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DRAG REDUCTION ON A PRODUCTION VEHICLE

HUSSAIN ALI

TATA MOTORS EUROPEAN TECHNICAL CENTRE

CONTENTS

- C_D trends in Automotive industry
- Major contributors to drag
- Inputs to Full Scale Testing
- Audi A2
- How Drag was reduced

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PRODUCTION CAR DRAG LEVELS

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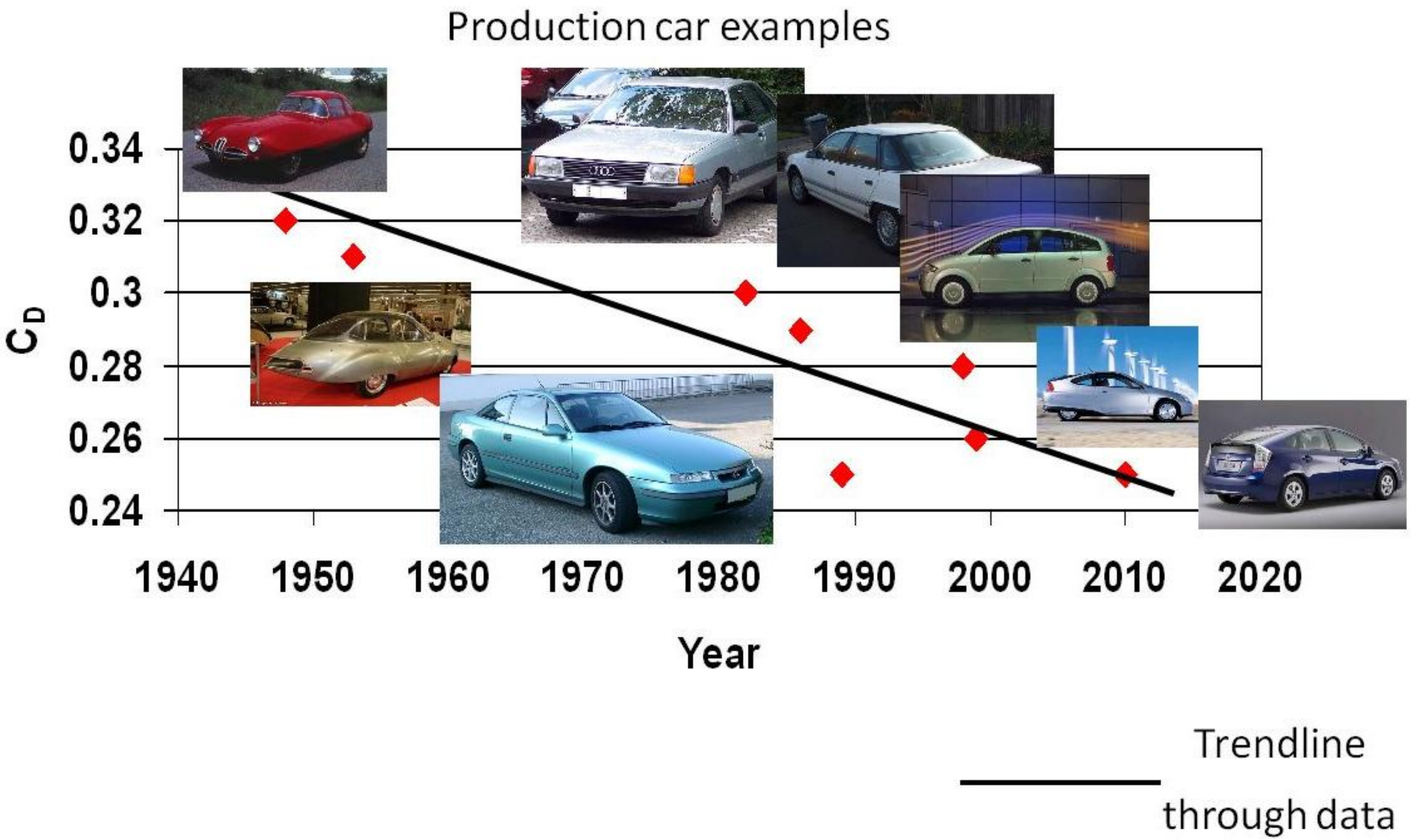


MAJOR CONTRIBUTORS TO DRAG

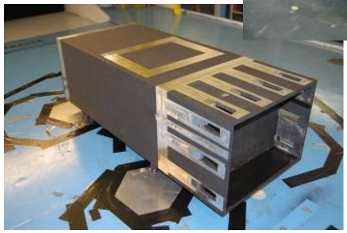
Base Pressures – Low pressure region at the rear of the car

Wheels and wheel arches – Up to 30% of cars total C_D

Cooling – Air passing through cooling components

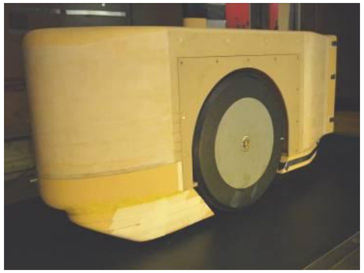
Underfloor – “Rough” exposed car parts in direct contact with airflow

