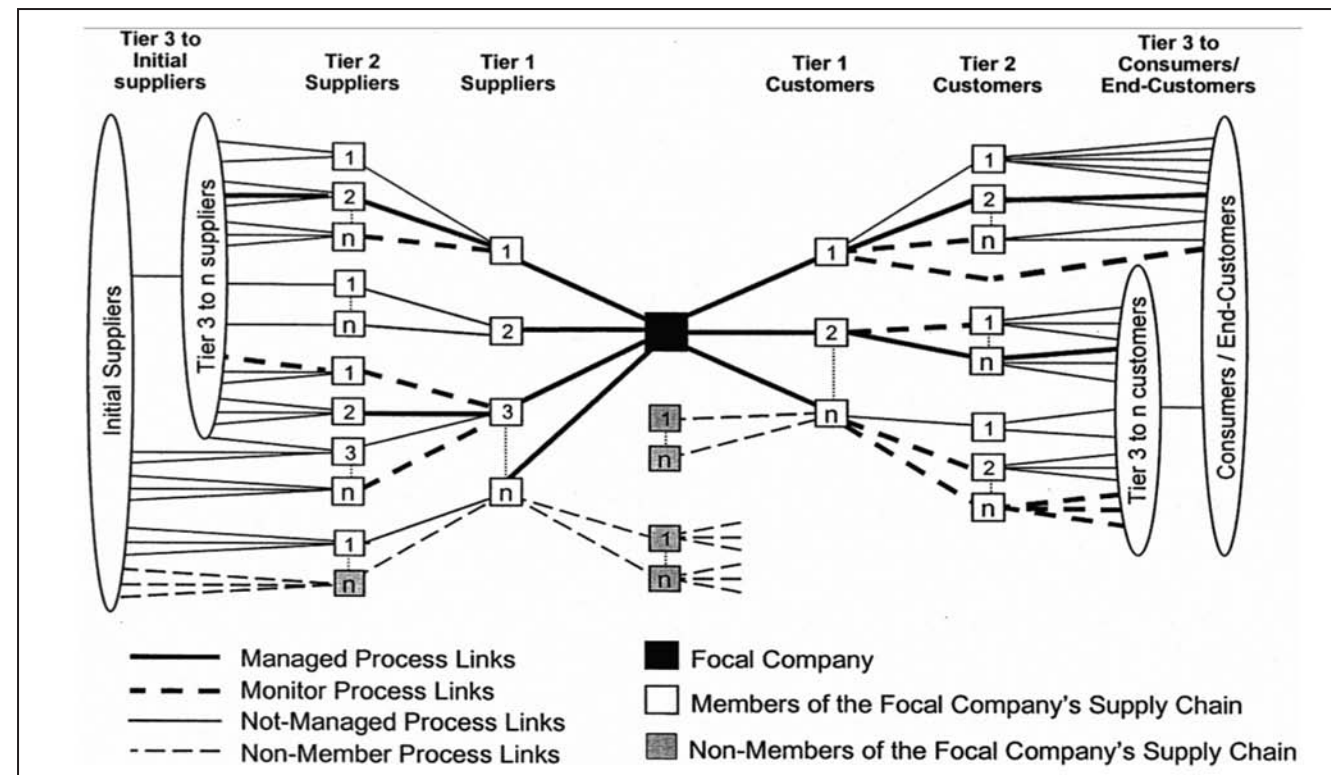


Figure 3

comes inevitable (Figure 5b), though joint projects do not abolish the competition between them.<sup>1</sup> In the end some core brand builders merge or form long-term strategic alliances in order to benefit from joint research and development, economies of scale and shared distribution channels (Figure 5c).

