FUTURE TRENDS AND TECHNOLOGIES IN THE TRUCKING INDUSTRY

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Introduction

Truck designs have changed dramatically over the past 10 years, incorporating many technologies that have improved productivity, safety, and ease of operation for the driver.

If we look at the technologies that have evolved and gained accepetance in the industry today, we can see areas and trends that will continue in the future.

Aerodynamics

For the long-haul trucker, fuel costs represent the most expensive portion of the operation. To improve fuel efficiency, truck manufacturers have focused on reducing aerodynamic drag.

The first use of aerodynamic design to improve fuel economy was pioneered by Kenworth in 1985 with the introduction of the T600A. The sloped hood design and the side fairings resulted in a fuel economy improvement of greater than 30% over other conventional truck designs. Within two years, every major manufacturer followed Kenworth's lead and developed aerodynamic models as well. Today, it is not uncommon to find fleets using the aerodynamic trucks that are averaging close to 7 mpg compared to a fleet average of just over 5 mpg a few years ago. Today, improvements in aerodynamics continues to be a focus of the manufacturers. In the U.S., the introduction of the T600 AeroCab has again reduced the aerodynamic drag of the T600 by 3% which translates to a 1.5% improvement in fuel economy; future designs may provide up to an additional 10% reduction in drag, or about 5% improvement in fuel economy.

However, trucks today are reaching the limit of aerodynamic performance that can be achieved through tractor design alone. While the tractor is the leading edge of the combination vehicle, and dictates the degree to which the airflow attaches to the combination, the trailer design influences the airflow once it leaves the tractor, and thus controls the total amount of aerodynamic performance that the combination vehicle can achieve.

Wind tunnel tests and real-world fuel economy tests conducted by several manufacturers have shown that significant improvement - on the order of 30% or more

improvement in fuel economy, can be achieved with a tractor-trailer combination that is aerodynamically treated.

Trailer aerodynamic treatments include pressure recovery, or boat-tail designs at the rear of the trailer, smooth side panels, side skirts, and enclosed and/or reduced gap between the tractor and trailer. As truck companies strive to increase productivity and reduce operating costs in the future, we may see strategic alliances form between truck and trailer manufacturers to develop optimized combination vehicles for aerodynamic performance.

There are other side benefits to improved aerodynamic performance as well. The splash and spray that the aerodynamically designed truck generates on wet roads is significantly less than that of a non-aerodynamic truck which improves the friendliness and safety of the aerodynamic truck to the other highway users. The reduced aerodynamic drag also reduces the horsepower requirement necessary to maintain speed and thus, more economical engines - in many cases smaller and lighter engines can be used which in turn improves productivity both through further improvement in fuel economy as well as a tare weight reduction which allows more payload.

Tire Technology

The tire manufacturers have played an important role in improving fuel economy as well. New compounds, construction methods and tread designs have been developed that have been shown in real world fuel economy comparison tests to contribute up to 10% fuel economy improvement with no degradation in tire wear or traction capability.

The tire manufacturers are also focused on ways to improve productivity. When used with appropriate outer end equipment, 19.5" tires developed by several tire companies can provide up to 600 pounds weight savings and lower fifth wheel heights to provide greater cube capacity. For many bulk haul applications, the lower profile tires can be used to lower the center of gravity of the trailer to provide increased roll stability.

Central tire inflation systems are being developed that are cost-effective enough to be commercially viable. These systems will help in operatons such as logging, oilfields, and other off-highway applications where mobility can be improved through the use of lower tire pressures. In such applications, deterioration of the dirt roads has been shown to be lessened through the use of lower tire pressure, and thus CTI systems help lower total operating costs by minimizing road maintenance costs.

Electronics

Electronics play a major role for the engine manufacturers to be able to meet the 1994 U.S. Environmental Protection Agency clean air emissions standard. In addition to controlling emissons, the electronic computer controls help to optimize engine performance, resulting in increased fuel economy, and computer shaping of both the torque curve and horsepower curve to improve drivability.

The use of electronic computers to control engine emissions and performance has led to the development of very reliable and durable electronic control modules (ECM) that can be used to support a wide variety of tasks focused on providing information to the driver, and controlling many other functions on the truck to improve performance. Without question, in the very near future, the use of electronic technology will have the greatest impact on truck operations.

Electronic technology has already been developed to provide the driver with critical information on truck performance. Dashs and gauges are now able to communicate directly with the ECM via the SAE J1708 databus to obtain operational information (eg, speed, water temperature, oil pressure, engine RPM). Added functionality such as instantaneous fuel economy and trip recording can be easily programmed through the use of electronic dashs and gauges to help coach drivers for maximum performance. Using the databus as the communication channel for gauges eliminates the need for large complex electrical harnesses and multiple sensors which improves the overall servicability of the truck.

Electronics will also help with diagnostics and preventive maintenance. Diagnostic recorders are already commercially available which communicate with the engine and record fault codes and the condition at which the code appears. Interfacing a hand-held diagnostic recorder with a personal computer, the truck maintenance manager can easily maintain an accurate service database for each truck.

Current work in electronics is also focused on developing sensors that can more accurately diagnose when maintenance is actually required - thus, instead of routinely repacing filters, brake and clutch linings, oil, and even tires as part of a preventive maintenance program, electronic sensors will be able to tell exactly when maintenance is needed saving both time and money for the operator.

