Future Trends in Transportation and Their Effect on Fifth Wheel Design

In looking back over the last few years in international transportation, we see that many of today's technologies were yesterday's fantasies. Looking forward to the next century we know that the pace of technology will move at an ever increasing rate and that our industry's requirements will be changing and growing as well. Suppliers to the international transportation industry must anticipate these new requirements and bring to the market products that best address the changing needs of the customer. These trends in transportation and their effect on the design and manufacture of fifth wheels will be the focus of this paper.

In the transportation industry of yesteryear, manufacturers and suppliers to the industry were the "innovators" motivated by their contacts with the customer base. Today this process has developed into a co-operative venture between the manufacturers of vehicles, component suppliers and customers, with everyone contributing their own vision of the future. We believe the following transportation topics will be the primary focus of this co-operation in the future:

- Continued improvements in safety
- Continued improvements in reliability and performance
- Reduced maintenance requirements
- Improved driver comfort and ergonomics
- Reduction in chassis (fifth wheel) weight and chassis (fifth wheel) height
- Improved environmental performance, i.e. lower emissions, noise reductions, better fuel economy, designs for recycling, etc.

Our industry is continually striving to improve products in the six topics listed above through the innovative and cost effective application of new technologies. This paper will address the use of these technologies by highlighting the ongoing efforts within three areas of application:

I. Use of improved design and testing techniques

II. Advanced material research

III. Electronic applications

A brief review of each area follows, highlighting those technologies that are being applied to the fifth wheels of today and those new or emerging technologies that show significant future promise.

I. IMPROVED DESIGN AND TESTING TECHNIQUES

The technology employed in the design and testing of fifth wheels is radically different today than that used just 10 years ago. Gone are the drafting boards of the past, replaced by sophisticated CAD/CAE systems employing 3D solid modelling and dynamic simulation techniques. Powerful finite element analysis techniques are employed in conjunction with laboratory fatigue testing, data analysis techniques and specialised test equipment. In addition to laboratory endurance testing, Holland Hitch employs proving ground accelerated durability testing that confirms acceptable performance levels for the product over its expected service life. A typical vehicle configuration and test loop description are shown in Figures 1 and 2. The laboratory and accelerated durability tests are monitored against actual field performance to confirm reliability and validity. These capabilities have recently resulted in the design and release of a cast steel fifth wheel rated for standard highway loads that weighs only 120 kilograms at a 150 mm mounted height, a savings of over 10 kilograms from previous designs with improved durability, strength and reliability of the product.

