Car handling qualities and driver modelling

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Hypothesis

- driving: do it and observe the quality
- learning by reinforcement: built-in objectives; trial / error / sensitivities; continuous improvement; optimal controls
- neural network model
- good quality? - stability; controllability; consistency; smoothness

Learning examples

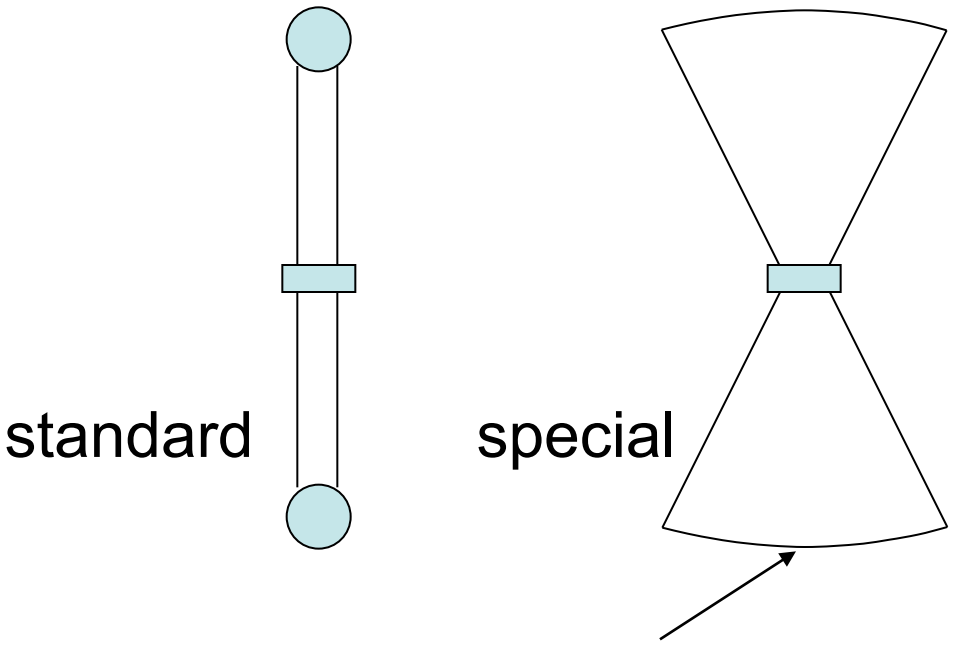
- bicycles; stabilisation; progression
- unicycles
- cars; guidance
- the go-cart; reverse steering
- low speed, low G practice; high speed, high G loss of control
- crashing the borrowed motorcycle

Loss of quality

- the engine flat-spot
- the sticky throttle control
- bump steer; torque steer
- steering system clearance
- early power steering systems
- the “Sporty Corvair”

Learning to ride a bicycle (progression)

- outrigger wheels; non-smooth
- stabilising rear wheel for child's bicycle



Richard E. Klein, University of Illinois
(www.losethetrainingwheels.org)

