# Motorcycle Rider Naturalistic Driving Study

## Feasibility Study of Instrumentation to Collect Behavior Data to Identify On-Road Rider Behaviors

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Driving Transportation with Technology

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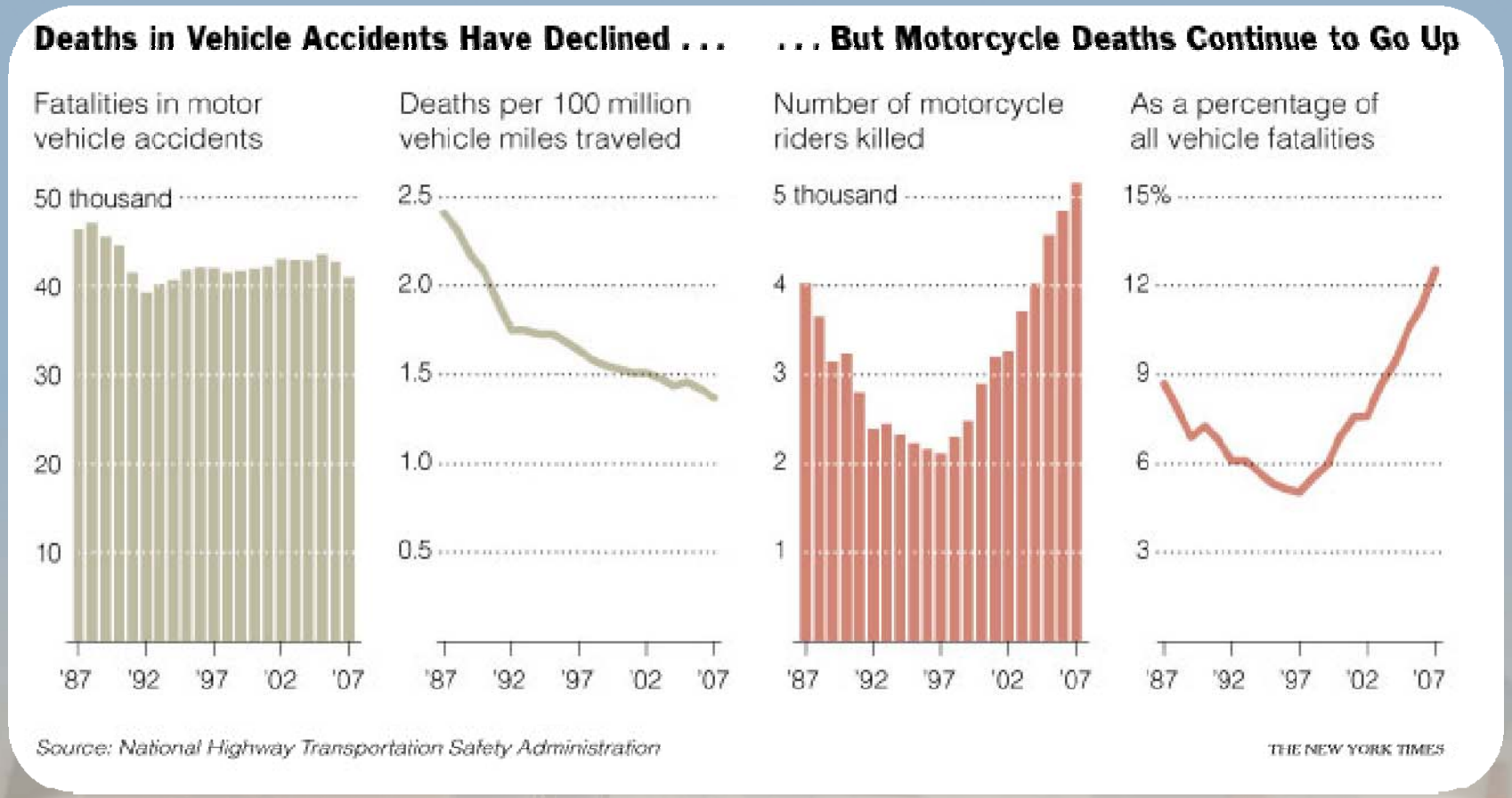
# Background

