

Powertrain at the Crossroads

Mapping the Future for the Global Bus and Truck Industry



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Foreword

The late impact of the global financial crisis on the truck and bus industry has been profound. However, other forces – equally powerful but currently attracting less attention – are also driving significant changes in the powertrain industry. These forces will fundamentally change the rules of the game for players in the truck and bus industry, affecting OEMs, dealers and suppliers alike. As the transformation taking place in the passenger car industry shows, the changes now happening are so great that they may reshape the industrial structure of countries that are heavily dependent on the commercial vehicle industry.

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Executive Summary

Based on our experience with clients and a recent study of most of the world's commercial vehicle manufacturers and global suppliers, Arthur D. Little has undertaken a thorough analysis of how new powertrain technologies will impact the bus and truck value chain in 2020.

Several key findings can be drawn from the study:

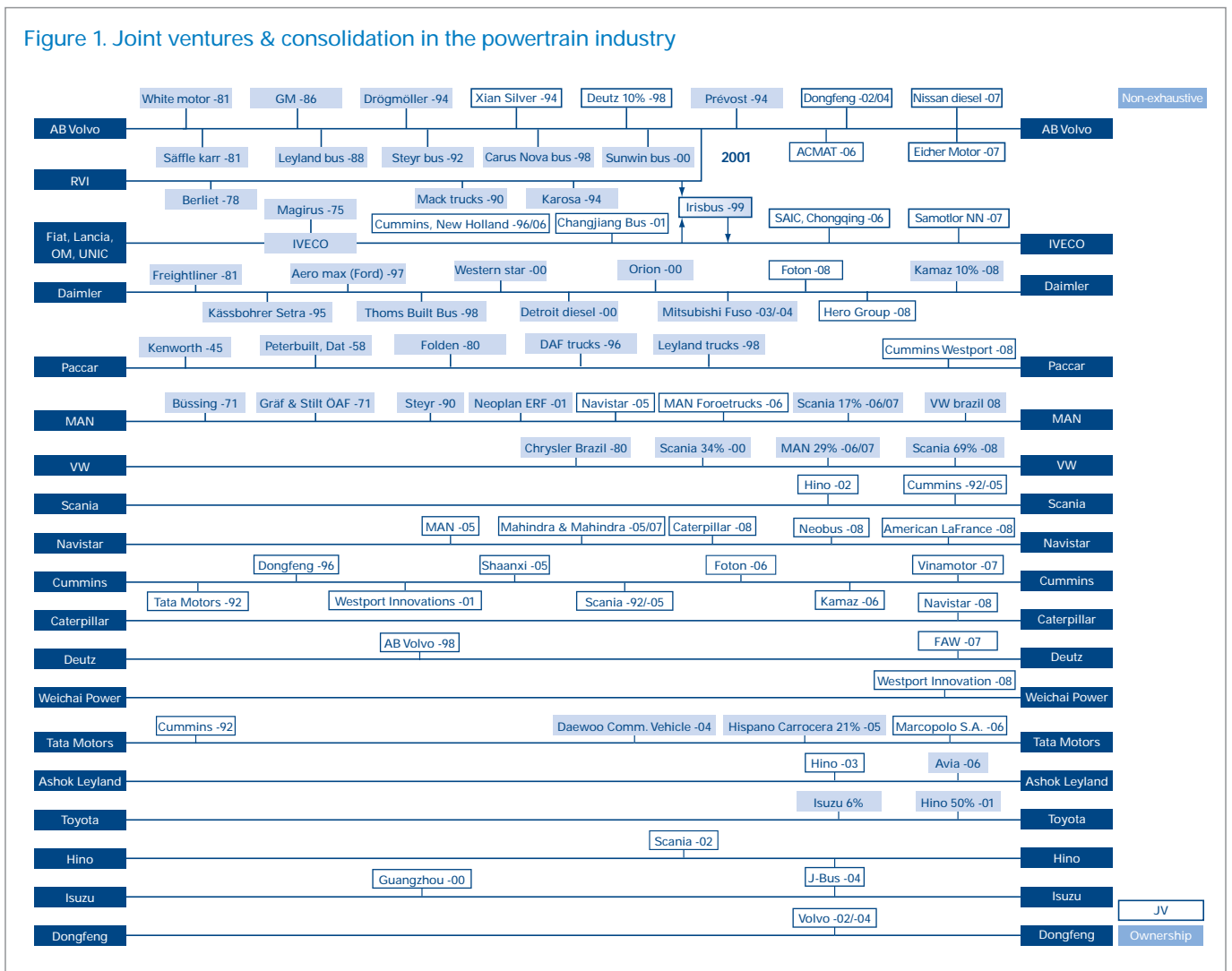
- Macro constraints, such as oil scarcity, emissions regulation, green profiling and local regulation, will increase the fragmentation of market requirements.
- The impact of these macro constraints will vary depending on how and where the vehicles are used.
- In parallel, the range of potential powertrain technologies available to meet the challenges of the future is richer than ever.
- Although Diesel technology will remain dominant, new technologies will gain market share, mainly for urban applications.

