SPECIAL ASPECTS OF RVAD

AND THEIR RELATION TO DRIVING DYNAMICS

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1. Introduction

After more than a decade of so-called lean engineering and lean production in the automotive industry, the organizational structure of automotive companies is still complicated, maybe more than ever. This, of course, is due to the fact that the automobile is a very complex technical object with a lot of interaction between its components and functionalities. Many motorists who – in these days - break down with their brand new cars and some garages, which – without success – try to fix the problem, know the complexity of interactions in modern cars.

However, this facet of complex interdependence, which takes place in our cars, though negative, only reflects the complexity of physics our modern cars deal with. Whereas in the old days the driver had a steering wheel, a break and accelerator, today our cars feature advanced assistance system, like anti-lock, ESP, active steering, anti-roll, anti-dive etc. In the future even autonomous driving may be possible. On the other hand, development departments in the industry, at least the OEMs, are still organized somewhat like a shelf for spare parts. There is a department for engines, gearboxes, brakes, axles, body, interior, etc. But, to stay honest, there are also departments for driving dynamics and aerodynamics. However, generally driving dynamics belongs to the chassis development whereas aerodynamics is associated with the body development or the so-called entire car development. Consequently, engineers from both disciplines are located a bit apart and have no common boss. Often they only talk to each other, when a problem occurs. Such a problem could be customers' complaints about lack of side wind stability. As there is no department for side wind stability, there is no person who is responsible. So, often the problem is moved back and forth before solutions may be worked out.

This simple – but realistic – example demonstrates the interaction physics organizes in our cars. Driving dynamics and aerodynamic are closely linked together. They take place in parallel. They may be considered as two aspects of vehicle dynamics. Two aspects out of many more. Furthermore, we should keep in mind that noise and vibration also have a lot to do with dynamics.

In the following we will high-lighten some aspects of the interdependence of aerodynamics and driving dynamics. The latter will be considered in all three physical components, longitudinal, vertical and lateral dynamics. Each of these components may interact with aerodynamics, as will be shown by simple examples.

Of course, many of us have often seen illustrations like figure 1.1 taken from Hucho [1], which show how many vehicle functions, may be affected by aerodynamics.

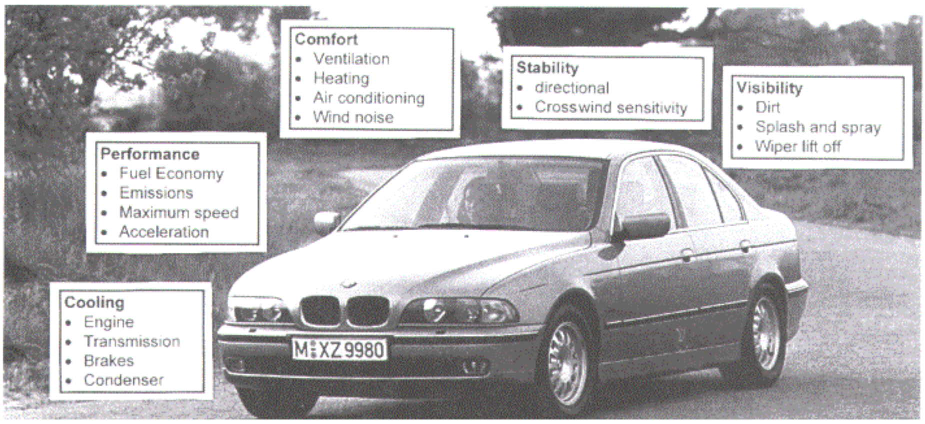

Fig 1.1: The scope of automotive aerodynamics [1]

However, to gain a better understanding of "vehicle dynamics" and what it is all about we have to take a closer look, see figure 1.2.

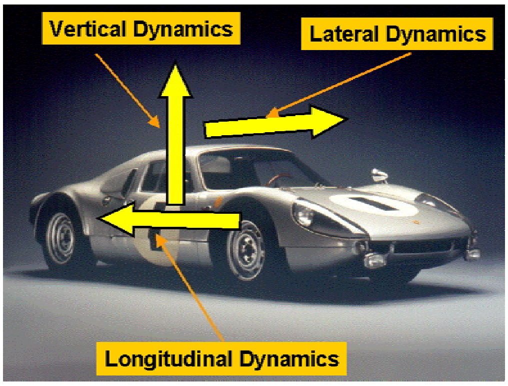

Fig 1.2: Components of vehicle dynamics

- Longitudinal Dynamics
  mainly affects drag forces, break forces and traction forces. There is also an impact on fuel consumption.
- Vertical Dynamics
  Aerodynamic lift and downforce are velocity dependent vertical forces. Depending on the aerodynamic characteristics of the car the forces may be steady or unsteady. The latter case may lead to vertical oscillations ("porpoising") [2].
- Lateral Dynamics
  is important for cornering performance and stability: Aerodynamic lift or downforce will determine level of maximum tire-side forces.