



# What is Vehicle Dynamics?

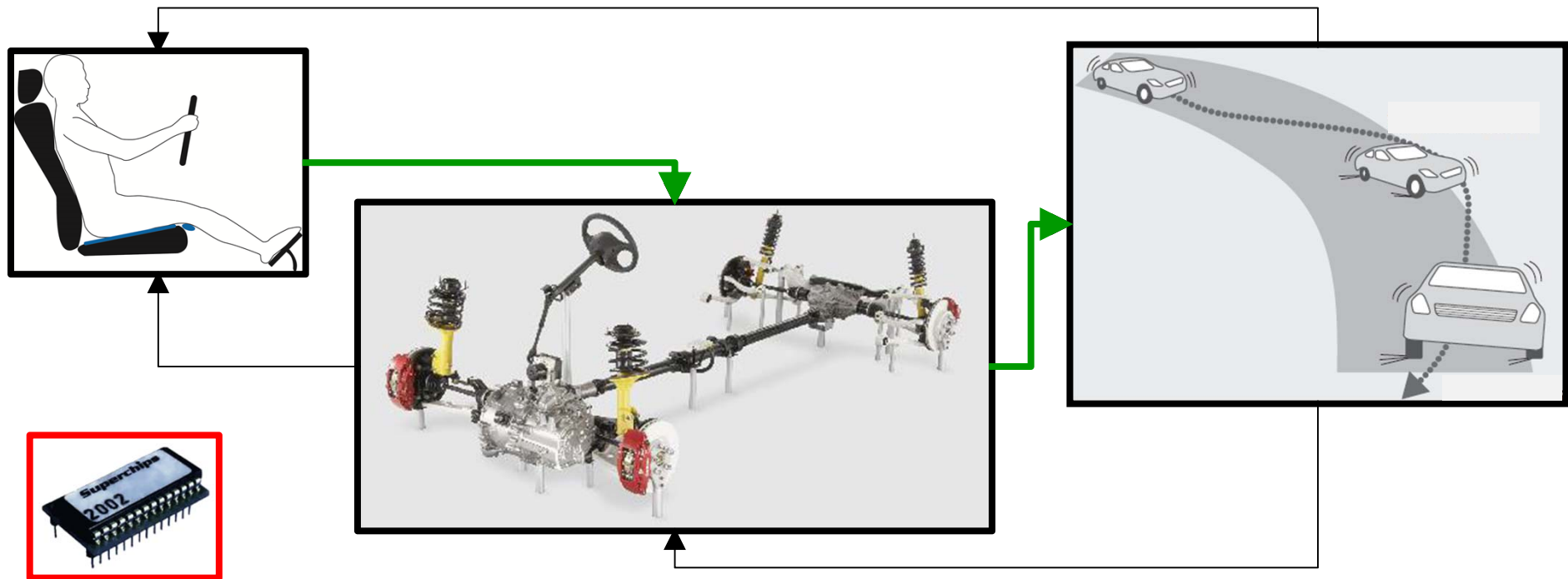
*by Bengt Jacobson*

SAFER & SVEA seminar "Vehicle Dynamics Challenges"  
May 15, 2013, Göteborg

# Vehicle Dynamics is a subject motivated by several “vehicle attributes”

- **Safety**
- **Driveability**
- **Energy/Transport efficiency**

# Vehicle Dynamics in Safety

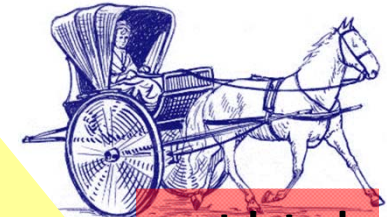


1. Good vehicle dynamics for **driver in the loop** improves safety.

2. Vehicle Dynamics is used in two ways for **automatic** functions:

- To **trigger** automatic function (warning or motion actuation) when driver **needs OR wants** help, given what is:
  - Normal driver&vehicle behaviour
  - Physical limitations (road-friction, trailer behind, ...)
- To **control**. Especially “feed-forward” control needs knowledge about the controlled system.

