Evaluation of Allison Transmission FuelSense®2.0 with DynActive ® Shifting for Improved Fuel Economy

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Introduction

FuelSense®2.0 with DynActive® Shifting is an innovative algorithm-based transmission shift strategy developed by Allison Transmission.

Timeline

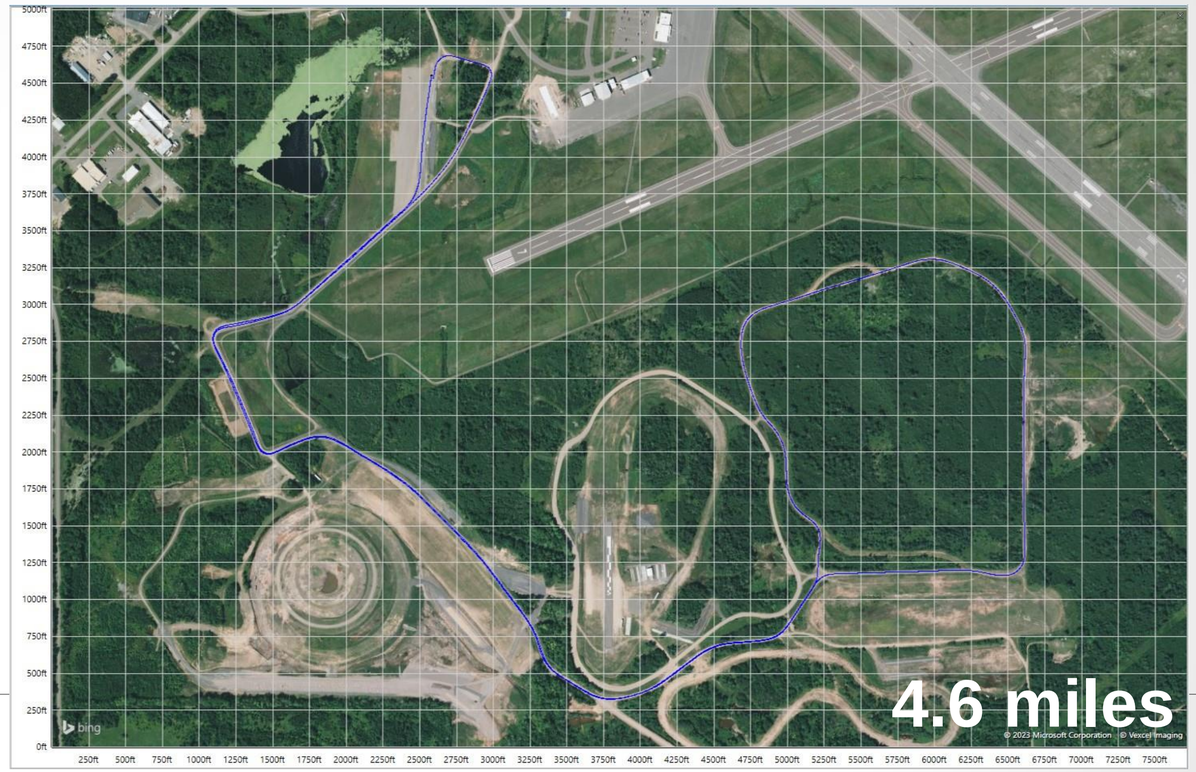
- May 2023 – CRADA # 23-03 signed to evaluate DynActive® Shifting
- Jun-Jul 2023 – User trial at Keweenaw Research Center
- Sept-Nov 2023 – Dynamometer test for HEMTT at GVSC PEVEL
- Jan-Feb 2024 - Dynamometer test for PLS at GVSC PEVEL
- Jan 2024 - Dynamometer test for FMTV at Allison VE+ET

Theory of Operation

- DynActive® Shifting is an algorithmic-based control logic which selects transmission gear based on inputs such as driver demand, engine load, and available engine torque.
- Upshifting to a higher transmission gear drops engine speed which often places the engine in a more efficient operating point and may also reduce accessory loads (i.e. cooling fan).
- Fuel savings can occur at both transient and steady-state driving
  - Urban stop/go traffic
  - Vehicle convoy at 20-40 MPH
- Balance of vehicle performance vs fuel savings can be set through changing the bias level.
  - 0% = Greater performance
  - 100% = Greater fuel economy
- Enabled through a flash GEN V and newer TCMs.

