Accounting for Fatigue in Systems Design and Operations: Issues and Opportunities

http://www.webmd.com/sleep-disorders/ss/slideshow-road-fatigue

Introduction of the Panel at the:
Fatigue Management Conference
March 20, 2017
1:30-3:00pm

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TOUCHSTONE EVALUATIONS INC.

Technology Impacts

- New and innovative technologies are revolutionizing mobility and the way we conduct work.
  - Redefining our work and our transportation systems
  - Changing the nature of driving – and also many jobs
- These innovations are making significant improvements in usability, safety, efficiency, and productivity.
- But they are also bringing potential issues -- some associated with operator behavior, attention, and alertness.
- As a result, it is important that designers account for human strengths and limitations in system design.

Today's Panel

For Example . . .

- Technology has increased driver comfort, and reduced physical stress and aversive stimulation
- Drivers now enjoy (from Fletcher et al. (2005)):
  - Improved climate control to maintain a constant temperature regardless of weather
  - Improved suspensions, designed to minimize repetitive skeletaI strain injury
  - Better sound damping, to reduce road and traffic noise
  - Power-assisted steering and braking
  - Augmented sensing with the ability to "see" more than the driver otherwise would
  - Cruise control to reduce the muscle strain of accelerator-control over long periods
  - Better roadways -- smooth low-curvature divided roads – as well as multiple lanes or overtaking zones to reduce the stress of waiting behind slower vehicles or use of an oncoming traffic lane for overtaking and passing traffic
- Some argue that these advances can insulate drivers from the road and have the potential to reduce engagement with driving
- And, with the integration of automation – drivers will have the ability to transfer additional elements of the driving task to the vehicle

Periods of Low Stimulation & Engagement--Can Perhaps Affect the Driver's State

Underload,

Boredom,

Lower Arousal, &

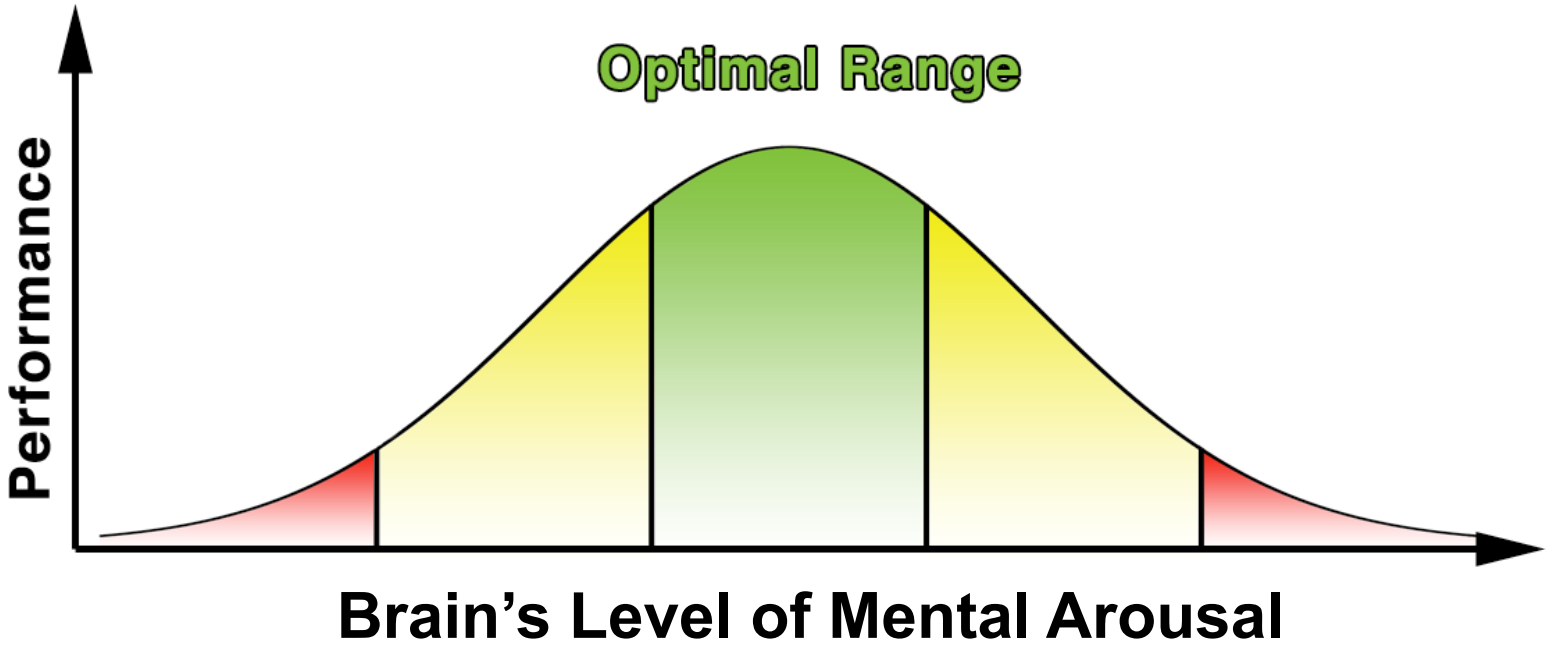
Drowsiness??