large radius of curvature, to be reduced as learning proceeds

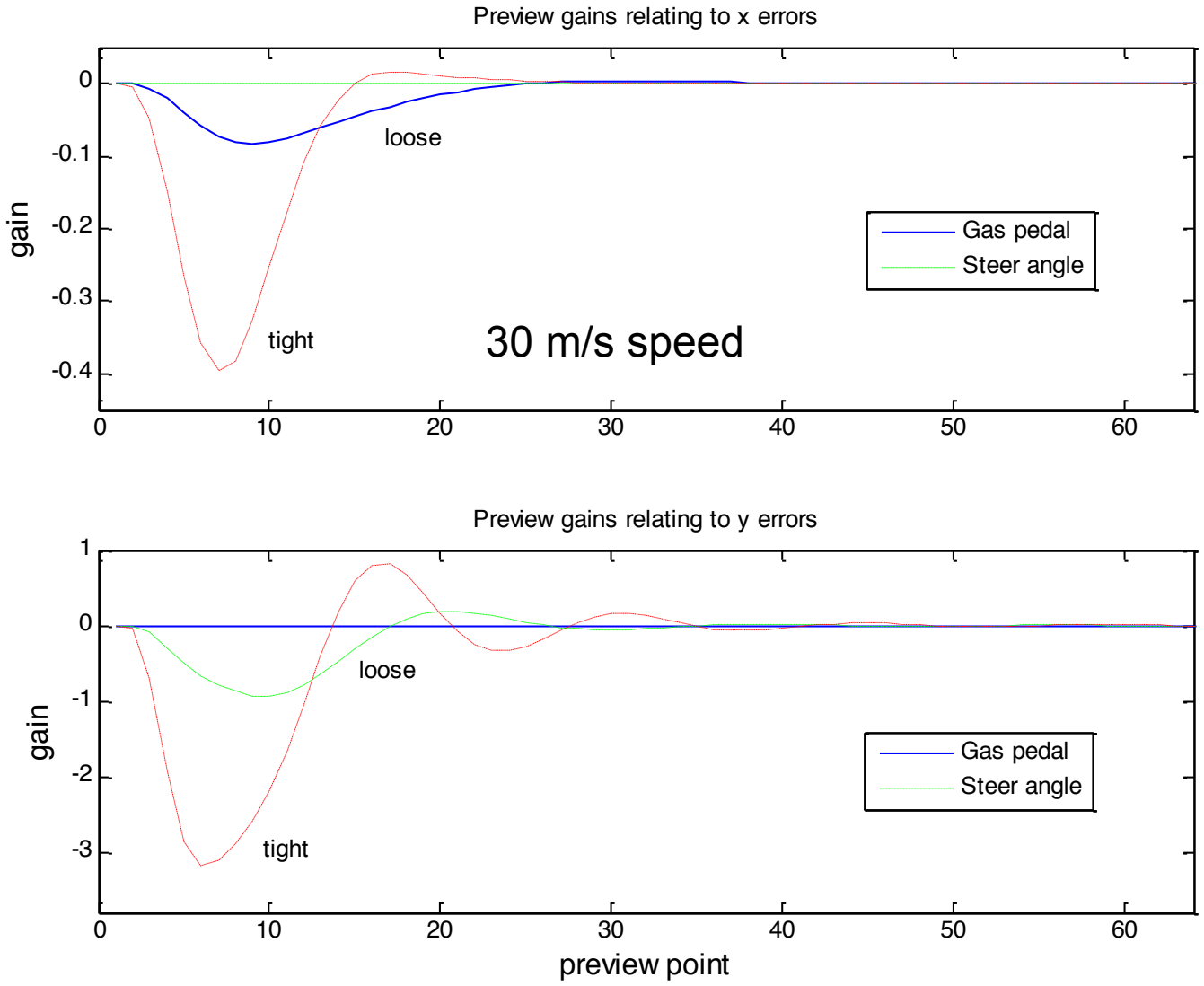
Car model

- flat road; simple aero forces
- combined-slip tyre forces
- steer angle and throttle position controls
- multibody system, rear wheel drive, front heavy
- engine map etc.
- near straight running, symmetric, smooth

