

Improving car-carrier safety through Performance-Based Standards



Emerging Researcher Symposium

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Outline

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2. Objectives
3. Tail swing study
 - South African car-carrier fleet
 - South African legislation
4. Detailed PBS assessment
5. Conclusions

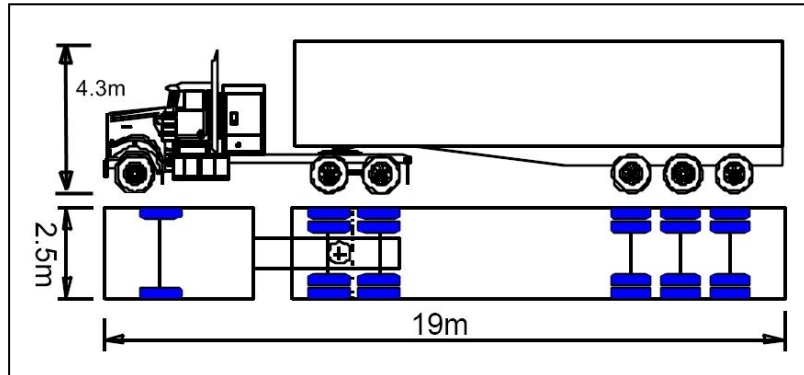
Background: Problem identification

- Until recently, South African car-carriers operated under abnormal load permits
 - +0.3 m height, +0.5 m length over legal limits
- This practice is in the process of being phased out
- South African regulations will be enforced, unless (proposal):
 1. Vehicles comply with the Australian Performance-Based Standards scheme (as part of the South African PBS demonstration project)
 2. Operators are RTMS accredited
- South African car-carriers have very large rear overhangs (4 to 6 m) vs. the Australian limit of 3.7 m
 - Tail swing is likely to be a critical standard