Thinking About
Mental Arousal & Performance

Yerkes-Dodson Law

The relationship between

physiological or mental arousal – and performance



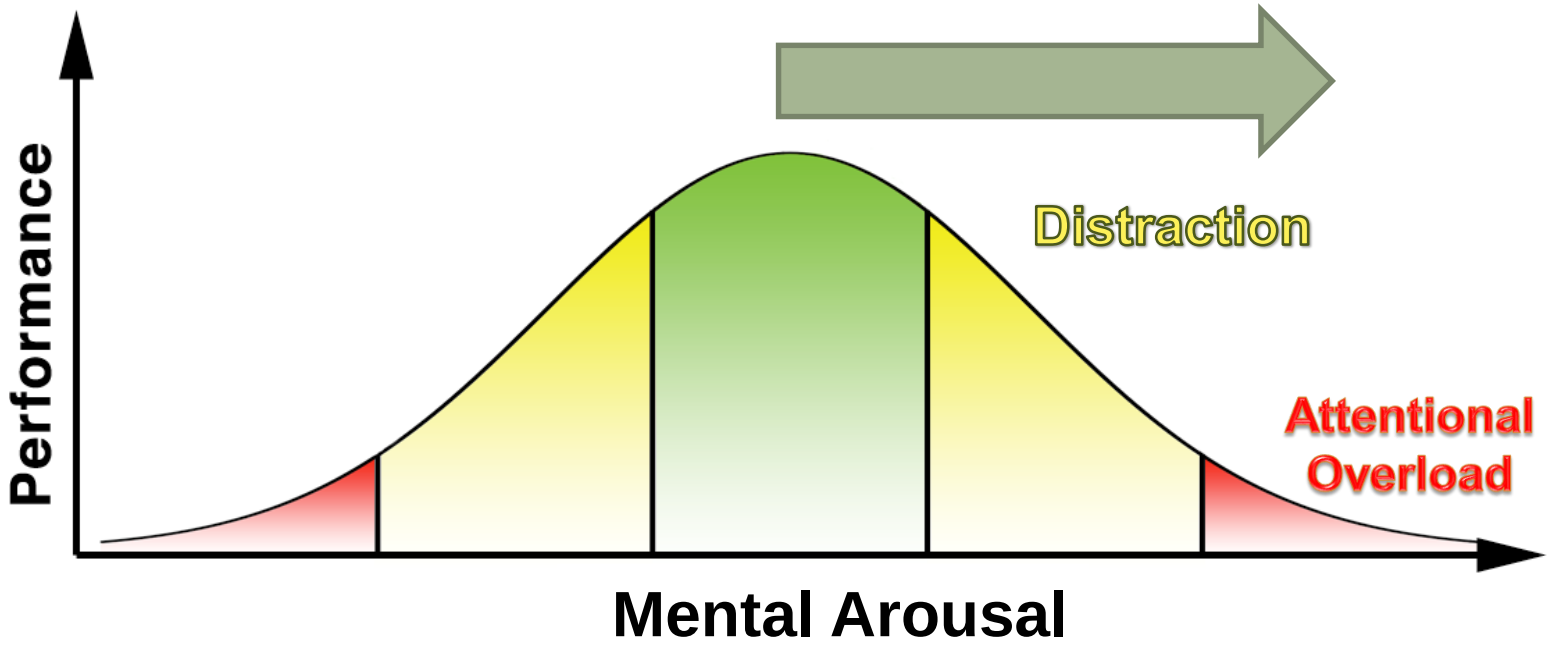
Adapted From:

AHEAD

Advanced Human Factors Evaluator for Automotive Demand

Too Much -- ***Interrupted Focus***

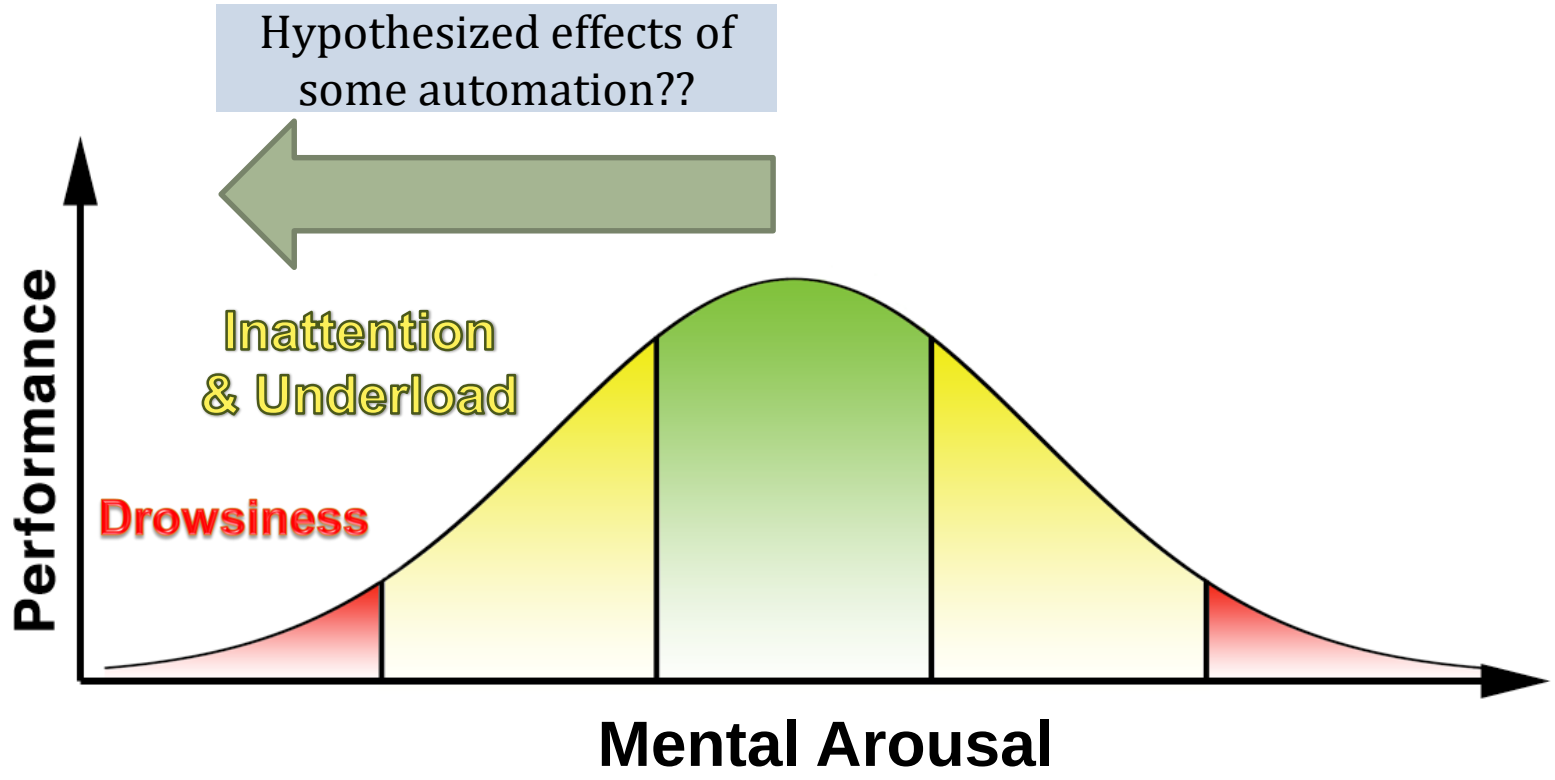
When the driver receives an ***excessive amount*** of stimulation, performance degrades as capabilities are overloaded