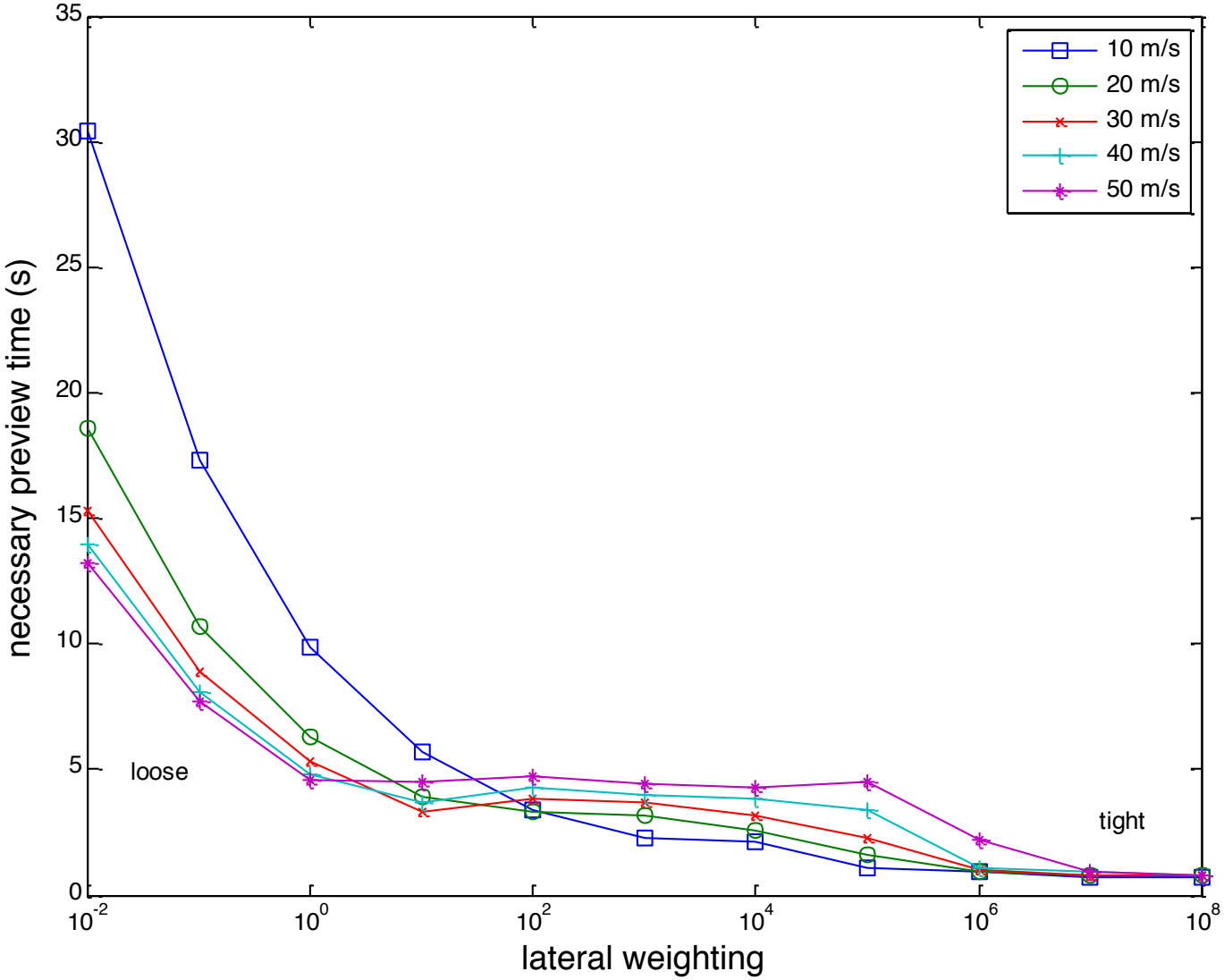
Optimal controls

- balance accurate path tracking with low control activity; tight and loose controls
- longitudinal and lateral decoupling
- concentrate on steering
- state-feedback control for general good quality
- preview controls for good tracking
- diminishing returns for more look-ahead