As a result of the increasing fragmentation of market requirements and the wide range of technology opportunities available, uncertainty about the future has never been so high. The questions that the industry faces are complex and occur at all stages of the value chain: how to understand the shifting demand? how to identify the future preferred technologies? which segments to serve? which technologies to invest in? what alliances to initiate in order to safeguard economies of scale?

Arthur D. Little's analysis shows that the most successful companies will address this period of changes with a comprehensive approach, combining advanced market analysis with review of the product portfolio and technology strategies. It also shows that the need to share strategic and technology risk requires new forms of collaboration between OEMs and suppliers.

Introduction

Figure 1. Joint ventures & consolidation in the powertrain industry



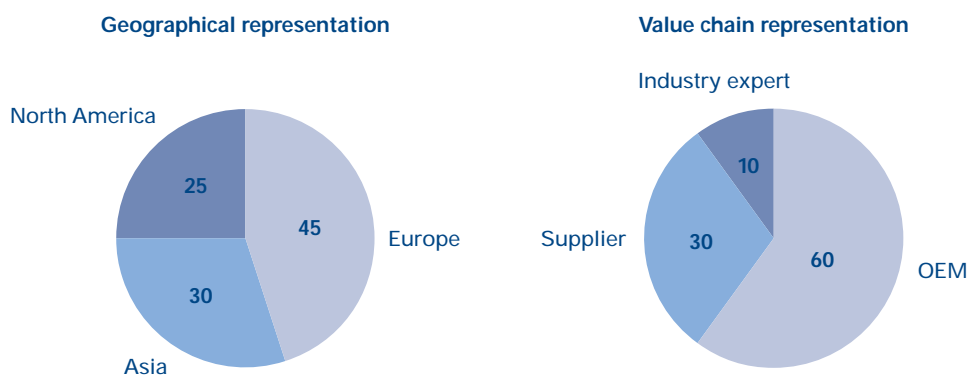
The transportation of goods and people remains central to the economy. Beyond the current financial crisis, road transport will continue to grow as wealth continues to increase and spread around the world.

During the last 20 years, the truck and bus industry has been under constant pressure from customers to improve transportation efficiency and from legislators to meet increasingly severe regulatory requirements.

As a consequence, Diesel technology has been developed to meet stricter standards and deliver greater efficiency.

The level of investment required to fund this development in powertrain technology has been a key contributor to the increasing number of partnerships and consolidation in the industry. Today, the industry consists of multinational companies and large – and expanding – regional players (see figure 1).

Figure 2. Distribution of participants in the Arthur D. Little study in (%)



Looking ahead, the market for commercial vehicles is expected to continue to evolve dramatically and powertrain technology will continue to play a key role. To gain a better understanding of the industry and its future, Arthur D. Little conducted a study of more than 30 bus and truck industry executives around the world. The study focused on commercial vehicles over eight tons and considered the outlook for this sector from 2020 onwards.

Figure 2 shows the geographic distribution of the participants and what part of the value chain they cover.

This Arthur D. Little study identifies the issues at the top of the executive agenda and that, as a result, every company is developing short- and long-term strategies to address them.

“Looking ahead, the market for commercial vehicles is expected to continue to evolve dramatically and powertrain technology will continue to play a key role”.

