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Tesla, Inc. v. Nikola Corporation
US Patent 10,077,084
Tesla Ex. 1018

2000-01-3402

Ergonomics Program at Freightliner

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ABSTRACT

This paper describes the ergonomics program at Freightliner and how it is integrated in the engineering and design process. It will also describe how we use advanced technologies such as 3-D Digital Human Modeling with RAMSIS and how these are applied to the design process to ensure optimized ergonomics in our trucks.

INTRODUCTION

Sound ergonomics is an important differentiator among all vehicles but especially among trucks, because professional truck drivers spend many hours at a time on the road in their trucks. It is not unusual for a truck driver to spend up to 10 hours each day behind the wheel and to log more than 100,000 miles per year. With today's changed anthropometrics, demographics and shortage of qualified truck drivers, good ergonomics in trucks has become even more important to attract and retain drivers. Due to secular growth (younger generations are taller than older generations) and an increase in overweight people (40% of the adult populations is overweight or obese) cab and seat design has to accommodate taller and bigger drivers. In addition, during the last decade the number of female truck drivers, including those of class 8 trucks, has nearly doubled from 100,000 to 175,000 (1). This also has important implications for the design and layout of the driver cab and seats. Today this anthropometrically more versatile driver population must be accommodated by addressing the spatial and comfort needs of shorter and smaller female drivers as well as taller and heavier male drivers.

Traditionally, general ergonomic guidelines provided in textbooks, published papers and SAE procedures have been used. However, these guidelines are often not specific enough for the truck environment, are out-dated, and frequently fail to address any interactions that different items would have with each other. For example, the location of a dash-mounted shifter may be optimized for reach and reduced effort to actuate, but at the same time obscure vision to important controls. Therefore a truck OEM has to build bucks or prototypes, select appropriate test subjects that reflect their domestic and international truck buying populations and then test for ergonomic, safety and comfort concerns. This is always time consuming and expensive to develop and build the hardware, find test subjects and administer tests. Also to build bucks, you have to have the design completed to a certain point to produce parts. This becomes especially difficult early on in the truck development cycle. It is very important to incorporate good ergonomics early on in the concept phase, when changes are still easily and economically made. With today's shorter product development cycles, the use of virtual mock-ups and virtual people in a CAD environment is one solution that can provide quality information early on in the design process. In addition, the 3-D CAD environment is easily changed when new design proposals or different iterations need to be evaluated. This is much faster and less costly than modifying existing hardware or building new bucks.

ORGANIZATIONAL OVERVIEW

To address ergonomic and comfort issues Freightliner has a dedicated ergonomics and human factors group that is part of the Engineering Body Center. The Ergonomics group works closely with styling, interior and exterior body groups, chassis and safety departments to implement ergonomic design in our vehicles. We provide support to all truck platforms within Freightliner, which allows for uniform ergonomic guidelines, criteria and tool applications.

Ergonomic support is provided during all phases of the truck and feature development cycle. However, the main emphasis for us is to provide input early on in the concept phase when design concepts are developed. This allows Freightliner to implement optimized ergonomic design and changes relatively easily and economically.

In order to evaluate many ergonomic issues early on in the concept phase we employ RAMSIS, a 3-D Human Model for ergonomic evaluations. This allows us to perform necessary ergonomic investigations in the CATIA CAD environment even with little geometry defined. In addition, we use SAE and ISO guidelines and perform subject testing in either concept bucks or trucks.

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