Issued: October 1998

Tomorrow's Truck Position Paper Series

Developed by The Maintenance Council's (TMC)
Tomorrow's Truck Committee

- Tomorrow's Truck Task Forces
- Tomorrow's Truck Far Horizons Subcommittee
- Tomorrow's Truck Technology Demonstrator Subcommittee

Featuring TMC's Tomorrow's Truck Positions on:

Reliability and Durability From a Customer Perspective

Tomorrow's Braking System

Tomorrow's Cooling System

Tomorrow's Driveline System

Tomorrow's Tire Performance Expectations

Tomorrow's Interior Lighting System

Tomorrow's Trailer Productivity

Tomorrow's Total Vehicle Alignment

Tomorrow's Total Vehicle Electronic Architecture

Tomorrow's Computer Function
Tomorrow's Computer Placement
Tomorrow's Driver Interface
Tomorrow's Electrical Harnesses
Tomorrow's Service Diagnostics
Tomorrow's Vehicle-to-Office Data Communications

The Maintenance Council
A Technical Council of the
American Trucking Associations

Dedicated to the Improvement of Equipment, Its Maintenance and Maintenance Management

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INTRODUCTION

In 1984, The Maintenance Council (TMC) of the American Trucking Associations launched a new initiative aimed at increasing awareness of equipment user needs and influence among manufacturers and suppliers. This initiative was called “Tomorrow’s Truck.”

TMC undertook this mission because of a firm belief by its members that equipment users are the best source of information about the demands put upon vehicles. Since 1984, TMC’s Tomorrow’s Truck Program has been successful at promoting activities that improve transport equipment, its maintenance and maintenance management by influencing future equipment design through collective equipment user input.

TMC’s Tomorrow’s Truck Committee sets the direction of this effort by:

- identifying the equipment user agenda for future truck design.
- establishing expectation benchmarks for various aspects of equipment, such as maintainability, durability, etc.
- partnering with other organizations to further its goals.
- communicating equipment user needs to industry.

The Tomorrow’s Truck Committee creates Tomorrow’s Truck Task Forces to develop position papers on equipment user needs and expectations of future vehicle designs. These Task Forces state “what” users want in future designs, leaving manufacturers to determine the “how” through their own efforts and through TMC Recommended Practices and other industry standards development.

This document is a collection of TMC’s most recent position papers with respect to various aspects of Tomorrow’s Trucks. These position papers were developed as consensus statements, crafted with input from equipment users, manufacturers, and other segments of the commercial vehicle industry.

TMC members sincerely hope that these papers stir discussion and spur innovation in future vehicle design for the betterment of our industry and our global community.

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Issued: October 1998

Tomorrow's Truck Program Position Paper

Reliability and Maintainability From a Customer Perspective

Developed by The Maintenance Council's (TMC)
Tomorrow's Truck Far Horizons Subcommittee

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT

Some organizations define a process called "systems assurance" under which fall reliability, maintainability, safety and quality assurance and whatever particular concern(s) the organization may have (e.g. system life cycle cost). Standardized definitions for these aspects of performance or "-ilities" can do much to improve the systems assurance process in the commercial vehicle industry.

This document—prepared by the Tomorrow's Truck Far Horizons Subcommittee—presents various definitions for reliability and maintainability, and indicates how these definitions relate. It also shows there is a need to specify these qualities so equipment designers can respond to customer needs appropriately.

RELIABILITY

There are various definitions for reliability, all of which generally say the same thing. However, some authors define different kinds of reliability, a few of which will be explained.

Reliability is being able to deliver without failing. Reliability is also the probability that a given device or system will perform adequately for the intended period of time under the operating conditions encountered. It also is the probability of performing a function, under specified conditions for which designed, for a specific period of time. Some organizations break overall system reliability down into:

- Design Reliability—covering failure rates of various component parts, intrinsic population reliability.
- Manufacturing Reliability—covering the effects of the fabrication process and quality control processes on reliability.
- End Use Reliability—covering the effects of field use, handling, storage and maintenance procedures.

In addition, there are categories covering initial introduction (infant mortality), use and deterioration phases.

Reliability is often a measure of a design controlled parameter, but it helps the designer establish the proper parameter if he or she knows how the device/system is to be used and maintained.

The exponential model of reliability using the "Mean Time Between Failure" (MTBF) parameter is the most widely used method of reliability modeling. It is expressed mathematically as:

$R=-e^{-t\lambda}$

where: R=Reliability

e = 2.718

t = a specified period of failure free operation

λ= Failure rate

There are two interesting views of reliability pertinent to the trucking industry. The first is from a paper by a Boeing Co. engineer. The author notes that the defense and aerospace industries place a heavy emphasis on serviceability and maintainability. But more attention needs to be paid to this area by the commercial sector, especially the automobile/commercial vehicle industry [1].

The other states that reliability can be taken as "the duration of failure-free performance under stated conditions." The concept of a failure-free operating life (with a program of planned maintenance) has been accepted for many years by mechanical and civil engineers who design against failure modes from the onset, allowing a margin of strength over the anticipated loads. Minimum time to failure has commonly been accepted as a specification of reliability. Electronics engineers have embraced "Mean Time Between Failure (MTBF)." However, specifying reliability in terms of failure rate or MTBF is not in the best interest of either customer or supplier [2].

Reliability Characteristics

From the designer's point of view, reliability requirements must be expressed so that the aim is absolutely clear. This means establishing a precise requirement which is predictable and measurable. Thus, it must be quantitative. Qualitative statements result in vagueness as to what is meant by expressions like "reliable," "very reliable," and so on.

It is also important that the meaning of reliability should be clearly understood. Failure rate or mean time between failures are the terms most familiar to engineers. However, these terms are often insufficient in themselves to fix a requirement, if it is coupled with a requirement for a planned life between overhauls.

Failure Definitions

All reliability characteristics depend upon a measure of failure frequency. Failure, as a word, is in such common use in the language that reliability characteristics are often discussed without any attention being paid to what it really means. Where a design is to be controlled by measures of failure frequency, or quantities derived from it, it is vitally important that failure should be defined clearly. BS 4778:79 (1) defines failure as the termination of the ability of an item to perform its required function. This, in turn, raises the question of what function is. Many engineers would take the view that the termination of a function in, say, a rotating piece of equipment means that it has stopped or been stopped in order to save it from damage. This is a simple, complete and manageable definition. At the same time, however, when levels of performance are important, and they often are, it is possible for an equipment item to be running well below its designed performance and still not to have failed by stopping. Here failures can be defined as performance below some tolerable level. Many practical engineers however are unhappy with such a definition because in reality systems are often kept running in order to achieve the completion of a scheduled task despite sub-standard equipment..

In many instances this difficulty can be dealt with by specifying an MTBF or permissible failure rate for failures consisting of complete stoppage. Another way would be to specify planned life between overhauls, when the termination of that life is defined by a specified drop in maximum performance. But this will not always do. For example, in a protection device a sluggish response might result in damage to the parent equipment. In such a case failure must mean an unacceptable level of performance.

BS 4778 calls a second category a minor failure. In effect, this means a failure of some component which does not, in itself constitute a failure of the equipment as whole. Because the component is no longer satisfactorily performing its function a repair is called for though the timing of it may be chosen by the maintainer. Minor failures do not directly affect the reliability of the equipment as a whole. However, their repair gives rise to costs and hence are undesirable. Every effort must be made to design them out. Consequently, it is appropriate also to quote a permissible minor failure rate as one of the reliability characteristics for an equipment.

MAINTAINABILITY

Maintainability is defined as a characteristic of design and installation which is expressed as the probability that an item will be retained in or restored to a specified condition within a given time, when the maintenance is performed in accordance with prescribed procedures and resources. It has a profound impact on operation and maintenance costs and is closely related to reliability.

Transit industry professionals have noted a need for easy-to-maintain products because of low skill levels in their maintenance personnel pool. Basically this requires finding the most cost effective means to:

1. Identify failed units.
2. Remove and replace failed units.
3. Remove units just before their failure.
4. Provide easy access for maintenance.

A report on the subject states:

"The achievement of planned life, and indeed the avoidance of failure due to wear out in short life parts, may well depend upon preventive maintenance and maintainability, i.e., the ease with which the equipment can be maintained. Maintainability is thus an important factor in specifying reliability. It is usually specified by placing a limit (a percentile of repair times, normally the 95th). As with failure there may be different categories of repair, e.g. repairable at sea failures not to exceed 10% of all failures. To pursue a maintainability requirement the designer needs to know the maintenance policy that will be adopted in service, e.g. repair by replacement or repair in situation what maintenance facilities will be available: and the nature of the skills available in the maintainers.

Since failures of wearing items can be forestalled by preventive maintenance, there is always a temptation to over maintain to achieve a specified reliability. It is therefore prudent to place a limit on the number of preventive maintenance man-hours which may be called for in achieving the specified reliability." [3]

What this means is that maintainability is "the ease with which equipment can be maintained", and points out that maintainability is an important factor in specifying reliability.

SAE has a definition for maintainability (SAE J817a for construction and industrial machinery) which is: "measure of the ease with which routine or periodic preventive maintenance actions can be performed. These actions includes items such as lubrication, adjustments, preventive maintenance, clearing and inspections."

OTHER "ILITIES"

SAE J817a defines serviceability and repairability : "A measure of the ease with which a failed part, assembly, system or machine can be restored to a state of operational readiness."

There is also SAE J1032, “Definitions of Machine Availability,” which contains definitions for availability, failure, mean time between failure, and deals also with time-to-repair, man hours-to-repair, and an additional terms relating to repair of equipment.

Finally, durability is determined by the ratio of operational cycles received between failures versus the number promised by the designer, or how long it will really last.

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Issued: March 1997

Tomorrow's Truck Program Position Paper

Tomorrow's Brake System

Developed by The Maintenance Council's (TMC)
Tomorrow's Brake System Task Force
Under the S.6 Chassis Study Group

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT

The brake system of a commercial vehicle is obviously a key component for safe and reliable vehicle operation. The demands on today's brake systems have increased dramatically, due to reduced vehicle rolling resistance and heavy payloads. Although system designs—driven by advanced technology—have evolved to meet these demands, this design evolution has unfortunately not kept pace with user expectations for enhanced performance, reliability, and reduced maintenance of the brake system.

In support of The Maintenance Council's Tomorrow's Truck initiative, TMC's Tomorrow's Brake System Task Force offers this vision of future brake system requirements. Hopefully, this position paper will spur innovation to meet the expectations of commercial vehicle owners, drivers, technicians, and support personnel. Designers and vehicle manufacturers should find this paper useful as it provides a guidepost of desirable features for Tomorrow's Truck—without compromising vehicle safety or legal requirements.