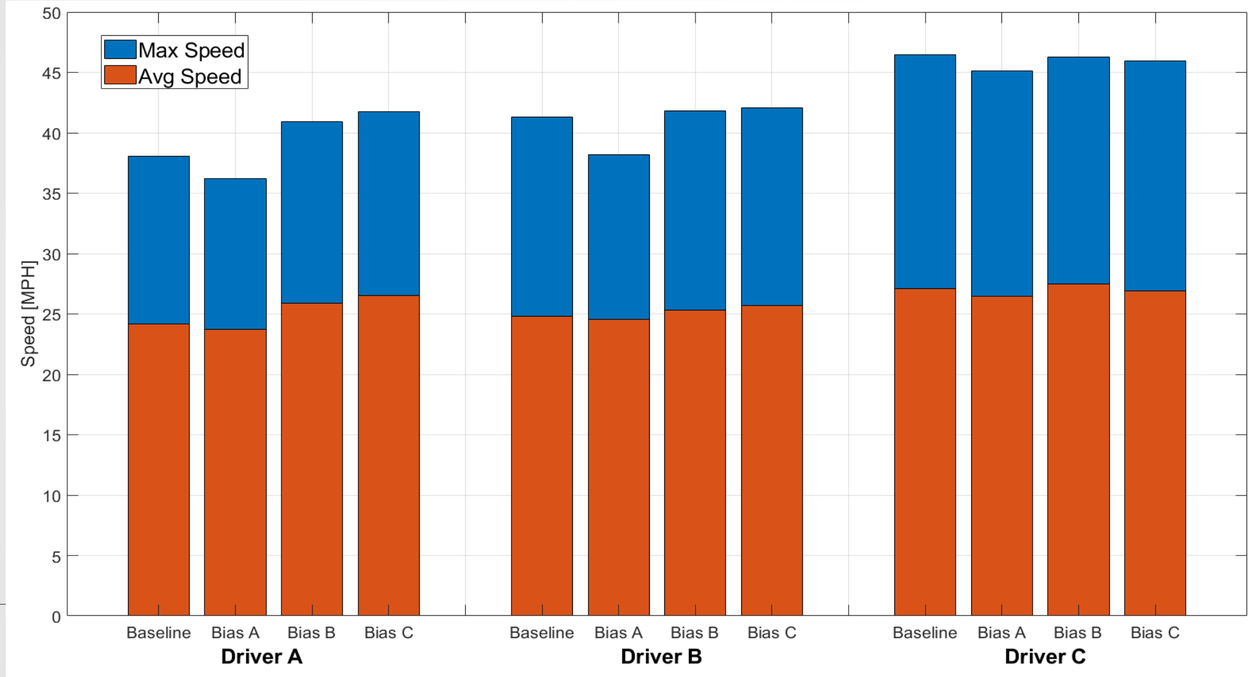
Driver Perspective from User Trial

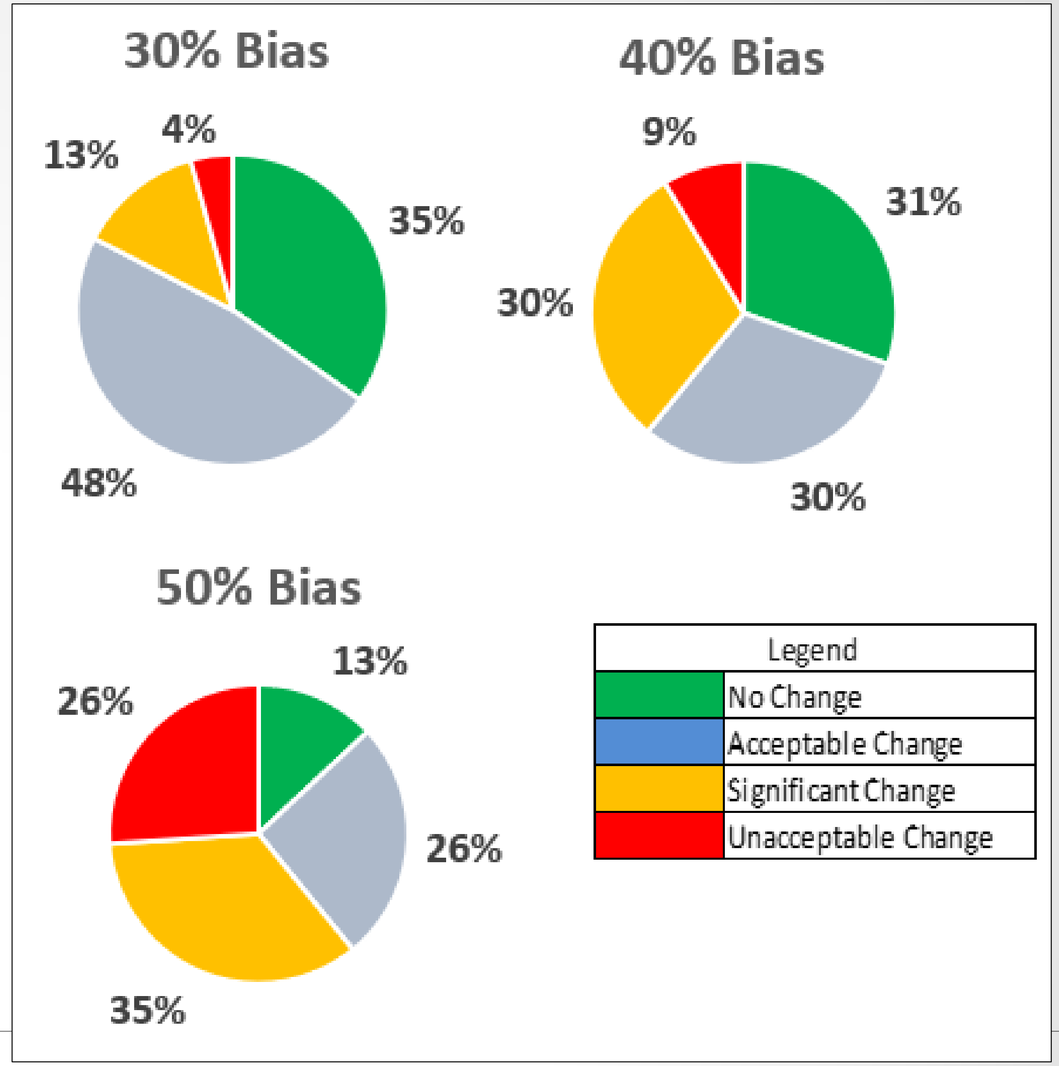
- FMTV, HEMTT, and PLS were tested at Keweenaw Research Center (KRC) for driver survey and initial data collection from CAN bus.
- Each vehicle was tested with three different bias levels.
- Vehicles were loaded to vehicle curb weight (VCW), gross vehicle weight (GVW), and gross combined vehicle weight (GCVW).



