APPLICATION ENGINEERING TRUCKS FOR OPTIMUM PERFORMANCE - AN AUSTRALASIAN PERSPECTIVE

It's interesting to compare and contrast the two major sectors of the automotive industry, cars and trucks.

An engineering purists view of a car is merely a means of getting from points A to B safely, reliably and economically. If this statement held true for everybody we would all be driving Mini Minors.

We know that many other factors are important to the car consumer. Size of the family, type of social activities the car will be used for, brand loyalty, dealer support, performance requirements and economy are just some of the decision factors that determine whether a car will be fit for its intended purpose.

This practical approach however ignores some of the powerful intangible factors that influence one's purchasing decision. Will I feel good about myself when I drive this car. Will others look on in envy. Will this car satisfy my hoon requirements or my social groups norms. Is this an adequate statement of my disposable income and status. The convertible Porsche displays that unmistakable statement of arrogance that makes every Commodore driver want to beat it at the traffic light.

Generally speaking, trucks and cars differ in one key area. A truck is required to earn income, a car is not. It is this requirement to earn income and show a positive net present value over the whole of its life that governs the purchase decision. Above all other factors if the choice boiled down to one of two trucks – the one you hated, but would earn money from, vs the one you loved but would lose money, any thinking customer would choose the former.

Only when the whole of life costs of the two product options are similar do other intangible factors come into the equation.

It is the key role of the truck salesman and manufacturer to know each customer's business almost as well as the customer. In this way we can specifically tailor the product to suit that business and hence maximise the return. This is why some truck manufacturers offer literally thousands of options to achieve this task. Our industry refers to this task as application engineering.

A correctly application engineered truck reduces the whole of life costs in terms of both expenses and revenues. The truck will use less fuel, require less maintenance (two of the largest operating expenses) and have a higher resale value. Equally it will do more income earning work, have more uptime, preserve the freight and enable you to provide a better service to your customers. All this sounds very nice. So what is Application Engineering and how is it done?

The practical side to Application Engineering answers the question will the truck be fit for its intended purpose?

Most major truck and engine manufacturers use sophisticated computer programs to predict the likely performance of the truck. The calculations for engine power are quite complex. Total engine power required comprises;

The rolling resistance power demand.

This represents the portion of engine output that overcomes tyre static and dynamic rolling resistance. Friction is present in all mechanical systems.

The grade resistance power demand.

This represents the portion of engine output that is required to climb a specified grade. Overcoming gravity if you like.

Air resistance power demand.

This represents the portion of engine output that is required to overcome air resistance. The more aerodynamic a truck, the less power that is required to overcome air resistance. As a point of interest at about 80 kph air resistance saps about ½ the available engine output.

Accessories power demand.

This represents the portion of engine output that is required to run accessories such as the fan, alternator, air conditioner, power steering etc.

Total Power Demand

All these components give rise to the total engine power demand. A practical example of this is a tipper and dog loaded to 44 tonne. It needs 270 hp to maintain 100 kph on the flat and 450 hp to maintain it on a 1% grade. A typical design criteria.

The trend in Australia and New Zealand is to higher and higher output engines. This is not because of some power fetish but is in recognition of the trend away from kilometres per hour to kilometres in the hour. Maintaining consistent speeds up hill and down dale is more efficient and safer than crawling up hills and then speeding down. A practical example of this is a truck operating in Australia that travelled in excess of 620,000 km in its first twelve months of life. This represents 52,000 km per month, 12,000 km per week, 1700 km per day. Perhaps more graphically represented is this truck had an average speed of 71 kph 24 hours a day, 7 days a week, 365 days per year. It was also road speed limited to 100 kph.

Now we know our truck has the grunt to do the work, we need to focus on the driveability of the truck.

Firstly startability.

Largely a function of diff ratio, first gear ratio and clutch engagement torque. The truck must be able to lift-off on the maximum expected grade with the engine at idle.

Secondly gear splits and overall reduction.

Transmission and rear axle ratio choices can make or break a spec. Poor choices here effect fuel economy, trip times, driver acceptance and induce premature driveline failure. Our markets typically require 13-18 speed overdrive main transmission and slow rear axle ratios. Europe and the US prefer 7-9 speeds and very fast rear axle ratios.

Now that we're satisfied the truck will perform acceptably, the next step is to ensure it will live. Application Engineering Approval is a fundamental prerequisite to warranty acceptance at Kenworth. Calculations for frame strength, clutch, transmission, driveline, axle and suspension capacity are performed with the end result being four outputs.

a) Gross vehicle mass or GVM
b) Gross combination mass or GCM
c) Warranty approval
d) Statutory regulation approval.

