Human Factors in Traffic Engineering

CEE-6603: Final Report

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Dear Dr. Aaron

In response to the final assignment posted on T-square on 8th January 2016, we are submitting our final paper. This report is prepared based on our best understanding of human factors in traffic engineering.

Based on the literature review and case study, the attached report shows the definition of human factors in traffic engineering and its applications in the transportation field. If you have any questions or need clarification regarding the attached report, please contact me by email or telephone.

Sincerely,

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Human Factors in Traffic Engineering Report

1. Introduction

Human factors engineering is defined as the science that applies knowledge from psychology, physiology, and kinesiology to the design of devices and systems for safe and effective human use. As a profession, human factors engineering includes a range of scientists and engineers from several disciplines that are concerned with individuals and small groups at work (Holstein 2016).

Human factors engineering has many applications across the diverse fields of science such as biomedical engineering, industrial engineering, mechanical engineering, etc. This paper, specifically, aims at exploring the application of human factors in the field of traffic engineering.

In a transportation network, user error is an eminent cause of crashes (HSM 2010). Such errors mostly rise due to human physical, perceptual, and cognitive limitations. For example, drivers may make erroneous judgment regarding closing speed, curve negotiation, and passing intersection during yellow light. It is the job of a traffic and highway engineer to effectively use the principles of human engineering to design highways and its respective elements in a way that drivers have a safe experience.

In addition to highway design, human factor engineering is also applied to the design of vehicles. The role of human factors in vehicle safety research is to provide an understanding of how drivers perform as a system component in the safe operation of vehicles (NHTSA 2010). Drivers’ performance is affected by several environmental, psychological, and vehicle design factors, and human factors purpose is to determine which aspects of vehicle design should be modified to improve driver performance and reduce unsafe behaviors.

With this brief introduction, the next section will be devoted to a review of the literature on human factors application in traffic engineering. Further on, section 3 discusses a number of case studies where the application of human factors engineering in traffic is discussed.
2. Literature review

There are numerous studies in literature on the application of human factors principles in traffic engineering. Here, we have categorized the research in four areas: intersection, speed management, pedestrian and bicycles, and visibility.

2.1. Intersections

An intersection collision avoidance study was conducted by Bellomo-McGee (2003), with the aim of evaluating Intersection Collision Avoidance System concepts aimed at reducing the number of high-crash intersections in three states. Based on the study, the human factors important to the selection and design of infrastructure-based technology was identified as driver age, vehicle gap acceptance, and response to emergency events. They recommended more studies to validate their preliminary findings and human factor testing to meet the requirements of the operational concepts such systems.

In another study by Bonneson and McCoy (1994), driver understanding of protected and permitted left-turn signal displays was investigated through a survey to establish whether signal design would cause confusion and safety concerns for drivers. The results showed that only 70 percent of respondents correctly understood the meaning of Protected and Permitted Left Turn (PPLT) signs, and this understanding increased among the more educated, and decreased among the more experienced and older drivers. In addition, the survey indicated that the exclusive vertical PPLT design is correctly understood by a majority of drivers.

Gattis and Low (1997) investigated intersection angle and drivers’ field of view. Their results indicated that a minimum intersection angle of 70 to 75 degrees will provide for an improved line of sight and consequently decrease the probability of crashes.

2.2. Speed management

Feng (2001) presented an overview of the research on the relationship between speed and safety. The studies show that drivers may not always accurately rate their driving behavior, so relying on subjective surveys may not be wise. In addition, weather has a close relationship
with speed and safety because it affects visibility, stability, and controllability of drivers and cars.

2.3. Pedestrian and bicyclists
For the case of bicyclist and pedestrians, less research has been conducted in United States possibly due to car being the more dominant mode of transportation. However, the behavior and movement patterns of both cyclists and pedestrians are important predictors in the occurrence of crashes and should further be investigated (Nabors et al., 2012). An analysis of pedestrian crashes by DaSilva et al. (2003) showed the effect of age and time of day on the frequency of pedestrian crashes. Children and teenager tend to have more accidents and more accidents occur at night time when visibility is limited.