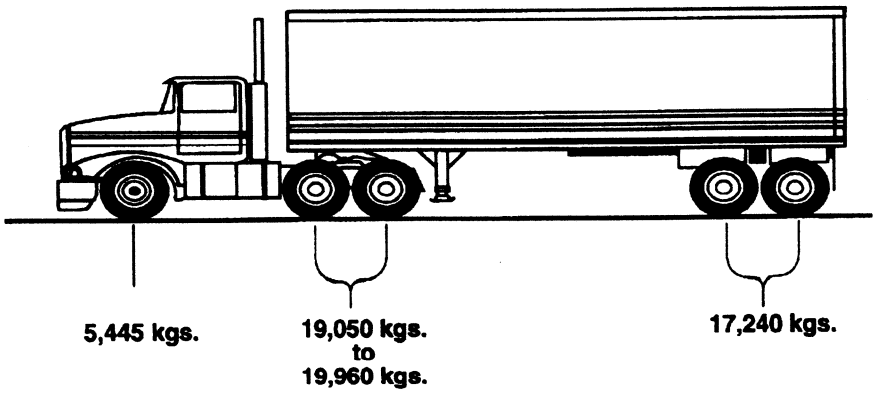

Figure 1

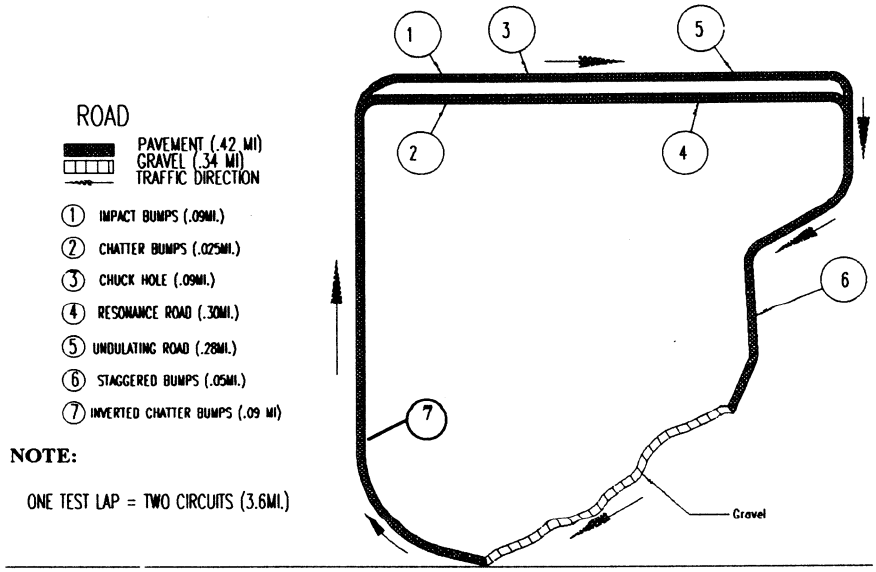

Figure 2: Durability Test Course

CAD/CAE and simulation techniques have also been employed to significantly reduce the release efforts of fifth wheels, addressing improvements in driver comfort. At Holland Hitch, our FleetMaster fifth wheel requires 50% less effort when compared to the previous model and 20% less than competitive units. Our new "3500" fifth wheel also exhibits less release effort with a 45% reduction from previous models. The most promising aspect of reducing release handle effort, however, has been the application of pneumatic powered release systems. These systems are now offered by most fifth wheel manufacturers and provide a real advantage to the driver in multiple couple type operations. The major drawback to most systems continues to be cost and the safety concern regarding inadvertent release of the fifth wheel. These systems will continue to evolve, becoming more cost effective while addressing the safety concerns of the industry.

To address the topic of reduced maintenance Holland Hitch recently introduced a release handle design that significantly reduces handle damage due to incorrect coupling alignment. In the past, when the kingpin of the trailer did not properly enter the throat of the fifth wheel, it could travel around the fifth wheel top plate and damage the release handle. This required repair or replacement of the release handle with the accompanying downtime. By providing a "dropped" handle as standard equipment, the kingpin passes over the handle during a miscouple eliminating the damage and the associated maintenance of the system. It is a simple but effective way to resolve a maintenance issue.

II. ADVANCED MATERIAL RESEARCH

The industry has been a traditional user of ferrous metals, both wrought and cast. Developments of higher strength low alloy wrought steels continue to provide significant weight reductions in mounting brackets and fabricated fifth wheels without sacrificing performance and durability. Casting technology continues to improve as well, resulting in a more consistent, sound casting with additional material strength and durability improvements. Application of th technology by Holland Hitch and its foundry partners has resulted in a cast steel fifth wheel that is 6%-8% lower in weight than previous models with durability improvements that enable us to provide a lifetime warranty on the casting itself.

Composite materials hold significant promise for future applications in fifth wheel design, either applied alone or in combination with other ferrous or non-ferrous materials. Holland Hitch has initiated work on a composite fifth wheel bracket mounting system that provides a 36 kilogram weight savings over current production versions. The bracket mounting system uses continuous fibre reinforced composites developed and used extensively in the aircraft industry. Continuous fibre reinforced composites are unidirectional tape or woven fabric glass or carbon fibres embedded in an epoxy or thermoplastic binder. Strengths can vary from 138 to 1,240 N/mm^2 and stiffness can range from half that of aluminium to twice that of steel. Density is typically half that of aluminium. (See Figure 3.)