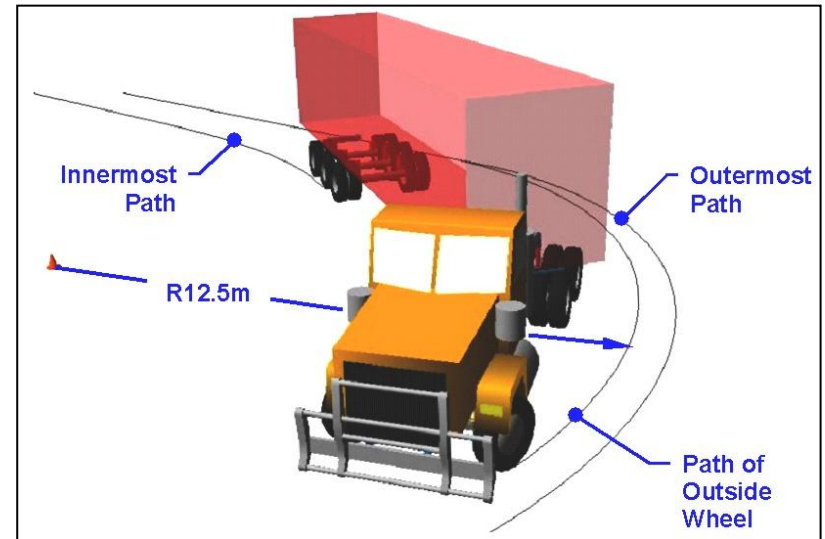


Background: Performance-Based Standards

Prescriptive Standards



Performance-Based Standards



What the vehicle looks like

Governs **mass and dimensions**

Constrains productivity

Constrains innovation

What the vehicle can do

Governs actual **on-road performance**

Allows **heavier and/or larger vehicles**

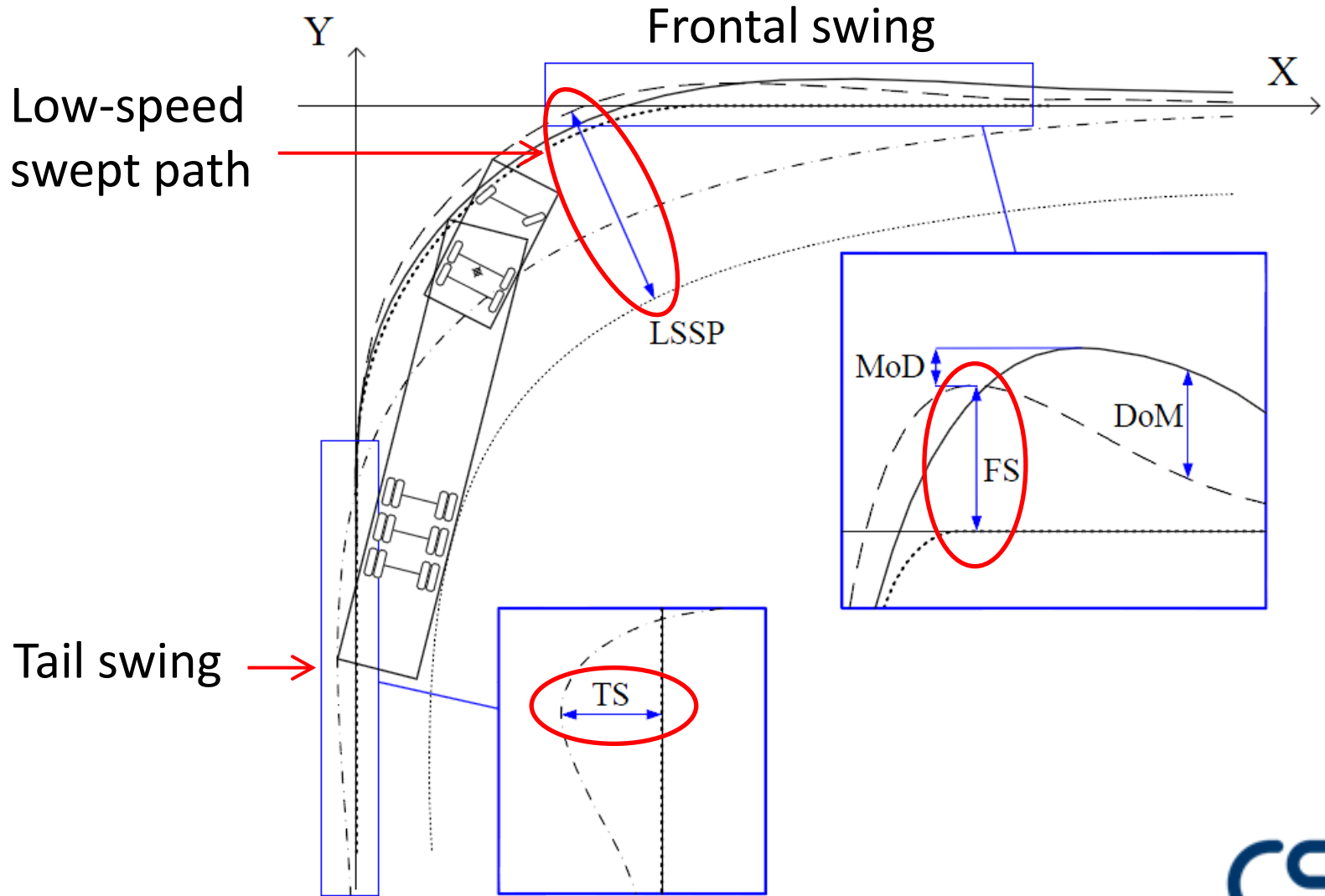
Promotes **innovation**

Background: Performance-Based Standards

- Australian PBS scheme adopted for SA demonstration project
- Vehicle safety is assessed using five safety-critical manoeuvres:

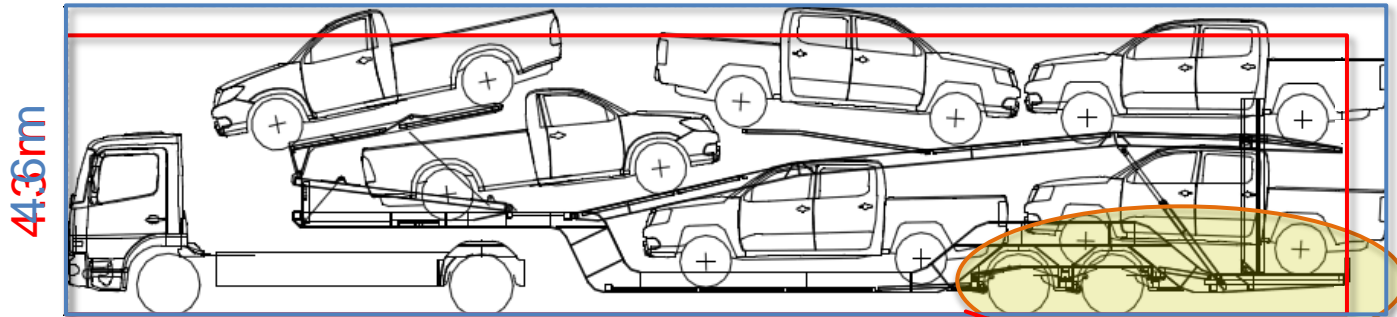
Manoeuvre/Test	Performance Standard
Low-speed 90° turn	Low-speed swept path Tail swing Frontal swing Steer-tyre friction demand
High-speed lane-change	Rearward amplification High-speed transient offtracking
Rollover	Static rollover threshold
High-speed pulse steer	Yaw damping coefficient
High-speed on uneven road	Tracking ability on a straight path

