

Lecture 1.2

1.2 Road User Characteristics

Overview of Human Factors in Traffic Engineering

Human factors engineering (ergonomics) analyzes how humans interact with roadway infrastructure and vehicles. Because human performance varies across individuals and environmental conditions, traffic designs must accommodate the 85th or 95th percentile human limitations.

Road user characteristics are broadly classified into four major categories: Physical traits, Mental capabilities, Psychological/Emotional states, and Environmental factors affecting performance.

Category	Examples & Traits
Physical	Vision, hearing, strength, age, and reaction time
Mental	Knowledge, intelligence, experience, and judgment
Psychological	Motives, emotions, habits, and risk perception
Environmental	Ambient lighting, weather, noise, and traffic density

Physical Characteristics: Vision Capabilities

Vision is the single most critical sense for road users, providing over 90% of the information required for driving and navigating. Key visual factors include visual acuity, peripheral vision, color vision, depth perception, and glare recovery.

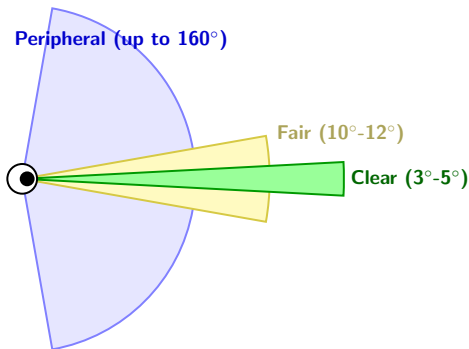
Visual acuity determines the driver's ability to see fine detail at a distance. Static acuity applies when both driver and object are stationary, whereas dynamic acuity decreases significantly as vehicle speed increases.

- Visual Acuity: Ability to perceive fine details at distance (20/20 standard)
- Dynamic Vision: Acuity drops substantially as driving speed increases
- Depth Perception: Estimating distance and relative speeds of oncoming vehicles
- Color Vision: Essential for identifying traffic signal lights and retroreflective sign colors
- Glare & Night Vision: Time taken for pupil recovery after bright headlight exposure

Vision Field and Cone of Vision

The human field of vision is divided into three distinct zones based on angular deviation from the line of sight: the Clear Vision Cone (3° to 5°), the Fair Vision Cone (10° to 12°), and the Peripheral Vision Field (up to 160° total).

Traffic signs, signals, and critical road markings must be positioned within the driver's clear vision cone (or near fair vision) so drivers can read legends without diverting their eyes significantly from the carriageway.



Speed Effect: As speed rises from 30 km/h to 100 km/h, peripheral field narrows from 100° to under 40° (Tunnel Vision).

Physical Characteristics: Hearing, Fatigue, and Age

Hearing provides crucial secondary cues such as horn warnings, emergency vehicle sirens, engine sounds, and railway level crossing alarms. Hearing impairment requires drivers to rely even more heavily on visual scanning.

Fatigue and advanced age significantly degrade physical performance. Elderly drivers typically experience reduced visual acuity, slower muscular response, stiffer neck movement, and extended perception-reaction times.

- Hearing Acuity: Essential for perceiving emergency sirens and auditory warnings
- Fatigue Effects: Causes microsleep, delayed reaction, and loss of lane keeping
- Age Factors: Diminished night vision, increased glare sensitivity, slower physical reflexes
- Permanent/Temporary Disabilities: Physical impairments requiring adaptive vehicle controls

Mental Characteristics of Road Users

Mental characteristics encompass a driver's intelligence, education, driving experience, familiarity with traffic regulations, and capacity to process complex information rapidly under stress.

Driver confusion occurs when road layout or signage presents ambiguous or conflicting choices. Clear, standardized, and uniform traffic signs (per IRC:67) minimize driver mental workload and decision-making time.

- Knowledge of Rules: Understanding traffic signs, markings, right-of-way laws
- Experience & Skill: Anticipating hazards, smooth steering, and proper gear selection
- Mental Workload: High workload causes driver errors; low workload causes boredom/drowsiness
- Expectancy Principle: Drivers react faster when road features conform to expected patterns

Psychological Characteristics and Driver Behavior

Psychological traits dictate a road user's attitude, emotional state, impatience, aggressiveness, risk-taking tendencies, and attentiveness. Psychological factors are heavily influenced by stress, personality, and social habits.

