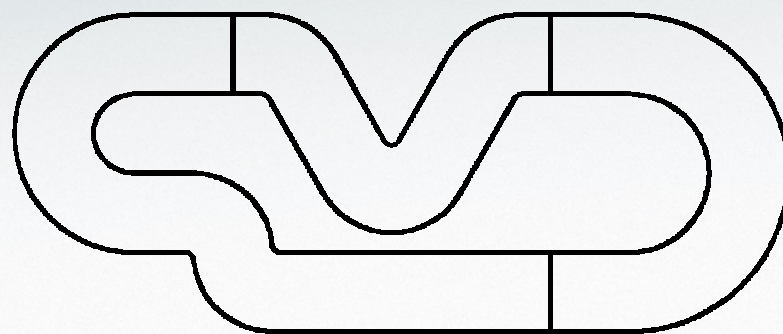




Global**Vehicle**Dynamics

Ford Torque Vectoring Control

Smart application of available chassis actuators

Jens Dornhege
jdornheg@ford.com
+49 (221) 90 31944

Derek Ward
dward68@ford.com
+49 (221) 90 38219

Lucian Lippok
llippok@ford.com
+49 (221) 90 35742



Ford Torque Vectoring Control

- The Problem
- Root Cause
- Solution Concepts
- Decision
- Conclusion



Feel the difference

The Problem

FWD with transverse mounted engine emerged as mainstream platform concept due to package, cost and low weight.

Major concept drawbacks, especially for performance derivatives, are:

- Power on understeer
- Reduced traction performance

Vehicle weight is a very sensitive theme in the current fuel-economy-conscious climate.