Adapted From:

Too Little -- *Inattention*

When the driver receives too little input, performance may degrade as inattention develops, and then drowsiness



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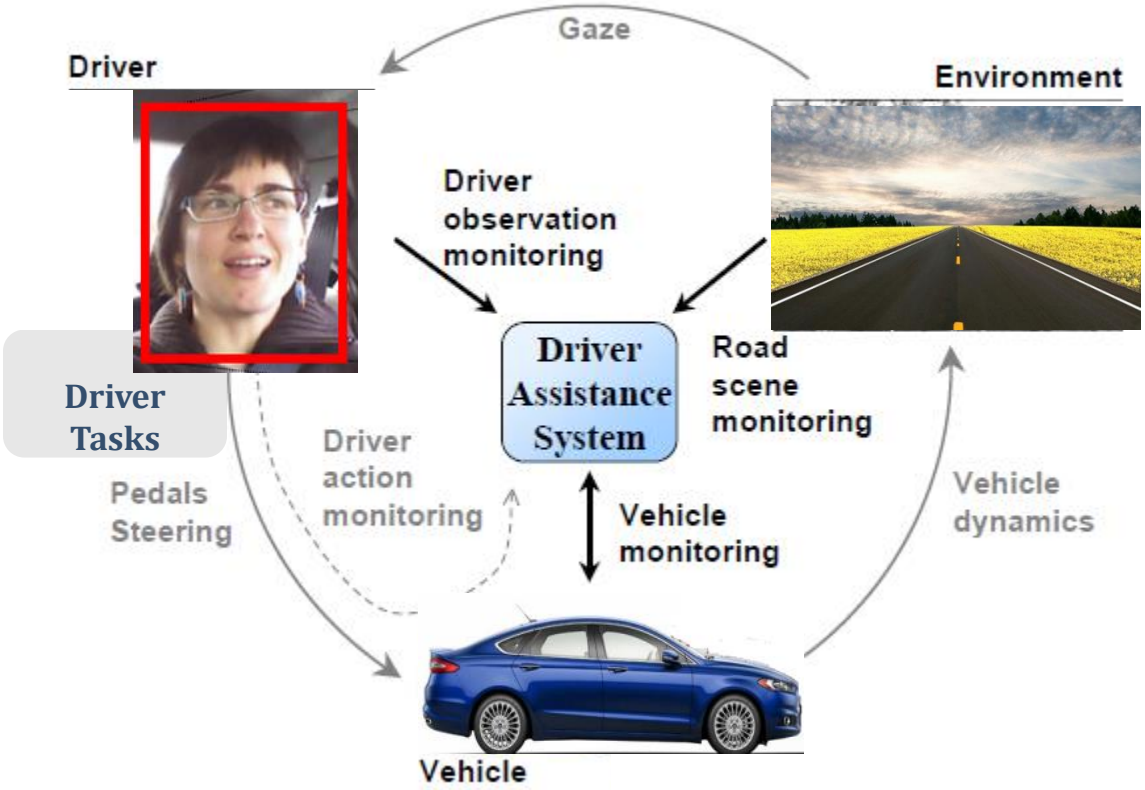
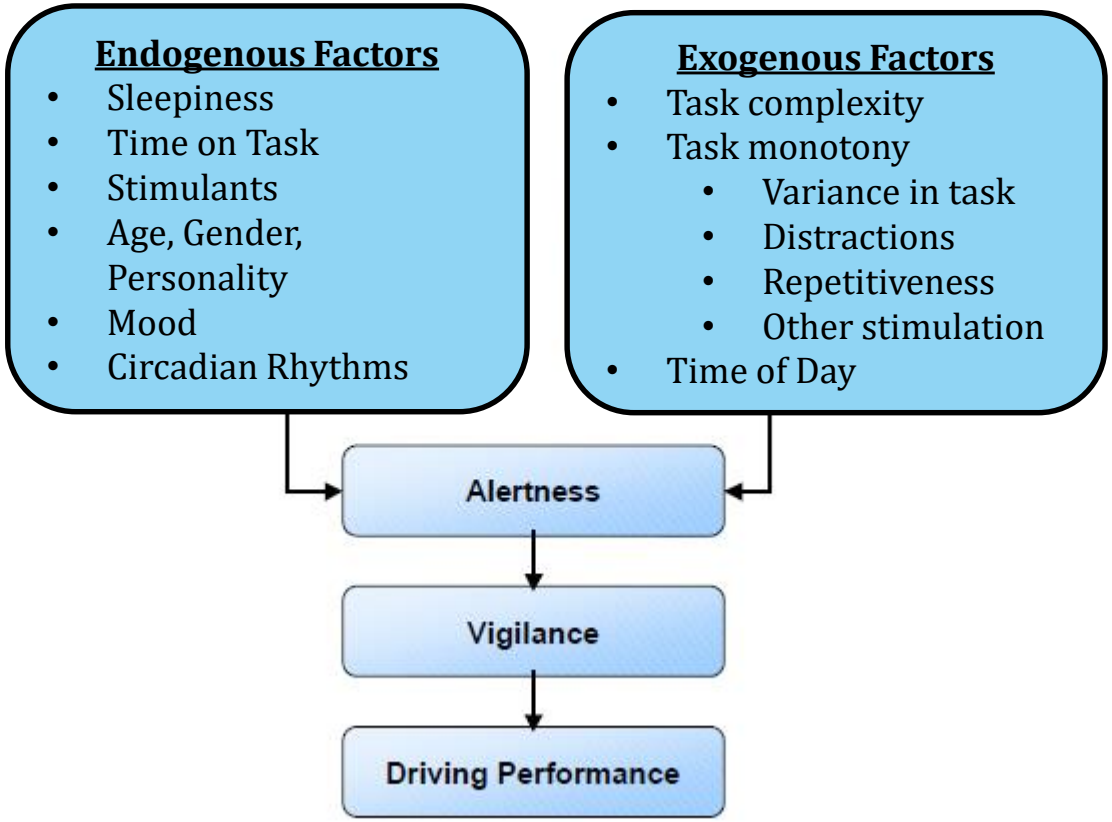
Systems Thinking is Critical For Managing These Issues