TMC FUTURE BRAKE SYSTEM PERFORMANCE REQUIREMENTS

1. Improved vehicle stopping capability under all driving conditions should be a high priority. This includes limiting systems and valve hysteresis to a minimum, minimizing the potential for brake fade, and eliminating steer axle pulls and dives contributed by the brake system.

2. Brake pedal pressure feedback for the driver (similar to passenger car hydraulics) is a highly desirable feature, as opposed to the position-sensitive pedal on today's air brake vehicles.

3. All electronic or data communication architecture used in the brake system must be compatible with SAE/TMC standards and available on all vehicles.

4. A system status indicator in the cab (similar to a fuel gauge) that gives the driver real time information on stopping capability or available reserve would be particularly useful.

5. System compatibility improvement among tractor, trailer, and converter dollies required in the areas of brake torque, lining temperature, apply and release timing, and electronic communication. Due to the

variety of equipment and operational parameters that exists, TMC should define a brake system classification scheme (i.e., Class 1, 2, and 3) for brake systems on tractors, trailers, and dollies. This would provide the user with a simple method of determining equipment compatibility and assist equipment integration management.

6. Brake system energy media must be designed to be free of contaminants or external influences (i.e., clean, dry air, fluid, or electrical current).

7. The brake system must be environmentally friendly. Manufacturers must give design consideration to noise, air quality, disposal requirements, fire hazardous material, recyclability, and energy efficiency when designing systems.

8. Manufacturers must base brake system design criteria on future projections of increased vehicle load carrying capability. For example, a 20 percent increase might be the criteria for both cubic volume and gross weight. In addition, future brake system designs must consider the impact of aerodynamic packages, radial tires, electronic engines, low drag drivelines, and other vehicle fuel economy enhancements on brake performance.

9. Manufacturers develop durable, cost effective, lightweight components for weight- conscious users.

10. When serial communication between the brake system, engine and transmission is available, the brake system status should have “go” or “no-go” authority to limit engine torque. Safe “limp-home” capability would be desirable.

11. Control of secondary vehicle retarding devices must be integrated into the primary brake control system and be compatible with the base brake system.

12. Basic brake system operation and performance must not be negatively affected by accessory systems or on-board communication links.

TMC BRAKE SYSTEM MAINTENANCE REQUIREMENTS

Manufacturers’ design efforts to reduce, minimize, or eliminate brake system maintenance in a safe and cost-effective manner should be a high priority. However, when maintenance is required, implementation of the following guidelines ensures timely and efficient maintenance:

1. Manufacturers should:
   - simplify maintenance by providing adequate training, that employs hands-on, written, video, and PC-based instruction;
   - ensure that common mechanical and electrical tools can be used;
   - standardize parts;
   - design brake systems that minimize labor whenever possible (such as, wheel, drum, and seal removal to reline brakes);
   - color code all plumbing and wiring to an industry standard.

2. For wearable items that require periodic maintenance, a system status indicator in the cab or readily accessible service indicators would be valuable. Establishing accurate, predictable maintenance intervals is desirable.

3. Manufacturers shall consider service indicators with user friendly data retrieval capability. The system could , for example, track maintenance requirements through satellite or fuel lane data communication (provided cost effective indicators are linked to the vehicle communication network).

BRAKE SYSTEM RELIABILITY REQUIREMENTS

Commercial vehicle reliability has improved dramatically over the past 10 years. The brake system has improved and is doing more work, but efforts must continue to improve in the future. To further enhance reliability, tomorrow's brake systems may incorporate electronic logic and self diagnostic technology. Manufacturers must therefore:

- Improve sensor and connector reliability. Smart systems with weak communication links will degrade the system.
- Develop a reliable electrical interface between tractor and trailer for both power and electronic communication.
- Rationalize system and component reliability in a cost-effective manner to provide maximum end-user value.

DESIRABLE BRAKE SYSTEM FEATURES

Besides the performance, maintenance, and reliability requirements of tomorrow's brake system, TMC's Tomorrow's Brake System Task Force also documented several desirable brake systems features to consider in future design activity as follows:

- Self-cleaning brake drums and linings.
- Programmable brake system with the capability of modifying base operating parameters to "tune" or 'change" a vehicle for a particular vocation.
- Safe "limp home" capability.
- Crash avoidance capability.
- Foundation brake maintenance capability without wheel or seal removal.
- Easy spring brake release (without external air pressure) for towing and recovery.
- Load proportioning brake system. ❑

Issued: October 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Vehicle Electronics Architecture

Computer Function Performance Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Total Electronics Architecture Compatibility Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT

Computer function, as used in this paper, refers to the roles assigned to and provided by the various electronic modules, controllers, and computers located on a vehicle. Each of these components may be an element of a larger overall vehicle subsystem consisting of sensor and switch inputs and electrical loads and actuators.

This position paper provides vehicle and vehicle system manufacturers with design guidelines for computer function performance expectations. These guidelines are based on input from both the equipment user and manufacturing communities.

COMPUTER FUNCTIONS

Computer functions, for the purpose of this paper, include the following:

- *Controls*, such as engine, transmission, and braking controls.
- *Instrumentation and Display*, such as instrument clusters and primary/secondary displays.
- *Information Displays*, such as warning indicators.
- *Route Guidance*, such as Global Positioning Satellite (GPS) and database storage.
- *Operator Instruction Media.*
- *Onboard Computing*, such as data collection, system monitoring, business support systems.
- *Regulatory Compliance, Diagnostic and Service Aids.*
- *Obstacle Detection*, including forward and side view supplemental information devices.
- *Occupant Restraint Systems*, such as passive and active restraints.
- *Data Recorders.*
- *Extra-Vehicle Communications*, such as satellite, cellular, radio, Dedicated Short-Range Communications (DSRC).

ISSUES AND EXPECTATIONS

A discussion of computer function is important because functional partitioning has a direct effect on the number of electronics modules installed in the vehicle. An unrestrained number of computers, as with any other part, places an added burden on vehicle design engineers and maintenance personnel. Yet, a monolithic approach can inhibit technical performance and innovation.

As electronic systems incorporate serial data links such as SAE J1708/1587 and J1939 for information sharing and control purposes, a clear understanding of the sources and uses of the data and information is required. This aspect of computer function assignment will assist in analysis and diagnosis of system issues.

A. Function Attributes, Categories and Assignments

Computer functions can be placed in two categories:

1. Protected functions. Protected functions include those related to legislative requirements and mission critical, out-of-service functions. These include the following:

- Engine, transmission, and braking system controls;
- Warning indicators, and primary and secondary instrumentation;
- Data recorders, such as tachographs;
- Obstacle detection.

2. Operational functions. Operational functions tend to be fleet-specified and fall into the category of operations efficiency. These include on-board computers (OBC), data recorders, communications systems, route guidance sensors and displays.

These functions are not fixed. As more functions are brought under electronic control, they can be assigned the appropriate classification.

B. Functional Partitioning

Vehicle functions should be assigned to one of the existing computers in the vehicle. The number of computers onboard should be based on need. The level of integration should take into account product liability and regulatory impacts associated with specific functions.

Protected functions should be provided by the appropriate computer based on the above. Ensuring that the appropriate supplier is responsible for guaranteeing the performance of that function is also a consideration.

The vehicle manufacturer, as the overall vehicle system integrator and architect, will, in conjunction with the component supply network, assign additional functionality into existing computers or new modules. Primary consideration should be given to the needs of the fleet user, the supplier relationship, and the specific function required.

Integration of a function should be based on a trade-off analysis that considers pricing, change control, functional synergy, real estate needs and availability, and technology risks.

Volume projections, the piece-price of an add-on module, and the cost of integration into an existing system should be evaluated to determine the piece-price impact.

Computer functions integrated into the same package must be synergistic and make sense.

Inclusion of various functions should not lead to unnecessary design changes. A dynamic product with a unique design should not drive change into a module that has an inherently different life cycle or change frequency.

Existing systems should not incorporate new functions that demand new, higher risk technology. The reliability of standard modules, for example, should not be compromised by the inclusion of a new, possibly unrelated, feature that uses a less reliable technology.

Given a favorable trade-off analysis, features and functions should be included in one of the vehicle computers or control systems, engine, transmission, braking, and cab electronics. This bias drives:

- Elimination of separate processes throughout the supply chain;
- System simplification;
- Component reduction;
- Ease of assembly.

C. Information and Control Flow

Ambiguous vehicle performance information should be avoided by using vehicle data links to broadcast information needed by multiple systems. One computer should be assigned the task of particular sensor input and signal conversion. Signal receiver selection should be based on across-the-board availability, functional synergy, and input/output connector-pin capability.

Compliance testing and validation are important to ensuring that accurate and nonconflicting data is transmitted and received. Full disclosure of new messages and changes should be made at the meetings of the existing SAE J1587/1708 and J1939 committees. It is important that component suppliers as well as vehicle manufacturers participate in these forums. System design and development engineers may use these sessions to identify changes desired by the entire supply chain and to formulate appropriate compliance activities.

To promote system simplification and control/information signal sharing, all microprocessor-based modules should include industry-standard data links for information and control communications.

D. Operating System Standardization

Software operating systems should be consistent with the protected or operational role of the system.

Protected functions such as engine control, ABS, gauge warnings, and vehicle speed control, are not to be compromised by the integration of other vehicle functions. ❑

Issued: October 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Vehicle Electronics Architecture

Computer Placement Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Total Electronics Architecture Compatibility Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT

"Computer placement," for the purpose of this position paper, refers to the physical mounting and location of the various electronics modules, controllers, and computers designed into the vehicle. The guidelines TMC proposes in this paper are also appropriate for "aftermarket" installation of electronics as well.

Computer function and location are linked. The number and complexity of the functions assumed by a computer has a direct effect on issues that affect its location. These include the physical size of the module, its input/output needs (as well as connector size), technology choice and environmental characteristics. This position paper provides vehicle and vehicle system manufacturers with design guidelines for the placement of on-board vehicle computers. These guidelines are based on input from both the equipment user and manufacturing communities.

COMPUTER PLACEMENT ISSUES

Computer modules and controllers are part of a system of sensors, switches, loads, and actuators. The design of the vehicle must account for the performance of the entire system of input devices, output devices, module, and interconnecting wiring.

Available vehicle "real estate" which can be used for electronics packaging is affected by the total vehicle design, including aerodynamics, visibility, service access, storage, operator ergonomics, drive environment, and material selections. Electromagnetic compatibility and radio frequency interference present packaging considerations as well.

Often the resulting system design will have to reflect optimized locations that have to meet conflicting requirements.

PLACEMENT APPROACHES

Computer placement can be approached from two perspectives.