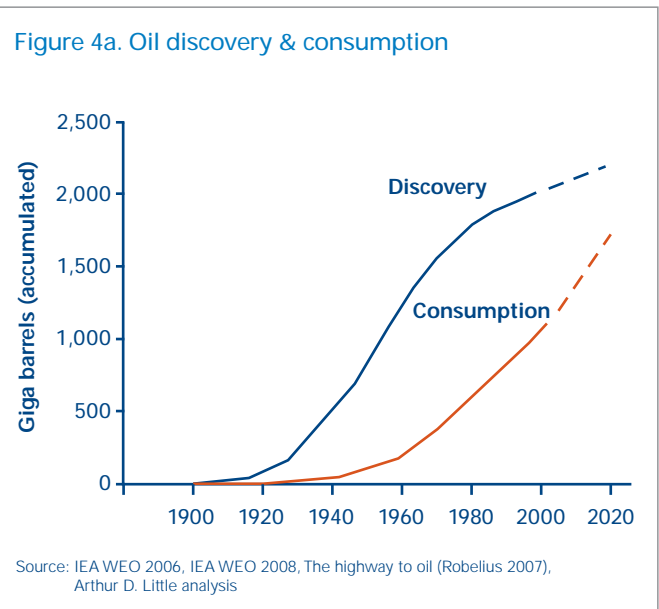
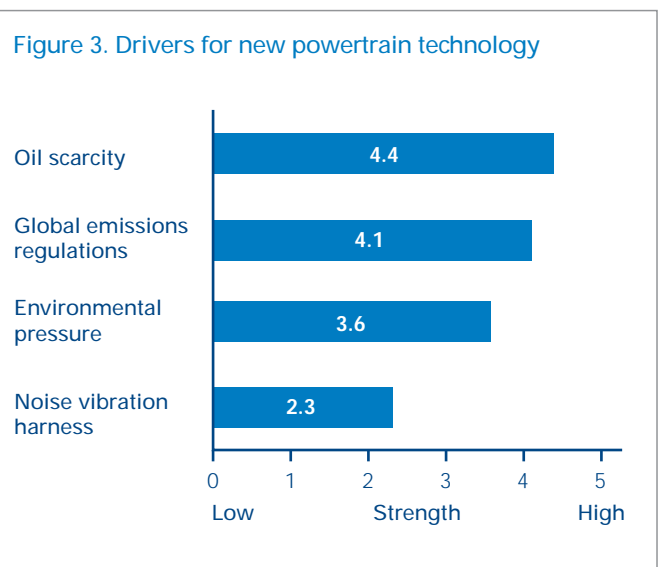
Macro Constraints Reshaping the Market

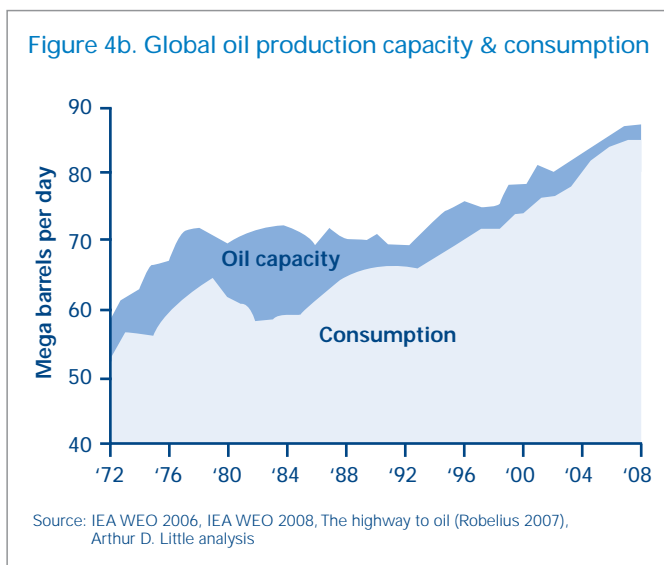
Three macro constraints will make the coming period one of the most uncertain ever for the industry. The expected oil scarcity and consequent high fuel prices and need for alternative sources of energy will have the greatest impact. Further developments in emissions regulation, including regulations covering CO₂ emissions, will continue to stress technology development. Finally environmental pressure, combination of green profiling and local regulation, will accelerate the development and introduction of new technologies.

“Further developments in emissions regulation, including regulations covering CO₂ emissions, will continue to stress technology development.”

The effect of these macro constraints will differ between regions (OECD, BRIC) and applications (e.g. city bus, long haul). Demands on the powertrain will not only become tougher, they will diverge more and more between market segments.

Respondents rate oil scarcity as the most important driver of new powertrain technologies in the coming decade, while global emissions regulation and environmental pressure are the next most important (see figure 3). It is interesting to note that respondents from Asia rate environmental pressure significantly lower.





Expected oil scarcity

Global oil consumption has grown steadily during the last century and is projected to continue to grow in the coming decades. The current decrease in demand must be considered a temporary phenomenon. At the same time, the rate of conventional oil discoveries has slowed creating apprehension about the true size of oil reserves (see figure 4a). Although a debate exists concerning "peak oil" (the point at which maximum extraction is reached and after which production declines), there is no doubt about the increasing cost of extraction.

Furthermore, as soon as demand returns to the level seen in early 2008, limited production capacity could cause a rapid increase in the pressure on oil supply and pricing (see figure 4b). The current low oil price is limiting new investment in exploration and extraction. It is therefore doubtful that capacity will be sufficient once global economic growth picks up again.

As a consequence, it is clear that oil scarcity will put the truck and bus industry under considerable pressure to reduce fuel consumption further and to move to fuels other than conventional Diesel.

