Allmänt om kursen

General information about the course

VEHICLE AERODYNAMICS 2004

Course nr.:

General course (ak) 5C1211, 4 credits

Contents:

20 h lectures + 10 h seminars and a laboratory exercise.

Aim:

The course is meant to give the students an introduction and an enhancement of their knowledge of fluid mechanics applied in the area of vehicle engineering. Different methodologies for the evaluation of the aerodynamic forces will be introduced. At the end of the course the students should be able to analyse and criticise present solutions and make an attempt of a good aerodynamic design.

Intended group:

Students (T4, M4, F4) with an interest for fluid mechanics and aerodynamics or in vehicle dynamics.

Contents:

Overview and review of physical fundamentals of Fluid dynamics. Boundary layers and vorticity. Fluid mechanics of aerodynamic bodies. Bluff body aerodynamics. Aerodynamic forces on road vehicles; their evaluation and possible strategies for their control. Design aspects of external and internal flows in vehicles. During the course seminars will be given on experimental and numerical methods in vehicle aerodynamics, aerodynamics of high-performance cars and aerodynamics of commercial vehicles.

Kursplan

Course layout

Contents:

Introduction and general overview

Kinematics and dynamics of fluids and fundamental Equations.

Aerodynamic Forces – Lift and Drag

Bluff body aerodynamics

The Aerodynamic of a passenger car

Directional Stability, Aerodynamic Forces and Moments

Air Conditioning and Noise

High performance vehicles

External lectures:

March, the 19st

The Influence of Aerodynamics on the Design of High-Performance Road Vehicles

Guido BURESTI

Professor in Fluid Mechanics at the Department of Aerospace Engineering

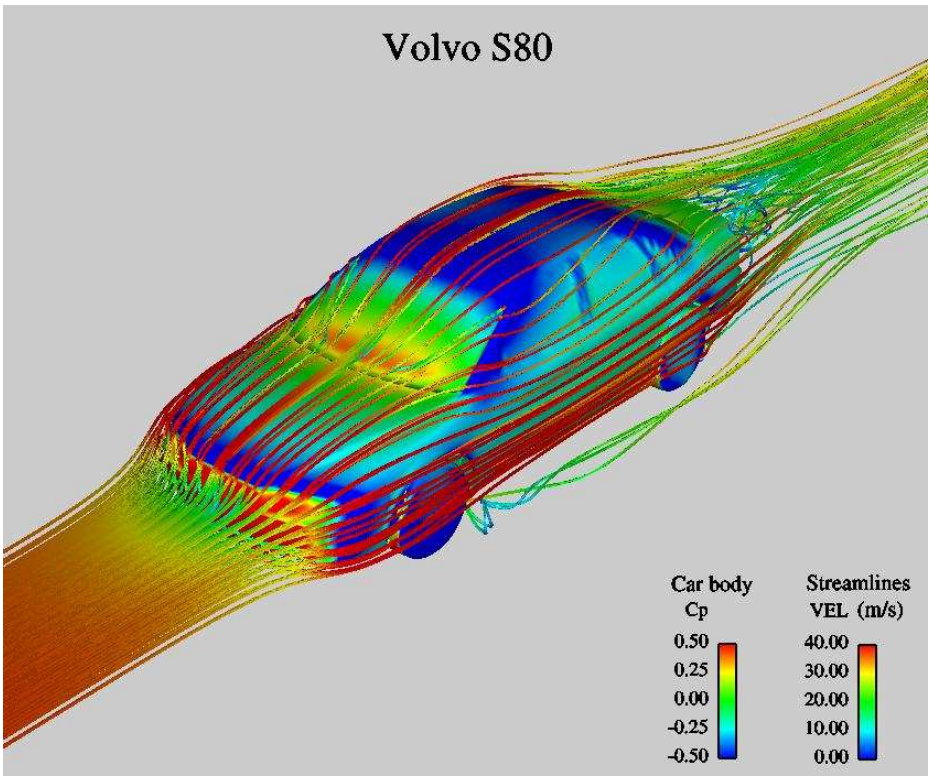
Universita' di PISA (Italy).

Abstract

In the project of high-performance road vehicles it is essential that aerodynamics be adequately taken into account during the whole design procedure in order to assure the achievement of the expected objectives in terms of maximum velocity and handling qualities. In the lecture, after a short introduction on basic car aerodynamics and a brief historical overview of its application in the design process, the specific aerodynamic requirements for high-performance vehicles will be described and discussed. Attention will then be focused on the methods, both experimental and computational, that are presently available to obtain the desired aerodynamic loads. In particular, the evolution of the design procedures within Ferrari Auto in the last 15 years will be described, and some examples will be considered in more detail. Finally, possible future developments and research topics will be suggested.