Studies are being done to assess the feasibility of using electronics to improve crash avoidance. One concept would be to integrate an onboard radar system that would detect cars and trucks and interact with the truck brake and/or

throttle system to slow or stop the truck depending on the circumstances.

Electronics are already the key to antilock and traction control brake technology. True total electronic brake control - brake by wire - has bee developed and is being tested and will provide improvement in brake timing and brake balance, particularly for longer combination vehicles. Theoretical computer simulation studies have also indicated the possibility of using electronic brake control to help control jack-knife situations.

Communication Technologies

Related to the increasing use of electronics is the increasing use of communication technologies (eg, cellular telephones, satellite communication and global positioning systems). Such communication technology allows truck to home base and truck to checkpoint communications that can support increased productivity. It is becoming more common to see portable computers and even fax machines being carried onboard long-haul trucks.

Intelligent highway vehicle systems will be able to provide the driver with information about traffic conditions and weather conditions that may impact his operation, and can provide alternative routing. Navigation systems can not only assist the driver with routings, but provide some degree of security as well, since the terminal can track the location of the truck in case it is stolen.

With the information provided by the engine ECM, it is foreseeable that in the future, in case there is a mechanical problem with the truck engine, the driver could call up his nearest maintenance terminal, connect the databus to his cellular phone and transmit the diagnostic information. Then, the maintenance shop could come for road service knowing exactly what the problem was.

Lightweight Components / New Materials

Use of new lightweight materials to reduce truck weight is a continual focus of truck designers and component manufacturers.

With the electronic controls, engine manufacturers are able to provide more horsepower with smaller engines. The 10 litre engines are now rated up to 375 horsepower, and it is anticipated that in the near future they will reach 400 hp. For many long-haul operations, given the improvements in aerodynamics, this horsepower range is sufficient, and the weight difference between a 14 litre engine and a 10 litre

engine provides a noticable increase in productivity. The reliablity and durability of the smaller block engines is also evolving to a point comparable to the large blocks.

Weight reduction in outer end equipment is improving as well. Aluminum hubs, centrifuse brake drums, smaller tires and lighter axles help provide a weight savings for increased payload.

Composite materials are finding new uses. For example, PACCAR's composite front spring provides a 120 pound weight savings over the equivalent standard steel spring with durability that equals and in many instances exceeeds that of the steel spring.

Truck manufacturers are exploring and using new plastic materials that provide the strength and durability required, yet also provide weight savings. New sheet molded compounds (SMC) and other plastics can provide a significant weight savings over traditional steel, aluminum and fiberglass components. Materials once used only in military applications, such as titanium alloys and metal matrixed aluminums are becoming cost effective for commerical use as well.

Cab Environment

Use of technology to improve the driver's environment is critical in supporting improved productivity and safety. As previously mentioned, development of electronic dashes and gauges will improve the accuracy and amount of useful information that can be provided to the driver during operation.

One area of focus to help reduce driver fatigue is that of noise reduction. Improved technologies for noise measurement and quantitative defintion of noise levels has led to the development of new barrier materials that result in a significant rduction of cab interior noise levels. Kenworth has used these materials in its QuietCab noise eduction package to obtain an interior noise level comparable to some cars. Ongoing research in noise reduction is now being conducted in the use of active noise cancellation which may help reduce not only interior noise levels, but exterior drive-by noise levels as well.

Ways to enhance the driver's range of vision and visibility are also being studied. Passive designs such as corner windows and back windows in the cab, and increased window areas in the doors all help to improve the range of vision. Use of closed circuit cameras for rear vision and side blind spots is also being seen. Developing technologies based on radar obstacle detection may evolve in the near future to be

interactive with electronic engine controls to assist in crash avoidance situations. Technologies that were developed in military applications are now being evaluated for feasibility in truck applications. Heads-up displays, ultraviolet lighting for improved night vision, drowsiness detection devices and heat sensing obstacle detection devices may soon be used to improve safety and driver ease of operation.

With team drivers, and individual drivers spending more time on the road, it is important for the truck designers to focus on creature comforts. There are steady improvements being made in the area of driver amenities both in the cab workspace as well as in the sleeper - providing more storage space, additional lighting, and better comfort in the sleeper. Seat manufacturers are improving their ergonomic designs to provide more comfortable seats with greater ranges of adjustment available to the driver.

Ride improvements have been considerable over the past few years. The increasing use of air suspensions - approximately 80% of the over the road trucks in the U.S. are built with air suspensions - coupled with a migration towards air suspended cabs and sleepers has made a dramatic improvement in truck ride. The social benefit in the increased use of air suspensions is the resulting reduction in dynamic pavement loading that will help preserve the highway infrastructure.

Alternate Fuels

As continuing focus is placed on emissions and clean air, the engine manufacturers are looking to alternativelly fuelled engines as an option. Caterpillar, Cummins, and Detroit Diesel all have active programs in developing engines that will use compressed or liquid natural gas fuels. While these engines may not have widespread application, for in-city and short haul through those areas where congestion compounds the emissions problem, alternate fuelled engines provide a viable option.

Concluding remarks

Technologies in general continue to evolve at a fantastic rate. The key challenge to the truck engineer is to selectively integrate into the truck those technologies that will enhance performance in areas of safety, regulatory compliance, productivity, driver comfort and ease of operations.