Emissions legislation

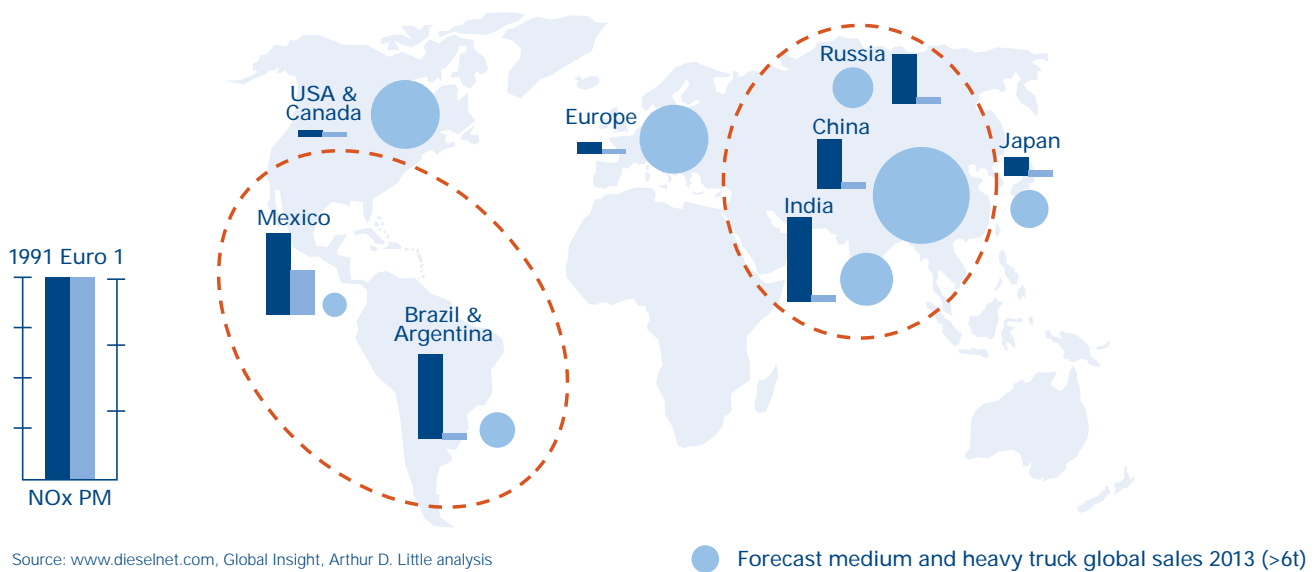
Emissions regulations in the OECD countries have forced powertrain manufacturers to reduce particles and NOx (nitrogen oxides) levels to a fraction of the levels emitted 20 years ago. Future standards such as Euro VI will continue to force these levels down.

In the mid and long term, two important forces within emissions legislation will have a substantial impact on the development of future powertrain technologies:

- With particles and NOx levels having been reduced to almost zero, the benefit of a further reduction in this type of emissions is marginal. The truck and bus industry must prepare for regulations on greenhouse gases, especially CO₂. The fuel consumption targets set out in Japan's *Top Runner*¹ program can be seen as a forerunner to future requirements. This legal pressure on CO₂ emissions goes hand in hand with demand from customers for low running costs. Because some of the technologies used to reduce NOx entail higher fuel consumption and therefore CO₂, the industry will need to strike a better balance between the two. Consequently, alternatives to conventional Diesel will become increasingly attractive.
- While Western Europe, the US and Japan are launching tougher requirements as Euro V and later Euro VI, US10 and later US13 and P-NLT respectively most developing markets will retain the less demanding requirements of Euro II, III or IV standards. A convergence of emission standards is expected to take place in the long run, but the market will remain split into two blocks for several years (see figure 5 overleaf). As an illustration, around 50% of the market (mainly BRIC countries) is still expected to apply less demanding emission standards in 2014.

¹ Energy efficiency program that covers 21 items including passenger and commercial vehicles, TV and electric toilet seats. In each category efficiency of the most efficient model on the market (Top Runner) becomes standard within a certain number of years.

Figure 5. Emission regulation – year 2014



As a consequence of the evolution in regional emissions regulations, the commercial vehicle industry faces the combined challenge of serving an increasingly fragmented market and developing new technologies.

Green profiling and local regulation

Green profiling and local regulation are growing in strength and will accelerate the implementation of national legislation and change customer buying criteria.

- In the corporate world, green profiling is a strategy whereby companies aim to secure business benefits by adopting an environmentally friendly approach. This trend is growing stronger in the truck and bus industry where a number of transporters and logistics companies have initiated green profiling to reduce the carbon footprint of their operation.
- In the public realm, an increasing number of cities or regions are imposing regulations that go beyond national emissions legislation: in the US, California is leading the implementation of tougher requirements, Beijing implemented Euro IV four years ahead of the national enactment, a growing number of European cities run environmentally friendly buses, etc.

The impact of these two trends has already been evident for several years in the passenger car industry (CARB legislation in California, specific CO₂ taxes in France, tax incentives to promote specific fuels such as ethanol, gas or Diesel, etc.). The result is a fragmentation of the market that requires specific development or adjustments to products. A similar market evolution lies ahead for the commercial vehicle industry.