2.4. Visibility
Visibility is an important matter in the safety of network users. Barker et al. (1998) conducted a study on improving the conspicuity of trailblazing signs for incident management. Their results indicated that using a color combination other than the traditional one will improve driver performance and safety.
Bullough et al. (2001) worked on traffic signal luminance and visual discomfort at night using a sample of drivers. Their study showed that red signals that meet ITE specifications are unlikely to cause discomfort for drivers, while yellow and green signals might do so. They have proposed dimmer yellow and green lights for better comfort of drivers.
Lewin et al. (2003) investigated the use of three different light sources for roadway lighting. Their findings indicate that the interrelationship between lamp spectrum, visibility, and safety requires field evaluation under conditions representative of normal driving. They do not make any recommendations regarding lamp type, since it involves numerous intercorrelated safety and cost factors.
3. Case studies

The advent of human factors in traffic engineering has transformed transportation systems toward a positive way. As mentioned, the knowledge on human factors has been applied to a range of transportation program areas to improve traffic safety, users’ comfort, and productiveness of human users and operators. This section shows a number of real cases in which the use of human factors engineering has helped traffic engineers in designing better transportation facilities. Many programs on human factors in the transportation research field have been broadly implemented by several US governments and authorities, and some private automobile companies. For example, the national highway traffic safety administration (NHTSA) has fulfilled a variety of studies on human abilities, limitations, and other human characteristics to the traffic safety (see Table 1).

Table 1. Traffic safety program areas that human factors were applied

<table>
<thead>
<tr>
<th>Program areas</th>
<th>Subcategory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety Problem Identification</td>
<td>Early adopters of technology studies</td>
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<td></td>
<td>Naturalistic driving studies</td>
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<td></td>
<td>Metric development</td>
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<tr>
<td>Visibility and Lighting</td>
<td>Headlighting</td>
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<td></td>
<td>Rear signaling</td>
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<td></td>
<td>Vehicle conspicuity</td>
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<td></td>
<td>Visibility</td>
</tr>
<tr>
<td>Driver Assistance</td>
<td>Warning systems (Forward collision, Lane departure, Intersection violation warning)</td>
</tr>
<tr>
<td></td>
<td>Other driver assistance (ACC, Parking aids)</td>
</tr>
<tr>
<td>Reducing Unsafe Behaviors</td>
<td>Alcohol impairment</td>
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<tr>
<td></td>
<td>Distraction</td>
</tr>
<tr>
<td></td>
<td>Teen drivers</td>
</tr>
<tr>
<td></td>
<td>Seatbelt and child seat use</td>
</tr>
<tr>
<td></td>
<td>Encouraging Fuel Efficient Driving</td>
</tr>
</tbody>
</table>

Reference: NHTSA (http://www.nhtsa.gov/Research/Human+Factors)
3.1. Visibility and Lighting
As discussed shortly in the literature review section, the understanding of human visualization ability is very important to assist human in avoiding traffic accidents. A large portion of traffic accidents are reported that they are related to the human visualization ability. Historically, many of them are related to the human’s perception of lights and others are largely related to the range of human’s eye sight. The following case studies show the relevant research on human visualization ability.