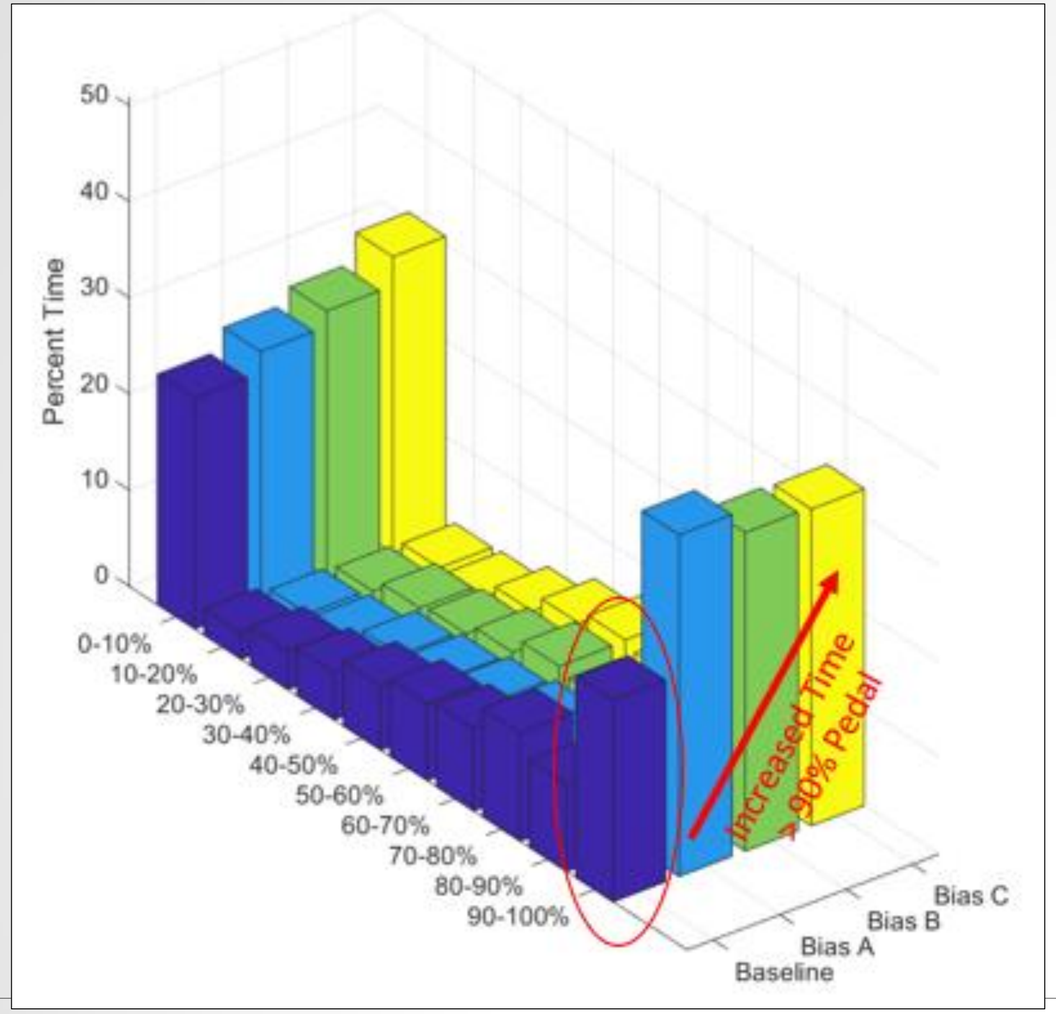
Driver Perspective from User Trial

- Based on feedback surveys, drivers were able to detect a change in the vehicle's performance.
- Measurements of course max speed and average speed did not show a significant change.





Driver Perspective from User Trial



- As general trend, drivers increased their time at >90% pedal position.
- By increasing pedal position, drivers were able to achieve similar lap times and max speeds on the course.
- Suspected cause for negative feedback was the sensation of being deeper in the pedal to achieve similar performance.

Driver Perspective from User Trial

- Fuel savings estimated using the “engine fuel rate” from the CAN bus.
- All three vehicles showed improvement in fuel economy with HEMTT and PLS posting the highest numbers.
- The highest bias levels did not always show the best improvement, but this is probably due to environmental factors and test repeatability.