“These trends are already a widespread reality in the passenger car market” – Industry expert and former senior executive.

The vast majority of executives interviewed for the Arthur D. Little study believe that the macro constraints (oil scarcity, emissions legislation, green profiling and local regulation) will be the main drivers for the development of new powertrain technologies. Oil scarcity – and its impact on oil prices – is seen as the most dominant factor. However Asian participants regard green profiling and local regulation as more important than European and American respondents. Worldwide most executives polled predict increased market fragmentation and an evolution of market segments.

Consequences for market segmentation

The macro constraints of oil scarcity, emission regulation, green profiling and local regulation will not drive market requirements uniformly. The legal requirements of different markets and the demands of customers will diverge.

Market segmentation will be defined increasingly by a combination of two factors: how the vehicle is used and where the vehicle is used.

- The first dimension (how) takes into consideration the nature of the transport and the usage cycle patterns (such as load, passenger versus goods transportation, degree of stop-and-go, distance driven per day, etc.).
- The second dimension (where) reflects the regulatory constraints (which will vary across regions and countries) but also the degree of urbanization. Other geographical characteristics (such as taxation policies, fuel quality, service network, possible alternatives to oil, etc.) will play an important role as well.

The impact of these two factors means, for example, that the requirements for a US garbage truck (driving exclusively in the city) will be significantly different to those of a long-range hauler driving across Europe.

Most respondents in the Arthur D. Little study recognize that the need to rethink market segmentation is urgent. It also seems that the increased fragmentation in market requirements expected by the industry will be mirrored by a similar divergence in the preferred technology for specific applications.

“Increased fragmentation in requirements between applications is inevitable and we have to apply a new approach in our product portfolio management” – OEM senior executive.

Solving the Technology Puzzle

To meet future requirements, the bus and truck industry needs to invest in a range of technologies. Improved Diesel engines, hybrid solutions and alternative fuels or gas are all credible sources of energy for future applications. However, because requirements will differ between market segments, the ideal powertrain solution for each will vary too, putting pressure on economies of scale.

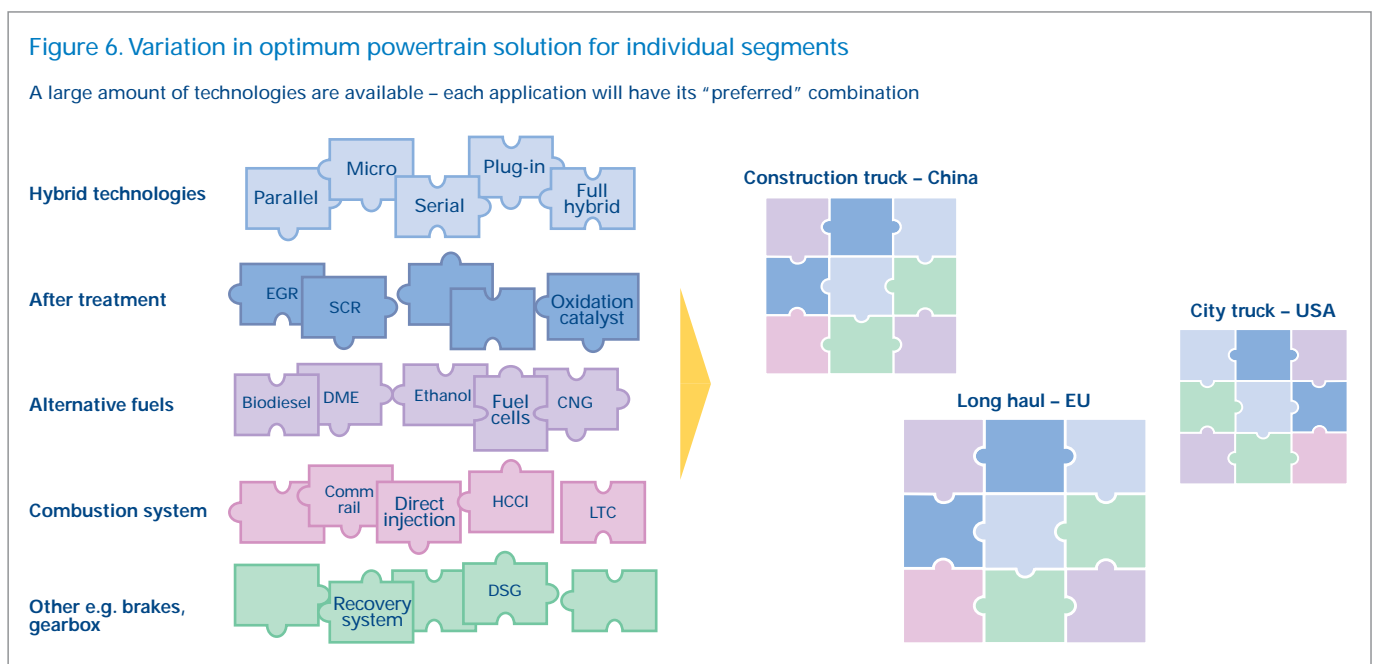
The truck industry has always been able to develop the technologies necessary to comply with legal requirements. It has also continuously improved technology to meet tougher customer requirements.