- Last year (2007), one in eight motor vehicle fatalities were attributed to motorcycles
- Motorcyclist fatalities have been increasing for 10 consecutive years
  - In 1997 fatalities from motorcycle crashes were at a low of 2,116
  - In 2007 deaths from motorcycle crashes have risen to 5,154 (128% increase)
- During the same 10 year period, deaths from motorcycle crashes rose from 5% to 13% of the national surface transportation fatality problem

# Background


Deaths in Vehicle Accidents Have Declined . . .
. . . But Motorcycle Deaths Continue to Go Up
Fatalities in motor vehicle accidents
50 thousand
40
30
20
10
'87
'92
'97
'02
'07
Deaths per 100 million vehicle miles traveled
2.5
2.0
1.5
1.0
0.5
'87
'92
'97
'02
'07
Number of motorcycle riders killed
5 thousand
4
3
2
1
'87
'92
'97
'02
'07
As a percentage of all vehicle fatalities
15%
12
9
6
3
'87
'92
'97
'02
'07
Source: National Highway Transportation Safety Administration
THE NEW YORK TIMES

# Background

- Data suggests this trend will continue
  - Motorcycle registration in 2007 up 75% from 1997
  - Increasing fuel costs motivate motorcycle use
    - Many motorcycles achieve 50+ mpg
- Some casual factors appear to include
  - Impairment
    - In fatal crashes, riders are 2.5 times more likely to be intoxicated than car drivers
  - Inexperience
    - In fatal crashes, riders are 3 times more likely not to have a proper license than car drivers
  - Age
    - Many riders are middle-age and older drivers who rode when they were young and they "think they have the same reflexes" – James Port
    - Fragility of older riders

# Limitations of Current Research

- Some of the best data we have is nearly 30 years old
  - "The Hurt Report", published in 1981 is a primary reference for motorcycle crash data
- Most research is based on crash databases (police reports)
  - Studies such as 100-car have demonstrated inaccuracies self-reported pre-crash information
- Little is known about the factors prior to motorcycle crashes
  - What is the differences in rider behavior and exposure of those involved in crashes vs. those who are not involved
  - What was the rider doing prior to the crash/near-crash
  - What environmental factors differentiate crashes/near crashes from baseline driving
  - How common are secondary tasks while riding
  - What opportunities are there for crash mitigation (collision avoidance warnings, abs, regulations, etc)

# Project Overview

- Phase I: Determine the feasibility of instrumentation (18 months)
  - Determine data acquisition system (DAS) requirements
  - Design and construct the DAS
  - Test and validate DAS (3 to 5 motorcycles)
  - Develop Phase II experiment
  - Recommend analyses for Phase III
- Phase II: Execute Naturalistic Study
  - Execution depends on the Phase I outcome
  - Instrument Personal motorcycle
  - Preliminary study size ~50-60 participants
- Phase III: Analyze Naturalistic Study Results
  - Design TBD based on Phase I and II outcomes

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# Phase I: Major Research Goals

- Determine if the technology exists to instrument motorcycles
  - Can we capture the data necessary to answer Phase II preliminary questions
- Demonstrate the feasibility of using the technology on motorcycles for naturalistic data collection
  - Will be verified by an independent evaluator

# Phase I Instrumentation Challenge

- Design and develop a DAS that
  - Fits unobtrusively in a motorcycle
    - Powerful
    - Small
    - Light weight
    - Weather proof

  - Is capable of providing the required data, for example:
    - Video of driving scene
    - Location (GPS, lane position , etc)
    - Dynamic state (velocity, acceleration, pitch, yaw, roll, etc)
    - Rider input (brake, throttle, fork rotation, etc)