Preview gains for tight and loose controls

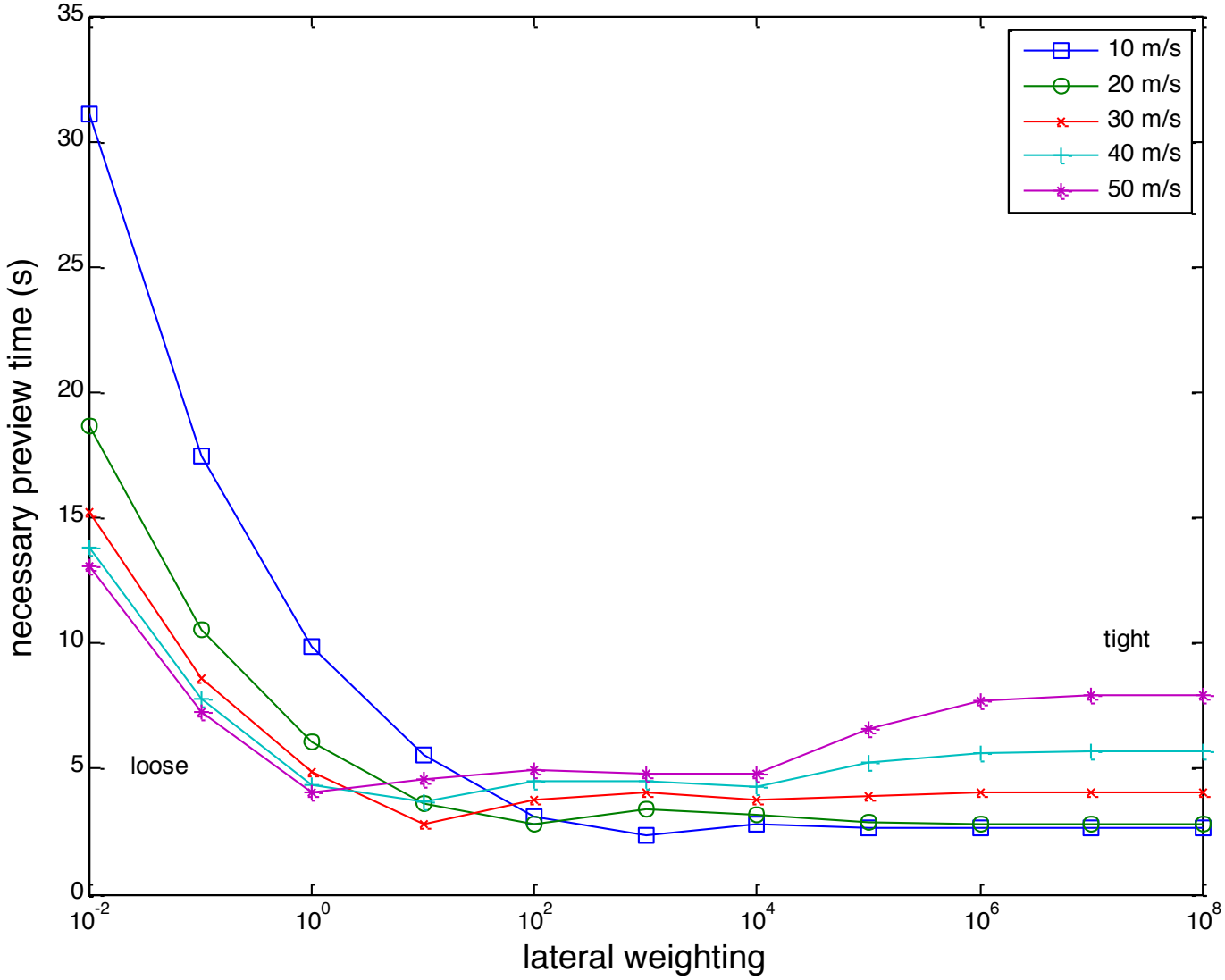


Preview time for standard