Looking ahead, a vast array of potential technologies exists to meet future market requirements in terms of fuel consumption, emissions, noise and reliability. These new technologies include systems such as advanced combustion systems, after-treatment devices, hybrid solutions, waste energy recovery systems and control engine management systems. Some of these technologies are still at an early stage of development while others are ready for production. In some cases, competitive technologies are promoted by different OEMs or suppliers.

However, as the requirements of the different applications diverge, the optimum powertrain solution for each segment will also vary substantially (see figure 6). The main challenge facing the commercial vehicle industry is therefore to develop common technology platforms that can serve several market segments and maximize volumes per platform to remain cost-efficient. This challenge will become more and more severe.

The winning technologies will not necessarily be those that are intrinsically the best. Many other parameters, including efficient lobbying, smart alliances and developments in other industries, will play a role. As always, in a period of technology shift, many options will compete before convergence takes place. All players must therefore invest effort and funding in solving the technology puzzle with very limited visibility of what the technology map will look like in 10 -15 years' time.

*“Preferred technology platforms will vary significantly between applications and we need to rethink our product portfolio”
– OEM Executive Senior Vice President.*



A Future of Unprecedented Uncertainty

The increasing divergence in requirements combined with the large array of possible technologies makes the coming period one of the most uncertain ever for the industry. Therefore, top management needs to dedicate significant effort to addressing key questions about the customer needs and the preferred future solution for each segment, the technologies they should control and the optimal focus (what market segments, what products) for their business.

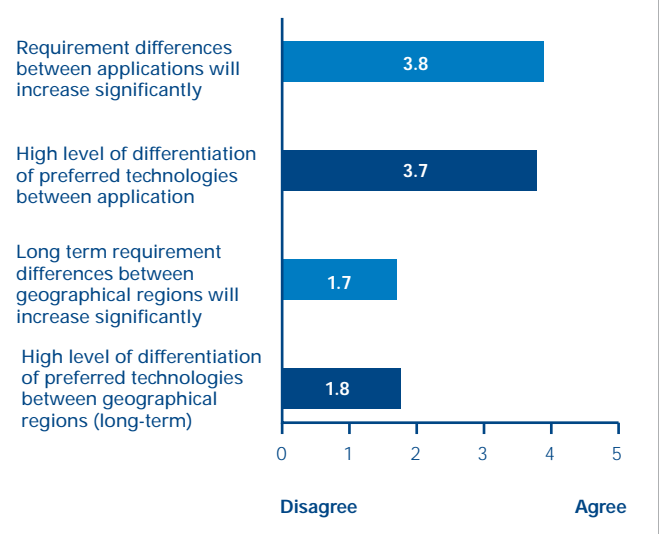
Looking beyond the current financial crisis, the increasing divergence in market requirements combined with the opportunities created by new technologies suggests that the truck and bus industry is facing a period of deep structural change. In fact, all respondents to the Arthur D. Little study believe this period will be unique in the history of the industry. Although current market conditions are the major concern for all executives in the short term, they point to the future powertrain as one of the main mid-term challenges that requires new strategic approaches. As always, in periods of deep change, some companies will come out stronger and others will find it difficult to survive. The Arthur D. Little study shows that the winners will be those companies that react rapidly and can master the increasing complexity in the industry and its dramatic transformation.

The majority of respondents in the study foresee significantly increased fragmentation in application requirements as well as greater differentiation in preferred technologies between applications (see figure 7). Within the next decade large geographical differences are expected to persist, but beyond 2015 global emissions requirements are expected to converge. In the meantime it is very probable that individual cities and/or regions will push restrictions on emissions beyond national requirements.

Which will be the preferred technologies?