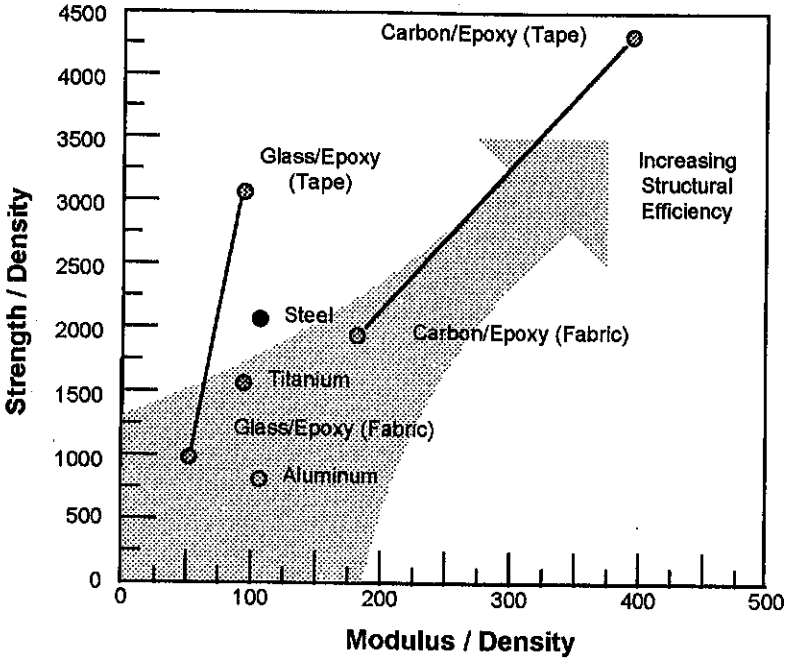

Figure 3

To achieve these structures, several production methods are available, including pultrusion, filament winding, resin transfer moulding and hand lay-up. Each has tradeoffs regarding structural efficiency and cost. Preliminary finite element analysis indicates that overall strength should be adequate for standard loads while the flexibility is somewhat greater than that for steel components. Initial prototypes have been completed and are currently undergoing both static and fatigue testing. While presently not cost effective as a substitute for steel, continuous fibre reinforced composites continue to move lower in the cost of the raw material and show significant improvements in production rates. (See Figure 4.)

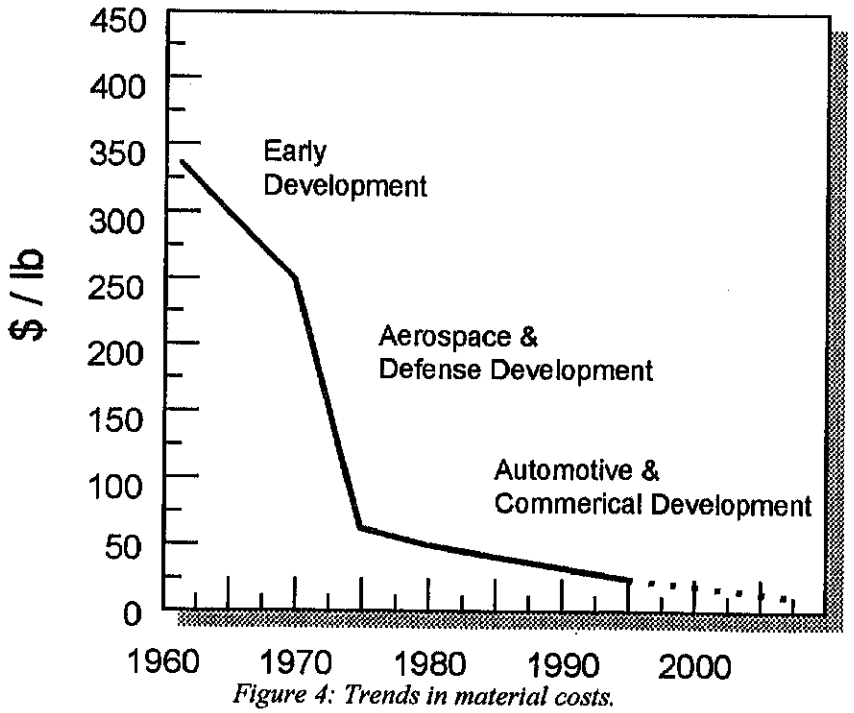

Figure 4: Trends in material costs.