1. A “boxes within a box” approach seeks to incorporate all functions into a single location. Computer function decisions would determine the level of packaging integration that occurs within the box.
2. A “bundled” approach distributed computers with their primary system; e.g., cab. engine, transmission, braking , etc.

The system designer’s choices will impact—and be impacted by—real estate availability, connector size and density, system diagnosis and service, temperature, moisture, and vibration demands.

Technology trends in electronics packaging offer opportunities in component miniaturization, environmental protection and thermal efficiency. Smaller size, however, comes at a cost in temperature management issues and piece price.

PLACEMENT EXPECTATIONS

1. Electronics modules and computers should be placed in the vehicle near the system served. This minimizes wiring interconnections at the cab and overall complexity.
2. Wiring system designs should have electronics modules placed so that the wiring system effectively isolates electromagnetically “clean” and “dirty” signals from each other. Designers should reference applicable SAE standards and recommended practices that address electromagnetically clean and electrical transient environments. The harness length that low-level signal circuits and higher current inductive load circuits share is to be kept at an absolute minimum.
3. Electronics should be placed in the vehicle so as to maintain a reasonable, reliable connector selection, while reducing wiring congestion. This will improve ease of assembly and ensure highly reliable wiring installations.
4. Electronic systems requiring operator interaction, such as instrumentation, gauges, and displays, are to be located in accordance with sound human factors principles.
5. Electronics should be designed with the thermal management, shock and vibration mounting techniques that allow the computer to meet industry and OEM environmental requirements associated with the system location. ❏

Issued: March 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Cooling System:
The Vision for Heavy-Duty Cooling Systems

Developed by The Maintenance Council's (TMC)
Tomorrow's Engines Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
The Maintenance Council anticipates that future heavy vehicle cooling systems will help: increase engine life, reduce maintenance costs, and optimize engine efficiency, reliability, and durability. However, in doing so, future cooling systems must be easy to service and maintain.

This document applies to Class 7 and 8 vehicles operated in on-highway applications. TMC's design expectation for "Tomorrow's Cooling System" is one million miles of operation with B10 component reliability expectations. TMC recognizes that certain vocational vehicles—such as garbage packers or construction trucks—may need performance enhancements to meet their specific service needs.

COOLING SYSTEMS DEFINED

The primary cooling system is defined as those components related to engine and charge air cooling. TMC recognizes that the engine cooling system interfaces with other vehicle systems and must fit into overall truck design. For example, the water pump is an essential component of both the engine and the cooling system. However, it will be addressed as an engine component. Likewise, auxiliary cab heating and air conditioning will be addressed as a cab and controls component.

RECOMMENDED DESIGN APPROACH

Suppliers should guide component design to optimize future system performance, durability and user-defined maintenance goals. Co-operative interaction of original equipment manufacturers (OEMs) and component partners should drive the system strategy.

MAJOR COOLING SYSTEM EXPECTATIONS

Major cooling systems include the:

- charge air cooling system
- air movement system, and;
- engine cooling system and coolant.

Engineers should design these systems to provide the lowest total cost per mile incurred during the one million mile expected life of the cooling system. Initial cost, scheduled and nonscheduled maintenance, nonproductive downtime, system component and system operational costs all comprise total cost per mile.

The system should operate effectively with appropriate maintenance in a heavy duty truck environment consisting of various vehicle applications, oil and fuel spills, sand, dust, mud, salt, ozone, bugs, road debris, cleaning solutions, heat, etc.

A. Charge Air Systems (CAC)

TMC RP 331, identifies serviceability and service life requirements for basic CAC system components (cores, tanks, brackets and hose attachments). The connectors (hose, clamps, pipes) should withstand the constantly changing forces caused by: component movement, clamps, higher boost pressures, higher heat, and the vacuum that occurs at the beginning of rapid acceleration.

B. Cooling Air Systems

In the Cooling Air System, the fan drive should fully modulate over the full range of the vehicle duty cycle. The fan drive should also respond effectively to the cooling needs of each independent heat exchanger. If a control system failure occurs, the drive should default into an operational mode.

The fan blade should be designed to operate at the highest efficiency possible, providing the required air flow while emitting minimal noise.

If a front end belt drive accessory system (belts, tensioners, pulleys, idlers, etc.) Is used, its service life should coincide with the million-mile expected life of the cooling system, and require minimal maintenance. The number of belts should be minimized to reduce replacement costs, noise and span vibration. Tensioning devices should be automatic.

Engine manufacturers, accessory suppliers and OEMs should work together to reduce the number of belt and pulley combinations/ types. A nonessential component failure (i.e., air-conditioning compressor) should not cause a mission disabling failure. An alternative to this requirement is a reliable early detection method of the nonessential component failure.

Brackets must be robust enough to maintain system integrity. The manufacturing process and materials used for accessory brackets should be such that the brackets can maintain proper belt and accessory alignment through the one million mile life of the cooling system.

C. Engine Cooling System and Coolant

The cooling system should feature a sealed design so that antifreeze concentration and coolant levels are maintained. All components are expected to maintain system integrity and coolant thermal properties. Coolant chemistry should not need inspection and coolant should not need to be replaced during the one million mile expected life of the cooling system.

Should coolant chemistry require monitoring, the system should self-monitor antifreeze concentration, coolant level, and SCA concentration and require no human inspection during the life of the coolant.

Should the engine coolant need to be replaced, that replacement should be based on the expected life or the condemning limits. Refer to TMC RP 326, “Recycling Engine Coolant” for the condemning limits.

Connectors (hoses, clamps and pipes) should maintain the integrity of the cooling system. Coolant losses or changes through leakage (internal or external) or permeation should not be tolerated. Self-adjusting clamps that respond to thermal changes in the cooling system are desirable. Connections should be leak- and maintenance-free, yet allow for easy component replacement. Hose connector components should be electrochemically compatible with the rest of the system.

Heat exchanger service life should meet vehicle system life expectancy. Heat exchangers should be lightweight, and resistant to internal and external corrosion and erosion problems. Radiators should exhibit metals compatibility with the entire engine cooling system. All cooling systems should have drain connections at the lowest point of the cooling system and be designed in a way that prevents coolant spillage.

Core designers should strive to eliminate external fouling (clogging with road debris, insects, etc.) in normal over-the-road operating conditions. Vocational cooling systems should be designed separately and not merely treated as a simple design variation of on-highway systems. TMC recognizes that the cooling systems on certain vocational vehicles do not necessarily fall into the million mile expected life category.

Reservoirs, radiator caps and coolant recovery systems are part of the heat exchanger system and should meet the same criteria as the heat exchangers as far as durability and weight. Coolant reservoirs used for servicing (checking coolant level or adding coolant) should be translucent and marked appropriately with both hot and cold full and add levels. Where possible, it should be made possible to check coolant levels without having to access the engine compartment.

Engine thermostats are also part of the cooling system and should help maintain system integrity for one million miles of operation. ❑

Issued: March 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Drivetrain System:

Developed by The Maintenance Council's (TMC) Tomorrow's Driveline Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT

The drivetrain system of today's commercial vehicles looks much the same as it always has, but beneath the surface it continues to evolve. Materials, lubricants, design and process innovations have all enhanced drivetrain performance and reliability, and the electronics revolution forecasts even more improvements in drivetrain operation.

However, while the drivetrain system has come a long way to better serve operators, user expectations, driven by competitive pressures both in and beyond the trucking industry, demand more from the drivetrain system. Better efficiency, reduced maintenance, greater reliability, longer life, easier operation, enhanced vehicle productivity and efficient, easy to use diagnostic tools are some of these expectations. What follows is TMC's challenge to vehicle producers and suppliers to develop the drivetrain system of the future which will meet those needs outlined above.

INTRODUCTION

The drivetrain system for this discussion includes the clutch (or torque converter), the transmission, the driveshaft(s), the axle(s) and any auxiliary retarders (separate from the engine) in the vehicle configurations of today. Conceptually, it is the controller and the distributor of power to the wheels, and if so equipped, can absorb power from the wheels up to, but not including, the engine and separate and apart from the service brakes. Thinking of the drivetrain system conceptually is important to ensure that our vision of the future includes products beyond the current drivetrain paradigm.

While this paper does emphasize the structure of the current drivetrain system, the engineering community is encouraged to explore or develop power transmission devices that would revolutionize the drivetrain system. This may include changes that eliminate or combine components in the drivetrain system, like the function of the clutch or the way engine torque is multiplied to the wheels.

This position paper reviews some general features of "tomorrow's drivetrain" and addresses sequentially, starting at the interface with the engine, the desired characteristics of the future version of today's drivetrain system.

Definitions for Figures

Reliability— B5 life refers to the percent of units failed at the associated mileage. As an example a B5 of 1,000,000 miles means that five percent of a sample population has ceased to function at one million miles. Or to state it from the positive perspective, 95 percent of the sample population continues to perform after one million miles has been achieved. Listed in this paper are five typical vehicle vocations for which the figures above express component reliability (in miles). Please refer to SAE J2391 for these as well as other vocational definition standards.

FUTURE DRIVETRAINS

General Drivetrain System Requirements for Tomorrow

1. All electronic devices or systems should have universal (not company unique) PC based diagnostics to control costs and to promote general availability to the user. Data should be reliable and easily retrievable by the user. In general, sensor reliability and sensor diagnostics need immediate improvement.
2. All electronic devices or systems should be easy to adapt to the vehicle and require minimal training.
3. The capability for relaying diagnostic information to remote locations via modems, satellite communications or other means, should be made simple and reliable.
4. All components of the drivetrain system should be maintenance free for the life of the components or 1,000,000 miles without the need for manual lubrication or adjustments. Should unplanned service be required, drivetrain system prognostics should be available which have the capability to forecast failures several thousand miles in advance of occurrences to prevent problems on the road.
5. The drivetrain design and its interface with other vehicle systems should feature improved serviceability and lower maintenance costs.
6. Vehicle manufacturers and suppliers should be attuned to legislative issues and should be prepared to introduce required product features to the industry in a timely and orderly fashion to eliminate confusion which results in service, maintenance and lost productivity issues. That is, as regulations for noise or allowable loading, as examples, are passed, there should be no burden placed on the user in any manner.

7. Innovations which enhance equipment productivity, such as lower chassis height, are needed. Improved environmental friendliness of the vehicle to the driver and the public is desirable.