Unless a major technical, environmental or political revolution takes place, Diesel technology will continue to dominate during the coming decade and potentially later. It has been shown that conventional Diesel technology can be continuously developed to improve performance and the current level of investment in R&D will secure further improvements. However, new technologies will emerge and claim market share, but many details remain unknown:

Figure 7. Fragmentation of requirements and technologies



- The level of penetration (within 15 - 20 years) of new technologies will differ widely between segments and there is no clear picture of the market share that new technologies will claim in each. New technologies are expected to be more widely used than pure Diesel engines for city vehicles, but the role alternative fuels or different kinds of hybrid solutions will play is subject to discussion. Even for long-haul trucks, varying degrees of electrification are expected to coexist with the traditional engines.
- Furthermore, even if there is agreement on the big picture (i.e. that the hybrid powertrain *will* come into existence), differences of opinion exist as to which future technologies will dominate at concept and system levels (optimal level of hybridization, how to recover energy waste efficiently, etc.)
- Finally, incertitude remains when these technology shifts are likely to occur. More than ever, external and uncontrollable factors, such as technology development in other industries or political initiatives, will determine the path and speed of change.

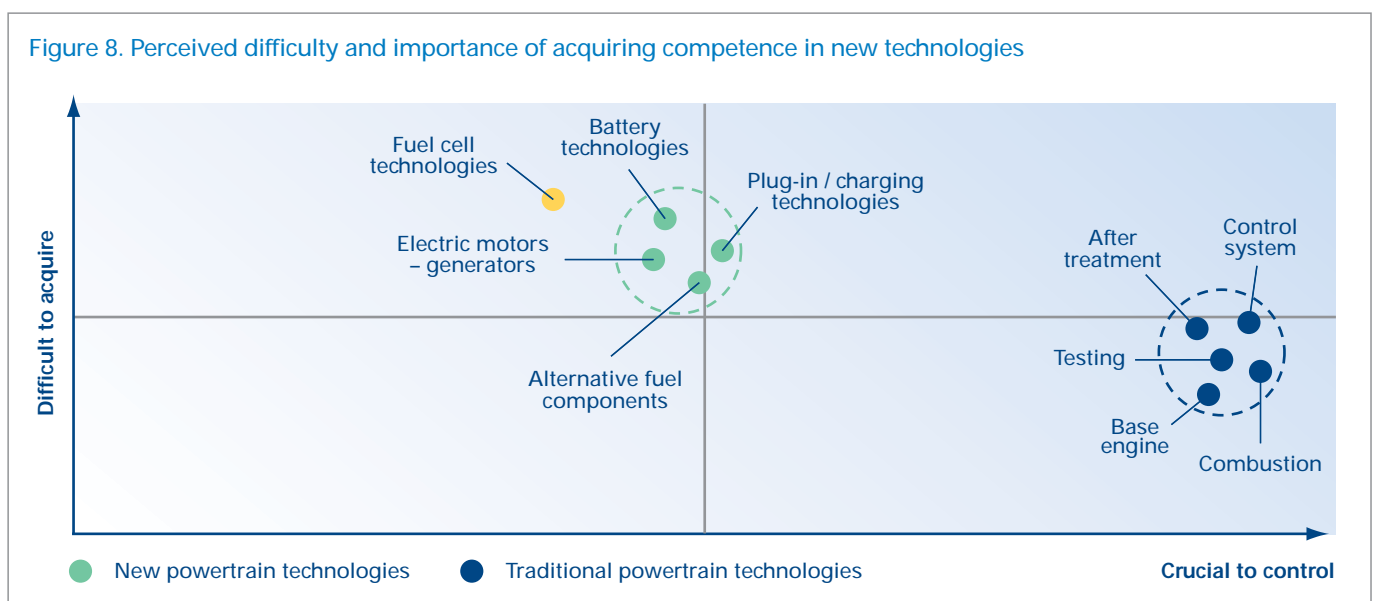
What technology to control and which technology to invest in?

The uncertainty surrounding future preferred technologies creates tension about what competences and capabilities each player (OEMs, suppliers, etc.) should control in future. The Arthur D. Little study reveals some interesting trends:

- Most OEMs consider it crucial to keep full control over traditional areas, such as combustion systems, after treatment, testing and control systems. Keeping or developing the right level of competence in these fields is not considered a significant challenge.
- OEMs consider it less crucial but more difficult to acquire competence in new technologies (see figure 8) such as battery, alternative fuels components and electric motors.
- OEMs see continuing to invest in in-house competence in the traditional technologies as a way of monitoring several development paths in parallel. However, this strategy also creates opportunities for suppliers to seize a large part of the future development value of new technologies.
- Europeans are more categorical in their statements while respondents from other continents show more hesitation in identifying which future technologies they should control.

There is no doubt that the powertrain industry is entering a period of technology change. As a result, the share of development budgets going into powertrain development is expected to increase in comparison with that devoted to the development of other systems. It is too risky for both OEMs and suppliers to put all their eggs in one technology basket, but also too expensive for them to develop all technologies internally and in parallel. In this environment, the winners will be those that develop product and technology strategies that are flexible enough to keep several options open and that enable a rapid shift between technology tracks.

“The uncertainty surrounding future preferred technologies creates tension about what competences and capabilities each player (OEMs, suppliers, etc.) should control in the future.”