Background: Performance-Based Standards

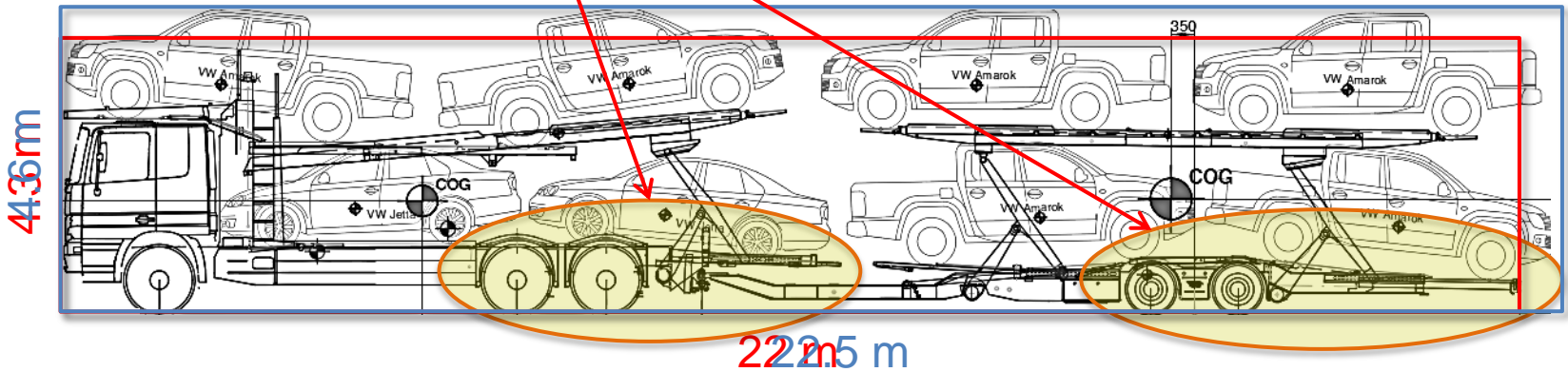


Background: South African car-carriers

WITHOUT abnormal load permit



Very large rear overhangs 18.59m



Objectives

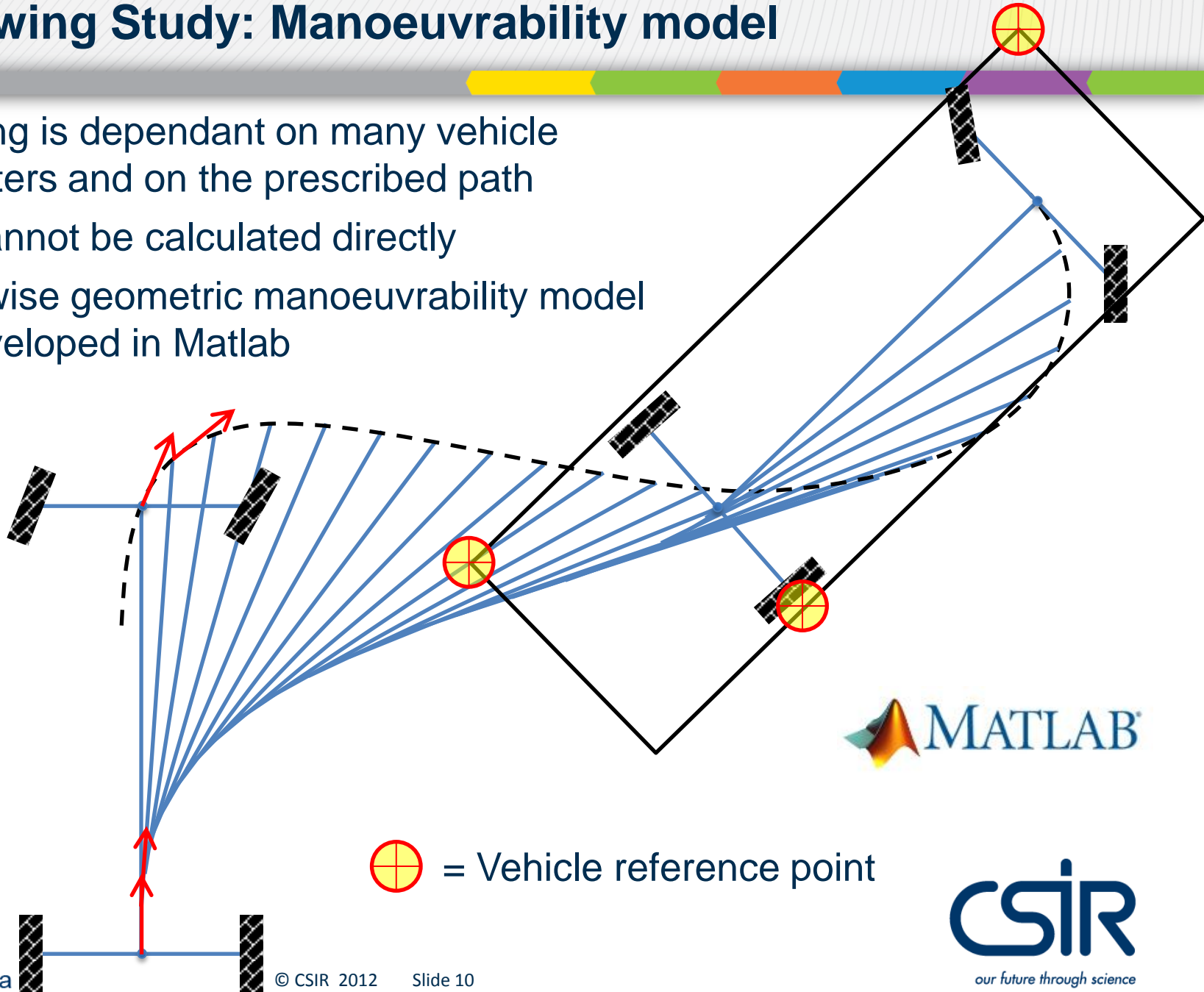
1.
 - a. Quantify the tail swing performance of the South African car-carrier fleet
 - b. Calculate the maximum tail swing permissible within the prescriptive confines of the South African Road Traffic Act
2. Conduct a full PBS assessment of a typical South African car-carrier design