3.1.1. Headlighting
In 2001, NHTSA opened a public docket requesting comments from the public about headlamp glare. Most responses received have been complaints. Accordingly, NHTSA initiated research to address these complaints and to investigate the causes and effects of headlamp glare. Their research focused on the risks associated with glare to oncoming drivers, including increased risks to drivers on two-lane highways, increased risks to drivers over the age of 50, and the overall effects of glare on driver performance. And through the research result, they recommended some measures to reduce the risks associated with glare to oncoming drivers.
Their result shows that glare is more critical on two-lane than on multi-lane highways, because the generally lower light levels on two-lane highways increases the effect of the scattered light in the eye due to less separation between oncoming vehicles and drivers’ line of sight, and because two-lane roads are less likely to have markings that improve lane-keeping. In addition, glare reduces visibility more for the older drivers over 50 years because the eyes of older drivers contain more dead cells that increase the amount of scattered light compared to younger drivers, resulting in a brighter “veil” over the scene. Also, glare increases discomfort for drivers, which might be related to poorer steering control, lane-keeping, and speed control.
According to the research, despite the very clear evidence relating glare to reduced visibility, there is little direct evidence linking glare to increased crash risk. This is because unlike drug or alcohol use, there is usually no way to determine precisely whether or how glare might have contributed to a crash. Yet some police reports of crashes mention glare
as a potential cause of crashes, and it is not unreasonable to expect that the reductions in visibility caused by headlamp glare increase crash risk.

3.1.2. Rear signaling (Enhanced Brake Lights)
Rear-end crashes account for more than 29 percent of all crashes. Such types of crashes often result from a failure to respond (or delays in responding) to stopped or decelerating lead vehicles (NHTSA, 2007). These crashes often result in serious injuries, loss of productive time, and high levels of property damage, particularly vehicle damage. Furthermore, these crashes often cause traffic congestion, resulting in reduced highway throughput. The real-end crashes occasionally result in occupant deaths, but the proportion is substantially less, contributing approximately 5.4 percent of traffic deaths in the United States (NHTSA, 2007).

Accordingly, NHTSA (2010) fulfilled the research about enhanced break lights for the real-end crashes including a series of inter-related studies and research projects intended to reduce the frequency and severity of rear-end crashes via enhancements to rear-brake lighting. The results of NHTSA found that use of brake signal configurations which simultaneously flash the brake lamps (both outboard and CHMSL units) at 5 Hz were found to be effective, reducing the crash rate by as much as a 5.1% (95% confidence interval: 3.5%-6.7%), equivalent to 21,723 fewer annual rear-end crashes. They also found that effectiveness of the simultaneous flashing signal was moderated by both signal luminance (brightness) and activation, or triggering criteria. And they tested the effects of distance on detection performance of these signals, with increased brightness from the signal source. Based on the test, they suggest that detection rates may remain fairly stable out to distances of 150 ft, but can be expected to drop at distances beyond the certain range.
3.1.3. Daytime Running Lights (DRL)

There have been arguments among engineers that high-intensity DRLs create problems with glare and turn signal masking and conspicuity of motorcycles. However, the annual number of motorcycle rider fatalities in the United States increased from 2294 in 1998 to 5290 in 2008 (NHTSA, 2010). Many multivehicle motorcycle crashes involve right-of-way violations where another vehicle turns in front of, or crosses the path of an on-coming motorcycle.

Accordingly, NHTSA (2011) performed a study to determine whether drivers turning left from the main road onto the minor road across the path of approaching traffic were influenced in their gap acceptance decisions by daytime running lights (DRL) on approaching vehicles. The results indicated that DRL on approaching vehicles did not significantly decrease the probability of gap acceptance suggesting that DRL may not encourage turning drivers to be more cautious. Despite the finding from one site that turning drivers were more likely to accept 3- to 4-second gaps in front of approaching vehicles with DRL as compared to approaching vehicles without DRL, there was no evidence from this study to suggest that this effect would influence crash rates for left-turn-across-path scenarios. DRL status of the approaching vehicle was not a reliable predictor of potential vehicle conflicts at either study site. Overall, the results do not provide evidence to support the use of daytime running lights as a countermeasure for fair weather daytime crashes involving right-of-way violations. In addition, the results suggest that enhancing the frontal conspicuity of motorcycles with lighting treatments beyond an
illuminated low beam headlamp may be an effective countermeasure for daytime crashes involving right-of-way violations.