Tomorrow's Clutch

1. Clutch durability too frequently is limited by failure of the pilot bearing. It is a common practice to service the clutch when the mechanic is in the process of replacing a failed pilot bearing. Pilot bearing reliability must be increased per requirements shown in Figure I to be consistent with the clutch or whatever engine-drivetrain decoupling mechanism is used.
2. Clutch replacement is caused too often by clutch release bearing failures. Reliability should be improved to be compatible with the requirements of Figure I.
3. Clutch or engine-to-drivetrain coupling component life must be increased. All engagement or torque transmitting elements must be more reliable as shown in Figure I.
4. The clutch's capability to manage drivetrain system vibrations as well as torque must be improved. As vibration demands grow from engine firing pulses, flywheel fluctuations and/or inertia/ stiffness changes throughout the

Figure I
Future Engine Decoupling Mechanism (Clutch) Reliability

Figure II
Future Transmission Reliability

drivetrain system, the clutch must properly control the system response characteristics.

5. If a clutch pedal is used to engage engine torque to the drivetrain in the future, clutch effort must be reduced, even in the face of rising engine torques, to improve driveability and to reduce driver fatigue. 65 lbs. is maximum allowable, but loads similar to automobiles (less than 40 lbs.) should be achievable.
6. Engagement characteristics should be less aggressive to promote smooth acceleration. This will enhance driver comfort and be less damaging to the drivetrain components.

Tomorrow's Transmission

1. Transmission torque and power capacities need to keep pace with vehicle powerplants. Drivetrain performance should not be surpassed by other vehicle system performance parameters.
2. Transmissions should not require external cooling provisions, regardless of horsepower and torque ratings.
3. Lighter weight is desired without the addition of cost. Some compromise may be viable in some vocations. Transmission reliability must meet the specification indicated by Figure II.

Tomorrow's Driveshaft

1. Driveshaft assembly reliability must be increased to meet the requirements shown in Figure III with sensitivity to joint angles reduced. Ten degree maximum operating angles and three-degree difference from one end of the shaft to the other (currently six degree and two degree respectively) are minimum requirements up to 2500 RPM at 250 hp.
2. Driveshaft assemblies should be maintenance free, requiring no periodic lubrication. Driveshaft assemblies should be free from vibration and noise amplification. The system should be free from manual adjustment requirements, such as suspension adjustments to control u-joint angularity. Removal of the driveshaft assembly for service should be made easier.

Tomorrow's Axles

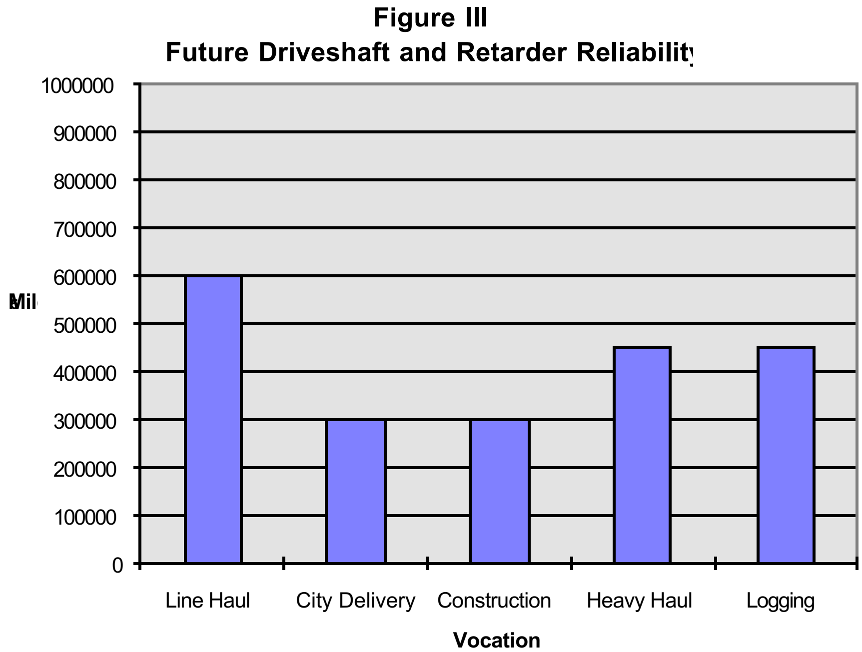
1. Reliability of axles needs to be increased as demonstrated in Figure IV but at lower cost and weight.
2. Axle vents need to be improved to eliminate lubricant escape and prevent water and other contaminants from entering the axle housing.
3. Wheel end components must be designed for 1,000,000 miles of service regardless of operating environments. They should be robust enough for manufacturing and vehicle shipping variations such that no servicing is required before the unit enters operation. Should unplanned service or maintenance be required, costs should be lower than today.
4. Differential locks for both cross axle and the interaxle differential should be automatically controlled. The system must protect itself and other components from any damage during differential lock actuation. Control needs to be sensitive to road conditions and should cause automatic disengagement when conditions call for it, such as cross axle lock in downhill slippery circumstances.

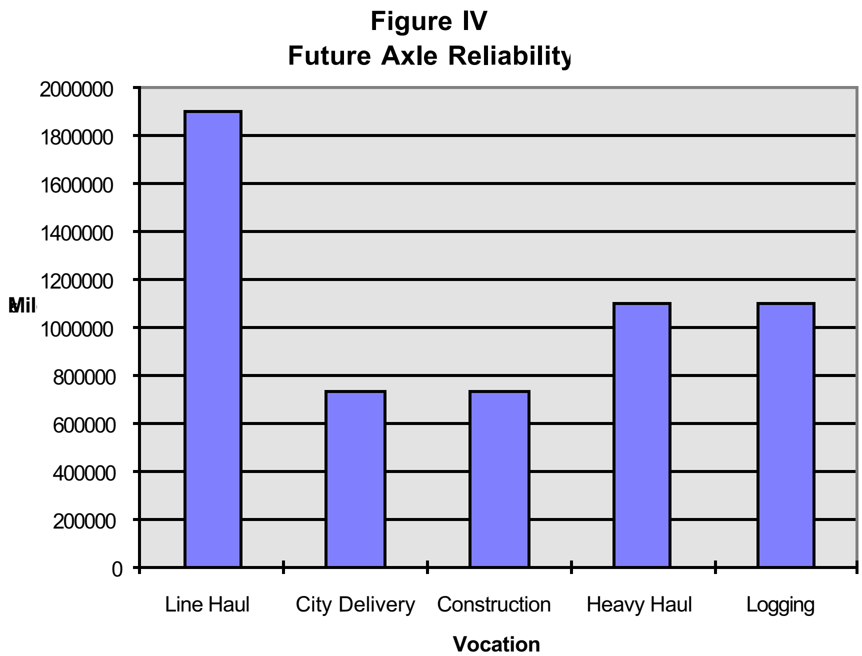
Tomorrow's Retarders

1. Retarders should be regenerative devices that can power the vehicle instead of dissipating energy as heat.
2. Retarders should be integrated with the driveshaft and silent in their operation. Retarder reliability must equal driveshaft reliability (refer to Figure III).
3. The operation of retarders should be transparent to the driver and should perform automatically with braking system actuation.

4. Retarders should be added to improve braking performance and reduce foundation brake wear. They must be cost effective and low in weight to minimize any adverse effect on economy or productivity.

Today's heavy-duty vehicles are sophisticated complex systems. Drivetrains have kept pace with this evolution. This document expresses equipment users' desires and expectations for "what" tomorrow's drivetrain system must deliver. It is the vehicle manufacturers and suppliers must now determine "how".





Issued: October 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Vehicle Electronics Architecture

Driver Interface Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Total Electronics Architecture Compatibility Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
The term "driver interface," as used in this paper, refers to systems and procedures that cause or require interaction with the driver of the vehicle. This interaction can encompass both on-board as well as off-board systems. However, communication methodology between on-board and off-board components will not be addressed in this paper.

This position paper provides vehicle and vehicle system manufacturers with design guidelines for the vehicle driver interface. These guidelines are based on input from both the equipment user and manufacturing communities.

DRIVER INTERFACE ISSUES

Perhaps one of the most significant driver interface issues today is the variation in control or interface features among vehicles. Drivers frequently must cope with inconsistent locations of interface points. Often the interface points are not visible due to changes in ambient light, and switch surfaces are not always large enough to be easily operated while the vehicle is in motion.

Interface points frequently lack intuitive operating characteristics. Drivers often need a manual to simply reset a clock, for example.

Beyond the operational issues of today rises the problem of *information overload*. The amount of information available to the driver is expanding rapidly. Dozens of new diagnostic sensors are being proposed that will provide the driver with detailed information about the "health" and safety of the vehicle.

Driver information systems such as satellite communications systems and real-time navigation, are expanding. Collision warning systems are being deployed by a number of suppliers— each with its own unique operator warning system. Changes in basic control systems, such as adding “hydraulic brake feel,“ to air brake systems, are being considered.

Dealing with the previously mentioned set of situations and expanding amounts of information is a daunting task. The driver could become overwhelmed with information without coordination and careful integration of a driver interface system.

The overriding concern is that the drivers' attention remains primarily on the critical task of driving. A well-designed driver interface system will provide the operator with key information needed to safely and effectively operate the vehicle, but not significantly distract him/her from the primary task of driving.

INTERFACE SYSTEMS AFFECTED

Driver interface systems include everything the driver uses to control or manage either the vehicle orvehicle subsystem. Examples include:

- Anti-theft systems.
- Attention deficit or drowsiness warning systems.
- Audio and video systems.
- Brake system.
- Cruise control or Power take off speed control.
- Diagnostic systems.
- Door and window controls.
- Engine and transmission.
- Heater and Air conditioning controls.
- Interior and exterior light controls.
- Miscellaneous accessory systems.
- Object avoidance systems.
- Operator record systems, i.e. trip logs, state crossing information.
- Satellite or cellular communication with other sites.
- Seat controls.
- Steering system.
- Supplemental information systems, such as video cameras.
- Vehicle status information; i.e., speed, air reservoir pressure, powertrain.
- Temperatures and pressures.
- Windshield wiper/washer controls.

FUTURE INTERFACE EXPECTATIONS

The driver's focus should remain on driving whenever the vehicle is in motion. Therefore, access to operational functions requiring execution of multiple steps that could contribute to driver distraction should be restricted to use when the vehicle is stationary only.

Driver interaction with the vehicle electronic systems should not distract from the primary task. The interface used should be capable of using the multiple data bus and software packages on the vehicle without the driver being required to switch between multiple software screens.

Function Characteristics

- The driver should hear or feel a response when a switch or touch control surface is operated.
- The driver should hear a response when speech-operated controls and systems are operated.
- System reaction to the operation of a switch should be quick enough that the driver doesn't feel a need reactivate the switch. The change of status or condition should not be delayed.
- Placement of controls and vehicle information outputs should encourage drivers to keep their eyes on the road and hands on or near the steering wheel.
- Warning lamps and instruments should not reflect on the windshield.