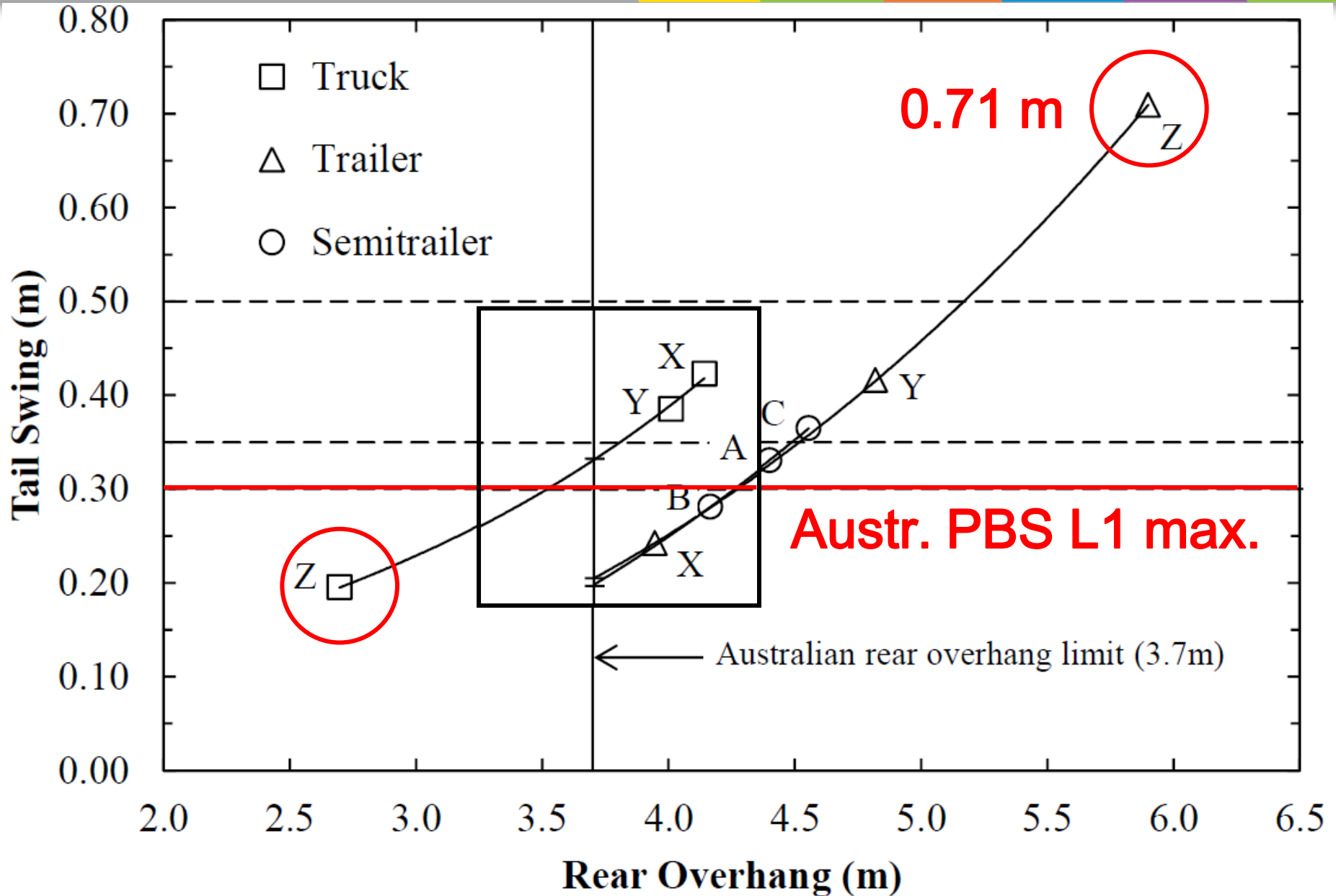
Tail Swing Study

Tail Swing Study: Manoeuvrability model



- Tail swing is dependant on many vehicle parameters and on the prescribed path
 - It cannot be calculated directly
- A step-wise geometric manoeuvrability model was developed in Matlab