25 years manufacturing experience producing trucks for Australia and New Zealand has given us a good understanding of what is required to make trucks live in our markets.

Both European and North American truck manufacturers often use our markets as a testing and proving ground for new trucks and components. We have higher equipment utilisation rates, higher load factors, worse roads, higher temperatures (in Australia anyway) and in my opinion higher quality and performance expectations. To try and quantify this the PACCAR Technical Center in Washington has determined that the duty cycle on our trucks about 3 times harsher than that of North American and even harsher again than Europe.

Recognising this fact manufacturers of rear axles offered in our trucks demand that thicker walled housings are used to prevent premature breakages. Steering gear capacities are increased to accommodate the additional shock load. In fact everything from bolt size to cable routing to crossmember location is revised for our market. As a previous Kenworth Chief Engineer was heard to say "god is in the detail".

Now you have a truck will live and perform to expectations, it is now time to turn to packaging issues.

Cab-over or conventional, long bonnet or short, wheelbase, fuel capacity, tare weight etc. are all considered integral to the application approval process. We try to optimise the truck and trailer combination to maximising payload and carrying capacity whilst satisfy all statutory mass limit and length regulations.

This process is ably demonstrated by two recent examples. The first is this K100 that we built for a coal mine in Queensland. The agitator bowl mixes an explosive cocktail of ammonium nitrate and diesel fuel. Pours it down pre-drilled holes then blows the sides of mountains away. It is 8 wheel drive and required extensive chassis, suspension, drivetrain and cab design. We were fortunate enough to win first prize in the Australian Institution of Engineers Design Excellence competition.

The second is a ground breaking roadtrain that hauls fuel out of Perth to the gold fields at Kalgoorlie. It legally grosses at 126 tonne. Apart from the obvious truck design work the main feature that sets this application apart is the negotiation that Kenworth, the dealer and customer embarked upon with both state and federal authorities to approve the permit applications. Specific model approval for the tri-drive was obtained in record time. Can you afford not to application approve your next truck purchase?

What does the future hold for truck design?

Truck Cabs

Aerodynamics is rather passe now since the T600 was introduced. Whilst each new product release is usually more efficient than the last, those ground breaking quantum improvements are behind us. Expect traditional materials such as aluminium, steel and fibreglass to give way to radical futuristic composites. Composites are usually cheaper, stiffer and lighter. Expect bonding technologies to be used more prevalently. Greater emphasis will be placed on in-cab creature comforts and truck interiors will soon more closely resemble cars.

Truck Chassis and Suspensions

These components have remained largely unchanged for 50 years and I believe their time for engineers attention is overdue. Composite chassis rails and suspension parts. Greater use of air as a suspension medium for both steer and drive, even independent suspension may become prevalent so that chassis heights can be reduced.

Truck Driveline

More than ever the radiator to the wheel bearings need to be considered as one integrated system. Engine heat rejection needs to be reduced or radiator efficiency improved. Transmission and clutch manufacturers need to predict future movements in engine outputs so they are not caught napping. Soon the entire driveline will be communicating electronically enabling traction control, anti lock brakes and effortless transmission shifts.

Truck Systems

Expect brake by wire sooner than later. Using electronics instead of air will enable truck/trailer brake balance issues to disappear. Equally application and release times will be improved. Serious cost savings in lining maintenance are there for the taking.

Conventional electrical systems as we know them may disappear replaced by multiplexing. Imagine an electrical system that requires no circuit breakers or fuses, uses a fraction of the current cabling and enables problem diagnosis of the same sophistication as engine electronics. This may sound fanciful but we've just built one in Australia.

One of the biggest revolutions will come in the form of communication. Satellite navigation and instantaneous fleet management information will enable running costs to be determined far more accurately.

Design Systems

Truck design is now 100% computer aided. The Benchmark system used by PACCAR worldwide gives designers unsurpassed ability to assemble, test, weight and tool complete designs on the computer.

These images can be sent down the optic fibre to any one of a number of machines to make actual parts.
The time to produce new designs is reduced and quality is increased.

In closing, I've tried to give a little insight today into the theory of application engineering. We've got 40 people in our engineering department back in Australia and I'm not ashamed to admit that occasionally we do get the theory wrong. However over 25 years of manufacturing and designing trucks exclusively for Australia and New Zealand we've also gained a lot of practical experience too. That blend of theory and practise gives us a pretty good success rate.

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