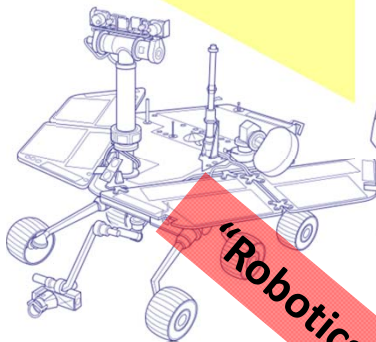
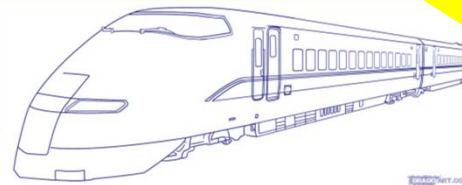
# What is vehicles in Vehicle Dynamics?



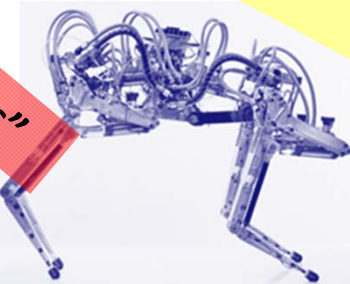
outdated



“Naval Architecture”



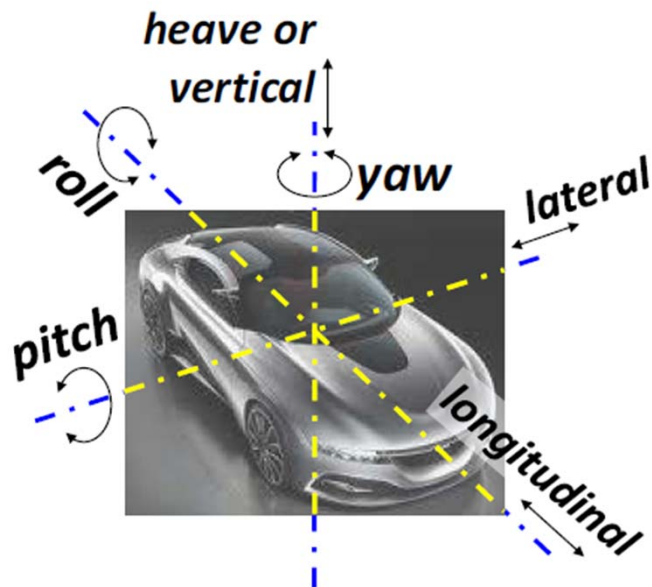
“Robotics”



“Aeronautical engineering”

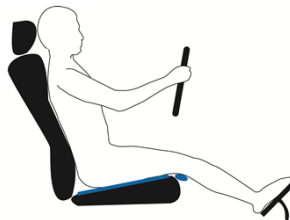
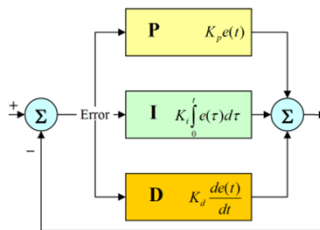
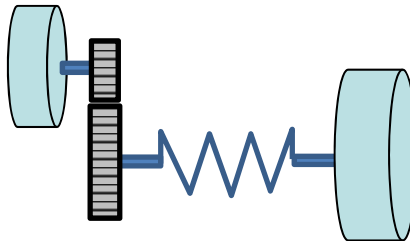


# What is dynamic in Vehicle Dynamics?



*Which are the dynamic  
(=time varying) quantities:*

- The 6 degrees of freedom (dof) from the **body** (per unit)
- (More if multiple unit vehicles and flexible frames)
- 2..3 motion dofs per road **wheel**
- 1..2 states per **tyre** (relaxation)
- **Steering wheel** Torque and Angle
- **Rotational** dofs in propulsion system
- “Signals/variables” in **Control algorithms**
- “Variables” in **Drivers**