	Bias A	Bias B	Bias C
FMTV	3.0%	2.0%	2.2%
HEMTT	7.9%	9.9%	11.2%
PLS	6.9%	5.1%	5.8%

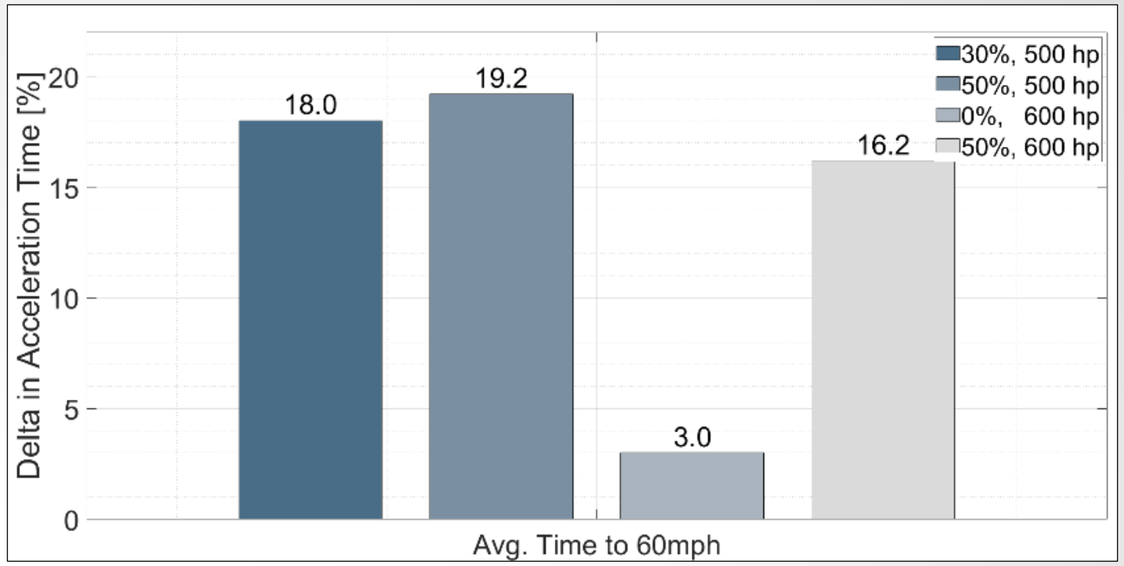
Chassis Dynamometer Testing

PEVEL
(Power Energy Vehicle Environmental Laboratory)