Performance Recommendations

- When interaction occurs between the driver and the vehicle any number of control and display concepts could be used. Examples include, but are not limited to: heads-up display, soft keys (touch screen), buttons located next to the display, controls on the steering wheel, speech input and output, etc.

- Developed technologies should support the driver using intuitive learning skills. This initiative can be supported through the use of universal symbols and/or safety-warning color schemes.
- Display brightness should automatically adjust to ambient conditions to avoid night blindness, and provide readability in sunlight. Also display controls should be included that allow the auto-adjustment to be overridden to meet driver preferences.
- Display brightness management should be independent of daytime running light systems.
- Gauges and displays should be visible when the driver has sunglasses on.
- Displays and gauges should be visible by 90 percentile of the population when in the driver seat.
- Actuation controls must be visible day and night.
- Actuation controls should be within the reach of 90 percent of the population when upright in the driver seat.
- Designers should be sensitive to the position and amount of force required to use controls and switches.
- Shape, color, size and texture should be used to indicate the function and operation of a switch.
- Once familiarization with the vehicle has occurred, primary actuation controls should be identifiable by touch without the drivers attention being distracted from the road surface.
- Product designers should use ergonomic study parameters to establish optimal display size and distance away from the user.
- There should be a consistency in the placement of gauges and switches throughout similar vehicles.
- Alarms and audible warnings should be standardized. Examples include having a tone group that should be used for safety issues and another for warnings.

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Issued: October 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Vehicle Electronics Architecture

Electrical Harness Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Total Electronics Architecture Compatibility Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
The electrical harness is the "central nervous system" of the vehicle. Proper vehicle function depends on this vitally important system. The purpose of this position paper is to provoke discussion on electrical wiring harness and electrical system design. This paper describes TMC's position on harness performance, maintenance, reliability requirements, and recommended features. However, this document does not refer to any specific system or load. This position paper provides vehicle and vehicle system manufacturers with design guidelines for the placement of on-board vehicle computers. These guidelines are based on input from both the equipment user and manufacturing communities.

FUTURE ELECTRICAL SYSTEM PERFORMANCE REQUIREMENTS

1. Improved electrical system performance under all operating conditions should be a high priority. This includes reliability, durability, and serviceability for connections, terminals, wire, sealing materials, harness coverings, and clipping devices.
2. Electrical interfaces reduce the quality and reliability of the electrical system. The number of interfaces should be kept to a minimum while still allowing efficient harness manufacture, vehicle assembly, and component service.
3. All circuits should have adequate electrical protection in the event a fault occurs. A fault should not damage electrical components except for devices expressly used for circuit protection.
4. Electrical harnesses should be environmentally friendly. Design consideration must be given to vehicle noise, air quality, disposal, recycling, and energy efficiency.
5. Electrical harnesses should be designed to allow the addition, by a trained professional, of extra equipment. This includes the ability to safely carry current in the main power and ground circuits, the ability to provide electrical protection, and the ability to access the appropriate portion of the vehicle.

6. Electrical harnesses should be designed to aid in troubleshooting vehicle faults. This includes fault detection, isolation, and correction.
7. Electrical harnesses should be designed around readily available components. This aids in harness manufacture and repair.
8. Electrical harnesses should be designed using components that meet the requirements of the application. Factors to consider include temperature, fluid imperviousness, physical strength, electrical properties, mounting dictates, cost, and weight.
9. Electrical harnesses should be designed so that the cable size is dictated by the load and physical strength requirements. Terminals and connectors should be selected based on the manufacturer's recommendation for cable size and current-carrying capacity.
10. Cable type should be selected, bundled, and routed based on the load, location in the vehicle, and application.

FUTURE ELECTRICAL SYSTEM MAINTENANCE REQUIREMENTS

Reduced maintenance requirements for the electrical system should be a high priority in the design of electrical harnesses. When maintenance is required, however, the system should be readily serviceable. The following guidelines will aid in developing an efficiently maintainable system:

1. Electrical systems should be designed in accordance with appropriate SAE/TMC recommendations.
2. The ability to maintain a vehicle should be simplified by providing adequate training and easy-to-follow instructions.
3. Electrical harnesses should be designed to allow for the use of common tools and procedures.
4. Vehicle manufacturers should standardize parts.
5. When designing the electrical system, adequate access should be provided to areas requiring maintenance.
6. Similar connectors should not be in such close proximity that they can be incorrectly mated.

FUTURE ELECTRICAL SYSTEM RELIABILITY REQUIREMENTS

Manufacturers should strive to develop highly reliable and durable electrical systems that last the life of the vehicle.

1. Interfaces, where one component mates to another, should be designed to last physically and electrically.
2. Wires exiting components directly should be designed and installed such that they last the life of the vehicle.
3. Elements of the system located in areas where environmental protection is required should be protected.
4. Interfaces that are intended to be disconnected and reconnected should be designed to survive repeated use.
5. Electrical harnesses that are intended to cross between areas of the vehicle that move independently of one another should pass through the region of least relative movement, or be designed to survive in the environment in which they have been located.
6. Drip loops should be provided to reduce the chance of moisture intrusion into an electrical component.

FUTURE ELECTRICAL SYSTEM FEATURES

In addition to the performance, serviceability, reliability, and durability requirements of the future electrical system provided above, TMC's Tomorrow's Truck Program has also documented several desirable features to consider in future design activity:

1. Electrical harnesses should be installed to the vehicle using self-sizing devices that do not require the removal of hardware already installed to the vehicle.
2. Electrical harnesses should be installed on the vehicle so that they need not be removed to perform routine maintenance on other areas.
3. Electrical systems should be designed using a minimum amount of connectors.

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Issued: October 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Interior Lighting Systems

Developed by The Maintenance Council's (TMC)
Tomorrow's Electrical System Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
Until recently, commercial vehicle Interior lighting systems have been very basic. Recognizing that system complexity is increasing, The Maintenance Council (TMC)—through this position paper—sets new design expectations for interior lighting systems with respect to performance, serviceability, reliability, ergonomic design and maintenance.

Packaging limitations, available power consumption, and costs have limited the number of lighting features in today's units. Tomorrow's trucks will require higher levels of performance from interior lighting systems. This paper addresses user-drive performance goals that:

- identify new features.
- reduce maintenance.
- reduce system complexity.
- improve reliability and safety.
- minimize packaging requirements.
- reduce electrical power consumption, and;
- minimize service requirements.

PERFORMANCE RECOMMENDATIONS

1. Reduced Electrical Power Consumption
As more and more electrical functions are added to the vehicle, the demands for available power increase. Thus, the electrical power consumption associated with today's lighting technology must be reduced. A more efficient lighting system will allow additional lighting features, while at the same time minimizing power demands.

2. Improved Visibility
Making interior controls and systems more visible to both driver and passengers reduces the required effort to locate and use them. Providing low-level lighting to these features eliminates the need to turn on overhead dome lamps, which cause glare and reduce visibility outside the cab, making for unsafe driving conditions. Practical applications of low-level lighting include: switch backlighting, map pockets and storage areas, door handle and window controls, and seat-belt sockets.

Increased Functionality
More convenient, practical and uniform lighting features need to be incorporated into sleeper cab storage areas. The glare associated with traditional dome lamps must be eliminated. The cab must be illuminated to provide a more user-friendly ergonomic envi-

ronment. A list of reduced power, but functional lighting features includes the following:

- Puddle Lights
- Foot Well Lights
- Entrance Step Panel Lights
- Exterior Door Handle Lights
- Decorative Headliner Lights
- Underbody Lights
- Misc. Courtesy Lights
- Illuminated Entry System
- Map Pockets
- Switch Back Lighting
- Instrument Panel Controls
- Storage Area Lights
- Seat Belt Sockets
- Interior Door Handles
- Decorative Logos
- Maintenance and Service Requirements

Increased Safety and Security

Perimeter lighting can be incorporated into a vehicle's design to provide overall security and comfort during cab entry and egress. Lighting features integrated into the door and trim structures should provide road surface puddle lights and step panel illumination. Light in these locations will help increase safety and prevent potential injury to occupants entering or exiting a vehicle. Perimeter lighting can also provide drivers additional security assurance as they approach the cab.

Design Flexibility

Greater design flexibility can permit design engineers to incorporate lighting features based on need and desire, rather than by packaging limitations and cost. Future designs need to incorporate the ergonomics and human factors associated with lighting. The designs can also integrate unique, optional themes (i.e. decorative trim surfaces with image/logo back lighting). This criteria can not be met unless the packaging of traditional lighting features is dramatically improved.

Packaging Improvements

The interior illumination system must require fewer components. System complexity and component packaging size must be reduced. The creation of smaller, thin profile, and flexible lighting structures can permit implementation of new unique features. The heat associated with incandescent bulbs currently limits the development of these structures.

Serviceability

Future interior lighting systems should not require the removal of interior structures, lenses and instrument panel modules to service failed lights. When required, service for the entire interior lighting system must be accomplished—start-to-finish—in 15 minutes or less. All components and related installation/removal tools must be common and available.

RELIABILITY REQUIREMENTS

Overall System Reliability

Tomorrow's trucks may require additional features in locations that would otherwise prove costly or troublesome with incandescent bulbs. Door puddle lights, entrance step panels, and exterior door handles, for example, would be exposed to extreme moisture and vibration problems generally experienced in a door mounted location. These bulbs are typically subject to high moisture exposure and high vibration shock environment. For these reasons it is uncommon to locate lighting structures there. TMC challenges manufacturers to develop a lighting system that can reliably provide light in these locations.

Reliability is also a concern at the vehicle assembly site. Bulbs are subject to a high failure rate due to handling during the vehicle assembly process.

System Service Life Expectations

The useful life of the interior lighting system should be equal to the life of the vehicle. Incandescent bulb technology is limited in this respect. Tomorrow's interior lighting systems must be capable of lasting longer while reducing maintenance needs.

Heat Elimination

Lighting features should be void of heat and feel "cool to the touch." This would allow lighting packages to be made smaller and simpler. Features can then be created in locations that otherwise had been size restricted.

Reduced Electrical System Complexity

Electrical short circuit concerns and routing/ packaging issues must be eliminated in tomorrow's trucks. Electrical circuit protection must be simplified by reducing the total system load to be protected. This would, in turn, reduce the electrical grounding load requirements.

Electro-Magnetic Interference (EMI)

Tomorrow's interior lighting systems must be immune to electromagnetic interference (EMI) to accommodate increasing vehicle electronic complexity.

Incandescent Bulbs

Design engineers should reduce the number of filament based light sources within a vehicle. Also, the bulbs that do remain should be made to last longer, be more reliable and use one bulb part number for as many different applications as possible (to help reduce bulb part number variances). A significant reduction in the number of bulbs would improve the interior lighting system reliability.