Global Automobile Market Scenario  
(Anonymous, 2007)

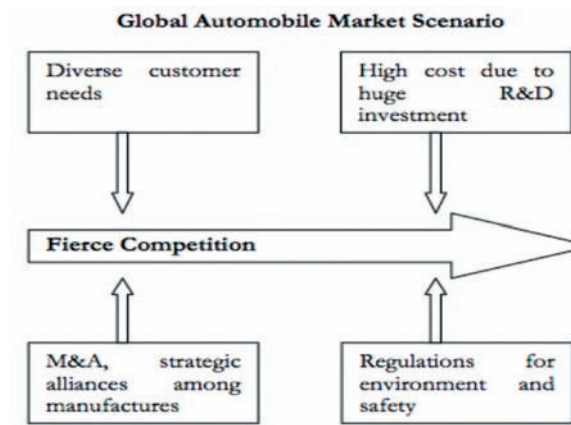
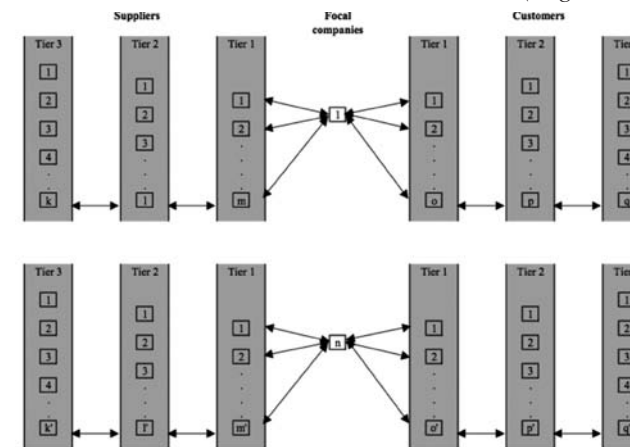
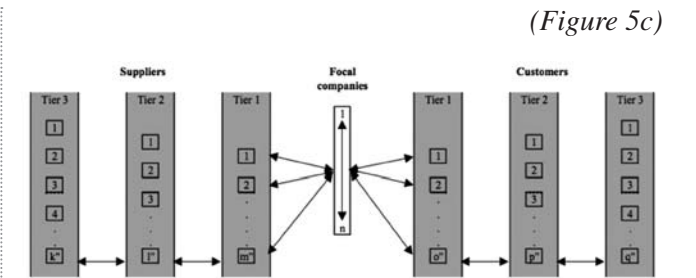
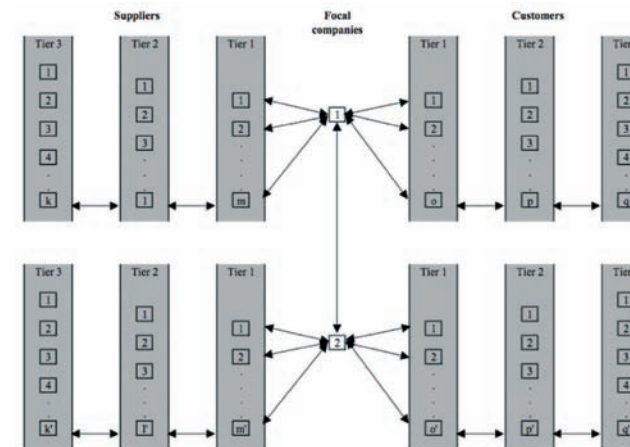


Figure 4.

(Figure 5a)



(Figure 5b)



(Figure 5c)

The earlier mentioned Figure 4 includes “Regulations for environment and safety”, which raises another thought as well: what is their impact upon Supply Chain Management, and what are the responsibilities they bring to the automakers? While studying this particular area, I will disregard the question of safety regulations here, since they are incorporated into automotive design and production in the same way as other customer expectations, e.g. comfort and anti-theft features. To ensure the vehicle is technically safe on the road is not an issue, because after the cars are sold to the customers the producer is naturally willing to provide all the necessary maintenance parts, similarly to the service network, which is more than happy to sell its maintenance and repair services as long as the vehicle is in use. In other words, the market takes good care of it.

Environmental regulations have a different impact. On the one hand, the governments are becoming more and more restrictive regarding emissions related to production and the following use of the vehicles. From the manufacturing point of view no factory, no assembly plant will ever receive a licence for operation, if their production processes are not duly certified as meeting emission standards. All new vehicles must similarly meet current regulations. This must obviously be taken into consideration well in advance over the whole length of the supply chain, increasing costs.