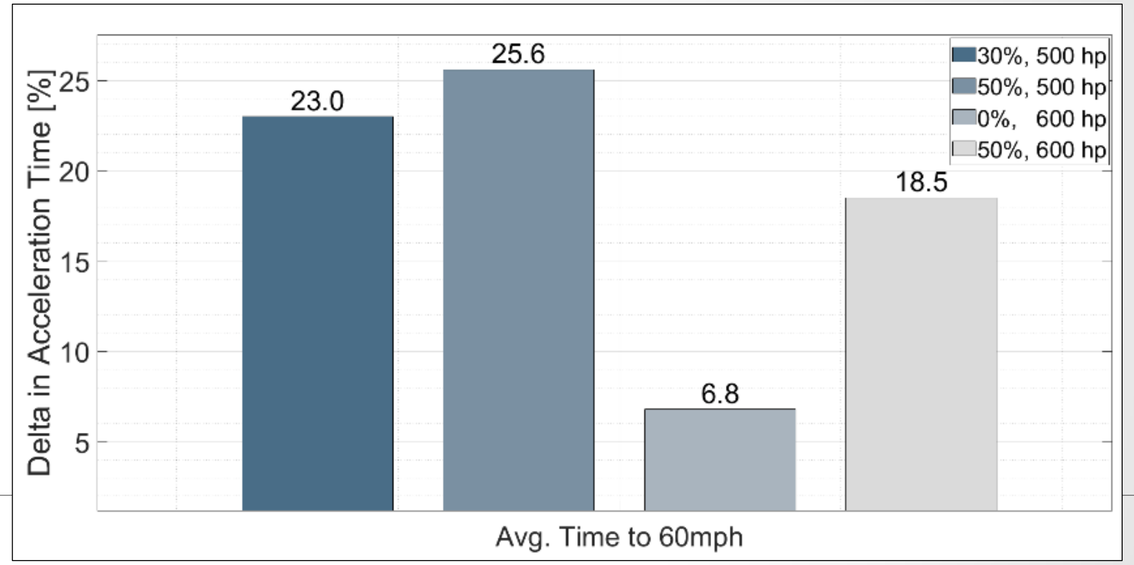
Chassis Dynamometer Testing

- Tested impact of modifying engine torque curve (500 hp vs 600 hp) to commonize TCM between HEMTT and PLS.
- All bias levels showed an increase in acceleration time.
- 0% bias had the least impact.
- Acceleration time increased at 120°F.
- Acceleration time increase less severe at 40 MPH or 50 MPH.

80°F



120°F



Chassis Dynamometer Testing