Adapted From: Fletcher, Petersson, Zelinsky (2005)

The **Driver**

Factors both inside & outside the driver contribute to fatigue



From: Fletcher, Petersson, Zelinsky (2005)

Monitoring the **Driver**

Eye Closure
Blink Rate
Blink Duration

Body Posture
Body Movement
Head Position
Head Nods

Biometrics
- Body Temp
- Heart Rate
- Respiration Rate

Educating/Informing/Coaching the **Driver?**

Should I try to drive?
I'm exhausted.

Do drivers understand enough about fatigue – and its potential impacts on driving and performance?

The Environment

- One possibility: Monitoring the environment for detection of road scene monotony

- Scene processing (e.g., **using computer vision**) to provide context awareness

  [e.g., detection of road scene monotony can perhaps be used to give context awareness to fatigue detection tools in order to increase accuracy]

The Vehicle/System & Its Performance

- Vehicle-based technologies offer many opportunities (though these technologies require rigorous testing and validation)
- There are many sensors on the vehicle which can feed information into fatigue detection and diagnostic methods (using "data fusion" with algorithms, machine learning, deep learning, or other advanced methods). *Examples:*

-Roadway Type (Straight, Curved, Intersection, . . .)
-Roadway Geometry (Straight, Curved)
-Road Surface/Friction
-Traffic Density
-Etc.

- Traffic Density
- Time of Day
- Temperature
- Precipitation

- Also, information about system performance (lateral and longitudinal control, stability) can sometimes be input into fatigue detection as well