Lower System Costs

Future lighting systems must be cost effective (less than or equal to) when compared to traditional systems, even when offering new features. Overall lifetime system costs can be further reduced by improved system reliability and longevity. Lighting features should operate with up to 3,000 hours life minimum. (This is two to four times today's average incandescent bulb lifetime.) Maintenance costs can be lowered by reducing repair frequency, improving access, and reducing system complexity.

CONCLUSIONS

Technological advances can improve tomorrow's interior lighting systems. The challenge that design engineers face is to make appropriate use of complementing multiple technologies for Tomorrow's Truck. Designers should pragmatically implement the correct technology to the right application. The optimum integration of different technologies into the vehicle's interior may be to use light emitting diodes (LEDs), incandescents, fiber optics, fluorescent lighting and any other new options, where each technology is best suited. TMC offers the following suggestions regarding this intention:

Fiber Optic Distributive Lighting

This system works on the principal of distributing light from centrally located sources to various locations throughout the vehicle. The heat-free and small nature of fiber optic lighting systems provides packaging and feature flexibility. The light source should be as easy to service as changing a fuse. It is best to implement fiber optics in groups of lights that function together. Examples include an illuminated entry system or an accessory lighting system. (See the "Additional Features" section.) A quantitative comparison is shown in Figures 1 and 2 for these systems.

Light Emitting Diodes (LED's)

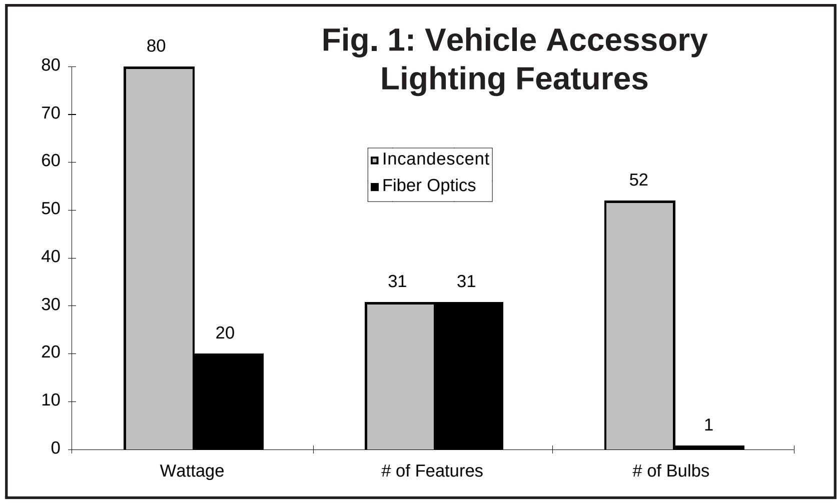
The small size and robust nature of LED's offer design engineers with a highly reliable option. LEDs exhibit very low electrical power draw, generate practically no ambient heat, and have extended service lives (approximately 20,000+ hours). Examples include small indicator lights in switch keycaps, and various back lighting applications.

Incandescent Bulbs

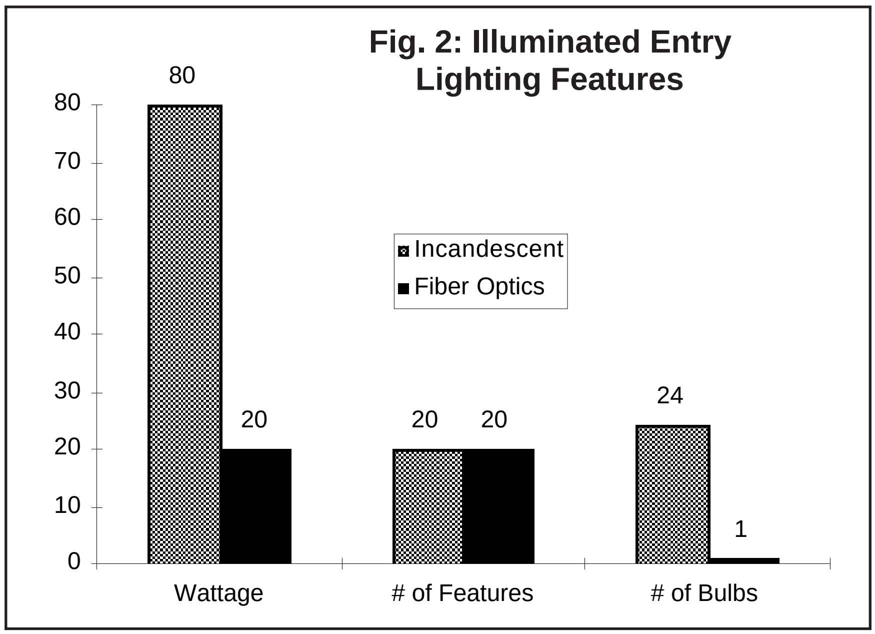
Features that are generally operated individually upon demand are good applications for incandescent bulbs. Examples include map, reading, and spot lights. To implement fiber optics on these individual features would require complex switching and shuttering and added cost to what otherwise is a low-cost feature.

Fluorescent Lighting

Fluorescent lighting offers the design engineer a very energy efficient light source that exhibits a “whiter” light and has less glare than traditional incandescent lights. Since the fluorescent bulbs have no filament, they have improved vibration characteristics. However, care should be taken to evaluate the effects of the electronic (and potentially audible) noises generated by the ballast. Cold weather performance and on-off duty cycle life may also be issues for review.



A content comparison between fiber optics and incandescent lighting technologies. The data reflects a concept vehicle that was retrofitted with fiber optics. Several features were added and the systems were compared, assuming equal feature content.



A content comparison between fiber optics and incandescent lighting technologies. The data reflects a concept vehicle that was retrofitted with fiber optics. Several features were added and the systems were compared, assuming equal feature content.

Tomorrow's Truck Program Position Paper

Tomorrow's Vehicle Electronics Architecture

Service Diagnostic Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Total Electronics Architecture Compatibility Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT

The term "Service Diagnostics," as used in this paper, refers to systems and processes developed to address diagnostic functions and can encompass both on-board and off-board system and process needs. It applies to electrical and electronic components and systems. The communication methodology and requirements between on-board components and off-board devices are also addressed in this paper.

This position paper provides vehicle and vehicle system manufacturers with design guidelines for the the development of service diagnostic systems. These guidelines are based on input from both the equipment user and manufacturing communities. TMC hopes its vision of future service diagnostic requirements will influence and spur innovation to meet the expectations of commercial vehicle owners, drivers, and maintenance support personnel.

SERVICE DIAGNOSTIC FUNCTIONS

1. Data collection and logic processes, including suggested action alternatives, should be aimed at the following:
   - 1.1. Detection and identification of failing or malfunctioning components.
   - 1.2. Detection and identification of component wear sufficient to affect vehicle performance, vehicle or driver safety, or endanger cargo.
   - 1.3. Determination and advisory of preventive maintenance needs.
2. Presentation of driver and fleet dispatch advisory messages for continued vehicle operation and suggested corrective actions for maintenance personnel.
3. Execution of self-correcting action to compensate for component failure, malfunction or wear.
4. Prediction of component failure in order to preempt actual failure with preventive action.

GENERAL PRINCIPLES AND GUIDELINES

1. The economic value of on-board service diagnostic functions must be carefully assessed relative to their cost and derived benefits. This economic equation will vary, and fleets need to be able to select those on-board diagnostic features that they can justify from a range of available options.
2. Whenever feasible, vehicle and component manufacturers should build diagnostic support into on-board electronics, taking advantage of sensors, ECU's, and communications already in existence.
3. Complex diagnostic functions should be performed in the least costly environment, generally off-board. Do on-board that which can only be done in that environment or which is economically feasible to do on-board. As an example, self-correction and data collection may only be done on-board. Other functions may vary depending on cost-benefit analysis.
4. Diagnostic functions, whether performed on-board or off-board, should consider the immediate user (driver, dispatcher, technician, or expert) and present information pertinent to that audience. Presentation of information should be done in a clear and concise way, allowing expansion into greater detail as required by the user and under the user's control.
5. Communication with and monitoring of vehicle electronics should be done in a way that masks the network technology from the user. Tractor, trailer, & container systems should universally use J1939 protocol. One physical connection should access all vehicle, trailer, and container components, and access to them must be provided when separated. A single user interface point should be capable of providing diagnostic information from all connected vehicle systems to the diagnostic user.
   - 5.1. Devices used to communicate information to the driver should make use other on-board common driver interface devices (message center display, command input device, etc.). When the vehicle is in motion, such diagnostic communication to the driver should not distract from the primary objective of operating the vehicle safely, and should focus on critical safety or emergency related information.
   - 5.2. Remote transmission of diagnostic data should be directly controlled and defined as to content, security, and frequency by the fleet owner.
   - 5.3. The ability to send commands to the vehicle for the purpose of running tests, extracting data, and simulating other on-board functions should be provided.
6. Diagnostic status and other parametric data should be universally available via broadcast or request, in a non-proprietary method, for use by all components in the diagnostic system.
7. All on-board ECU's should be field reprogrammable, with proper security control implemented. The ability to restore executable software and parametric data to original factory settings is required. The ability to create a fleet template of parametric data for ease of updating other fleet vehicles is desired but such capability must not violate any security or control protocols.
8. Off-board service diagnostic tools should:
   - 8.1. Have the ability to define, record, and display snapshot information, as well as continuously monitored status information, both broadcast and non-broadcast data.
   - 8.2. Have the ability to retrieve, display, and clear all fault and event information recorded in various ECU's. Provide fault code interpretation/ explanation.
   - 8.3. Provide decision support based query and analysis for the purpose of identifying corrective actions. Pro-

vide flexible interactive guided routines for this purpose.

8.4. Standardize attributes of customer password so that Fleet owner can use the same password for all components in a vehicle or fleet.

8.5. Have the ability to view and reconfigure ECU operating parameters in a simple, clear and concise manner. Provide assistance in understanding cause/effect relationships involved in reconfiguring ECU operating parameters.

8.6. Use consistent diagnostic terminology. Vehicle and component manufacturers should use common program function names and keys to minimize differences. Without sacrificing progress and competitive advantage between vehicle and component manufacturers, or between tool/software suppliers, the user interface to diagnostic functions and associated support information should strive toward standardization rather than unique non-essential differences in order to minimize technician training and confusion.

8.7. Be designed to maximize utility so as to spread investment costs; examples being to access repair and maintenance information, vehicle/ component specific information, parts documentation, or other business process information related to vehicle servicing. When computers are employed, they should be the most common industry standard types, running the most common industry standard operating systems. Diagnostic software applications should co-exist peacefully on such tools, following accepted software standards and practices.