LCVTP







University Research → Model Scale Tests → Wheel & Wheel Arch findings →

Full Scale Wind Tunnel Tests at Mira

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Audi A2

<u>Low C_D</u>

When measured in the Mira wind tunnel, the Audi A2 showed a Co-efficient of Drag (C_D) of 0.288

<u>Good Basic Aerodynamic shape</u>

The launch vehicle had a C_D of 0.25

FULL SCALE TESTING

Full scale tests carried out at Mira in Nuneaton

8m x 4m tunnel

Fixed ground tunnel

Balances in the floor

The next few slides will show how the C_D of the Audi A2 was reduced from 0.288 to 0.204

WIND TUNNEL TESTING

Cooling Drag

Cooling:

- All vents and intakes closed on front end
- Total Contribution: **9%** of total Drag

WIND TUNNEL TESTING

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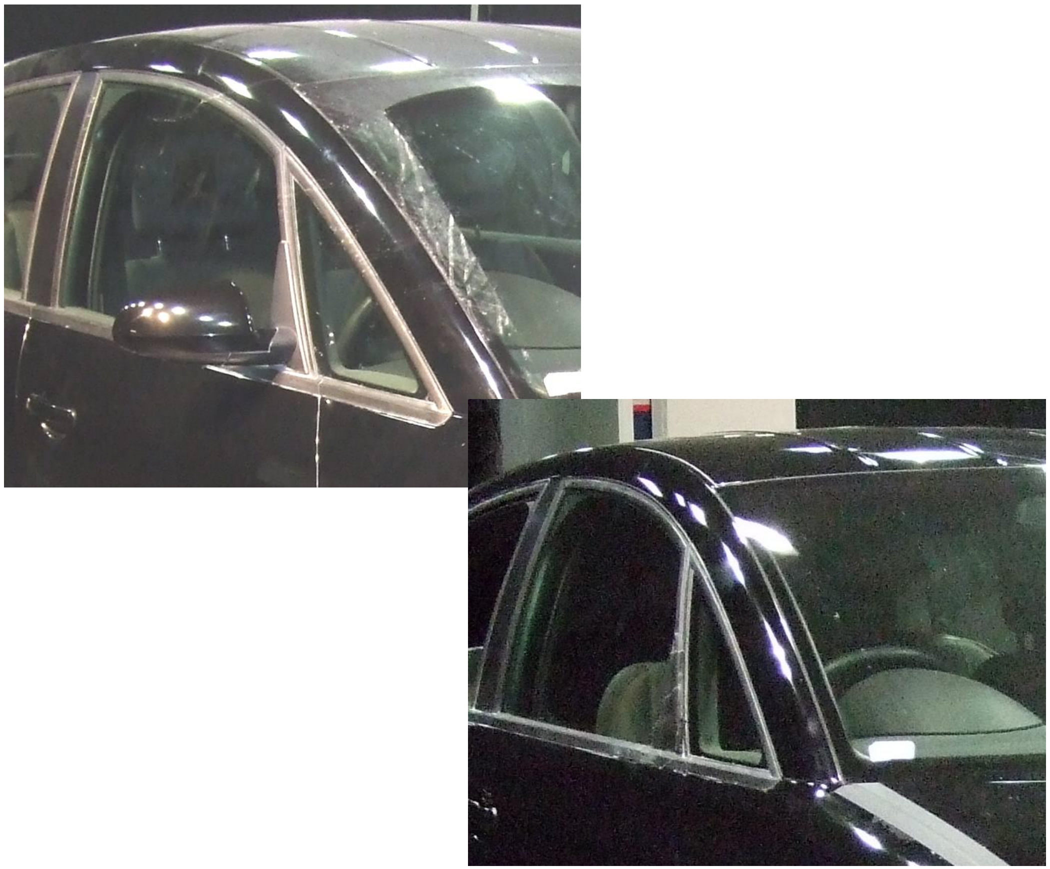
Underfloor Drag

Underfloor:

- Foamboard and tape
- All components covered
- Total Contribution: **7%** of total Drag

WIND TUNNEL TESTING

Door Mirrors



Mirrors:

- A-Pillar Vortex interaction
- Bluff rear face causes drag
- Total Contribution: **5%** of total Drag

WIND TUNNEL TESTING

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Wheels and Wheel arches

- Wheel Spoilers
- Wheel Blanking
- Wheel Arch Blanking

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Wheels and Wheel arches

- Underfloor Wheel Arch Blanking

WIND TUNNEL TESTING

Base Pressure Recovery

Raising the Base pressure can reduce the Drag

- Box Cavity Version 1

- Box Cavity Version 2

Prior to Box Cavity test, diffuser angle was 7°. Afterwards, optimum was 2°

WIND TUNNEL TESTING

Base Pressure Recovery

Raising the Base pressure can reduce the Drag

- Box Cavity Version 3

- Box Cavity Version 4

Prior to Box Cavity test, diffuser angle was 7°. Afterwards, optimum was 2°

WIND TUNNEL TESTING

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<u>Base Pressure Recovery</u>