What role to play in the value chain?

The coming period is characterized by substantial changes both on the market side (requirement divergence) and on the offering side (new technologies). Companies are unlikely to be able to serve the whole market in an optimal way and must figure out what role they want to/can play to remain competitive.

- The Arthur D. Little study indicates clearly that with the powertrain remaining a strategic differentiating factor, OEMs will avoid collaboration with each other (beside common lobbying activities) as far as possible. However, some players may be forced to search for alliances. The acquisition of companies (OEMs, small engine suppliers, etc) that cannot afford investment is very likely.
- On the other hand, no companies are prepared to give up their market positions voluntarily, even if they recognize that their product offering is unlikely to be the optimum solution for a changed market. The declared strategy of the global OEMs is to develop solutions for a limited number of core segments and to try to launch them for adjacent applications. For example, some global players are considering proposing their future low-emission variants (Euro V or even Euro VI) to the Chinese market, accepting an important overcost.
- The global companies' strategy creates good opportunities for other players. For example, the future volume for Euro III engines will be large enough to justify companies focusing on markets with less demanding emissions requirements. By doing so, companies can await progress in technical development before choosing and investing in promising technologies.

The nature of the collaboration between OEMs and suppliers will change. Several large and international suppliers see the forecast technology shift as an opportunity to take a larger part of the created value in future. Both sides are preparing for a reshaping of any future relationships:

- Suppliers will require more-profitable risk-sharing and greater transparency as the price for closer collaboration. In all cases, suppliers will be reluctant to become too dependent on a single client.
- OEMs will keep an active integration role in complete powertrain solutions. They will select suppliers very carefully, based on technology capability, financial stability and capacity to meet quality and reliability standards.

Deep structural changes are also expected to take place within the supplier basis.

- Niche players mastering advanced technologies will be acquired by large companies that will integrate the innovation in complete systems. These partnerships or acquisitions will give existing suppliers access to new technologies and will give innovative companies access to the truck and bus business.
- Non traditional automotive suppliers such as electric component manufacturers will enter the market. The trend is not manifest yet but is anticipated by most of the survey's participants.

Finally, close collaboration will also take place in the aftermarket. OEMs must offer their customers a dense network of workshops able to serve the new technologies. While the issue is relatively easy to solve for buses or local trucks, the challenge is substantially more difficult for long haulers. Reliable service places must be in place throughout Europe and the US before OEMs can propose products to cross-continental customers.

“Strategic collaboration and alliances will reshape the industry – as usual there will be both winners and losers” – OEM Executive Senior Vice President.

Conclusion

Major constraints and technology development create new challenges for the commercial vehicle industry. Driven by factors that are partly out of the industry's control, the future market will be characterized by:

- Greater fragmentation of the requirements on the powertrain.
 - New and/or different market segments (clusters of powertrain requirements).
 - More specialized powertrain platform(s) to meet competition.
 - Uncertainty around future preferred powertrain platform technologies.
 - Reduced economies of scale due to fragmentation in technologies.
- Go fast at high risk or be a fast follower: The changes are so profound that they will take place when several forces from the industry and from politicians and customers fully converge. Fast moving companies will take high risk and management must make up their mind about the right timing for change.
 - Develop an integrated product and technology strategy:
 - core capabilities must be (re) defined
 - modules must be revisited
 - the make buy strategy must be refined
 - new alliances must be formed
 - new partnership network must be established
 - Develop a flexible manufacturing set up: A highly flexible manufacturing footprint that can handle variations in volume, specification or geographic focus is necessary for future success. This future set-up must be developed in close collaboration with key suppliers.

The Arthur D. Little study shows that most companies are developing strategic answers to mitigate the risks arising from change. Although several methodologies can be employed, Arthur D. Little recommends a comprehensive approach, encompassing the complete value chain. Several issues need to be addressed systematically:

- Gain a better understanding of the drivers of fragmentation: Nobody knows how the macro constraints will evolve and how fragmentation will reshape the market. Several scenarios, based on different assumptions of the market constraints, should be developed. For each of them, the probability of occurrence and the possible consequences should be evaluated. The outcomes of these scenarios form the strategic framework for future decisions.
- Gain a better understanding of the new segments and their attractiveness: As always, when market segments emerge or evolve, the industry must invest in understanding their characteristics. The first step should be to define the new segments before analyzing their size and profile. Assessing the strategic attractiveness of each segment then allows companies to set their future priorities accordingly.

Opportunities for those that back the right technology in the right market at the right time are huge. However, recent examples from the passenger car industry show that mistakes in product offering or indecision in technology development can sink both small and large companies. It is up to each company to make the right choices now.

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The Future of Powertrains

Strategic collaboration and alliances will reshape the industry – as usual there will be both winners and losers.

Arthur D. Little

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