ITE'S PROPOSED RECOMMENDED PRACTICE GUIDELINES PROBLEMS AND SOLUTIONS

MATS JÄRLSTRÖM

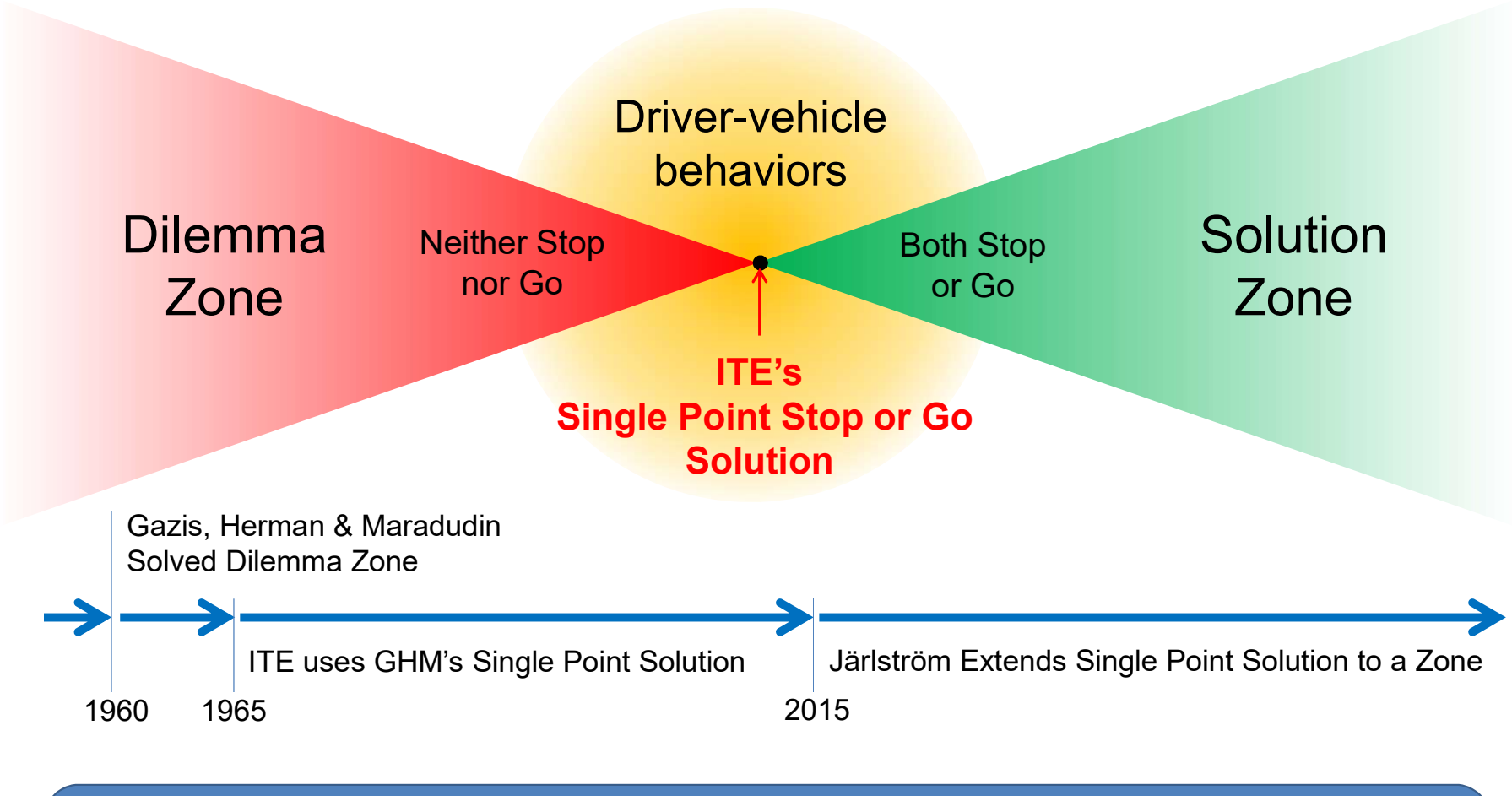
Advice from Dr. Alexei A. Maradudin

"…the duration of the amber cycle, and your suggestions for correcting them, are based on simple physics principles and on the careful observations you have carried out. As a consequence, it is difficult to argue against them without violating physics."