On the other hand, a totally new aspect has come into view, and, strangely enough, it emerges only after the vehicles get out of use. In other words, when the product has left the supply chain, which has been coordinated and controlled by the carmaker. We are witnessing another phenomenon in the automotive history.

“Oh, dear, we are losing our chains...  
Personal observation

Is There Life after Supply Chain? The Supply Circuit

The general supply chain concept follows the product to the end-user. Since the very beginning of the automotive age, when keeping a vehicle already made no economic sense to its last owner as opposed to having another one, the car was stripped of all usable parts and

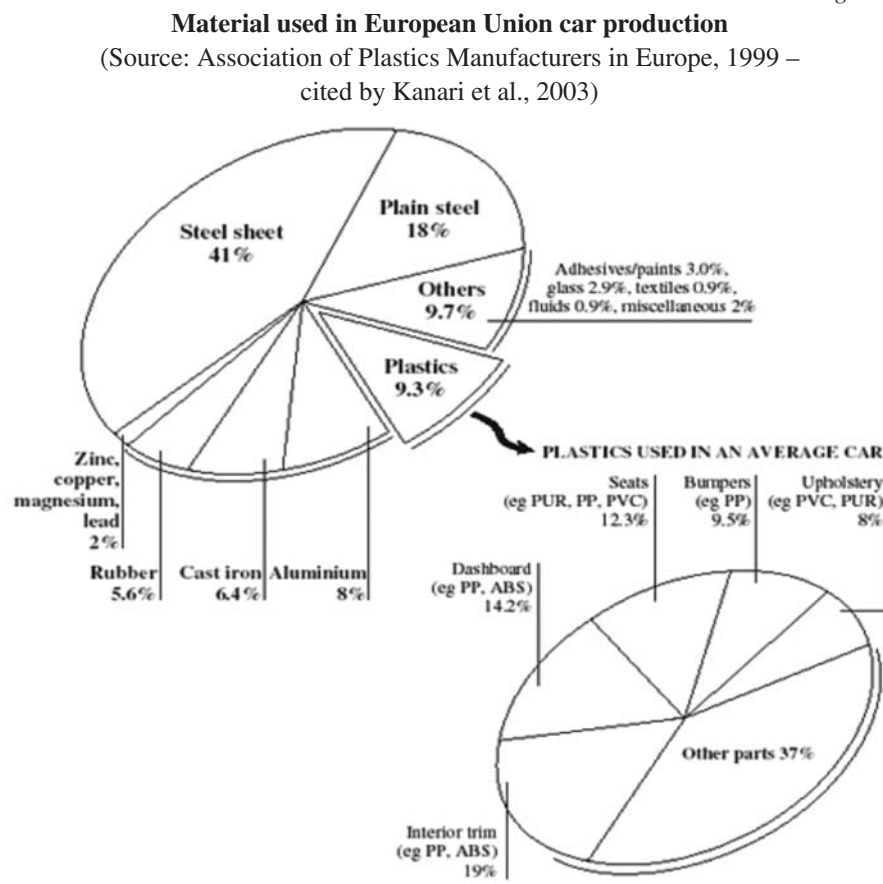
literally dumped out of the supply chain of the automotive manufacturing. The carmaker had no interest in it, with the rare exception when it had special museum value. In the sixties-seventies of the 20<sup>th</sup> century the industrial progress created a strong demand for scrap metal, which added value to the End-of-Life-Vehicles (ELVs), but did not change the routine attitude of the car manufacturers. They still did not need the ELVs; instead, the market was left “to clean the stables”, and it slowly became clear that humanity was facing a new environmental threat. When cars were considered luxury, their numbers were low. When the cars were made of steel and natural materials, and had an expected life of 20+ years, nobody was really concerned about the waste they would eventually produce. But time flies, cars have long become a mass product with comparatively short life span. A modern vehicle contains less and less steel and more and more plastics: “The consumption of plastics/composites in US-built automobiles increased from 79.2 kg in 1978 to 109 kg in 1992. By 2000 the average weight of an automobile is about 1350 kg containing 135 kg of plastics.” (Nourredine, 2006). Figure 6 shows materials in an average EU-produced car: apart from metals it contains 9.3% plastics, plus 5.6% rubber and 9.7% “others”.