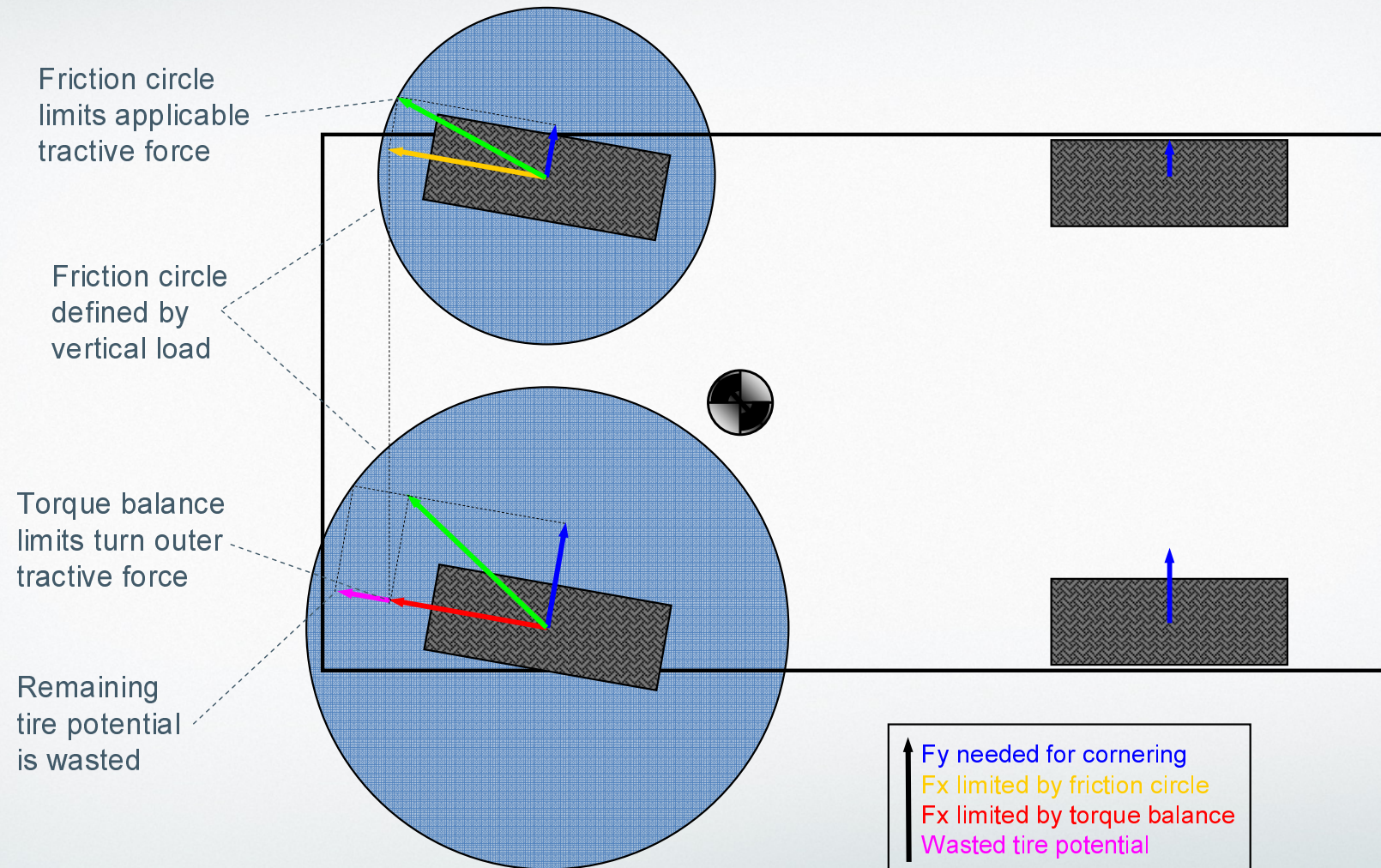
Root Cause – Load Transfer

Cornering forces in a vehicle lead to reduced inner wheel vertical load.