Raising the Base pressure can reduce the Drag

- Box Cavity Version 5
- Box Cavity Version 6

Prior to Box Cavity test, diffuser angle was 7°. Afterwards, optimum was 2°

WIND TUNNEL TESTING

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Base Pressure Recovery

Raising the Base pressure can reduce the Drag

- Box Cavity Final design

Prior to Box Cavity test, diffuser angle was 7°. Afterwards, optimum was 2°

Coventry University
JAGUAR
LAND-ROVER
MIRA
RICARDO
TATA
WMG Innovative Solutions
ZYTEK AUTOMOTIVE

WIND TUNNEL TESTING

Aerodynamic system created

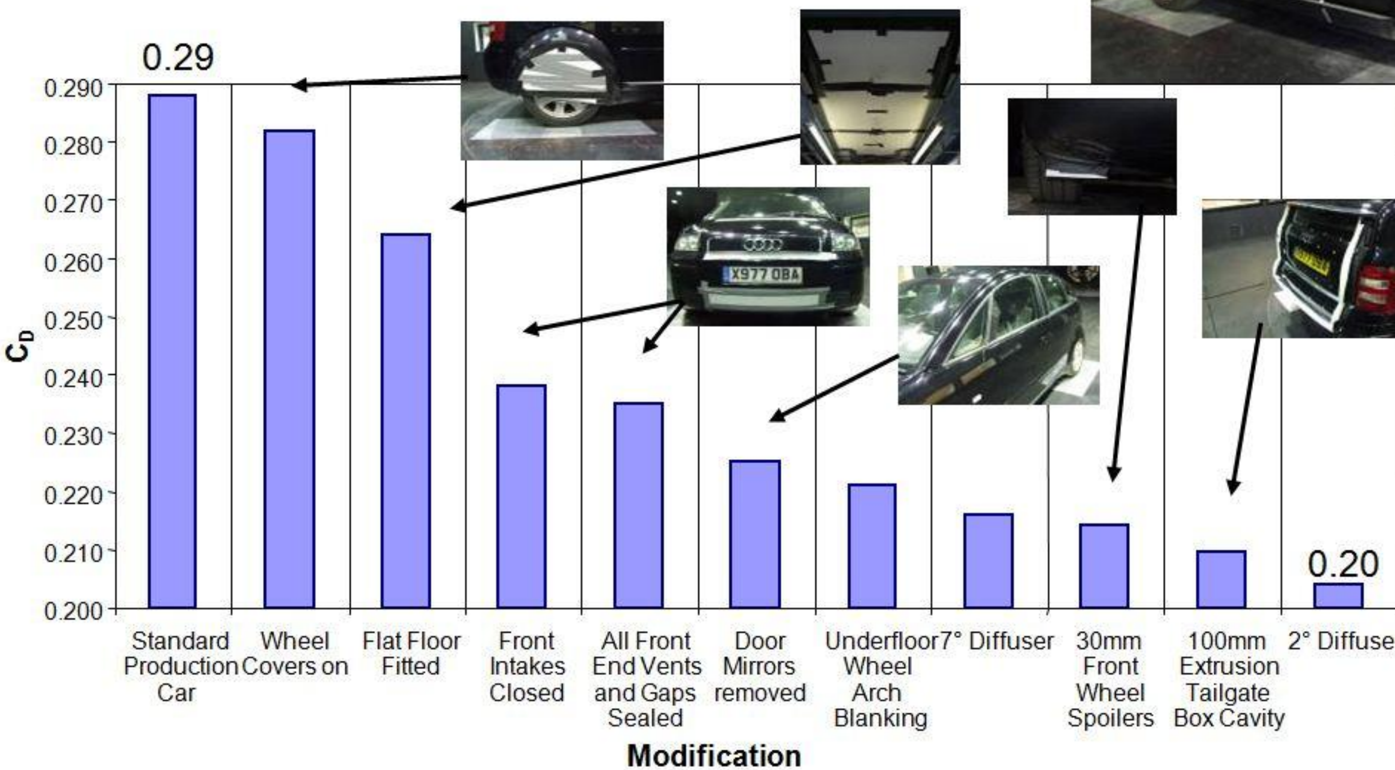
- Diffuser needs a flat floor for maximum efficiency
- 2° Diffuser cant be obtained without the presence of a box Cavity
- Box Cavity needs a diffuser to be present for best results

Interdependencies makes further refinements and drag reductions possible

Other interdependent relationships around the car

PROGRESS CHART

- Wind tunnel development
- Audi A2 represents low drag tall 1-box shape
- CD reduced from 0.288 to 0.204 (WIP)



CONCLUSION

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Summary

- Biggest contributors: Base Pressures, Cooling, Wheels & Wheel arches
- 30% reduction in C_D achieved
- Inputs key to successful Wind Tunnel development

THANK YOU