ONE-PEDEAL DRIVING
RAPID FEATURE DEVELOPMENT WITH SIMULINK

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This talk will introduce One-Pedal Driving, highlight its benefits, and describe Simulink’s role in its development.

1. One-Pedal Driving Basics

2. Benefits of One-Pedal Driving

3. Feature Development with Simulink
One-Pedal Driving allows for most driving to be performed without leaving the accelerator.

Strong coast regeneration provides confident braking levels.

The vehicle stops smoothly and holds stops with One-Pedal Driving.

Regen system provides one-pedal driving
Regen braking slows the vehicle to a stop without using the brake pedal.
The acceleration pedal dynamically adjusts to provide responsive propulsion and braking.
With One-Pedal Driving, the Bolt EV can achieve a stop on most grades:

- Level Roads
- Uphill Roads
- Slight Downhill Roads
One-Pedal Driving is realized through two key aspects

**Strong coast regeneration**

- Uphill – more aggressive stop
- Flat – natural stop based on coast regeneration
- Downhill – gradual, natural-feeling stop

**Speed trajectory control for complete stops**

**Maximum Coast Regeneration**

- Typical EVs
- Chevrolet Bolt EV

Braking G-Force

<table>
<thead>
<tr>
<th>Time</th>
<th>Vehicle Speed</th>
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<tr>
<td>0</td>
<td>0.15</td>
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Chevrolet Bolt EV
One-Pedal Driving is part of a customized driving experience

Activate One-Pedal Driving by shifting to “Low”

Temporarily activate One-Pedal Driving by holding the Regen-on-Demand paddle

Use both together for the highest level of regeneration

Coast (Zero Pedal) Regeneration

<table>
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<tr>
<th>Mode</th>
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<tr>
<td>Drive</td>
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<tr>
<td>Low</td>
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<tr>
<td>Drive with Regen-on-Demand</td>
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<td>Low with Regen-on-Demand</td>
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Convenience features assist the driver when using One-Pedal Driving

- The vehicle will remain at stop upon releasing the regen paddle.
- If the driver begins to exit, the vehicle will automatically apply the park brake or shift to park.
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Ease-of-use – provides continuous control with fewer pedal transitions

Conventional Driving
- Maximum Propulsion: 100%
- Zero Torque: 0%
- Maximum Braking: 0%

One-Pedal Driving
- Frequent pedal transitions
- Continuous torque modulation

Driver Pedals
- Conventional Driving: 100% propulsion, 0% braking
- One-Pedal Driving: 100% propulsion, 0% braking
Energy savings – One-Pedal Driving improves real-world EV range by increasing regeneration without expensive blended braking systems

Example: Additional Energy Capture with One-Pedal Driving
US06 Aggressive Driving Cycle

Brake Pedal Use Required in Other Electric Vehicles
Performance – effortlessly smooth driving on winding roads
Performance – jerk-free stops with no skill required

**Complete Stop with One-Pedal Driving**

- **Driver's Experienced G Force** vs. **Vehicle Speed (kph)** vs. **Time (seconds)**
- Graph shows the relationship between G force and vehicle speed over time for one-pedal driving.

**Complete Stop using Brakes**

- **Vehicle Speed (kph)** vs. **Time (seconds)**
- Graph illustrates the braking process with focus on vehicle speed and time.

Legend:
- Blue line: Vehicle Speed
- Red line: Driver’s Experienced G Force
FUN – an electric-only experience that you will never want to give up!
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Simulink was a key enabler for a short development cycle of One-Pedal Driving

For its software creation capabilities

As a support tool for control system development

90% of One-Pedal Driving software written in Simulink
Simulink’s capabilities prove useful throughout the entire software development process.
Simulink modeling facilitates the brainstorming, creation, and review of algorithms

Visual content in two dimensions

Textual content in one dimension
Stateflow provided a concise way to create and review a complex state machine in the One-Pedal Driving software
Simulink enables quick iteration because software can be created, tested, and modified all in the same environment.
Simulink provides powerful support for control system development

**Predict vehicle performance**

- Desired Speed
- Simulated Speed

**Tune calibrations with real-world data**

- Vehicle Accelerometer
- Modified Filter
- Baseline Filter
In summary, One-Pedal Driving is a superior driving experience, rapidly brought to market with the development capability of Simulink.

1. One-Pedal Driving lets most Bolt EV driving be performed without switching pedals.

2. One-Pedal Driving provides better driveability and increases regeneration to improve range.

3. Simulink enables rapid control algorithm creation through two coordinated avenues:
   iii. For algorithm creation, review, and testing
   iv. As a tool to support control system development