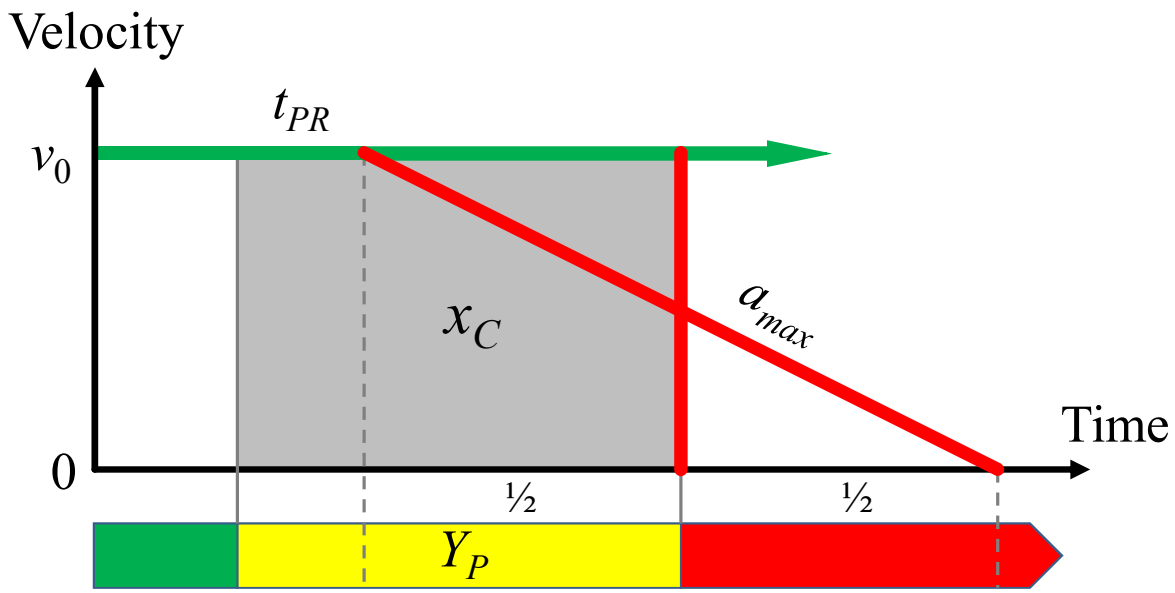
Best regards,

Alex

Timeline of the State of the Art



ITE's Minimum Permissive Yellow Model



Area = traveled distance

$$x_C = v_0 \cdot Y_P$$

GHM's critical distance

$$x_C = v_0 \cdot t_{PR} + \frac{v_0^2}{2a_{max}}$$

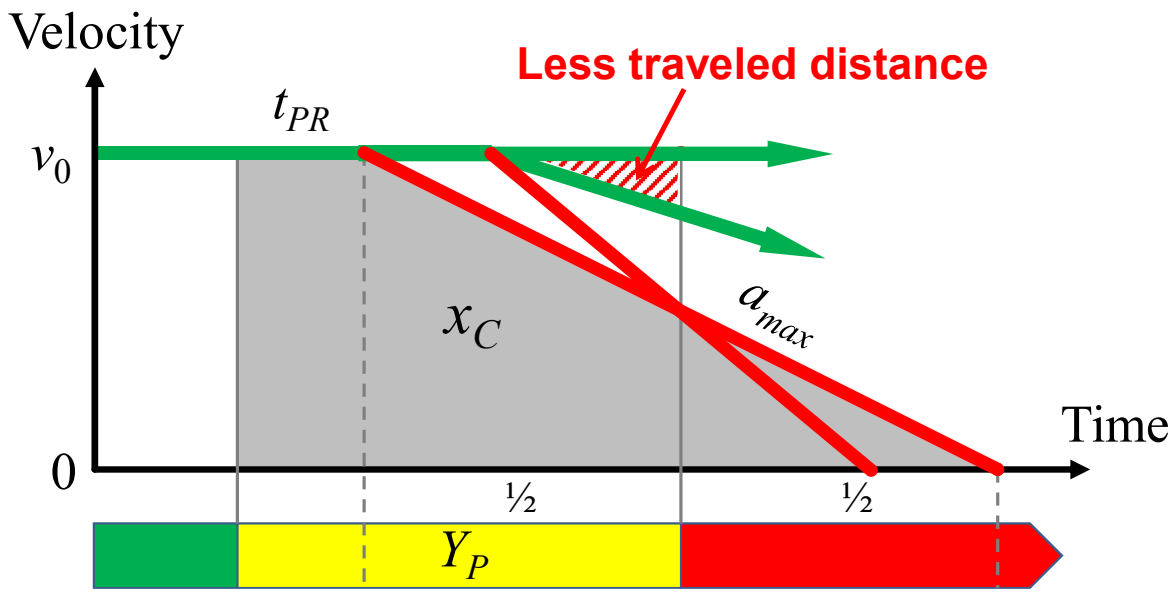
Set the two distances equal

$$v_0 \cdot Y_P = v_0 \cdot t_{PR} + \frac{v_0^2}{2a_{max}}$$

