A SYSTEMS APPROACH TO TRUCK DESIGN

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Much attention has been given in recent times about the importance of listening to the voice of the customer during product development to ensure that customers' needs are met and/or exceeded. The task is not as easy as it may appear to be, for to truly meet all customer needs, it is important to accurately define who the customer is.

From a manufacturer's and/or engineering perspective, a customer can be defined to be anyone whose needs must be met by the engineering of the product - and thus, the universe of customers expands far beyond just the end-user (ie, drivers) to include maintenance people, fleet owners, dealers, marketing and sales people, manufacturing engineers, assembly line people, customer service, suppliers, government regulators and other highway users as well.

With all these customers, each of whom may have different needs, and recognizing that customers' needs are dynamic and constantly changing, a greater level of communication and interaction with the customer is needed to guarantee that the product will meet all needs.

The first step in listening to the voice of the customer is to be sure that you are speaking the same language as the customer. To promote such communication, programs can be used to place the design engineers into the role of the customer.

Kenworth has used programs such as their Engineering Drive Team where engineers qualify for their commercial drivers license and are placed with a customer to drive for a week or more as a working member of a team operation to experience exactly how the product is used, and what exact needs are. Based on this program, in 1992, over 20 product improvements were incorporated in Kenworth products as a result of the engineers' collective experience. In 1993, the program was expanded to include a Mechanic's Team where engineers work in a Dealer's service shop to focus their attention on the need to create designs for ease of repairability and servicability. The Mechanic's Team program complements the Kenworth plant rotation program where engineers work at the assembly plants to focus on design for ease of assembly.

Information and feedback from user groups also plays an important role in product development. The Kenworth Drivers' Board is an example of a communication mechanism to obtain much information directly from the end-user. The

key suppliers at the design phase of a project, to extend engineering resources by relying on the expertise of those suppliers. By involving suppiers early in the design process, the manufacturer gains in the long run because the supplier learns more about the manufacturer's needs and will then be able to provide better service in future projects.

Before any product goes to market, the reliability and durability of the design must be tested. While the new design tools and analysis techniques provide a much higher degree of confidence than in the past, full scale testing under realistic conditions is needed for final verification of the design.

The PACCAR Technical Center provides support for Kenworth heavy truck testing. Engineers at the Technical Center have specialized training in durability and fatigue testing of components, environmental, EMI, RFI and electrical testing, vibration and acoustic intensity measurement and analysis, and material analysis. Depending on the product being tested, tests can be of individual components, subsystems, or full vehicle tests. Data has been acquired in operations ranging from typical over-the-road longhaul operations to severe logging operations in Malaysia, and from outback road train operations in Australia, to oilfield operations in Canada. The collective database ensures that the testing will cover the extreme boundaries of operation to verify that the design meets the expected performance standard.

From product definition through to production the key to a successful design is communication with the customer. The best way to ensure proper communication is to establish ways in which the engineers can directly interact with the customer to experience the customer's needs directly. New technologies have been developed which aid in translating these needs into designs quickly and accurately, the end result, after final verification testing, is a product that goes into production easily and meets or exceeds the needs of all customers. Then, with a view towards continuous improvement, the cycle begins again.

generation of computer aided design tools are readily available.

Software to assist in evaluating designs for ergonomic or human factor considerations will help the engineers ensure that placement of gauges and switches are within an appropriate range of motion or field of vision, and that the designs take into consideration all sizes of driver as well.

New design software allows the engineer to design parts as true 3-D solid models - that is, instead of representing a part as a collection of lines on paper, the engineer can now see the actual part, and assemble the parts on the computer. This enhances accuracy of design, for interferences and difficulties in assembly or servicability can be identified during the design phase and changes implemented as necessary before committing to prototype hardware.

Once the basic design of the part is complete, the same 3-D computer geometry can be used for stress analysis using Finite Element Analysis. In this type of analysis, the part is subjected to various stress loads on the computer, and the result is a color contour map of the stresses within the part. If there are unacceptably high stresses, the part can be redesigned on the computer. This eliminates repetition of a design-build hardware-test-redesign cycle that would slow product development in the past.

New technologies such as stereolithography or laser scintering than can use the same 3-D geometry to produce full scale plastic parts in a matter of a day or two. These plastic parts can be used for trial fit assembly, styling design reviews, clearance checks, and if the part happens to be a casting, the plastic part can be used as the pattern for a sand casting to get prototype parts for testing quickly.

Such design tools are gaining rapid acceptance among automotive suppliers, and thus, design information can be easily passed from the manufacturer to the supplier of the parts. In many instances, design geometry is now passed electronically which helps ensure integrity of design.

The same geometry can be used in support of technical publications, service and parts manuals, and assembly drawings. Thus, simultaneous engineering of support publications can occur, as can design of any assembly fixturing or tooling that is needed, further reducing time from design to production.

While every manufacturer and engineering manager would like to believe that they have a knowledgable staff, it is impossible to maintain expertise in all areas. Thus it is becoming more common to see strategic alliances form with

Board is comprised of over 500 drivers, half of whom do not drive a Kenworth product. There are team drivers, owner operators, and men and women drivers, all of whom are more than willing to give their input on what can be improved in truck design. Quarterly meetings, and monthly newsletters with surveys to obtain specific information about various design aspects are used to ensure a continual flow of current information is available to the design engineers.

Once the product has been designed, one way to validate that customer needs have been met is to be able to explain just how the design meets a particular need. In Tom Peters' book "In Search of Excellence" he relates a story about the time he bought a calculator and how impressed he was with the salesperson's product knowledge and enthusiasm about the design of the product. The salesperson turned out to be a design engineer who was assigned to sales to get closer to the customer in order to find out more about customer needs and how to translate them into design criteria. While it is not always practical to rotate engineers through the sales organization, it is possible to simulate a sales situation to allow the engineers to experience communicating with a customer and try to explain how a design meets a customer need.

In 1993, Kenworth held the first engineering walkaround contest to provide such an opportunity to the engineers. The objective of the contest was to have the engineers play the role of the salesperson. The perspective customer was from the Kenworth training department, and the engineer had to explain the features and benefits of the Kenworth product well enough to obtain the sale. As a result of the contest, the Kenworth engineers have gained much greater appreciation for the need to work closer with sales and, in fact, the winning engineers now hold positions in the marketing department.

With a focus on continual improvement of the product, customer information cannot be viewed as important only during the product definition phase. Using a Deming team approach, it is possible to work with customers to gain a continuous stream of information in a process that is mutually beneficial. In this process, an engineer is assigned to work with a customer as a dedicated resource to assist the customer in refining the product specification to more exactly meet the customer needs. In return, the customer will provide objective feedback on how to improve the product, and will work with the manufacturer to verify new designs and serve as a beta site for new prototypes.

Once the design criteria has been established, it is important that the design be brought to production quickly and accurately. To assist the design engineers, a new