According to the official website of the European Commission, discarded cars generate between 8 and 9 million tonnes of waste each year in the European Union only ([http://ec.europa.eu/environment/waste/elv\\_index.htm](http://ec.europa.eu/environment/waste/elv_index.htm)). The unusable parts in fact are dangerous waste, and as such must be treated accordingly. In many industrially developed countries the growing environmental sentiment of the population positively influences the business policies of the car manufacturers, but a strong wish to build a proper image has never been sufficient in environmental matters, even though processing waste is in itself a profitable business. This insufficiency is clearly confirmed in a recent report related to ELVs in the EU:

*In many firms, there is unwillingness to take-up known innovative technology until it has been widely proved to be commercial. This leaves few market opportunities for technology to be proved commercially and, as a result, it may never be proved. Here, rational behaviour by individual firms (each looking after their individual risk) does not lead to the best outcome for the market as a whole (a market failure).*

Commission of the European Communities (2007)

Figure 6



But who shall carry this cross if not its creator itself? On individual level it can hardly be expected from the last user of the vehicle to solve the problem alone, just because the last users, as a rule, shall be extremely cost sensitive – nobody will seriously presume that old vehicles are driven by rich environmentalists. In countries, where deregistration and scrapping of ELV imposes administrative and financial burden on the last owner, the temptation is still high to dump it somewhere<sup>2</sup> and claim it had been stolen, or search for another loop in the law.<sup>3</sup>

Therefore it was absolutely logical for the European Parliament and the Council to adopt the Directive 2000/53/EC of 18 September 2000 on end-of-life vehicles (OJ, 2000), whose Article 5/4 says, “Member States shall

take the necessary measures to ensure that the delivery of the vehicle to an authorised treatment facility in accordance with paragraph 3 occurs without any cost for the last holder and/or owner as a result of the vehicle’s having no or a negative market value.” Moreover, the same Article 5 insists that the producers (i.e. carmakers and importers) are the ones who shall meet all, or a significant part of, the costs of the implementation of these measures, and emphasizes that “the normal functioning of market forces should not be hindered” – a subtle hint on governmental elephants in china markets.

Prevention of pollution is another indispensable aspect of EU legislation, and it has adequate presence in the above cited Directive 2000/53/EC: “Producers should ensure that vehicles are designed and manufactured in such a way as to allow the quantified targets for reuse, recycling and recovery to be achieved.” Here again, the responsibility of producers is clearly established – among everything else the Member States must ensure that producers shall, “in concert with material and equipment manufacturers, use component and material coding standards, in particular to facilitate the identification of those components and materials which are suitable for reuse and recovery.”

In the same Directive certain responsibility is placed upon the end-user as well:

*Article 5 § (3) Member States shall set up a system according to which the presentation of a certificate of destruction is a condition for deregistration of the end-of life vehicle. This certificate shall be issued to the holder and/or owner when the end-of life vehicle is transferred to a treatment facility. Treatment facilities, which have obtained a permit in accordance with Article 6, shall be permitted to issue a certificate of destruction. (OJ, 2000)*

Therefore, at the moment when the vehicle turns into an ELV, the last owner cannot abandon his/her vehicle anymore. He/She has no choice but to take it to one of the certified treatment facilities, established by the producer under legal obligation. The legal system pushes the last owner back to the supply chain, and the end-of-life vehicles slip back into the flow of materials, which is illustrated by Figure 7. The supply chain became a supply circuit. Even more so, there are strong indications that the “legislative dictatorship” of environmental protection is beneficial to the overall health of the automotive business. Those car-makers, who react faster to this dictate develop competitive advantages. In terms of energy costs it definitely makes sense

to consider recycling against producing from newly earned materials – Figure 8.