April, the 30th

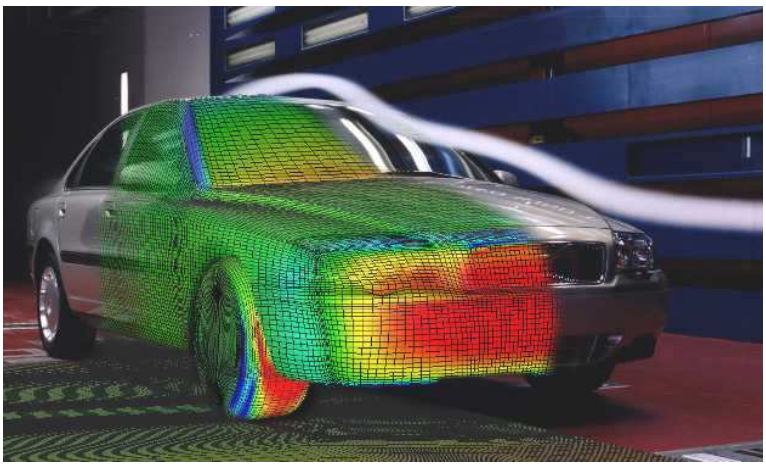
CFD at Volvo Car Corporation



to be decided

May, the 7th

Experimental methods in vehicles aerodynamics



Per ELOFSSON

SCANIA, Fluid Dynamics Centre
Function & Attribute leader, Aerodynamics

Abstract

The role of experimental fluid dynamics in the design process for passenger cars will be described.
An overview of wind tunnels designed for automotive testing will be presented.
Focus will be on aerodynamic testing at Volvo Car Corporation.
Traditionally, experimental methods for automotive testing have been aimed at flow visualization and direct force measurements using an external or internal force balance. In today's car testing, balance measurements are often used together with pressure and velocity field measurements. The additional pressure and velocity data are used in wake-analysis methods and the results help to identify which vehicle regions that need to be improved.

Examples from project and research work at Volvo Car Corporation will be used to illustrate the topics above.

May, the 14th

Race-Car Aerodynamics

Matthew John LAIGHT

Renault F1 (formerly Benetton Formula Ltd)

Senior Aerodynamicist and Head of CFD.

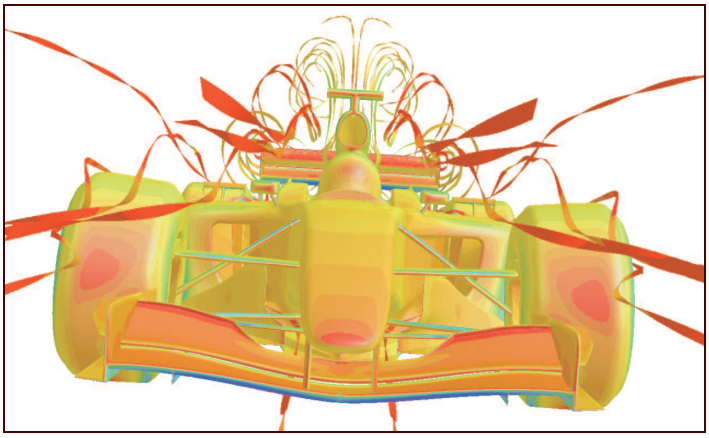
Abstract

Discounting a driver's particular aptitudes, aerodynamic improvements, as well as engine power, chassis design and tyre performance, are the major factors in determining a race-car's performance. In particular, advances in the understanding of vehicle aerodynamics, especially in the importance of aerodynamic downforce as opposed to drag reduction, have enabled enormous increases in cornering speeds of race cars.

A wide variety of cars, ranging from modified production cars to open-wheeled formula-one and Indy cars, are raced and, although racing can seem to be dominantly a commercial/media-led business, it is in fact a proving ground for much new technology and is seriously competitive between major automotive players. This seminar will provide an overview of race-car aerodynamics and highlight the differences between production-car aerodynamics and those important to both open-wheeled and enclosed-wheeled race cars. There will be discussion of both external and internal aerodynamics, as well as the experimental and computational tools used to analyse these flow regimes. Results from F1 model testing will show the importance of seemingly small modifications and the emphasis that competitors put on small percentage increases in downforce in an attempt to gain race advantage.

May, the 21th

The role of CFD in the aerodynamic design of a Ferrari Formula 1 car



Luciano MARIELLA

FERRARI F1 GeS

Head of CFD group.

Abstract

General overview on the main mathematical models available for CFD external aero simulations: Navier-Stokes, Eularian, Panel method, etc.

Main features, requirements and limits for each mathematical model, focusing the attention on the applicability to a realistic F1 car shape.

Close-up to the "Reynolds Averaged Navier-Stokes" model: mesh generation requirements, available turbulence models, precision, reliability and repeatability of numerical test.

Practical examples of CFD use inside the Aerodynamic Technical Office of Ferrari GeS: full car external aero simulations, wings development and improvement, thermal problems (like exhausts gas and brake cooling).

Realistic future developments for the CFD tools applied to the aerodynamic project of F1 car.

Kursansvar

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Lärare

Lecturers

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Förkunskapskrav

Prerequisites

To be specified.

Litteratur

Literature

R.H. Barnard (2001):"Road Vehicle Aerodynamic Design, 2nd edition". MechAero Publishing, 2001. ISBN 0954073401

Hucho, Wolf-Henrich (1998) “Aerodynamics of road vehicles, 4th edition” SAE International. (can be ordered at http://www.sae.org/products/books/R-177.htm)

Additional material will be given out during the course.

Laborationer

Laboratory exercises

to be decided

Projects

Projects

to be decided

Inlämningsuppgifter

Hand in assignments

to be decided

Kontrollskrivningar

Tests

Examination

Examination

Compulsory homework assignments. Written test. To get high marks an optional oral exam must be sustained.

Gamla tentamina / kontrollskrivningar

Old exam papers /tests

Övrigt

Miscellaneous information