Aluminium alloys have application potential in the fifth wheel arena as well. In past investigations performed by Holland Hitch, the application of aluminium to the design of fifth wheels produced less than favourable results due to the brittle nature of the material and high impact load conditions. Continued efforts to resolve the problem resulted in increasing section thickness to the point where the overall weight advantage was being compromised. Recent advances in aluminium alloy forgings, however, show promise in resolving some of the concerns of the past. These alloys provide improved corrosion resistance, increased toughness and higher elongation characteristics that bode well for future use.

The continued application of advanced design and testing techniques in combination with material development in ferrous and non-ferrous metals as well as structural composites will lead to future fifth wheels with significant weight reduction and improved performance at a cost effective price to the customer.

A non-structural application for new material technology can be applied to reduce maintenance intervals for transportation equipment. The goal of the industry in the United States is a tractor that requires no routine maintenance or servicing for five years or 800,000 km. While this may seem unachievable now, we must remember that engines with 70,000 km service intervals were unheard of just 10 years ago.

Typical maintenance intervals for fifth wheels, including cleaning, inspection, adjustment and relubrication, are 3 months or 5,000 km. Continuous improvements in lock design, materials and manufacturing techniques have resulted in an extension of this service interval on all new Holland Hitch fifth wheels to 6 months or 100,000 km. New developments in fifth wheels by our industry involve reducing maintenance and lubrication by incorporating permanently lubricated wear materials on the top surface of the fifth wheel and other high wear areas. While eliminating the requirement for relubrication of the unit, an environmental positive, wear pads must still be replaced as required and the locks themselves still require periodic lubrication. Material improvements will continue to provide longer wear life and coating technologies may eliminate the requirement for lock lubrication. One present design evolution by Holland Hitch calls for a composite of hard, durable self-lubricating material bonded to a steel backing plate to provide rigidity to the wear material, enabling the total volume of the pad to be available for wear, increasing the usable surface by 40% over present designs. (See Figure 5)

Evaluations of wear materials indicate that the material must have a relatively high compressive strength, in the range of 206 N/mm^2, while retaining the lubricity required for the operation. With this and other improvements, the units available in early 1997 should be capable of 2-3 years of maintenance free service on standard highway applications.

