Background

- Statistics
  - ½ million auto accident fatalities worldwide per year
  - 40,000 / year in US
  - Almost 3,000,000 injuries/year in US
  - 90% of motor vehicle accidents blamed on human error

Video on Distracted Driving

Driving Task Analysis

- **Strategic Tasks** – Purpose of trip, driver’s overall goal

- **Tactical Tasks** – Choice of maneuvers, immediate goals
  - Setting speed, passing, lane changes

- **Control Tasks** – Moment-to-moment operation
  - Speed adjustment, gap distance, lane maintenance
Primary Control Tasks

- What impacts control?
  - Poor visibility (fog, rain, dark)
  - Distraction by secondary tasks
    - Visual (in cab and external scanning)
  - Auditory, cognitive, motor
  - Road curvature
  - Roadway hazards (objects, vehicles, pedestrians)

1st order tracking control (speed, gap maintenance)
2nd order tracking control (lane maintenance)

Vehicle Controls & Displays

- In order to keep drivers' eyes on the road (PVAL), Displays should:
  - Be simple, easy to read and interpret – high contrast, large size
    - James Bond Rule: Height/Distance > .007
  - Controls should:
    - Be in a consistent location (e.g., wiper controls)
    - Compatibly linked to display (proximity compatibility)
    - Provide adequate separation (be able to feel for control)

Visibility Issues for PVAL

- Anthropometry – Seating, reach, viewpoint
  - Need for user-friendly adjustment controls (e.g., seat position)
- Illumination – traffic lights, reflectors, headlights (e.g., new LEDs)
- Signage
  - Minimize clutter
  - Consistent location (height and distance)
  - Easily identifiable class (shape, color)
  - Efficient readability (contrast sensitivity, glare)
- Resource Competition – in-cab distractions
  - Glances away from road should be < .8 s & > 3 s between
Controlling Resource Competition

- Eliminating cell phones while driving could save 2600 lives and prevent 330,000 accidents per year (Cohen & Graham, 2003)
  - Use auditory or tactile displays (e.g., talking navigation systems, virtual rumble strips)
  - Speech recognition systems
  - Heads-up displays – (problem: may mask real world)
  - Hands-free phones – reduce glances, but not cognitive distractions

Problem of Distracted Driving

- Between 4,000 and 8,000 crashes related to distracted driving occur daily in US.
- Driver inattention was involved in 80 percent of all vehicle crashes (65 percent of near-crashes)
- They contribute to as many as ½ of the 6 million crashes reported annually.
- Distracted driving includes
  - Cell phone use
  - Eating
  - Changing radio stations/CDs/tapes
  - Looking for items in vehicle
  - Trying to change equipment settings, etc.

Incidence of Cell Phone Use Among Drivers

The Percent of Drivers Holding Phones to Their Ears

- Nationwide
- Males
- Females
- Age 16-24
- Age 25-60
- Age 70+

Sources: National Drowsy Driving Prevention Use Survey, NHTSA’s National Center for Statistics and Analysis, 2004-2005
Experiment 1: Driver Distraction

Attention Lapses:
- Failure to scan intersection
- Stop in absence of stop sign
- False start at red light
- Stop at green light

Traffic Violations:
- Speeding
- Running stop signs/red lights
- Lane violations (centerline or edge crossing)

Experiment 2: Driver Situation Awareness

as a factor of Experience Level & Cell Phone Usage

Driving Infractions

as a factor of Experience Level & Cell Phone Usage
Collisions

• Reasons for Collisions
  – Control loss
  – Speeding
  – Risky behavior
  – Impaired driving
    • Fatigue
    • Alcohol
    • Age/Experience

Control Loss

Control Loss – Lane Departure (lateral tracking) or Roadway Hazard (longitudinal tracking)
  – 40% of all driving fatalities, 30% of all collisions
  – Due to:
    • Road/weather conditions (slick, poor visibility)
    • Fatigue or inattention
    • Overcorrection at high speed (rollover)
  – Solutions:
    • Wider lanes (2-lane highways 8x more likely to produce fatalities than interstates)
    • Rumble strips, reflective lane markers

Hazard Response

Hazard Response
  – Brake RT (~1.5 s) slowed by age, alcohol, & distraction

Speeding

Speeding – avg vehicle separation on busy road = 1.32 sec (safe braking time = 2 sec)
  – Increases control loss
  – Decreases hazard detection
  – Increases distance traveled after hazard detection (less time to respond)
  – Increases physical damage on impact
  – Perceptual problems
    • Smaller cars perceived as farther away
    • Higher off ground (SUV) lead to perception of slower speed (motion parallax)
    • Adapting to higher speed leads to perception of moving slower

Risky Behavior

Risky Behavior
  – Risk taking, showing off, overconfidence, hurried
Collisions

Impaired Driving
- Fatigue (50% of trucker deaths, 10% of all vehicle fatalities)
  - Low arousal / circadian rhythms (2 - 4 am, 12 – 2 pm)
  - Tired (long distance)
    - 47% of truckers have fallen asleep at wheel
    - < 6.5 hrs / day of sleep increases risk
- Alcohol (50% of fatal accidents)
  - Legal limit = .08 BAC in FL; RT, tracking, info processing all affected at less than .05 BAC
  - Confounded by time of day, drowsiness, low visibility, personality.