8.8. Employ industry standard vehicle application program interfaces, such as TMC RP 1210A, “Windows Application Program Interface,” in the design of software applications so that all diagnostic applications can use a common physical vehicle connectivity environment

8.9. Should be capable of being run remotely from a distant site. While monitoring can occur while the vehicle is operating, most off board diagnostic functions should not be enabled if there is any negative effect on the vehicle or driver while it is in operation.

SPECIFIC VEHICLE COMPONENT REQUIREMENTS

Component ervice diagnostic systems should:

1. Provide early warning of brake wear and fade.
2. Monitor air compressor performance.
3. Provide tire pressure, temperature, and wear monitoring.
4. Provide light bulb self-checking and failure location identification.
5. Provide access to vehicle unique wiring and plumbing diagrams.
6. Provide monitoring, compensation, and alerts for all components of the starting and charging system.
7. Monitor oil quality and recommend change.
8. Monitor coolant quality and recommend change.
9. Monitor air intake system, and recommend maintenance action.
10. Monitor air conditioning system to protect compressor from failure.

Tomorrow's Truck Program Position Paper

Tomorrow's Tires

Reliability and Durability Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Tire Reliability and Durability Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
During the last 20 years, tires and wheels have changed marginally in both size and appearance, but have taken huge leaps in terms of performance, durability, safety and cost-effectiveness. Building on this success, this position paper identifies future design goals and expectations for tomorrow's tires. These expectations include: longer and cleaner wear, improved traction and braking, improved fuel economy, easier maintenance, reduced environmental impact, greater road hazard resistance, and greater retread and repair durability.

FUTURE TIRE PERFORMANCE EXPECTATIONS

All efforts to improve tire performance ultimately center on reducing tire cost per mile (CPM). The following are TMC expectations for future tire performance:

1. Continued advances in technology must yield longer tread life, both in terms of miles per 32nd rate-of-wear and actual removal mileage, even with the greater engine horsepower we see now and in the future.
2. Future tires must generate less irregular wear and be more tolerant of vehicle alignment.
3. Future tires must provide better starting, stopping and cornering traction in wet and dry conditions. However traction is improved, via compound or tread design as examples, tire noise must be controlled, resistance to flat spotting must improve, and the tendency for hydroplaning must reduced, and tire-related splash and spray must be reduced.
4. Future tires must have less stone retention and therefore less stone drilling casing damage. They must also have improved casing retreadability and repairability as well as visually improved tire appearance in terms of ozone or weather checking which is, at present, part of the natural aging condition.

5. Future tires must have greater tire uniformity to improve vehicle ride and reduce vibration, or reduced tire/wheel balancing requirements. More uniform tire construction will reduce driver complaints on pulling, (radial force, ply steer, conicity), and lopping or wobble, (radial and lateral runout, improper bead seating). Better uniformity will also produce casings of identical dimensions, which will enhance dual matching and retreadability using mold cure systems.
6. Tires must be more resistant to heat from speed, load and varying internal pressure. They must reach their operating temperature more quickly and maintain it more evenly.
7. Tires need to be more durable in terms of surviving impacts, road hazards, and punctures. They must also be better at resisting damage from mounting procedures and tools. Tire inner liners will improve air retention or the retention of whatever gaseous inflation medium is used.
8. All of these performance advances must be achieved while maintaining, or even reducing, rolling resistance and, therefore, increasing vehicle fuel economy.

MAINTAINABILITY EXPECTATIONS

1. Manufacturers should make tires as maintenance free as possible. This could be accomplished by the development of run-flat truck tires or even self-contained and disposable tire/wheel assemblies.
2. In the short term, making future tires easier to maintain means making air pressure maintenance easier. This could be achieved by the use of flow-through/self-sealing valve caps, and easier accessibility to the inside tires of the dual. Pressure in duals can be more easily maintained if there is only one valve to check and adjust pressure through—i.e., use of a pressure equalizer between duals. Replacing duals entirely with single wide base tires should also be investigated further. Pressure maintenance would be faster if shop compressors used developed greater air volumes more quickly for tires requiring pressures over 100 PSI.

   Air pressure maintenance systems promise to ease pressure maintenance. Electronic tire tags, consisting of miniature pressure sensors that allow users to read pressure without touching a tire, also merit examination. These tags alert users to tire pressure needs by identifying only the tires needing attention. On-board pressure management systems should monitor and automatically/continuously adjust pressure—even when the vehicle is in use. TMC believes better tire pressure maintenance will further reduce the occurrence of tires running flat and subsequently reduce the tire debris currently found on the road.
3. Future tires must have improved casing life. Nitrogen, or some other alternative inflation medium that is readily available, may offer an easy and inexpensive means of improving pressure maintenance and enhancing casing durability.
4. Improvements can be made in valve stems, valve stem grommets/seals, and valve cores, to make inflation, deflation, inspection and air chamber sealing more reliable in all applications and climate conditions.
5. Tomorrow's tires must be clearly marked and easier to mount, especially when considering directional tread designs. Tires must be easier to inspect on and off the vehicle, and easier to accurately measure remaining tread depth. Tire brand, tire size, ply rating, DOT numbers, high point marks (HPM), and balance marks must be large and legible. However, accuracy cannot be sacrificed.

RELIABILITY EXPECTATIONS

Future tires should feature greater performance, reduced maintenance, and *greater reliability*. Tomorrow's tires will operate at higher sustained speeds, in all climate conditions and must minimize any occurrence of casing component separation, any internal air pressure loss, and be balanced for life to reduce any irregular wear. Future tires must continue to meet and/or exceed all future legislative regulations.

DURABILITY EXPECTATIONS

Depending on application, tires must be engineered in such a way as to match the service/maintenance life of the vehicle they are mounted on. For example, future tires in linehaul service should be able to achieve a million cumulative miles for original tread and all subsequent retreads. Fewer tire changes and longer service intervals will reduce cost per mile. Tires must be resistant to road hazard failures, and further reduce PSI loss through the tire casing without and sacrificing any other performance aspects.

SERVICEABILITY EXPECTATIONS

Future tires must be easier to mount and dismount from a wheel. They must not require additional external lubricant and the bead will be of a design that ensures perfect, concentric seating every time. These tires must have a standard and more visible GG ring to visually confirm at a glance, the perfect concentric seating of the tire to wheel.

Future tires must be marked more clearly and in an industry standard fashion. Basic tire markings, such as size, max. load and pressures, DOT, unique tire identification, and other pertinent data, must be designed and molded to be more easily read when mounted on a vehicle.

Tire weight must be reduced to ease handling, provide better rolling resistance, fuel economy characteristics and reduced F.E.T.

Tires should be repairable from the outside, not requiring a dismount, or they should be designed to be self-sealing or have the capability to run without air for short periods of time and mileage before replacement. There should no longer be a need for a spare tire.

Tires should be smaller to facilitate greater cubic capacity for trucks and trailers. Also, these smaller tires should operate at lower pressures, less than 100 PSI, and should incorporate the largest possible footprint at the lowest possible pressure to reduce road surface damage.

ENVIRONMENTAL ISSUES

Future tires must be designed so that they do not have an adverse affect on environmental quality.

These tires, at the end of their useful lives, must be totally and safely disposable. Tire construction materials should be non-toxic. And, as long as tires are held before disposal/recycling, the inner liner should include some material that makes the tire interior inhospitable to insects and wildlife.

EDUCATION/TRAINING

Future tire and wheel systems will require new and more efficient means of training personnel to handle new technologies. A comprehensive, objective, and recognized program must be made readily available, easy to understand and conducted in a short period of time. ❑

Tomorrow's Truck Program Position Paper

Tomorrow's Trailer Productivity

Performance Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Trailer Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
This position paper offers trailer designers recommendations for improving future trailer construction and configuration by and after 2002. These recommendations are based on input from both the equipment user and manufacturing communities. TMC hopes its vision of future trailer expectations and requirements will influence and spur innovation to meet the needs of commercial vehicle owners, drivers, and maintenance support personnel. TMC expects that future innovations will result in reduced operational costs.

GOAL DEFINITIONS

In order to achieve the most versatility in trailer equipment, basic goals are required. These goals will be described using the following terms:

Acceptable Performance — Levels of acceptable design life when operated in specific vocations or levels of service and acceptable time limits assigned to complete specific maintenance and repair activities. For example, a semi-trailer designed for linehaul truckload use should be capable of operating for 10 years or 1,000,000 miles. An air brake system for a linehaul truck load semi-trailer should be capable of operating for 500,000 miles before requiring overhaul. Technicians should be able to replace slack adjusters and stroke indicators within no more than 30 minutes.

Maintainability — A measure of the required repair and maintenance effort needed to ensure safe and reliable operation. All labor hours and parts cost would be included in this summary. For example, a trailer that would require periodic servicing every 15,000 miles and some additional unscheduled servicing would be a trailer with poor maintainability Conversely, a trailer which only required periodic servicing every 500,000 miles and no unscheduled service would be rated as a trailer with excellent maintainability.

Reliability — The performance capability of a component or system as measured against a design standard. For example, a trailer suspension system in a line haul semi-trailer that is intended to operate for 500,000 miles before overhaul would exhibit poor reliability if it required overhaul after 100,000 miles of operation. The level of reliability is a ratio of the actual component or system's performance as compared to the original design standard.

Durability — The measure of the design life. For example, an air brake system in a line haul semi trailer operating 500,000 miles before needing an overhaul would be classified as having excellent durability. In the same line haul operation, a semi trailer air brake system needing overhaul at 100,000 miles would not be classified as having an acceptable level of durability.

Serviceability — The measure of the relative level of time and effort required to accomplish acceptable maintenance or specific repair activities. For example, an air brake system in a line haul semi trailer using an extended-life brake application valve located on a mounting plate at the front of the suspension sub-frame, accessible to the technician sitting under the trailer floor for repair or replacement, would have excellent serviceability. Conversely, poor serviceability would result if the value were mounted high inside the subframe surrounded by suspension parts and brake hoses which would need to be removed or disconnected to repair or service the valve.

TRAILER DESIGN CHARACTERISTICS AND NEAR-TERM EXPECTATIONS

Trailer Versatility

Trailer manufacturers have accomplished much to improve trailer operational versatility, such as the introduction of curtain-side, plate-side and composite construction sidewall designs. Additionally trailer designs capable of efficient road, linehaul and intermodal operation have been developed, along with low floor height, high cube designs using low-profile wheels and tires. Expanded applications of these and related designs, should lead to additional opportunities for productivity, durability, reliability and serviceability improvements.