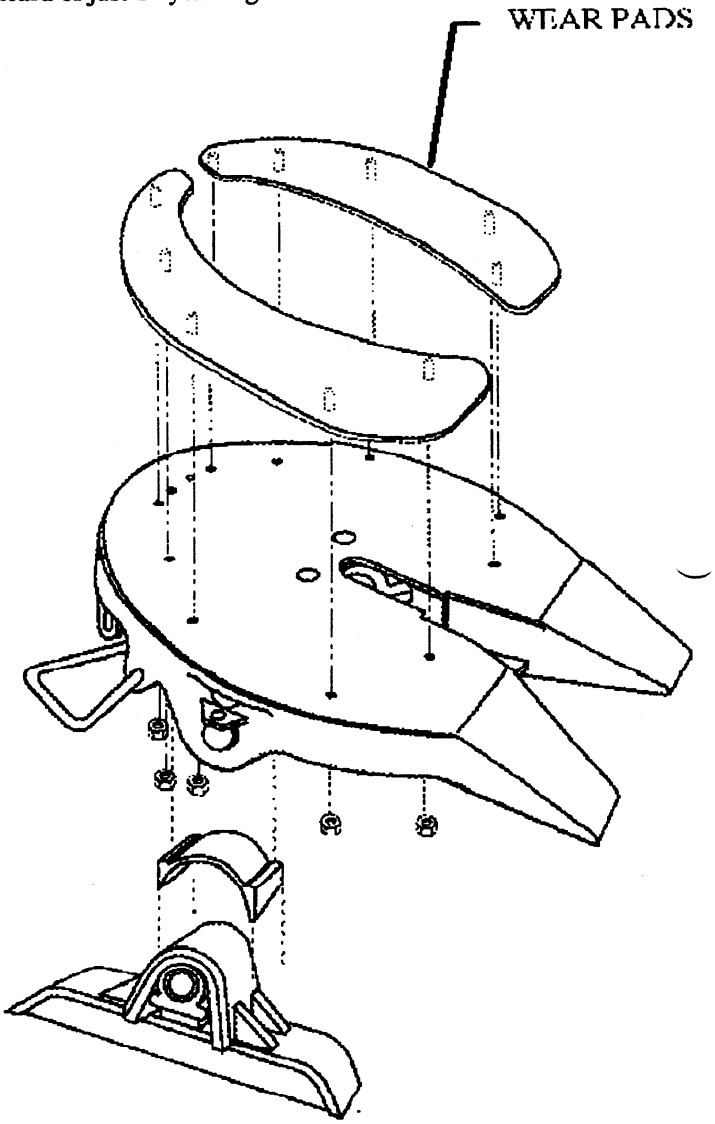

Figure 5

III. ELECTRONIC APPLICATIONS

A few years ago it would have seemed laughable to suggest that a 130 to 135 kilogram hunk of metal designed to lock a tractor and trailer together would be an application for electronics. Today, however, this application is not only feasible, but it has the potential to provide substantial benefit to the industry as a whole.

Holland Hitch designers are presently evaluating the use of sensors and computer logic to inform the driver when the fifth wheel is properly coupled to the trailer. Existing designs inform the driver that the lock system is in its proper coupled position but these systems do not evaluate the relative kingpin position or the sequence with which the system became coupled. Holland Hitch has utilised the current state of chip technology to design a system that not only informs the driver that the unit is coupled, but also that the kingpin is in the proper position and that the coupling events took place in the proper sequence. Included in this approach are built-in diagnostics and the capability to give

the driver various types of alert signals if a proper couple has not been achieved. These signals can range from an audible buzzer, a warning light, tactile feedback through the steering wheel or limiting the engine to idle speeds through the engine ECU. Prototypes of the system have been running successfully in the U.S. for approximately six months with expected release for sale in early 1997.

A proper work environment for the driver/operator has become a prerequisite for driver satisfaction and retention. Major improvements have been made to ride, climate control, lighting and the overall ergonomics of the tractor cab. Comfortable drivers are more productive and alert than ones fatigued and sore from their job environment. Part of the fatigue for some drivers is the stress of coupling properly.

To alleviate the stress of proper coupling and the potential damage and safety considerations of a false couple, Holland Hitch has begun to investigate the use of sensor technology to assist the driver in guiding the tractor to the trailer. This system has the potential of informing the driver of the alignment and distance to the kingpin while backing. (See Figure 6.) A prototype of the system is currently under evaluation and preliminary cost estimates look favourable. A full fleet test of the system is anticipated for late 1996.