- HEMTT driven at 20 MPH, 40 MPH, and 50 MPH on Munson Fuel Economy Loop at both 80°F and 120°F.
- Majority of fuel savings came from 20 MPH runs.

Munson Fuel Economy Loop

	500 hp		600 hp	
	30%	**50%**	**0%**	**50%**
VCW	8.4%	8.2%	6.8%	8.9%
GVW	11.4%	11.5%	9.9%	11.6%
GCW	11.3%	11.5%	9.5%	10.9%
Average	**10.4%**	**10.4%**	**8.7%**	**10.5%**

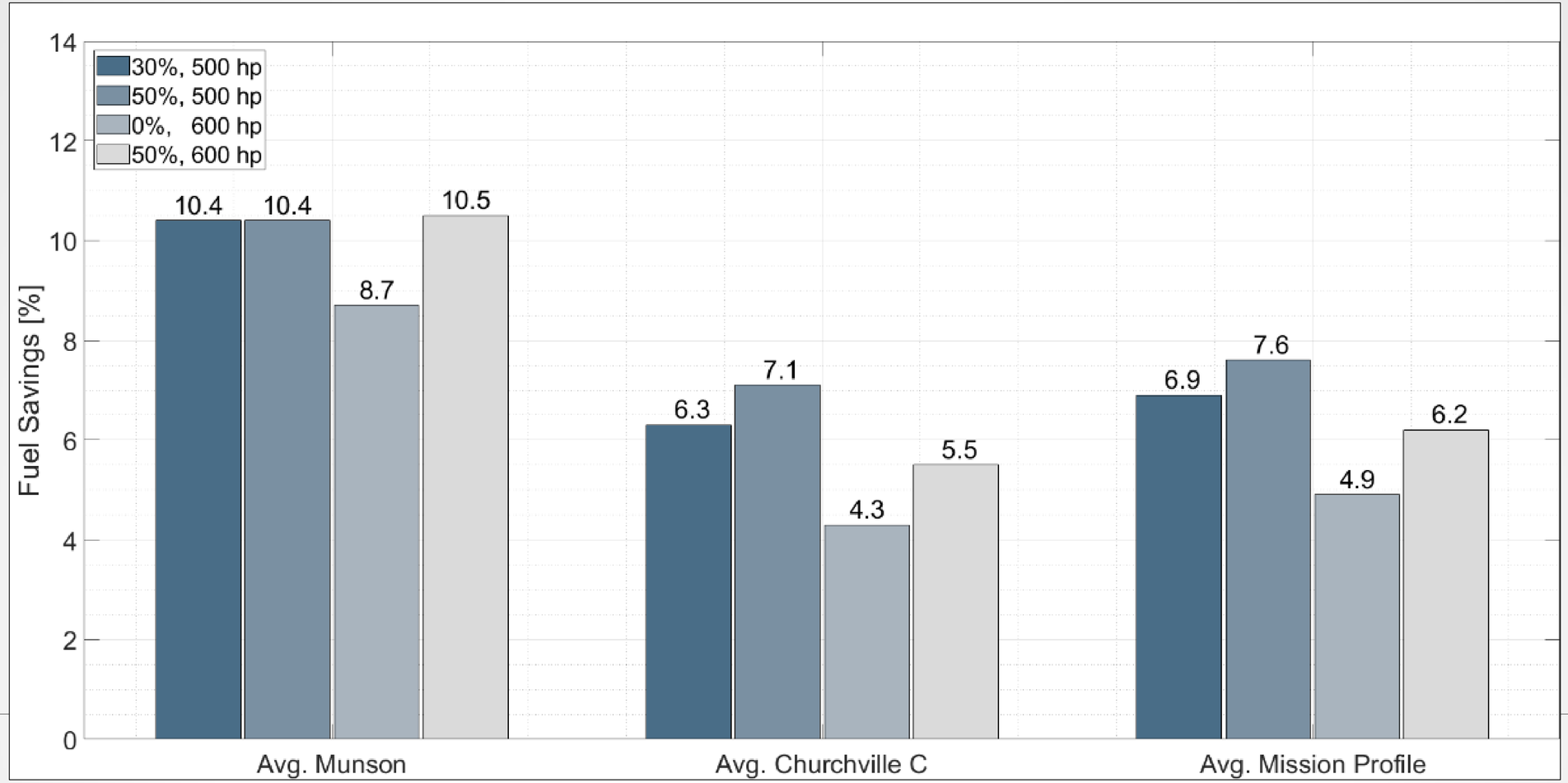
- HEMTT driven at 35 MPH and 45 MPH at both 80°F and 120°F.