Solve for Y_P (Divide by v_0)

$$Y_P = t_{PR} + \frac{v_0}{2a_{max}}$$

ITE's Minimum Permissive Yellow Model



Exceeding a_{max}

Area = traveled distance

$$x_C = v_0 \cdot Y_P$$

GHM's critical distance

$$x_C = v_0 \cdot t_{PR} + \frac{v_0^2}{2a_{max}}$$

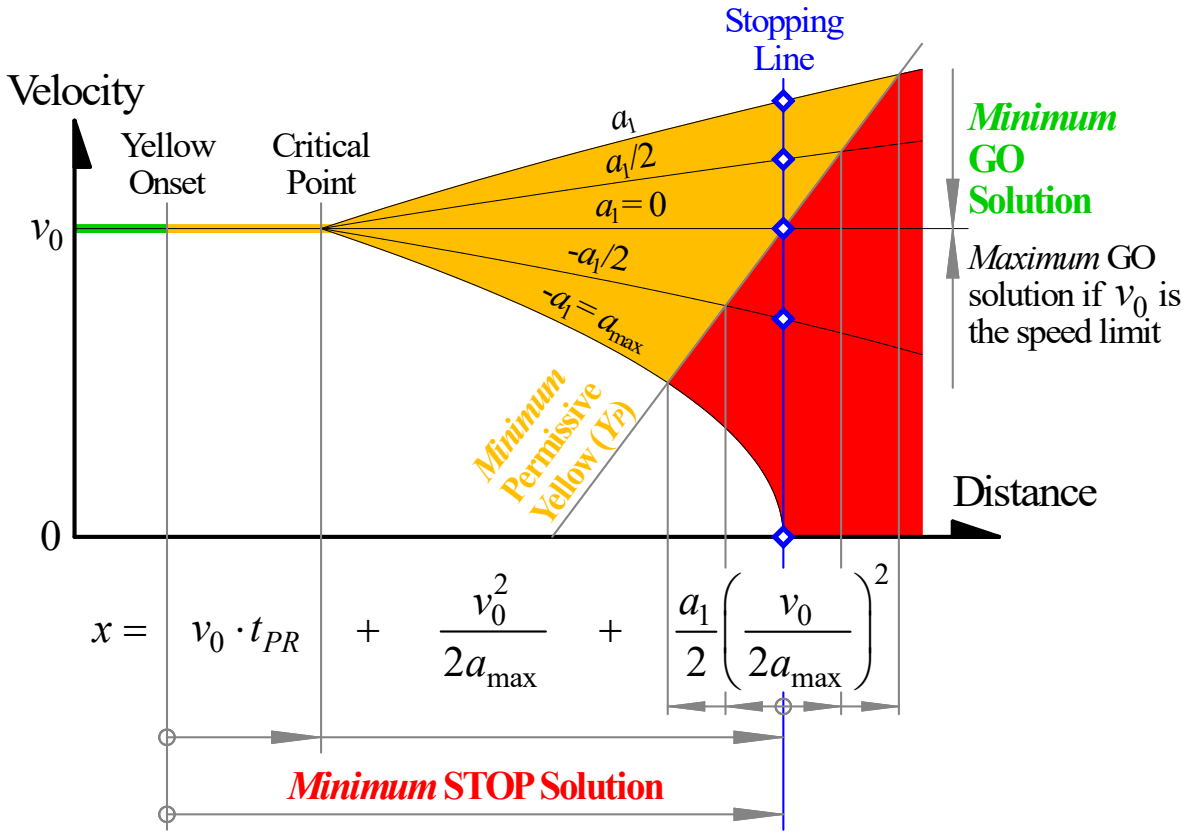
Set the two distances equal

$$v_0 \cdot Y_P = v_0 \cdot t_{PR} + \frac{v_0^2}{2a_{max}}$$

Solve for Y_P (Divide by v_0)