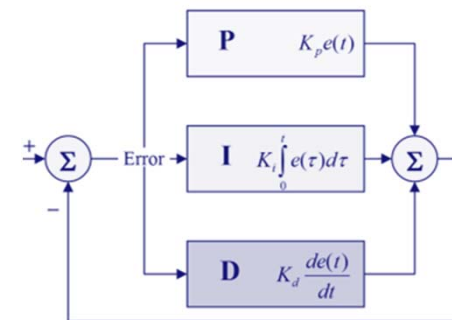
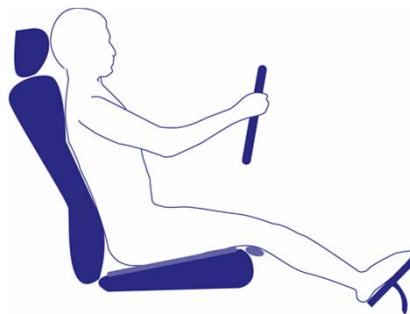
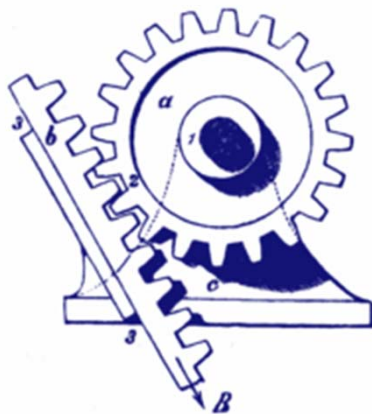




# Definition from Wikipedia

**Vehicle dynamics** refers to the [dynamics](#) of [vehicles](#), here assumed to be ground vehicles. Vehicle dynamics is a part of [engineering](#) primarily based on [classical mechanics](#) but it may also involve [chemistry](#), [solid state physics](#), [electrical engineering](#), [communications](#), [psychology](#), [control theory](#), etc.

This article applies primarily to [automobiles](#). For [single-track vehicles](#), specifically the two-wheeled variety, see [bicycle and motorcycle dynamics](#). For [aircraft](#), see [aerodynamics](#). For [watercraft](#) see [Hydrodynamics](#).



# Is Vehicle Dynamics only the sum of other subjects?

## *Is there unique knowledge, not found in other subjects?*

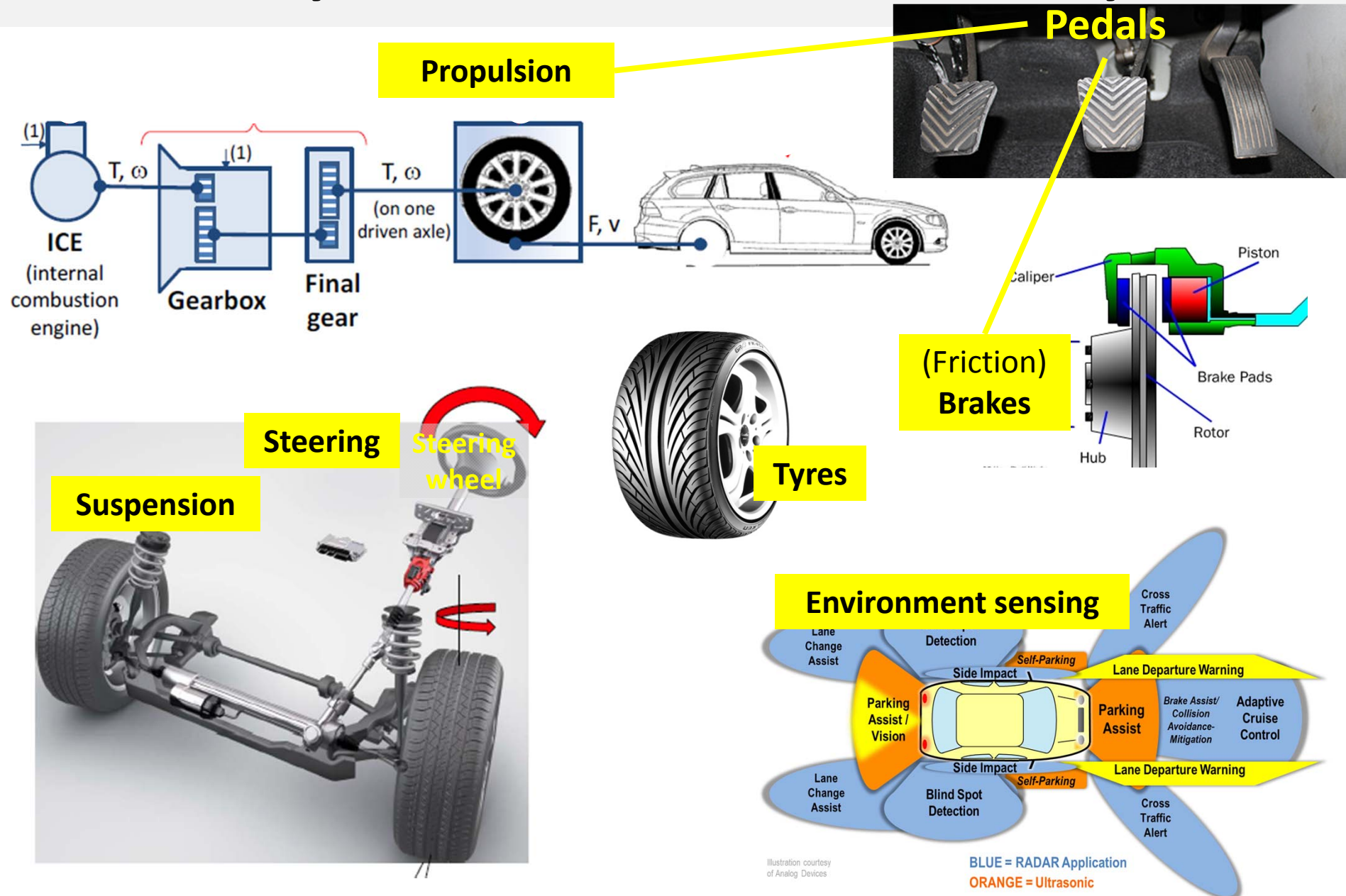
Vehicles are **complex** product, where novel solution has to fulfil many requirements and be integrate-able (to low cost!) in existing vehicle architectures/platforms.