car at various speeds for different weights

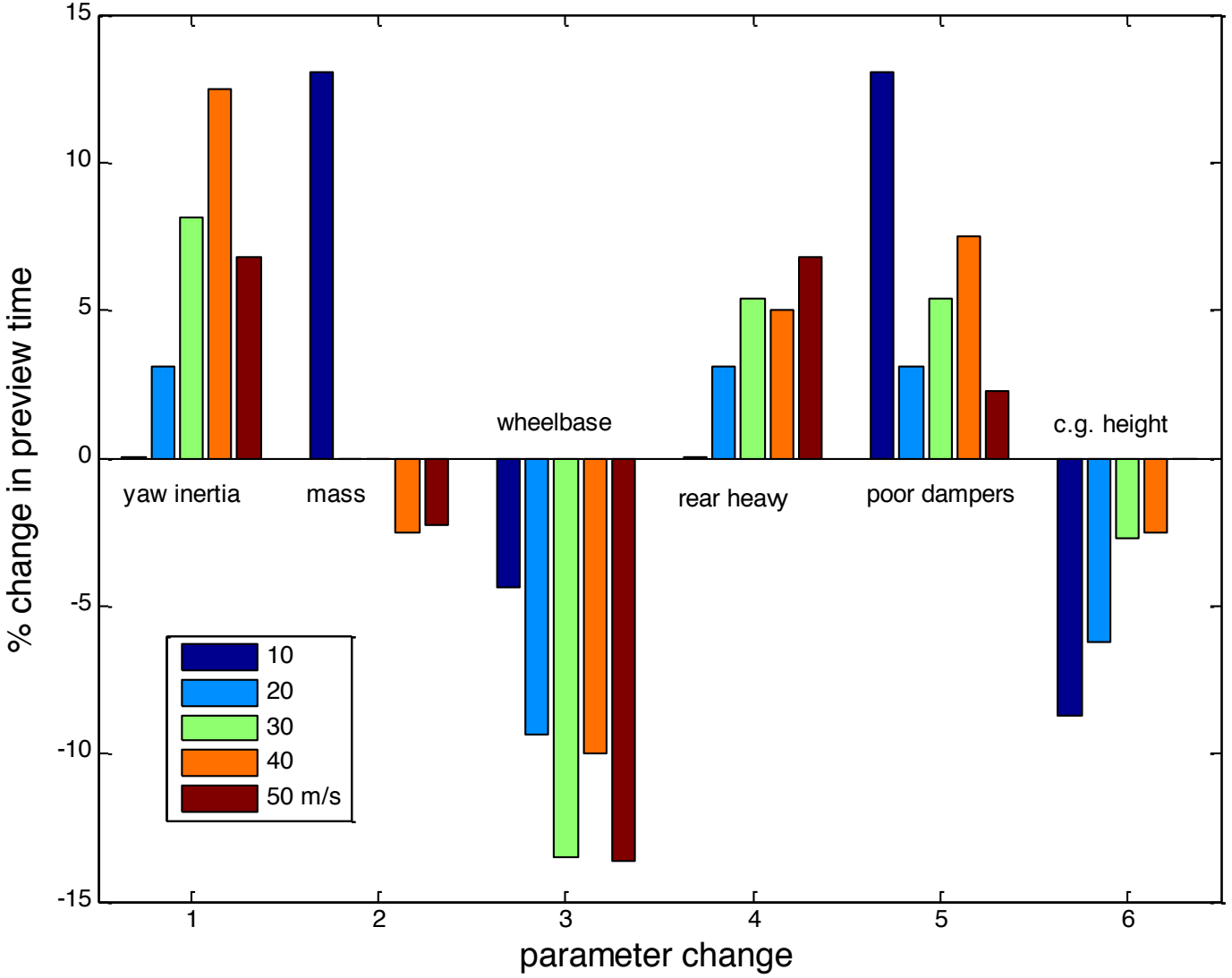


Tomizuka-Whitney criterion;