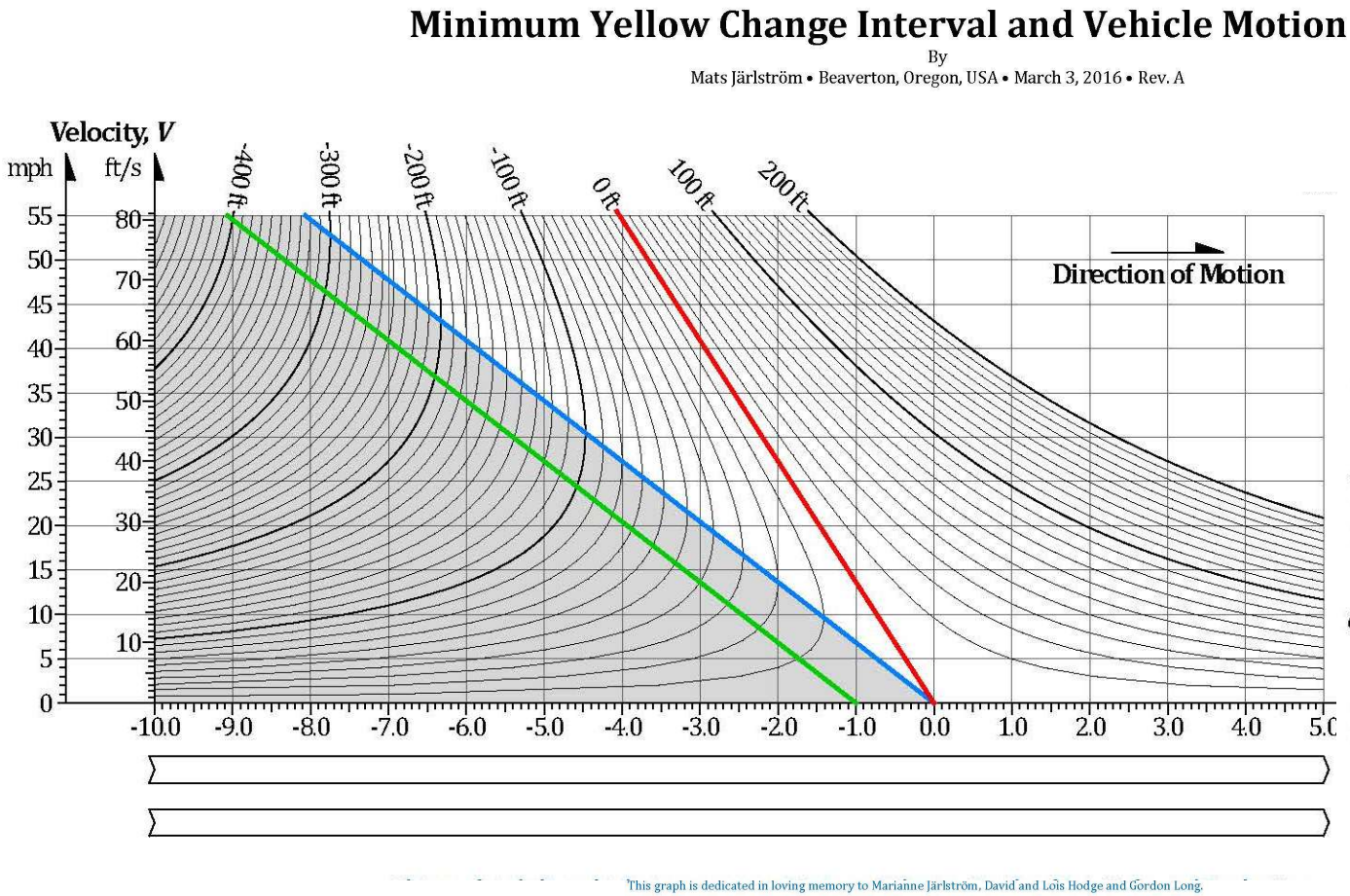
$$Y_P = t_{PR} + \frac{v_0}{2a_{max}}$$

ITE's ZERO Tolerance Solution - Problem



Entry Dilemma

Universal Graph Solution



Permissive Entry Distance Term

$$"Permissive", Y_P \geq t + \frac{V_L}{a} - \frac{V_E}{2a} + \frac{d_E}{V_E}$$

$$"Restrictive", Y_R \geq t + \frac{V_L}{a} - \frac{V_E}{2a} + \frac{d_{CE}}{V_E}$$