Emotional disturbances such as road rage, grief, or extreme haste impair critical judgment, leading to tailgating, illegal overtaking, red-light running, and speeding.

- Emotional State: Anger, anxiety, and frustration increase risk tolerance
- Attitude Towards Safety: Willingness to obey traffic rules versus willful non-compliance
- Aggressive Driving: Tailgating, improper lane weaving, and speeding
- Habit Patterns: Automatic responses built through years of driving experience

Environmental and External Influences

A road user's performance is not static; it changes dynamically based on external environmental conditions. Heavy rainfall, fog, dust storms, glaring sunlight, and extreme night darkness alter visibility and psychological stress levels.

High traffic density, complex multi-lane junctions, ambient urban noise, and excessive roadside visual clutter (billboards, neon lights) overload driver cognitive processing.

- Weather Impact: Fog and heavy rain reduce sight distance and tire traction
- Lighting Conditions: Night driving reduces contrast; glare from oncoming high beams blinds drivers
- Traffic Complexity: High vehicle density increases stress and demands constant vigilance
- Commercial Clutter: Unauthorized roadside hoardings distract drivers away from traffic signs

Pedestrian Characteristics and Behavior

Pedestrians represent the most vulnerable class of road users (VRUs). Unlike vehicles, pedestrians can change speed and direction instantaneously, but lack protective body armor during collisions.

Standard traffic engineering design assumes a normal pedestrian walking speed of 1.2 m/s (IRC recommendation), reduced to 0.9 - 1.0 m/s in areas with high proportions of elderly citizens or school children.

- Standard Walking Speed: 1.2 m/s used for calculating signal pedestrian clearance intervals
- Vulnerability: 100% exposure to impact forces in vehicle-pedestrian collisions
- Behavioral Traits: Propensity to take shortest path ('desire lines'), jaywalking, impatient crossing
- Pedestrian Infrastructure: Footpaths, zebra crossings, pedestrian refuge islands, skywalks

Cyclist and Two-Wheeler User Characteristics

In developing nations like India, motorized two-wheelers (motorcycles, scooters) and non-motorized bicycles constitute up to 60-70% of urban traffic volume, creating a highly heterogeneous traffic mix.

Two-wheeler riders exhibit unique traits: small physical footprint, single-track balancing dynamics, rapid acceleration, high vulnerability, and a tendency to squeeze through vehicle gaps.

- Heterogeneous Traffic Mix: High percentage of 2-wheelers in Indian traffic stream
- Balancing Dynamics: Vulnerable to skid on wet, greasy, or gravel-strewn road surfaces
- Lane Discipline: Frequent lane filtering and lateral movement within lanes
- Safety Requirements: Dedicated bicycle tracks, exclusive advanced stop lines (bike boxes)

Driver Impairment: Alcohol, Drugs, and Distractions

Driver impairment due to alcohol or substance abuse is a major cause of fatal road crashes worldwide. Alcohol acts as a central nervous system depressant, impairing coordination, lengthening reaction time, and reducing risk awareness.

In India, under the Motor Vehicles Act, the legal Blood Alcohol Concentration (BAC) limit is 30 mg of alcohol per 100 ml of blood (0.03% BAC). Modern mobile phone distractions (texting, talking) produce cognitive impairments equivalent to drunk driving.

Factor	Key Details & Interventions
BAC Legal Limit (India)	30 mg / 100 ml (0.03% BAC)
Impairment Effects	Loss of muscle coordination, poor depth estimation, severe delay in PIEV reaction time
Distracted Driving	Mobile phone use, texting, adjusting infotainment screens
Engineering Fixes	Continuous rumble strips, forgiving roadside barriers, automated enforcement

Summary: Road User Characteristics

This lecture covered the multi-faceted human factors governing road users: physical visual capabilities, mental knowledge, psychological emotional traits, and environmental influences.

We examined specific characteristics of drivers, pedestrians (1.2 m/s walking speed), two-wheeler riders, and the catastrophic effects of fatigue, alcohol, and distractions on traffic safety.

- Road users are variable; designs must accommodate 85th/95th percentile human limits
- Vision provides ~90% of driving info; Cone of Vision governs sign placement
- Pedestrian clearance signals rely on standard walking speed (1.2 m/s)
- Next Lecture: Detailed study of Vehicular Characteristics (Static & Dynamic)