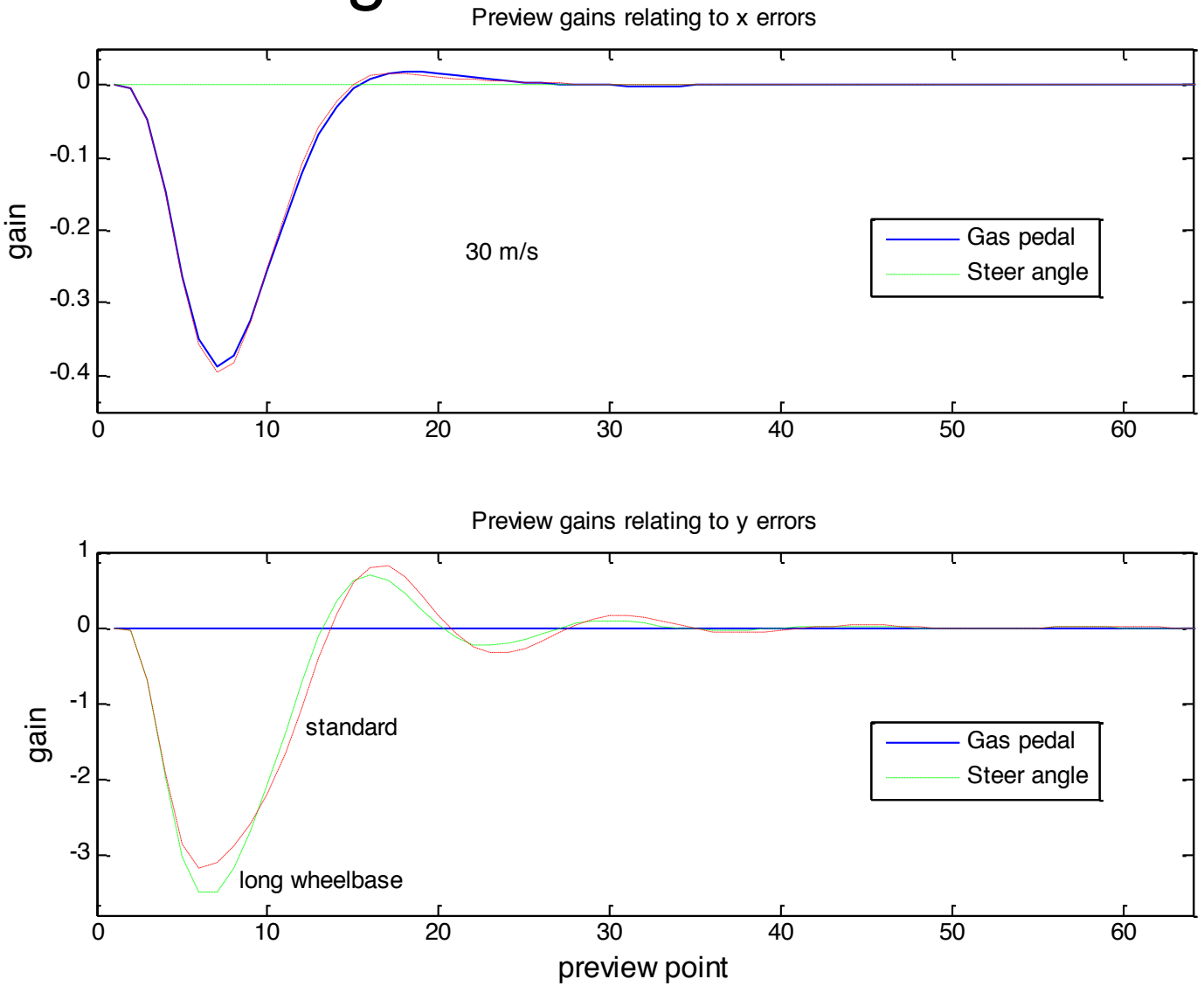
10 times the longest time constant of the closed-loop system



Preview time parameter sensitivities for lateral weighting 100



Preview gain sequences for standard and long wheelbase cases



Summary

- hypothesis on learning; consistency and smoothness vital; nonlinearity is O. K.
- stability; controllability; lack of faults; nature of faults
- for curvy roads, short preview and well-damped motions are best
- parameter influences worth studying
- for the M1, a Cadillac will do