Most challenging and competitive/valuable solutions appear when **conflicts between requirements** can be eliminated or relaxed.

No, the **unique knowledge** for Vehicle Dynamics includes how to set several functional requirements and assess/verify those. This includes:

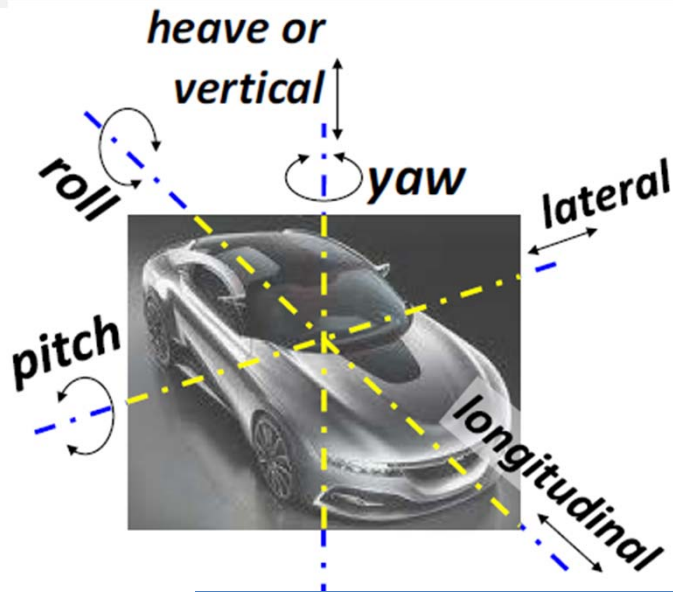
- Use standard **manoeuvres and measures** as far as possible (typical ISO). Invent own only if no established.
- Use established **requirement levels** when available (such as legislation or rating). Invent own only if no established.
- Assess versus a **fair reference vehicle**, typically a prediction of typical vehicle at a certain targeted future time instant.
- Many measures are difficult to objectively quantify, since they address the interplay between **driver and vehicle**. Own **driving experience** is valuable.