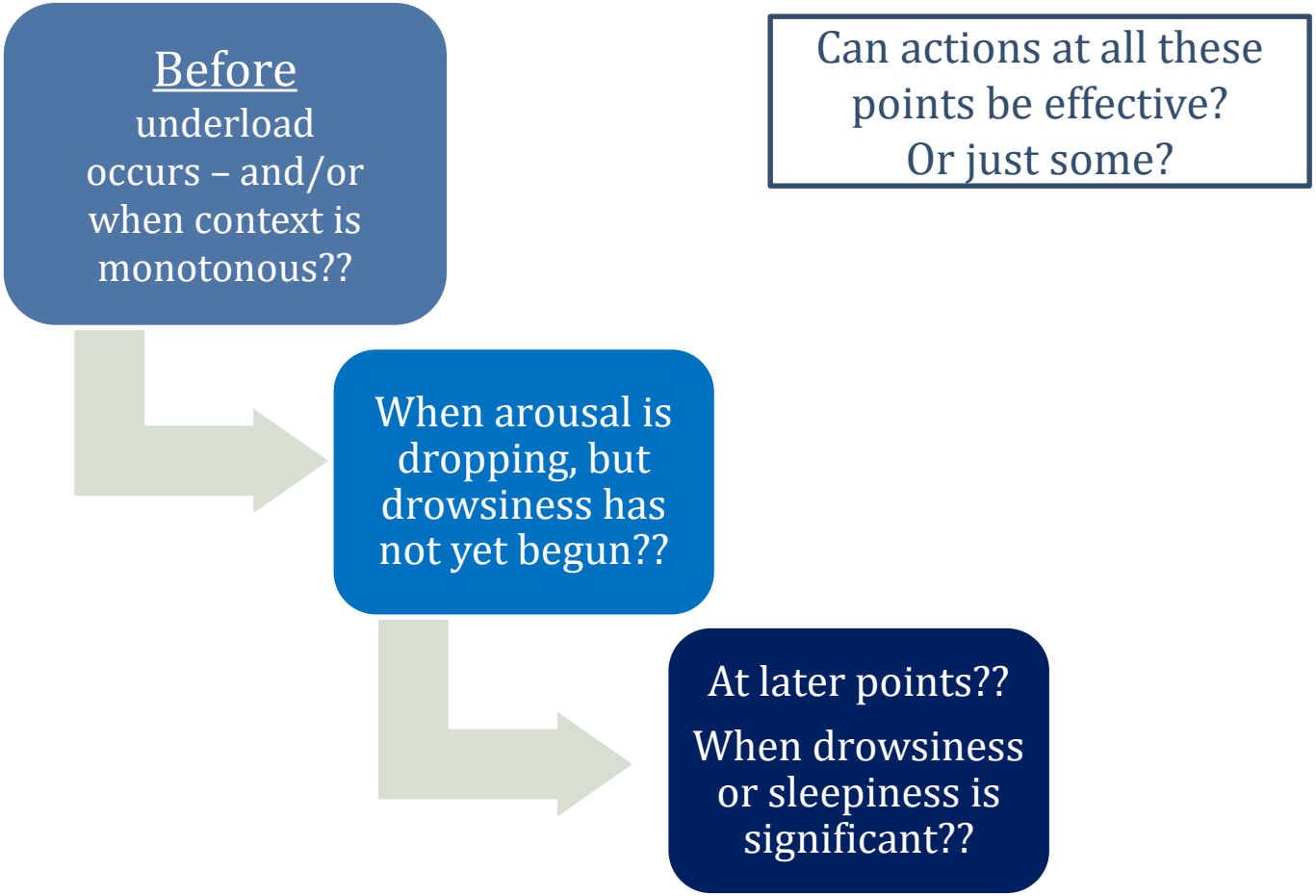
Developing Management Strategies
(Countermeasures)

- There are many types of approaches
- **And management strategies** will perhaps include both:
  - ❖**Prevention strategies**

    (e.g., identifying conditions of monotony or conditions of underload *before* they develop into drowsiness)
  - ❖**Mitigation approaches**

    (e.g., approaches that might be taken if performance becomes adversely affected, or advanced fatigue and even episodes of sleep are detected)
- And may well vary in terms where in the fatigue timeline they are implemented

What ***Are*** the Opportunities to Intervene With Prevention/Mitigation??



Many Issues and Opportunities To Be Explored

Today's Panel will discuss issues that are involved in addressing operator fatigue and alertness in design – as well as safety impacts of driver stress, workload, and fatigue.

Our speakers are:

- **Maureen Short**: General Motors
- **Steve Boyd**: Peloton Technology
- **Gerald Matthews**: U. of Central Florida