Where $V_L \geq V_E > 0$ and:

d_E = Legal definition of vehicle entry distance

d_{CE} = Legal definition of vehicle clearance and exit distance

($V_E = V_L$ yields GHM's original solution)

Sir Isaac Newton’s Laws of Motion States:

First law :

"A body at rest will remain at rest, and a body in motion will remain in motion unless it is acted upon by an external force."

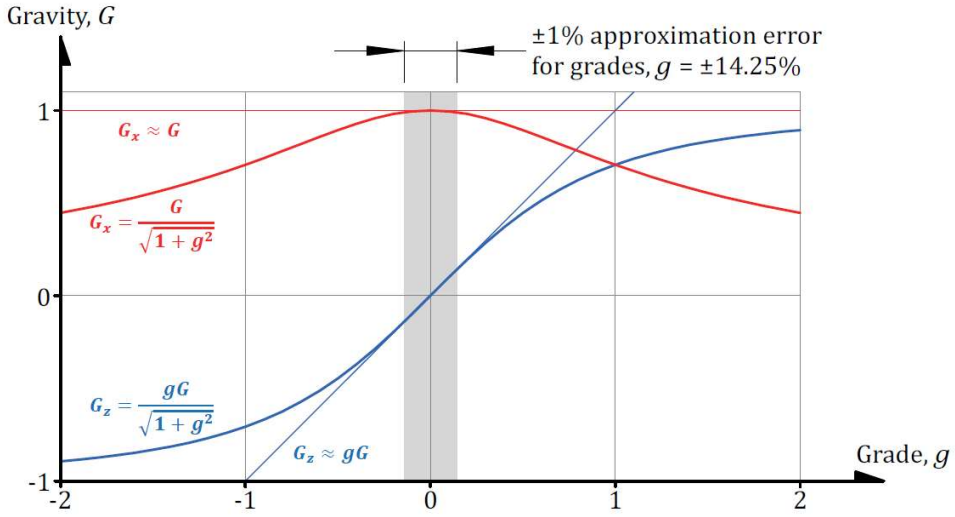
Second law:

"The force acting on an object is equal to the mass of that object times its acceleration."

ITE’s incorrect uphill grade implementation

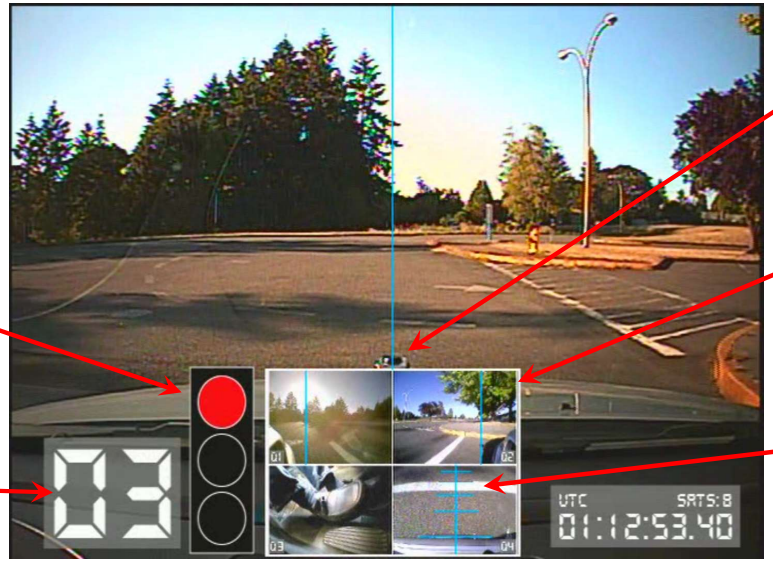
A Simplified Grade Solution

$$G_x = \frac{G}{\sqrt{1+g^2}} \approx G \qquad G_z = \frac{gG}{\sqrt{1+g^2}} \approx gG$$



Volvo S60 rendering used with permission from Volvo Cars

Vehicle Dynamics – VBOX Live Demo



GPS Antenna and Video Cameras Q1, Q2 and Q4 Location

Quad Camera Views:
Q1: Left – Q2: Right
Q3: Pedals – Q4: Down

Q4 Camera View:
System Timing Reference and Distance Calibration.