Tail Swing Study: South African fleet performance



Tail Swing Study: South African regulations

Vehicle type	Rear Overhang	
		
Rigid truck	3.7 m	5.01 m
Semitrailer	3.7 m	6.32 m
Tag-trailer	3.7 m	7.00 m

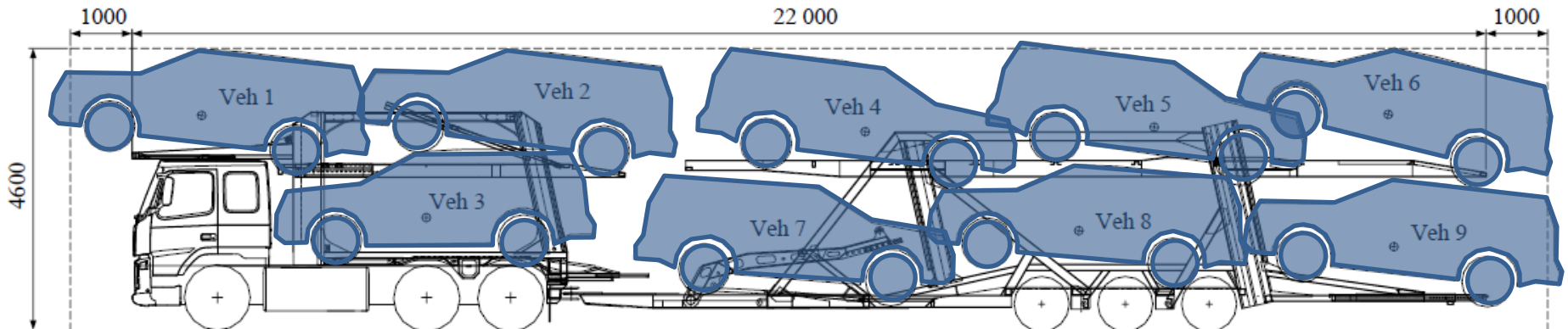
Up to 417% times the Australian PBS Level 1 tail swing limit achievable within SA regulations



Detailed PBS Assessment

Detailed PBS Assessment: Research method

- Simulations conducted using **truckSIM[®]** and **MATLAB[®]**
MECHANICAL SIMULATION™
- Vehicle:
 - Volvo FM400 6x4 + Unipower Maxiporter Mk3
- Payload:
 - 9 x Ford Expeditions (1998).
 - 2 562 kg, Centre of Gravity 777 mm above ground.
 - Multiple load scenarios.



Detailed PBS Assessment: Results

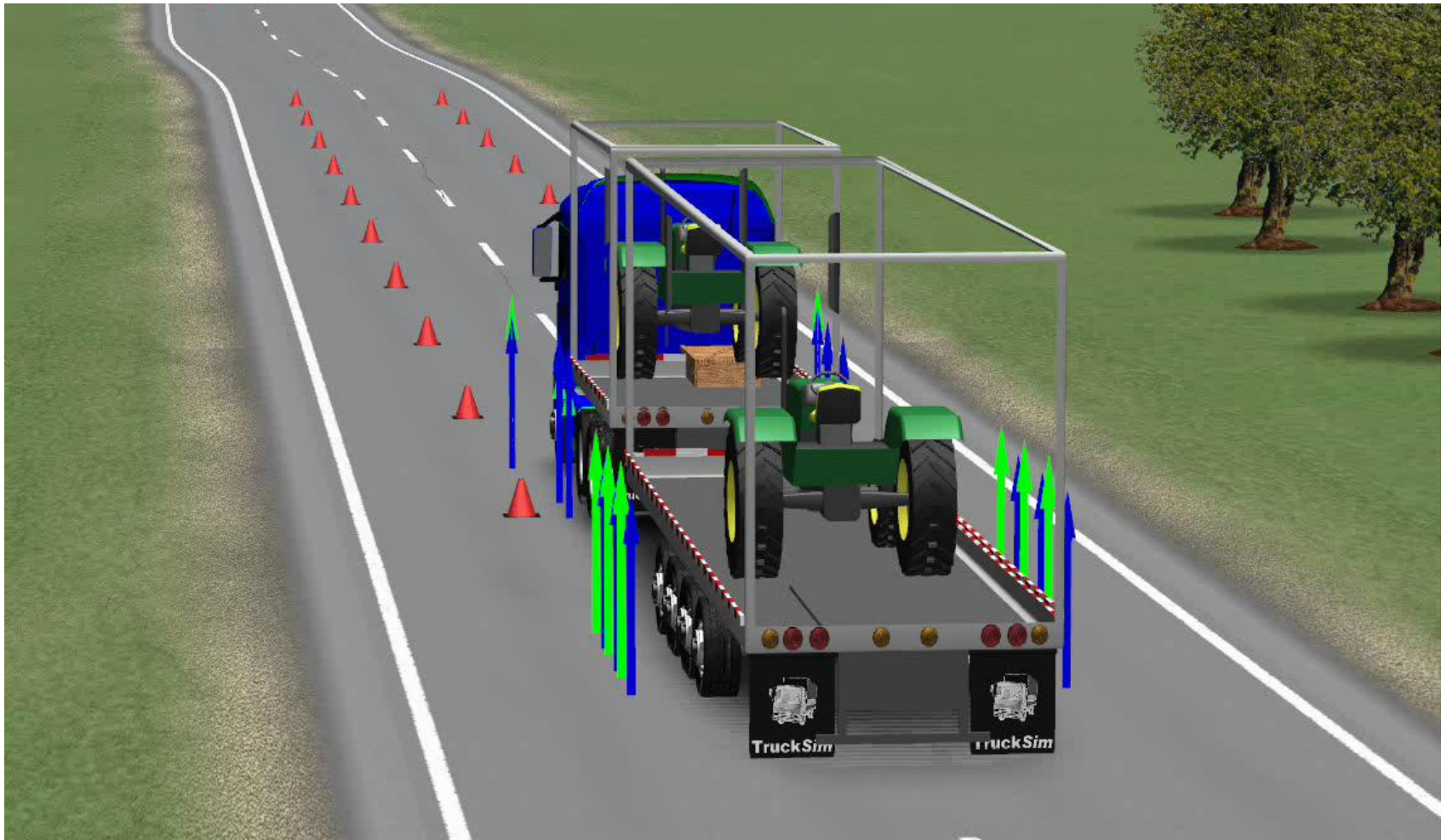
- Initial assessments showed the vehicle to fail certain standards
 - The failed standards are highly sensitive to trailer wheelbase
- A parametric study followed to determine a suitable trailer wheelbase that would meet both performance and practical requirements
 - Trailer wheelbase increased from 9 m to 10 m
- Trailer rear corner geometry refined to meet stringent tail swing limit
- Final PBS design:



Detailed PBS Assessment: Results

Standard	Allowable values	Baseline vehicle	PBS vehicle
Low-speed swept path	≤ 7.4 m	6.7	7.2
Tail swing	≤ 0.30 m	0.66	0.30
Frontal swing	≤ 0.7 m	0.7	0.7
Steer-tyre friction demand	$\leq 80\%$	34	34
Static rollover threshold	≥ 0.35 g	0.35	0.38
Rearward amplification	$\leq 5.7 \cdot \text{SRT}_{\text{rrcu}}$	1.82	1.27
High-speed transient offtracking	≤ 0.6 m	0.7	0.6
Yaw damping coefficient	≥ 0.15	0.09	0.29
Tracking ability on a straight path	≤ 2.9 m	3.0	2.9

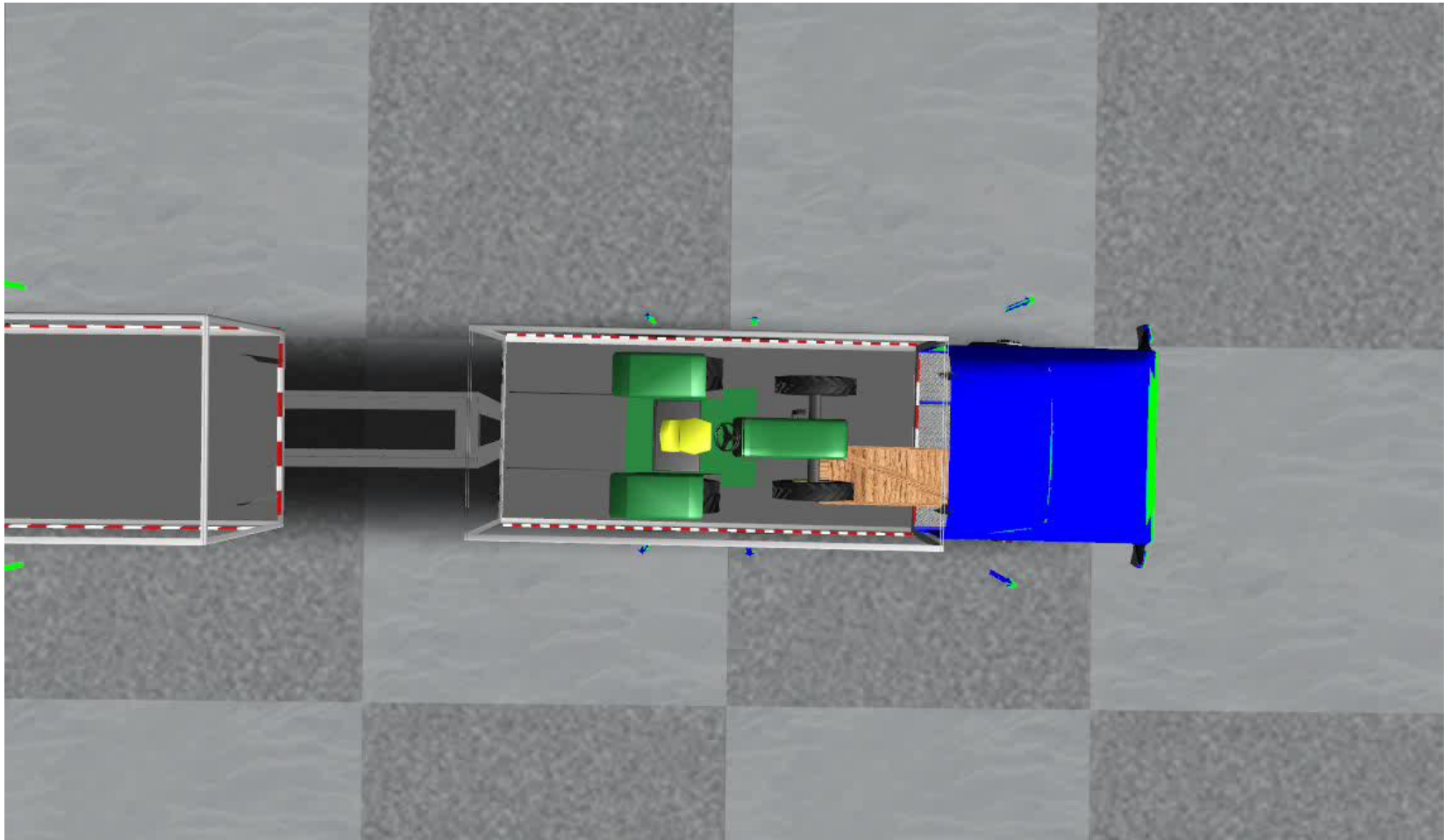
Detailed PBS Assessment: High-speed lane-change