Churchville C

	500 hp		600 hp	
	30%	**50%**	**0%**	**50%**
VCW	8.0%	8.9%	5.9%	6.1%
GVW	6.4%	6.6%	4.0%	5.9%
GCW	4.6%	5.8%	2.8%	4.5%
Average	**6.3%**	**7.1%**	**4.3%**	**5.5%**

Chassis Dynamometer Testing

OMS/MP Split of 85% secondary roads (Churchville C) and 15% primary roads (Munson)



Conclusion

- Fuel savings due to DynActive® Shifting are vehicle and drive cycle dependent.
- Highest fuel savings observed on HEMTT were at convoy speeds of 20 MPH.
- Vehicle acceleration performance decreased at 80°F and 120°F. Even with the most aggressive shifting, acceleration time to 60 MPH grew by 3-7%.
- Acceleration time increase less severe at 40 MPH or 50 MPH.
- Averaged fuel savings across all vehicle weights (VCW, GVW, GCVW) and ambient temperatures (80°F, 120°F) measured significant fuel savings.
  - ✓ Munson = 8.7-10.5%
  - ✓ Churchville C = 4.3-6.3%
  - ✓ Misson Profile = 4.9-7.6%

Questions

Thank you!

References

[1] Department of the Army. (26 June 2020). *AR 70-38: Research, Development, Test and Evaluation of Material for Worldwide Use*.

[2] Department of the Army. *FuelSense®2.0 Software Update for the Medium & Heavy Truck Fleet.* CRADA # 23-03.

[3] Allison Transmission Inc, "FuelSense®2.0," AllisonTransmission.com. 10140-02-highway-fs-flyer-sa8814en_final-lr_web.pdf (allisontransmission.com) (accessed Feb. 26, 2024).

[4] S. Beiter, S. Zielinski, "HEMTT Mobility Performance and FuelSense®2.0 Testing," Test Report, GPMH23025, 10 Jan 2024. DTIC AD1229466.

[5] S. Beiter, S. Zielinski, "PLS Mobility Performance and FuelSense®2.0 Testing," Test Report, GPMH23026, 01 April 2024. DTIC AD1229405.