*Green with environment – automotive industry and its impact on SCM*

The environmental policy of our modern united Europe has always had a distinct connection to the automotive industry. Among the few first directives that were dealing with issues, that we now call environmental, were Directive 70/157/EEC “on the approximation of the laws of the Member States relating to the permissible sound level and the exhaust system of motor vehicles” (OJ, 1970a) and Directive 70/220/EEC “on the approximation of the laws of the Member States relating to measures to be taken against air pollution by gases from positive-ignition engines of motor vehicles” (OJ, 1970b). It is only fair to mention, that at the beginning all directives of the European Community, which actually resulted in improved environmental protection, as a matter of fact, had no particular aim to achieve that. Environmental protection started as a by-product of the Community’s harmonization programme (OJ, 1969), and slowly and steadily developed into a comprehensive policy. As a result the EU member states are setting more and more demanding conditions to the distribution of automotive products in their territories. The manufacturers can only meet these conditions, if they take them into consideration during the design process. And they really do so. E.g. the requirement to make 95% of vehicle weight recyclable by 2015 will be met by all manufacturers producing for the EU market. The official website of FIA (Fédération Internationale de l’Automobile) is citing very confident and very understanding car-makers, who are equally sure that the requirements will be met perfectly, no matter who is talking – the European Mercedes Benz about its S-Class model, the American General Motors about its Cadillac, or the Japanese Honda, whose European Head of Corporate Affairs, Chris Rogers clearly states:

*“We’ve known about this legislation for a long time. There are provisions for it in our business plan, and we realise that it is a part of selling high-quality cars in Europe.” (FIA, 2005)*

The above is not just political phraseology, because non-compliance with EU requirements definitely means major disruption of business activities for the whole automotive industry. There is no other choice, but to comply.

Which trade is next?

Kanari – Pineau – Shallari:  
End-of-Life Vehicle Recycling in the European Union