Figure 2. Example of DRL problem

3.1.4. Visibility (Backover crashes)
Backover crashes involve a person being struck by a vehicle moving in reverse. Tragically, the victims of backing crashes are frequently young children. These crashes are likely to be the result of some combination of vehicle blind zones, drivers’ inadequate visual scanning behavior, and drivers’ expectation that no obstacles are present behind the vehicle. NHTSA (2008) has undertaken research to examine the first two of these contributing factors. The study tested drivers’ use of rearview video systems in naturalistic driving conditions will provide information about drivers’ eye glance behavior during backing maneuvers with and without a rearview video system. The study examined the rear visibility of current vehicles to determine what range of blind zone sizes exist and provide information that can be used to determine whether a link exists between blind zone size and backover crash incidence. And the results also showed that average direct view rear longitudinal sight distances were shortest for small pickup trucks, compact SUVs, and compact passenger cars. Average rear sight distances were longest for full-size vans (45 feet), mid-size SUVs (44 feet), large SUVs (≥ 34 feet), and large pickup trucks (35 feet).
Images from: https://www.hoffmannpersonalinjury.com/rearview-video-systems-added-to-list-of-recommended-safety-technologies/

Figure 3. Examples of rearview video system

Image from: http://www.gizmag.com/cadillac-video-rear-view-mirror/35302/pictures#4

Figure 4. The example of vehicle blind zones and drivers’ inadequate visual scanning
3.1.5. Crash Warning Interfaces (Connected vehicle program)

The Connected Vehicle (CV) program is a major initiative that will improve transportation safety and mobility through the use of communications technology to enable vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) data transmission. The key to the CV concept is connectivity among vehicles, the transportation infrastructure, and personal communications devices. The human factors issues concern how to integrate and display all of the information a driver may want or need in a manner that is safe and usable. Regarding this, NHTSA (2014) research focused on how to ensure that important safety messages are effective (i.e., result in high rates of driver comprehension and proper responses). The challenges are that the CV concept may provide drivers with a large number of safety messages, many sorts of non-safety information, and a variety of different design and display concepts implemented by various manufacturers and developers. Their research consists of four distinct research as following:

- User-Based Structure for Message Coding: Investigating the perceived urgency of various driving event scenarios by drivers. (e.g. “How important is it that you receive information about this situation right NOW?”)
- Urgency Coding Within and Across Modes: Perceived urgency across visual, auditory, and tactile modalities and within different parameters of each of these modalities.
- Multiple Warning Events: Investigating whether collision avoidance systems should present individual crash alerts in a multiple conflict scenario, or only present one alert in response to the first conflict and suppress the subsequent alert to the second conflict.
- Portable Device Pairing: Investigating the extent to which driver response to imminent crash warnings is affected by the degree of integration when there are multiple CV products in the vehicle.

3.2. Unsafe Behaviors

Drivers’ unsafe behaviors such as alcohol impairment, drug use and unfastened seat-belt have threatened the drivers’ safety. In 2004, there were 16,694 alcohol-related fatalities reported,
equal to one alcohol-related fatality every 31 minutes for the year. Recently distractions by portable devices such as phone, text message, and internet usage have posed a big problem. So, the understanding of and preparing measurements for the drivers’ unsafe behaviors is very important to enhance the human safety. This section, therefore, will describe types of unsafe behaviors and show some research to alleviate them.

3.2.1. Alcohol Impairment
As mentioned, NHTSA reported that there were 16,694 alcohol-related fatalities in 2004, which is equal to one alcohol-related fatality every 31 minutes and representing 39% of the total traffic fatalities for the year. Alcohol-related crashes are distinguished by their severity, overrepresentation of recidivist offenders and certain age groups, and a disproportionate occurrence at certain times of day. Table 2 shows that alcohol-related crashes are more likely to result in loss of life and to involve single vehicles. Almost two-fifths, 39 percent, of the alcohol-related crashes in 2004 resulted in a fatality. Almost half, 47 percent, of the alcohol-related crashes in 2004 involved a single vehicle compared to 28 percent involving multiple vehicles (Pollard et al., 2007).