Programmable Traffic Signal Overlay

Instantaneous Vehicle Velocity (Uncompensated)

Live STOP, GO and RIGHT TURN demo video (.avi) and data (.vbo) files:
http://www.jarlstrom.com/ite/VBOX_Live_Demo.zip (27 MB)

Free RACELOGIC analysis software, **Circuit Tools** (ver. 2):
https://www.vboxmotorsport.co.uk/index.php/us/customer-area/software

The following 10 pages show screen captures from the above files.

Problems with ITE's Recommended Practice

- Zero tolerance model creates driver dilemmas
- Model does not apply to turning maneuvers
- The "permissive" entry dilemma
- Incorrect 1982 grade implementation

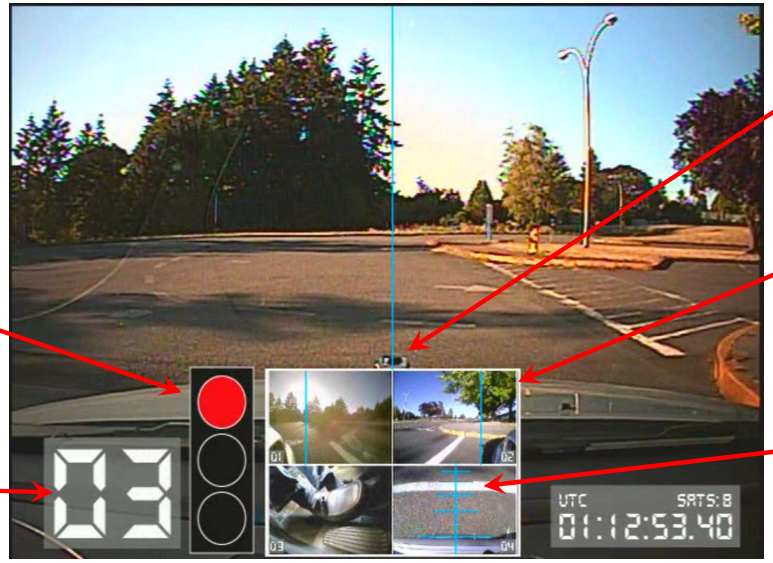
Conclusion: ITE's RP needs to be revised

Questions

Disclaimer

Backup

Vehicle Dynamics – VBOX Live Demo



Programmable
Traffic Signal Overlay

Instantaneous
Vehicle Velocity
(Uncompensated)

GPS Antenna and Video
Cameras Q1, Q2 and Q4
Location

Quad Camera Views:
Q1: Left – Q2: Right
Q3: Pedals – Q4: Down

Q4 Camera View:
System Timing Reference
and Distance Calibration.

Live STOP, GO and RIGHT TURN demo video (.avi) and data (.vbo) files:
http://www.jarlstrom.com/ite/VBOX_Live_Demo.zip (27 MB)

Free RACELOGIC analysis software, **Circuit Tools** (ver. 2):
https://www.vboxmotorsport.co.uk/index.php/us/customer-area/software

The following 10 pages show screen captures from the above files.

DISTANCE – Yellow Onset: STOP

DISTANCE – Yellow Onset: GO

DISTANCE – Yellow Onset: RIGHT TURN

DISTANCE – Stop Bar: ALL (Reference)

TIME – Yellow Onset: STOP

TIME – Yellow Onset: GO

TIME – Yellow Onset: RIGHT TURN

TIME – Stop Bar: GO

TIME – Stop Bar: RIGHT TURN

TIME – Stop Bar: STOP

ITE's incorrect uphill grade implementation

Sir Isaac Newton's first law of motion states:
"A body at rest will remain at rest, and a body in motion will remain in motion unless it is acted upon by an external force."

Hence, an occupant of a vehicle moving at constant velocity in any spatial direction is not acted upon by an external force.

Sir Isaac Newton's second law of motion states:
"The force acting on an object is equal to the mass of that object times its acceleration."

Thus, an occupant of a vehicle will only experience an external force acted upon them if the vehicle is changing its motion in any spatial direction. The source to the change of vehicle motion can be from one or a combination of Earth's gravity on a grade or the vehicle's motor or its braking system or its steering mechanism.