Drowsy Driving
- Sleepiness slows reaction time, decreases awareness, impairs judgment
- Roughly 51% or 100 million people are on the roads feeling sleepy while they are driving.
- Nearly 2 in 10 drivers (17%) or 14 million people say they have actually fallen asleep at the wheel in the past year.
- Drowsy driving causes at least 100,000 crashes and 1,500 deaths annually in the US each year according to NHTSA reports
- Roughly 1/6th of all crashes are thought to be produced by driver inattention/lapses
  - Possible contributing factor: Sopite

Drowsy Driving Countermeasures
- Avoid Driving during your body’s down time.
  - take mid afternoon break.
  - avoid driving between midnight and 6 a.m.
- Avoid alcohol and medication (that may impair driving).
- Avoid heavy meals.
  - eat healthy snacks instead.
- Plan for the unexpected.
  - e.g., poor road conditions, delays.
  - do not stress about them, take a deep breath and relax.
  - do not rush or speed to make up time.
- Get a good night’s sleep (8 hrs).
- Drive on long trips with companion.
  - passengers can help look for warning signs of fatigue, share driving.
  - Schedule regular stops, every 100 miles or 2 hrs.
Collisions

Age / Experience

- Young drivers more involved in loss of control accidents
  - Less skill, greater risk taking, overconfidence
  - Faster, more likely to drive at night, alcohol
  - Lack of tactical/strategic judgment (distraction)

- Older drivers more involved in loss of attention accidents
  - Slower RT
  - Smaller field of attention
  - Inability to time share
  - Reduced visual capability (only minor issue)
    - Compensate by driving more slowly and under more favorable driving conditions
    - Possess less control, but greater tactical judgment

Aging of Drivers (in Florida)

Causes of Crashes in Florida

Under 70 vs. Over 70

For detailed statistics on all vehicle crashes in Florida in 2004 go to:
http://www.hsmv.state.fl.us/hsmvdocs/CF2004/CF2004ToPrint.htm
Improving Driving Safety

• Driver Characteristics
  – Selection & Training
    ■ Drivers education - little evidence of improved safety
    ■ Raising driving age - increase 16 to 18 saves lives
    ■ Graduated licensing – restrictions for first few years
      (e.g., daytime driving, to school or work, no young passengers, driving w/adult, NO CELL PHONES)
  – Adaptation and Risk Calibration
    ■ Calibration of risk – take risks because of perceived low probability of accidents
    ■ Risk Homeostasis Theory (Wilde, 1988) – Drivers maintain stable level of risk regardless on innovation (e.g., ABS)
      Theory not well-supported – drivers not good at assessing risk.

• Driver Characteristics
  – Regulatory Compliance
    ■ Speed limit enforcement – raising speed limit from 55 to 65 mph increased fatalities by 16%
    ■ Automatic Speed Adjustment – regulates auto’s maximum speed when entering zones
      Not likely to be used (voluntarily)
  – Fitness to Drive
    ■ Assess driver’s cognitive and psychomotor abilities
      Computerized tasks
      Driver monitoring systems (e.g., EEG, Perclos)

• Vehicle Characteristics
  – Sensors & Alerts – draw attention to following distances and lane departures
    ■ E.g., haptic feedback accelerator pedal, virtual rumblestrip
    ■ Problems – cry wolf syndrome, complacency
  – High Mounted Brake Lights – mandatory after 1980’s HF research (taxi cab study)
  – Amber Accelerator Release Light (experimental)?
Improving Driving Safety

- Roadway Characteristics (signage)
  - Positive Guidance – signal light cycles consistent with driver expectations and speed
  - Consistency – sign placement, road curvature
  - Guardrails, Lane Separations, Emergency Lanes

- Driver x Vehicle Characteristics
  - Mandatory Seatbelts, Airbags
    - Seatbelt non-compliance raises fatality risk by 40%
  - Automatic Notification (GM- OnStar)
    - in case of airbag deployment

AAA Tips for Managing Distractions

- Familiarize yourself with the features of your cell phone before you get behind the wheel and use only when necessary
  - (Steve’s advice: only use when vehicle is not in motion)
- Do not engage in emotional conversations while you drive
  - (Steve’s advice: this applies to in-vehicle passengers, avoid all cell phone conversations while driving)
- Do not combine distracted activities such as eating, tending to children and talking on your cell phone all while driving
  - (Steve’s advice: pull off the road to engage in any one of these activities)
- Preset radio stations/climate control and familiarize yourself with the features of your vehicle’s equipment, especially if renting a vehicle
- Secure items that could move around when car is in motion
- Pull safely off the road to deal with children, reading a map or trying to locate objects in the vehicle. Review road maps prior to entering vehicle.
- Do your personal grooming at home – not in the car.
- Ask passenger to help with activities that may be distracting