Table 2. Alcohol-related crashes by number of vehicles involved and severity, 2004

<table>
<thead>
<tr>
<th>Alcohol-Related Single Vehicle</th>
<th>Alcohol-Related Multiple Vehicle</th>
<th>Alcohol-Related Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Percent</td>
<td>Number</td>
</tr>
<tr>
<td><strong>Fatal Crashes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10,307</td>
<td>47</td>
<td>4,661</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14,968</td>
</tr>
<tr>
<td><strong>Injury Crashes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>92,000</td>
<td>16</td>
<td>76,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>168,000</td>
</tr>
<tr>
<td><strong>Property Damage Only</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>138,000</td>
<td>11</td>
<td>110,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>247,000</td>
</tr>
</tbody>
</table>

Also, the report of pollard et al. showed that alcohol-impaired drivers in fatal crashes are more likely to have been speeding. In 2003, 41 percent of the alcohol impaired drivers in fatal crashes were speeding compared to the 14 percent of drivers in fatal crashes by non-alcohol impaired drivers. In addition, the alcohol-impaired drivers are less likely to have valid driver licenses at the time of the crash. In 2004, 9 out of 10 drivers in fatal crashes with BAC = 0 had valid licenses compared to 76 percent of drivers with BACs of .08 to .14, and 73 percent of those with BACs ≥ 0.15. Alcohol-related crashes occur more often at certain times of day and days of the week. Additionally, more alcohol-related crashes occur at night. The report said from 9 p.m. to 6 a.m. the proportion of crashes that are alcohol-related ranges from 60 percent to 76 percent.

Accordingly, the NHTSA Administrator has stated that this fatality rate is a national concern during her 2006 testimony to Congress, referring to the provisions in the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy For Users (SAFETEA-LU) legislation to provide increased funding to reduce impaired driving. In support of this mandate, NHTSA (2007) report showed their research result on Technology to Prevent Alcohol Impaired Crashes (TOPIC) assesses the capability of existing and anticipated technologies to detect and prevent alcohol-impaired driving. It also includes a concept of operations to describe how to implement technology-based countermeasures while addressing concerns such as privacy, public acceptance, and legal issues.

The breath-alcohol ignition interlock device (BAIID) is an aftermarket product hardwired into the ignition circuit of a vehicle that prevents starting until a breath sample has been given, analyzed for ethanol content, and found to be below programmed limits. BAIIDs have been found to reduce DUI recidivism by 40 percent to 90 percent in various studies. Solid-state breath alcohol monitors are sold as screening devices and have been proposed for primary interlocks. The solid-state detectors are claimed to have accuracy and specificity than the tin-oxide cells (Taguchi cells, named after the inventor) found in most screening devices in current use. Some of the prototypes for primary interlocks developed in Sweden use these new technologies, the Swedish government considered making them mandatory in new vehicles in a few years, and they are being installed in test fleets now. While those solutions to reduce the number of alcohol-related crashes have been effective, NHTSA is also considering new technologies to detect alcohol vapor as the following:
• tunable-diode laser spectroscopes;
• carbon nanotubes that exhibit changes in optical or acoustic properties proportional to the concentration of ethanol vapor flowing through them;
• nano-crystalline perovskite oxides doped with strontium that selectively catalyze the oxidation of ethanol and measure the energy released; and
• solid-polymer-electrolyte sensors.