Detailed PBS Assessment: Rollover



Detailed PBS Assessment: Tail swing



Conclusions

1. About 80% of SA car-carriers fail the tail swing standard
2. The 0.30 m tail swing limit correlates well with the 3.7 m rear overhang limit in Australia
 - In comparison, South Africa allows rear overhangs of up to 7 m → Tail swing up to 1.25 m
3. The baseline car-carrier failed four performance standards. Design modifications yielded a PBS-compliant design, with improved safety in six standards
4. The benefits of a PBS approach to heavy vehicle safety, for car-carriers in particular, have been demonstrated



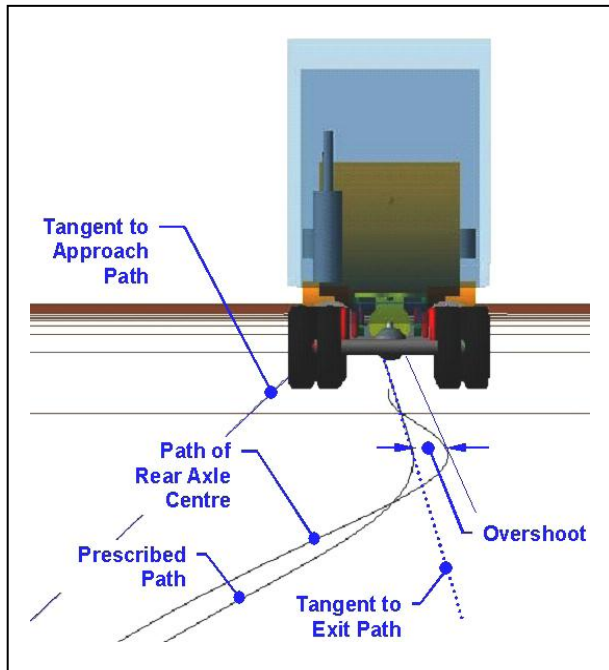
Thank you



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Background: Performance-Based Standards