Ride Quality

The effect that air ride suspensions have on reducing freight loss and damage and improving driver retention, along with corresponding reductions in component cost and weight makes these systems an attractive option over spring suspension systems. Adding reliable active or servo-activated, reduced-maintenance suspensions, with controlled shock absorbers and better dampening characteristics would further improve performance. Extending suspension service life to 500,000 maintenance free miles—by using components with upgraded bushings and bearings—would also advance performance.

Trailer Dynamics

Federally mandated antilock braking systems (ABS) are already in successful use. Development of heavy vehicle electronic braking systems (EBS) is making progress. This should result in a safer, more reliable and durable system. Going forward, full loop feedback brake systems—which sense vehicle speed, weight and stability and adjust braking to compensate for road conditions, climatic conditions and object proximity—would assist in controlling the vehicle operating envelope.

Splash and Spray

Tractor aerodynamics have reduced combination vehicle splash and spray in recent years. Textured anti-spray mud flaps and plastic filament skirting are examples of current industry solutions, but success has been marginal and the splash and spray problem still exists.

Axle Alignment
TMC recommends using axle alignment reference indicators on trailer bodies to help maintain lifetime axle alignment. Correct alignment has been demonstrated to be a major factor in longer tire tread wear. Sensors that measure lateral force and transmit an out of alignment warning would be beneficial.

Wheel Ends
Manufacturers of wheel ends, axles, axle nuts, bearings and seals have systems available to ensure optimal wheel end bearing adjustment All, unfortunately, are proprietary and non-interchangeable. A shake out is inevitable and superior systems will become established. The use of synthetic lubricants has extended the life of wheel seals and reduced lubricant leakage, but more work is needed. Use of low-profile tires and related wheel-end equipment, has increased and lower aspect ratio tires, smaller wheels and brakes, with extended life linings will offer the opportunity for even more increases in trailer cube, interior dimensions and improved maintainability and reliability. Automated lubrication systems have progressed substantially during the last several years and assist in reducing scheduled maintenance.

Trailer Support Legs
Higher-strength, easier and faster acting gearing, mated to advanced design leg tubes have resulted in support leg systems with improvements in durability and serviceability. Sealed lifetime lubrication or extended lubrication cycles and low temperature capability are needed value adding characteristics.

LONG-RANGE GOALS/EXPECTATIONS
Looking forward to 2002 and beyond, TMC expects many new developments in heavy truck technology that will reduce operating cost-per-mile. Among major trailer concerns is that "smart trailers" will be incompatible with older tractors and trailers which are not technologically advanced.

Improved methods of inspecting brakes in an expeditious and repeatable manner (with validated readings) is also needed.

The requirement for improved durability and a five-year or 500,000-mile service interval for suspension and running gear components remains un-met by manufacturers.

Other desired developments include:
- Electrical distribution systems which support long-life, maintenance-life LED lights.
- Better trailer aerodynamics and cube utilization without sacrificing one at the expense of the other.
- Stand-alone global positioning satellite (GPS) trailer tracking systems which can communicate, independent from tractor electrical power, with control locations.
- Improved air and electrical coupling connections, especially on longer combination vehicles (LCVs).
- Development of interior components which extend the damage protection envelope while reducing dependence on forest-related products.
- Odometer sensing capability integrated into the trailer ABS electronic control unit with visual or electronic stored data retrieval capability.
- Advanced security systems which prevent unauthorized entry into trailers.
- Durable and environmentally safe paints and finishes.
- Reduced electrolysis and increased rust protection.
- Studies regarding the application of new materials and processes into the structural and operating systems of trailers and bodies. ❑

Issued: October 1998

Tomorrow's Truck Program Position Paper

Tomorrow's Vehicle Electronics Architecture

Vehicle-to-Office Data Communications Expectations

Developed by The Maintenance Council's (TMC)
Tomorrow's Total Electronics Architecture Compatibility Task Force

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
Bidirectional communication of data between trucking fleet offices and their vehicles is becoming increasingly more important to the trucking industry for a variety of reasons. The need to control costs and improve delivery performance for customers has driven many equipment users to make major investments in vehicle systems, communications equipment and office systems. In many cases, the prudent and efficient use of these technologies have indeed allowed equipment users to gain an edge for a time on their competition.

The future promises to be even more challenging. Customer expectations will continue to increase (cost, quality of service), competition will continue to be fierce, and communication and computer system technology will continue to evolve at a very rapid rate. In addition, vehicles will become increasingly more sophisticated due to regulatory requirements, safety concerns and increased functions to improve efficiency. Also, it is unlikely that the vehicles within a fleet will be more homogeneous in the future than they are today. Hiring and keeping competent drivers and technicians will continue to be a difficult issue. Given these factors, what should the future of vehicle-to-office data communications look like?

This position paper offers a vision of future requirements and suggestions for Vehicle-to-Office Data Communications, based on equipment user and manufacturing input. TMC hopes this paper will spur innovation to meet the expectations of commercial vehicle owners, drivers, maintenance and support personnel.

BACKGROUND

Vehicle-to-office data communications systems tend to support a number of key work flows within an equipment user's business. These include data that is directly associated with vehicle operations/logistics such as vehicle location, load content, estimated time of arrival (ETA), permits, fuel consumption, etc.

"Customer Relations" uses a similar set of data to keep customers apprised of the status of their goods and deliveries. "Maintenance uses vehicle data that is associated with diagnostics, fuel consumption, Electronic Control Module (ECM) security passwords, breakdown handling, etc.

"Accounting/Finance" uses vehicle data to perform invoicing, payroll, and a multitude of other transactions. Often, messages changing load delivery status, directions, etc. must be communicated to the driver.

Many fleet functional areas need varying "levels" of the data to accomplish their missions. For example, diagnostics often require a very detailed set of data from the vehicle in order to properly troubleshoot and correct a problem. On the other hand, a monthly summary of fleet fuel consumption data pointing out major exceptions is adequate in many operations.

Future vehicle-to-office data communications systems should support as many of these needs as possible and be designed to work with the major variations in office computing equipment (hardware, operating system/environment, software), communications systems and vehicle based electronics systems. These systems must be designed in such a way that components interact with minimum reconfiguration as new equipment and office applications are added. (For example, the World Wide Web provides a similar function for accessing widely disparate information in a relatively easy manner for Internet users.)

FUTURE VEHICLE-TO-OFFICE DATA COMMUNICATIONS PERFORMANCE REQUIREMENTS

Based on member input, TMC believes future vehicle-to-office data communication systems should meet the following performance expectations:

1. Suppliers should develop vehicle-to-office data communications software applications that allow access to all vehicle information in a secure, timely and consistent manner, regardless of vehicle location, configuration or communications technology employed.
2. These software applications should be capable of bidirectional communications with the vehicle.
3. These software applications should be capable of working on a variety of fleet host systems.
4. These software applications should allow access and transmission of data in a timely manner. Examples might include vehicle position, sending an urgent text message to the driver, etc.
5. These software applications should allow fleets to protect their data and systems, and suppliers to protect their proprietary interests.
6. These software applications should be compatible with existing industry standards such as:
   - SAE J1587
   - SAE J1939
   - TMC RP 1210A
   - RP 1208
   - TMC VMRS 2000
   - SAE J2403 (Medium / Heavy-Duty E/E Systems Diagnostic Nomenclature), etc.

To meet these requirements, TMC recognizes that equipment users and manufacturers must work together to establish standards that will provide the framework upon which to build these software applications. ❑

Issued: March 1997

Tomorrow's Truck Program Position Paper

Tomorrow's Total Vehicle Alignment

Developed by The Maintenance Council's (TMC)
Tomorrow's Total Vehicle Alignment Task Force
Under the S.6 Chassis Study Group

The Maintenance Council
A Technical Council of the
American Trucking Associations

ABSTRACT
Vehicle alignment remains a problem among North American equipment users, despite previous efforts by The Maintenance Council's Tomorrow's Trucks Program to communicate this problem to the manufacturing community. Alignment problems typically cannot be corrected without unnecessary expense and downtime—a situation that equipment users find unacceptable. In this paper, TMC challenges the industry with 10 goals that, if achieved, would satisfy both equipment users and owners.

ALIGNMENT CONCERNS DEFINED

Vehicle alignment, unfortunately, continues to be an area of concern among North American equipment users. Alignment problems typically cannot be resolved without added expense and downtime and this area has not yet been addressed fully by equipment manufacturers, despite the fact that TMC members have asked them to do so in all three previous TMC Tomorrow's Trucks papers.

Equipment users expect improved alignment performance from the next generation of vehicles. Tractor and trailer axle alignment—in relation to the center line of the vehicle—needs to be improved greatly. Alignment between the tractor and trailer(s) also needs to be improved.

Some current specifications call for rear axle alignment settings that still produce side scuffing of 15.6 feet per mile. This level of misalignment does not produce *visible* tire wear, but *actual* tire wear begins well before it becomes readily apparent to the eye.

Many cost conscious equipment users today align vehicles themselves before placing them into service. This should not be necessary. Tomorrow's vehicles should be aligned at the factory to make sure that:

- all tires track parallel to the vehicle's center line, and;
- the vehicle attains optimum tire wear, fuel economy and driveability.

New tire designs featuring deep tread patterns are susceptible to irregular wear from even small increments of misalignment.

10 USER-DEFINED GOALS FOR IMPROVING VEHICLE ALIGNMENT

Based on its study of the current state of affairs, TMC's Tomorrow's Total Vehicle Alignment Task Force charges the industry with fulfilling the following goals:

1. Since true alignment can only be determined when the vehicle is loaded and in motion, manufacturers must develop new standards, techniques or equipment that measures alignment while the vehicle is loaded and in motion.
2. Vehicles must be consistently delivered to the customer in perfect alignment. The alignment must also remain perfect throughout the vehicle's service life. Additionally, alignment must not be affected by component/vehicle service and repair.
3. The trucking industry must define a standard for alignment accuracy, work to maintain that standard industry-wide, and develop a system to measure it.
4. Manufacturers must redesign the fastening systems used to maintain vehicle alignment with respect to Goal 2 above. These systems include axle positioning systems, attachment systems, etc.
5. Manufacturers must use closer tolerances on initial alignment of both tractors and trailers. This would help the industry achieve Goal 2 as stated previously.
6. Manufacturers must design vehicle steering systems that eliminate front tire scuffing during turning maneuvers.
7. The industry must develop an on-board vehicle system that monitors and alerts equipment users of alignment problems. If this system is electronic, it should be compatible with and incorporated into existing vehicle electronic systems.
8. The industry must develop alignment measurement systems that are easy to use and offer repeatable results.
9. The industry must develop a standard alignment system that affords simple realignment when required. ❑