# Phase I Instrumentation Challenge (cont)

- Need to consider:
  - Effects of leaning in corner
    - Accelerometer orientation
    - Gyroscope orientation
    - GPS orientation
    - Radar orientation
  - Motorcycle capabilities
    - Higher acceleration
    - Rapid changes in roll angle
    - Wheelies
- Other sensor challenges
  - Capturing rider eye/face video
  - Fork rotation considering angle
  - Capturing rider hand position
  - Brake (front/rear bias)
  - Throttle

Figure Source: Hima, Nehaoua, Arioui, (2007)

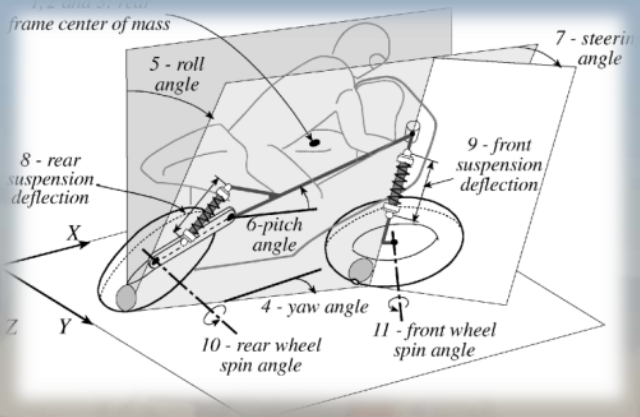


Figure Source: Cossalter, Lot (2002)

# Phase I: Preliminary Instrumentation

- VTTI is presently developing a DAS that is the likely candidate for motorcycles
  - Slightly larger than a deck of cards
  - Can process two channels of video
  - Expandable through CAN network
  - Accelerometer and gyro
  - Machine vision
  - WiFi

# Phase I: Prove DAS Feasibility

- Test-track data collection
  - 3-5 motorcycle types
  - Naive participants
  - Prescribed set of typical maneuvers
  - Analyze results and improve the DAS
- On-road data collection
  - Use improved DAS from test-track results
  - 3-5 participants using their personal cycles
  - Two to four weeks per participant
  - Use expected Phase II methods
  - Analyze results and improve DAS
  - Recommend the final DAS for Phase II

# Phase II Example Research Questions

- What are the riding behavior differences between drivers who have crash and near-crash events vs. those who do not
- What are riders attending to when they have conflicts, near crashes, and crashes?
- How is exposure related to crash and near crash involvement
- Under what environmental conditions to near crashes and crashed tend to occur
- How does lane placement effect crash and near-crash involvement
- How often to other vehicles appear to fail to see motorcycle?

# Motorcycle-Like Vehicles
## Opening the Market to Additional Drivers


# References


1. Cossalter V and Lot R. A Motorcycle Multi-Body Model for REal Time Simulations BAsed on the Natural Coordinates Approach. *Vehicle System Dynamics 36: 423-447, 2002.*
2. Hima S, Nehaoua L, S´eguy N, and Arioui H. Motorcycle Dynamic Model Synthesis for Two Wheeled Driving Simulator. *Proceedings of the 2007 IEEE ITS Conference, Seattle, WA, 2007.*
3. Hurt HH, Ouellet JF, and Thom DR. Motorcycle Accident Cause FActors and Identification of Countermeasures Volume I: Technical Report. Washington D.C.: U.S. Departmetn of Transportation, 1981, p. 425.
4. MSF. Motorcycle Safety Foundation Calls for Commencement of Motorcycle Crash Causation Study. In: *Urges Motorcyclists and Drivers to Work Together to Reduce Rider Deaths on Nation's Highways The Wall Street Journal: Business Wire, 2008.*
5. NHTSA. 2007 Traffic Safety Annual Assessment - Highlights. Washington D.C.: NHTSA, 2008.
6. Wald ML. Motorcycleists Deaths' Rise by More Than 6 Percent. In: *The New York Times. New York, August 15, 2008.*