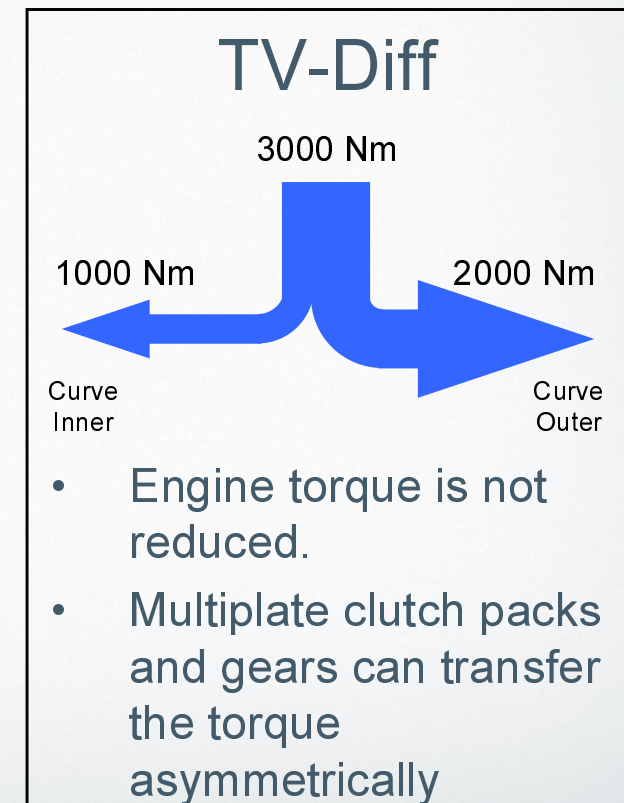
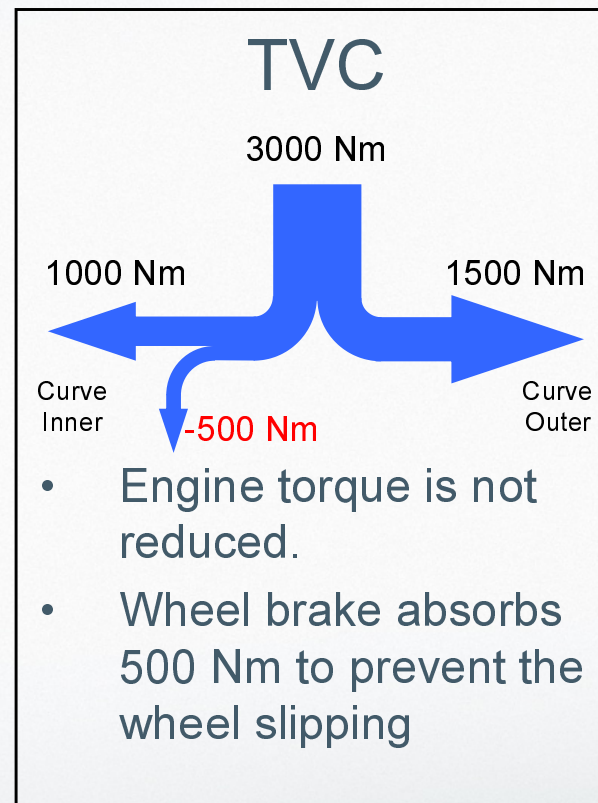
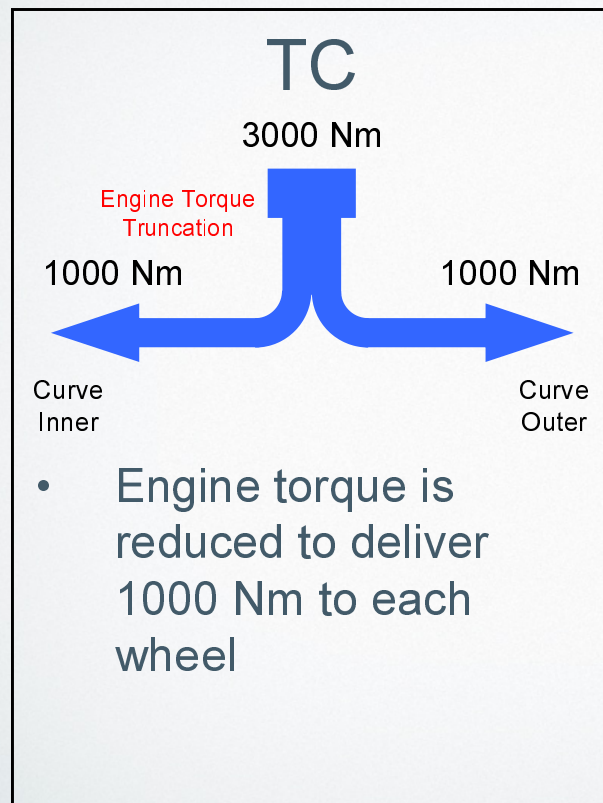
In front wheel driven vehicles with high performance engines this may lead to the inner wheel slipping when accelerating out of a turn.

Vehicle Acceleration in a Turn



Solution Concepts – An Example

Assuming in a left turn the gearbox delivers 3000 Nm driving torque and the curve inside wheel can transfer 1000 Nm.



The Decision – Brake vs. Differential

Pro Differential

- During system activation the energy loss in the clutches is lower than in the brakes
 - Less fuel consumption increase when in use
 - Possibly better acceleration in low gears
- The differential actuator is less intrusive
 - No change in longitudinal acceleration during activation and modulation
 - Specialized system is easier to control with less hysteresis and smoother application

Pro Brake

- No weight increase
 - No fuel consumption increase when not in use
 - No acceleration deficit due to power to weight ratio
 - No increase of front load distribution for FWD vehicles
- TVC can be modulated over a wide range
- Simple integration / harmonization with existing ESC system
- Slight reduction of engine power available for acceleration when active, but increases the ability to get available power on the road
- Lever arm to steering axis is smaller than for driveshaft forces, resulting in less steering disturbance
- Cost efficient solution – software only



Feel the difference

Ford Torque Vectoring Control



Conclusion

- Evaluating technical and cost benefits TVC is preferred solution for FWD vehicles over a TV-Differential
- TVC minimises the slip in the curve inside wheel, possible to maintain the lateral grip capacity of the tire
- TVC provides driver assistance in mid to close-to-limit handling
- TVC increases power-off stability "at the limit" (reduced slip angle overshoot)
- Strongly reduced power-on understeer
- Less ESC interventions lead to a comfort improvement