3.2.2. Distraction

Although the definition of distracted driving may seem obvious, the term distracted driving has been used to represent different driver conditions. According to NHTSA (2010), some reports or news articles use the terms inattention and distraction synonymously. While drowsiness and daydreaming can be categorized as inattention, the term distraction as used in this plan is a specific type of inattention that occurs when drivers divert their attention away from the driving task to focus on another activity instead. These distractions can be from electronic distractions, such as navigation systems and cell phones, or more conventional distractions such as interacting with passengers and eating. These distracting tasks can affect drivers in different ways, and can be categorized into the following types:

• Visual distraction: Tasks that require the driver to look away from the roadway to visually obtain information;
• Manual distraction: Tasks that require the driver to take a hand off the steering wheel and manipulate a device;
• Cognitive distraction: Tasks that are defined as the mental workload associated with a task that involves thinking about something other than the driving task.
Even though all of the distracted driving behaviors can degrade driving safety, the crash consequences of such reduced driving performance are difficult to characterize. For example, people may operate devices differently when they know they are being studied than they do in the real world. They may increase the distance between themselves and the vehicle in front of them or they may slow down. What is known, however, is that some drivers do not compensate appropriately, sometimes resulting in crashes. One method to overcome some of these limitations of controlled experiments is the use of naturalistic data collection in which the behavior of drivers using their personal vehicles on real roads is recorded by an array of on-board instrumentation. Regarding this, NHTSA sponsored one such naturalistic study, conducted by Virginia Tech Transportation Institute, in which 100 cars in Northern Virginia were instrumented, commonly known as the 100-Car Study (Klauer et al., 2006). The study confirmed that distraction is a common occurrence while driving; many distractions increase the relative risk of crashes and near-crashes, and distractions that require drivers to take their eyes off the road are potentially more of a safety problem than purely cognitive distractions. Table 3 shows their result of relative risk of engaging in various secondary tasks. Based on the results, reaching for a moving object is the most risky behavior observed, increasing crash risk by more than eight times that of just driving.
Table 3. Odds ratio for secondary tasks in the 100-Car Study

<table>
<thead>
<tr>
<th>Type of Secondary Task</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reaching for a moving object*</td>
<td>8.82</td>
</tr>
<tr>
<td>Insect in vehicle</td>
<td>6.37</td>
</tr>
<tr>
<td>Looking at external object*</td>
<td>3.70</td>
</tr>
<tr>
<td>Reading*</td>
<td>3.38</td>
</tr>
<tr>
<td>Applying makeup*</td>
<td>3.13</td>
</tr>
<tr>
<td>Dialing hand-held device*</td>
<td>2.79</td>
</tr>
<tr>
<td>Inserting/retrieving CD</td>
<td>2.25</td>
</tr>
<tr>
<td>Eating</td>
<td>1.57</td>
</tr>
<tr>
<td>Reaching for non-moving object</td>
<td>1.38</td>
</tr>
<tr>
<td>Talking/listing to a hand-held device</td>
<td>1.29</td>
</tr>
<tr>
<td>Drinking from open container</td>
<td>1.03</td>
</tr>
<tr>
<td>Other personal hygiene</td>
<td>0.70</td>
</tr>
<tr>
<td>Adjusting the radio</td>
<td>0.50</td>
</tr>
<tr>
<td>Passenger in adjacent seat*</td>
<td>0.50</td>
</tr>
<tr>
<td>Passenger in rear seat</td>
<td>0.39</td>
</tr>
<tr>
<td>Child in rear seat</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Note: Statistically significant results are with *

Reference: Klauer et al., 2006

3.2.3. Teen Drivers

According to NHTSA (2010), novice teen drivers have exceptionally high rates of crash involvement. Inexperienced teen drivers have exceptionally high rates of crash involvement. In 2006, 5,658 young drivers between the ages of 16 and 20 were killed in traffic crashes, and an additional 410,000 were injured (NHTSA, 2007). Teen drivers in general have much higher per-mile crash rates than more mature drivers. Crash rates are highest at age 16. Per-mile crash rates (for crashes of all types) for 16 year olds are about double those of 18-19 year olds. While the difference is not as extreme for fatal crashes, 16 and 17 year old drivers also have the highest crash rates for these most severe crashes. Under some driving conditions, this already extreme crash rate becomes even greater, such as when there are multiple teen passengers or during night driving.
The traditional ways to reduce novice teen driver crashes are including driver training, graduated licensing, enforcement, and safety education. Even though the benefits from those measures have been demonstrated, some studies pointed out that the benefits have yet been modest. Regarding this, another approaches, in recent years, are to use in-vehicle technology to sense and respond to teen driver behavior. Their idea is that if key behaviors can be sensed, technology provides the opportunity for real time feedback to the driver, alerts to parents, summary reports of incidents, evaluations of performance, coaching to correct errors, or provision of rewards or sanctions.