# Vehicle Dynamics as combination of subsystems





# Vehicle Dynamics is influenced by many subsystems

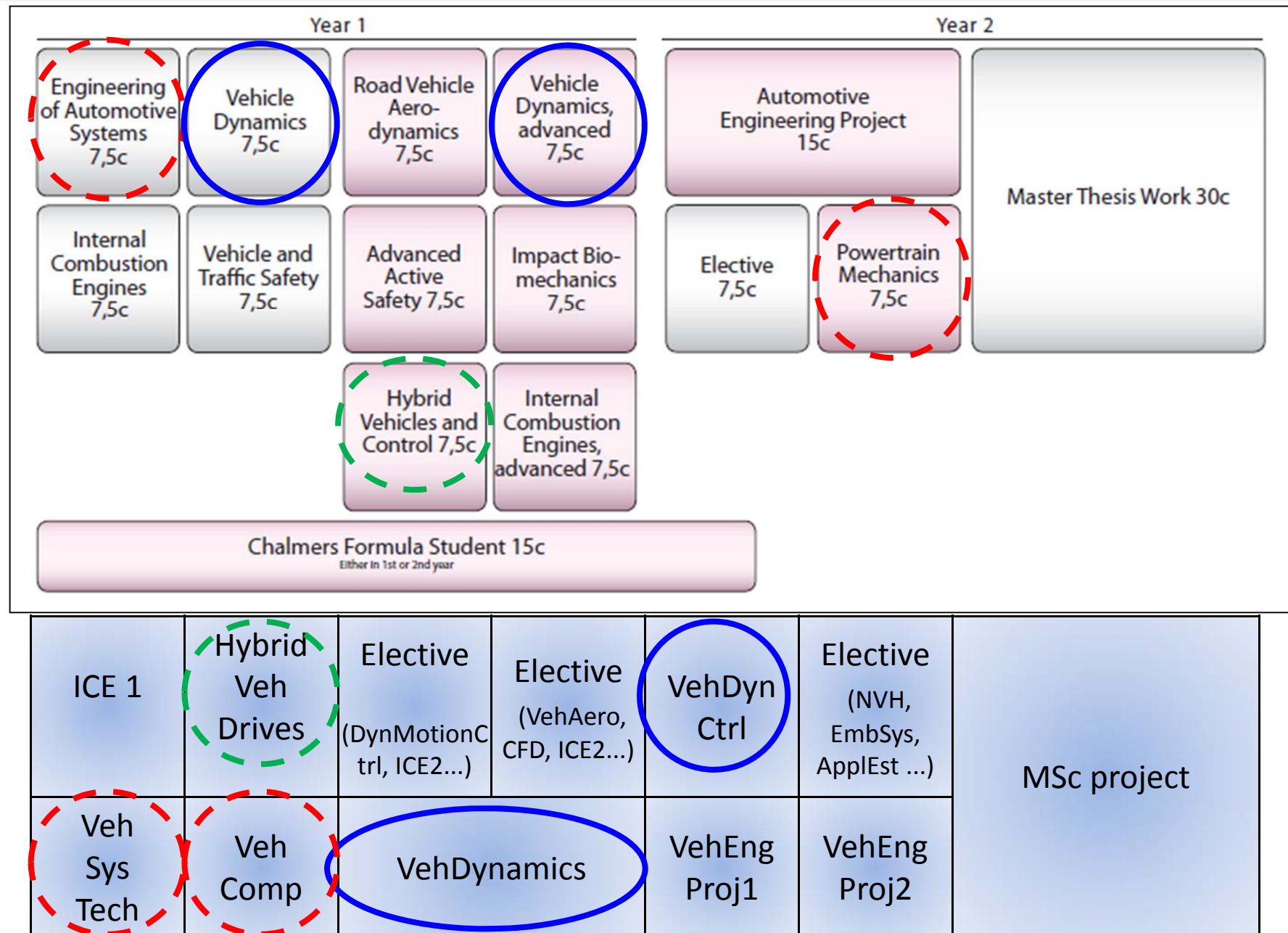


	Longitudinal Dynamics	Lateral & Yaw Dynamics	Vertical, Roll and Pitch Dynamics
Propulsion system	★	★	★
Brake system	★	★	★
Steering system	★	★	★
Suspension system	★	★	★
Environment sensing system	★	★	★
Tyres	★	★	★

# Where do we find vehicle dynamics in Sweden?

- **Engineering universities:** Academic (education and research, competence centres)
- **Authorities:** Society (legislation, consumer recommendations, research, simulators & other test facilities)
- **OEMs:** Vehicles (deep knowledge in their own vehicle type)
- **System Suppliers:** Various focus on Vehicle Dynamics
- **Knowledge suppliers:** Consulting, varying focus on Vehicle Dynamics
- **SVEA:** Network for automotive engineers, Sweden's representative in FISITA

# Chalmers' & KTH's MSc programmes in Automotive Engineering



*Thanks for your attention!*