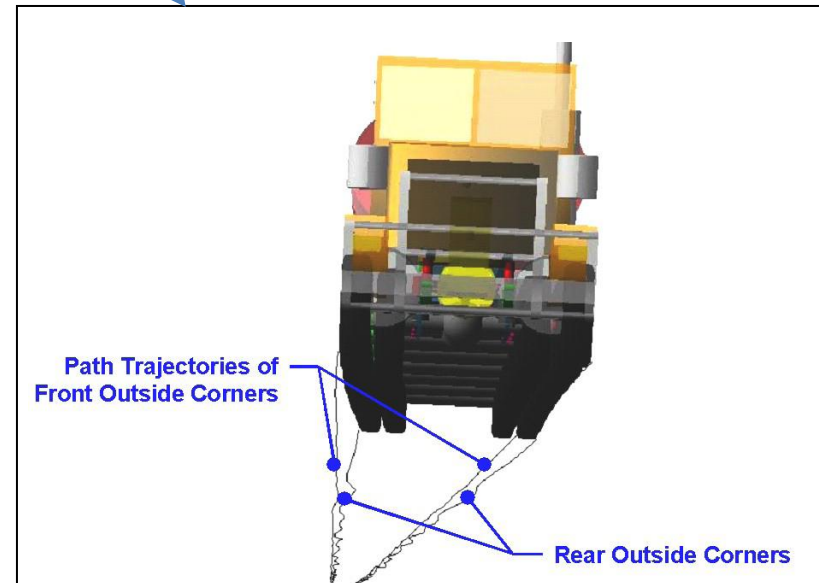
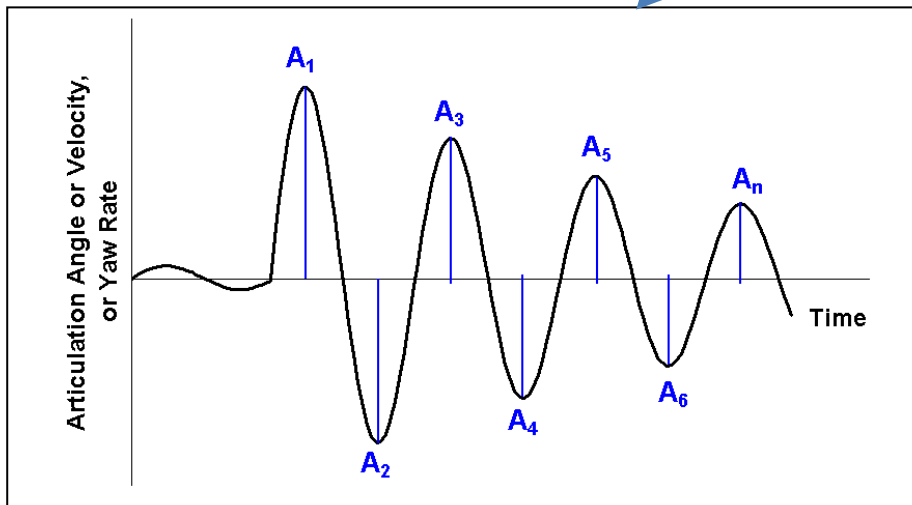
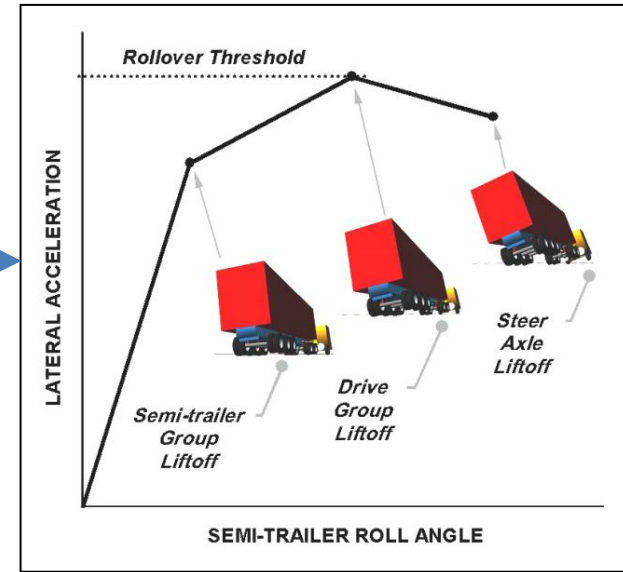


High-speed transient offtracking

Static rollover threshold

Tracking ability on a straight path

Yaw damping coefficient

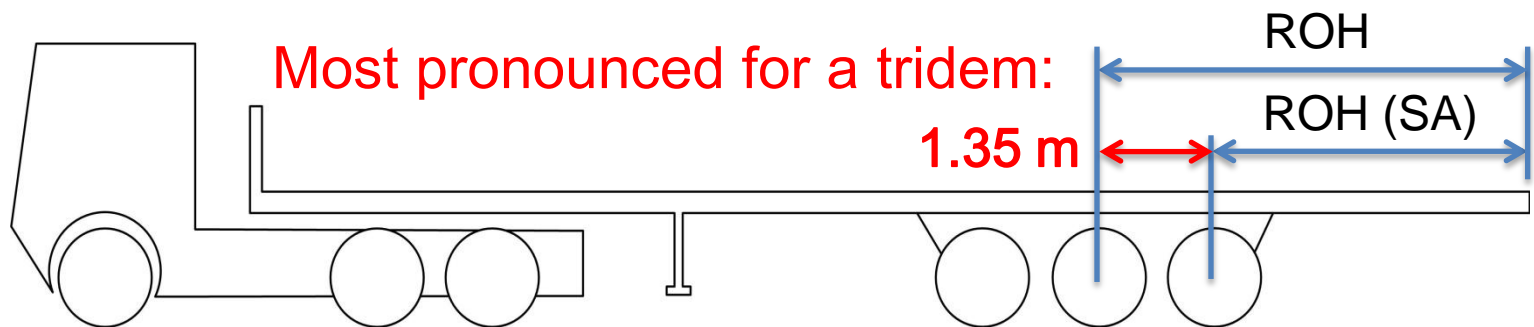


Tail Swing Study: Results (South African Regulations)

- SA regulations limiting rear overhang:

Vehicle type	Rear overhang	Wheelbase/Length	Combination Length
Rigid truck	60%·WB	WB ≤ 8.5 m	12.5 m
Semitrailer	60%·WB	WB ≤ 10 m	18.5 m
Tag-trailer	50%·Trailer length	Trailer length ≤ 11.3 m	22.0 m

- SA definition of “rear overhang”:



Tail Swing Study: Results (South African Fleet)

- Maximum width regulations:
 - 2.5 m in Australia
 - 2.6 m in South Africa
- Additional 50 mm either side
- Assume max. tail swing to occur at a yaw angle of 30° relative to the entry tangent
 - Additional 43 mm tail swing

Good correlation between Australian rear overhang and tail swing limits