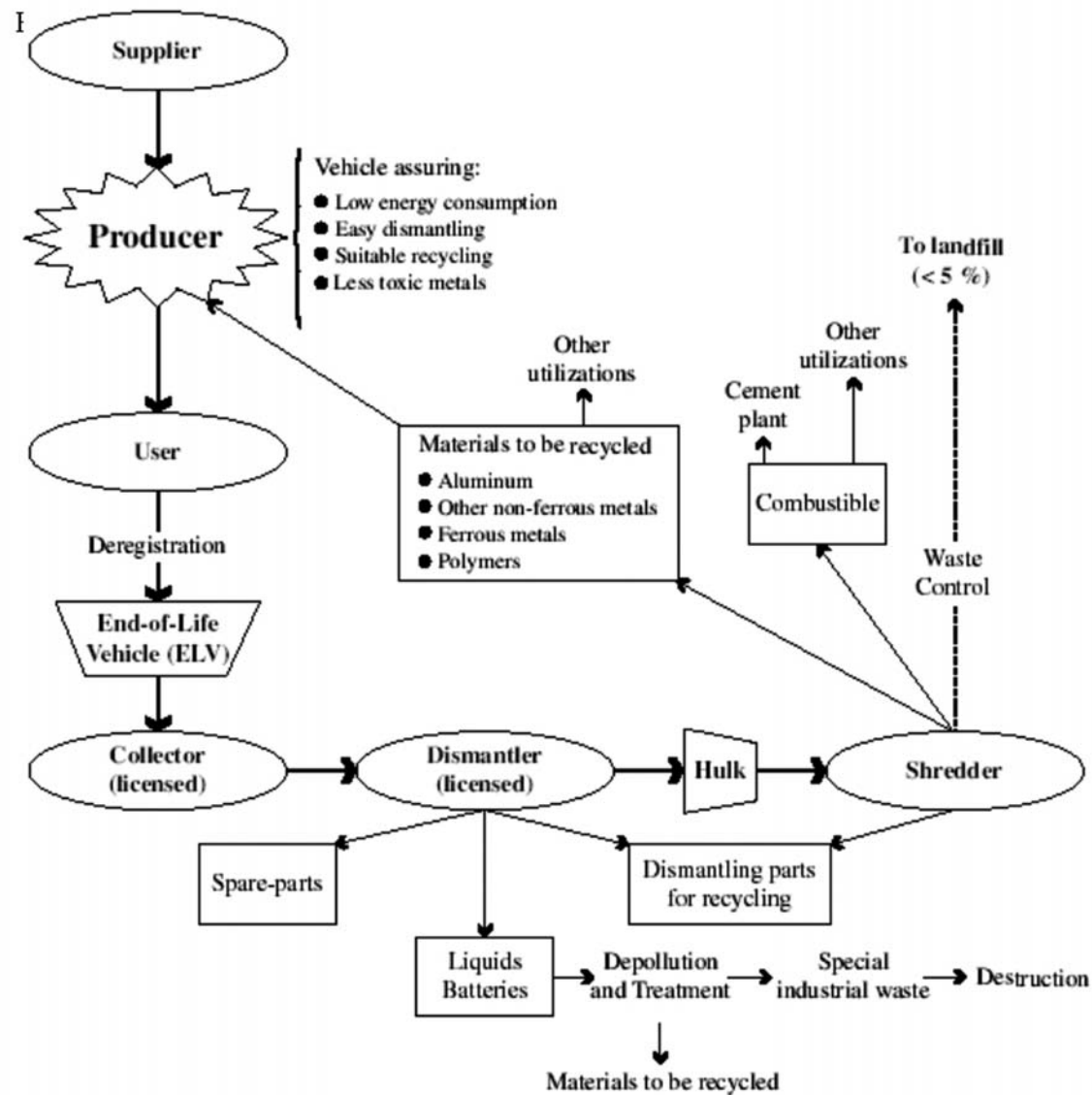


Figure 8

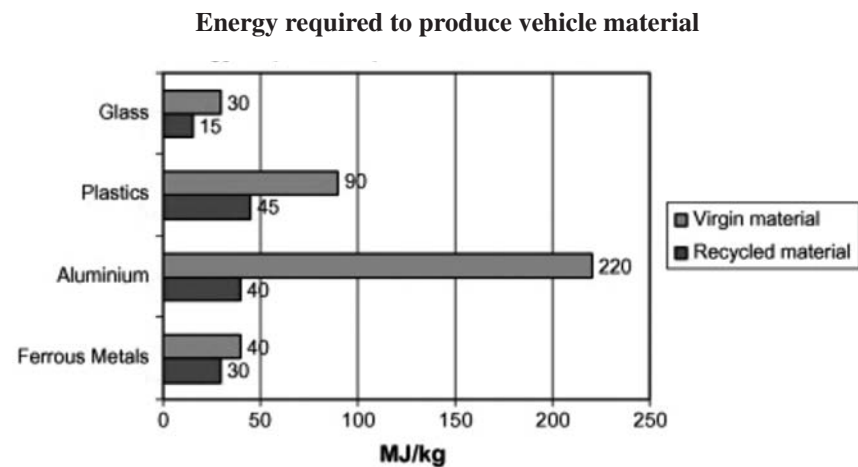


Figure 8

Footnote

- <sup>1</sup> For example, the joint venture between archrivals VW and Ford, when they produced the triplets of VW Sharan, Seat Alhambra and Ford Galaxy models on the same assembly line in order to cover this low volume segment.
- <sup>2</sup> In 2000, “the Year of the ELV Directive”, 238,000 ELVs were abandoned in the UK alone – Department of Trade and Industry data, cited by Fergusson (2006).
- <sup>3</sup> E.g.: it is an open (or, at least, well unguarded) secret that not one Austrian ELV has been sold for as much as EUR 20 to neighbouring Hungarian dwellers, who never intended to register it, nor to dispose of it in a proper way.

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