As a part of teen driver safety project, the NHTSA explored one promising approach to reduce novice teen driver crashes: using advanced in-vehicle technologies to monitor novice teen driver’s behavior. Such technologies can be integrated into a device to monitor and reduce unsafe behaviors through several interface approaches, including:

- **Vehicle Adaptations**: Automatically prohibiting behaviors detected, e.g., safety belt interlocks;
- **In-Vehicle Feedback**: Providing drivers with real time information, e.g., speeding in curves;
- **Reporting**: Recording behaviors to transmit them at a later time to parents, insurance companies, driver educators, etc.

And their goal is to provide a knowledge base about teen driver behaviors and support for the development of recommendations for the capabilities, operational concepts, and interfaces that would lead to effective, acceptable, and widely deployed technologies.

### 3.2.4. Drowsy Driving

According to NHTSA (2014) drowsy driving is a significant contributor to death and injury crashes on our Nation’s highways, accounting for more than 80,000 crashes and 850 fatalities per year. Thus, the successful detection of drowsiness is a crucial step in implementing mitigation strategies to reduce the cost to society of drowsy driving. NHTSA has built upon prior research in detecting impairment from alcohol and distraction, the goal of this research was to determine the extent to which alcohol impairment algorithms could detect drowsiness and distinguish it from alcohol impairment.
To do this, they collected data from seventy-two participants during daytime (9 a.m. - 1 p.m.), early night (10 p.m. – 2 a.m.), and late night (2 a.m. - 6 a.m.) sessions to provide data for algorithm testing and refinement. Driving data indicated a complex relationship between driving performance and conditions associated with drowsiness: compared to daytime session, driving performance improved during the early night session, before degrading during the late night session.

As a result, the research showed the feasibility of detecting drowsiness with vehicle-based sensors. Results show that the differences in the manifestation of alcohol and drowsiness impairment do not allow for a single algorithm to detect both types of impairment. These results suggest promise in a vehicle-based approach to impairment detection including multiple types of impairment.

4. Conclusion and recommendation

This paper described the application of human factors in the transportation engineering field. It was shown that that human factors are widely used in developing vehicle equipment, transportation facilities and relevant regulations. While human factors are mainly utilized for reducing traffic accidents, they are also used for enhancing human comforts. The early stage of human factor engineering in the transportation field focused on physical abilities of human for enhancing traffic safety. For example, the studies about human visualization ability have been applied to adjusting vehicle lighting and developing rearview devices. In addition, the past studies also focused on unsafe behaviors of human such as alcohol impairment, distraction and teen drivers. In particular, it is reported that the unsafe behaviors have caused more severe traffic accidents than others. To solve the problem, some studies aimed at developing devices to detect unsafe behaviors and suggesting regulations to prevent people from doing such unsafe behaviors.

Nowadays, the human factor engineering in the transportation field has broadened its research area with the advent of new technologies. For example, human perceptions of a range of traffic information have been studied with the development of connected vehicle technologies. Also, it is expected that human factor engineering will be more important with the on-going research on these new technologies.
To sum up, this research recommends that the relevant engineers and researchers understand the impact of human factors on a variety of traffic situations. Also, they need to understand that many traffic situations are not only affected by one specific human factor, but also by a combination of several human factors.

5. References


17) NHTSA (2014) Assessing the Feasibility of Vehicle-based Sensors to Detect Drowsy Driving