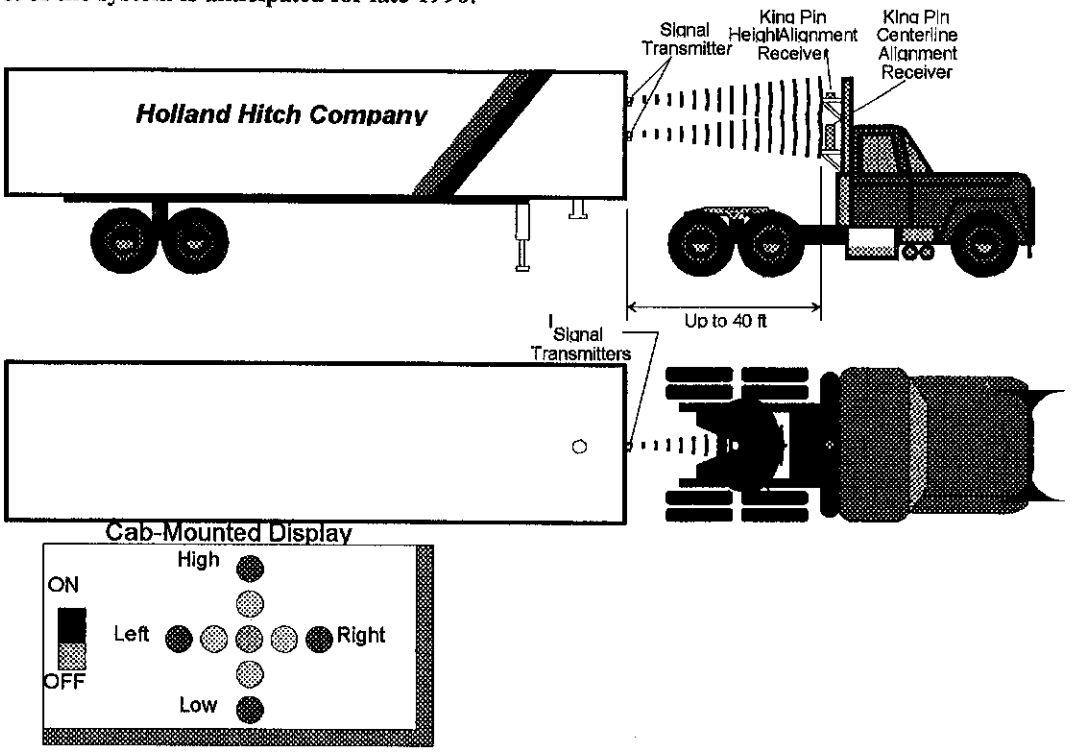

Figure 6

An application of electronics, with a longer development cycle, is a fifth wheel with "force" sensing capabilities. One use for this "force" information is in the area of electronic braking systems for tractor/trailers. Electronic braking can reduce the lag time between pedal actuation and brake application, but with fifth wheel load inputs it can also provide the ability to control the tractor and trailer brakes separately for improved directional stability, shorter stopping distances and more precise control. This is achieved by the braking system comparing the actual forces being exerted on the fifth wheel by the trailer to a predetermined desired force and adjusting the brakes so that the actual forces approximate the desired forces. This could provide true brake balance and optimise braking in real time.

Holland Hitch is also participating in a U.S. government funded program on truck stability enhancement with the goal of developing a roll stability advisory system to "condition" the driver to the roll stability of the vehicle combination. The fifth wheel will provide vertical force, longitudinal force and roll moment data to the system which will then deduce the rollover threshold of the vehicle. The threshold will then be displayed in a manner to condition or train the driver to the current rollover condition of the vehicle. As the vehicle is driven, a real-time display of the roll of the unit may be displayed with supplemental audio signals as attention getting cues where appropriate. Full vehicle testing of the system is scheduled to begin in October 1996 with program completion by August 1997.

Other potential applications for a "force" sensing fifth wheel include weigh-in-motion, eliminating the need for vehicles to stop at scales to be weighed. In this use, the vehicle would transpond the weight to an inspection station, thereby registering the vehicle and its weight without the associated downtime for stationary weighing and extra fuel usage during these stationary periods. The data exchange could also include the date of the last safety inspection, vehicle ID and destination.

Holland Hitch is presently working towards a "force" sensing fifth wheel concept that incorporates the sensor into the top plate itself. This allows for complete flexibility in applying this technology to a variety of field applications. By incorporating new transducer technology, the mounted height of the fifth wheel will be increased by less than 10 millimetres, providing a robust design with accuracies of better than ±2% of total scale, well within the demands of the industry. Current testing and evaluation of prototypes has shown promise, however, full fleet testing is yet to be initiated.

THE FUTURE

So what will the future hold for the fifth wheel industry? Holland Hitch can envision major changes in the not too distant future. It is entirely feasible that by early in the next century a fifth wheel will be available to the international transportation industry that

1) weighs 80-90 kilograms less than current models,

2) requires no maintenance or servicing for 7 years or 900,000 km,

3) incorporates a push button release system backed up by an electronic indicator for alerting the driver to an improper coupling,

4) includes a trailer docking aid to assist in coupling and,

5) incorporates a "force" sensing feature that is integrated with the electronic brake system, a roll advisory system and weigh-in-motion system.

Besides all this, we might also have a fifth wheel system that allows close coupling to the tractor for improved aerodynamics and reduced fuel consumption. Anything is possible!