



Introduction: Mathematical engineering in the industry

Joan Vazquez Molina

2019-10-21

Course: Mathematical Modeling in the Industry

MSc in Mathematical Research

Universitat Politècnica de València

JVazquezMolina@driv.com

Agenda

- What is Mathematical Engineering?
- What do I do at DRiV?
 - Transitioning from the Academia to the Industry.

Towards a definition of mathematical engineering

The traditional fields of mathematics

- “Mathematics includes the study of such topics as quantity, structure, space and change. It has no generally accepted definition.” (Wikipedia)
 - *Quantity*: Arithmetic, Number theory
 - *Structure*: Algebra
 - *Space*: Geometry, Topology
 - *Change*: Analysis
 - + Logic & foundations (meta, philosophy)
 - + “Applied mathematics”

VNIVERSITAT
DE VALÈNCIA

Applied Mathematics Department

Numerical analysis

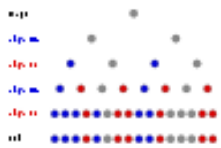
Numerical analysis of images,
multiresolution and simulations

Ordinari differential equations and
partial differential equations

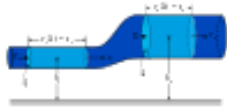
Dynamical systems

Towards a definition of mathematical engineering

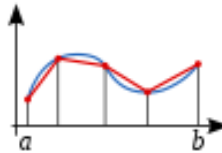
Some fields of applied mathematics



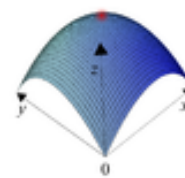
Game theory



Fluid dynamics



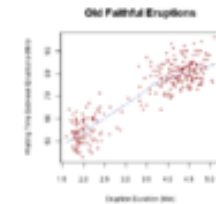
Numerical analysis



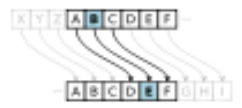
Optimization



Probability theory



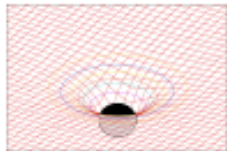
Statistics



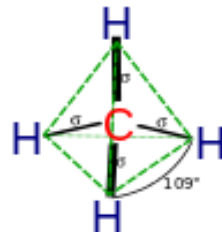
Cryptography



Mathematical finance



Mathematical physics



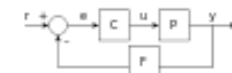
Mathematical chemistry



Mathematical biology



Mathematical economics



Control theory

Towards a definition of mathematical engineering

So, what is applied mathematics?

Applied Mathematics Is Bad Mathematics

Paul R. Halmos (In *Mathematics Tomorrow*, 1981)

It isn't really (applied mathematics, that is, isn't really bad mathematics), but it's different.

Applied mathematics is not a definable scientific field but a human attitude. The attitude of the applied scientist is directed towards finding clear cut answers which can stand the test of empirical observation. To obtain the answers to theoretically often insuperably difficult problems, he must be willing to make compromises regarding rigorous mathematical completeness; he must supplement theoretical reasoning by numerical work, plausibility considerations and so on.

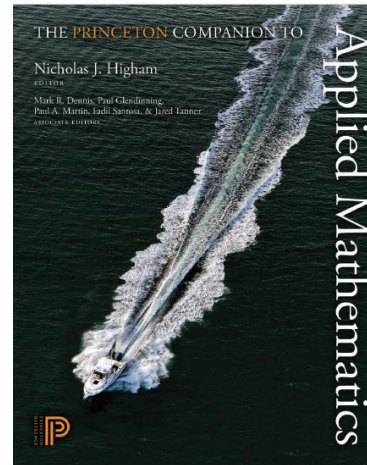
Courant (1965)

Essentially, mathematics becomes “applied” when it is used to solve real-world problems “neither seeking nor avoiding mathematical difficulties” (Rayleigh).

Rather than define what applied mathematics is, one can describe the methods used in it. Peter Lax stated of these methods, in 1989, that:

Some of them are organic parts of pure mathematics: rigorous proofs of precisely stated theorems. But for the greatest part the applied mathematician must rely on other weapons: special solutions, asymptotic description, simplified equations, experimentation both in the laboratory and on the computer.

The applied versus pure discussion is not always taken too seriously. Chandler Davis quotes the applied mathematician Joseph Keller as saying, “pure mathematics is a subfield of applied mathematics”!



Towards a definition of mathematical engineering

And what is engineering?

Engineering is the use of [scientific principles](#) to design and build [stuff]
(Wikipedia)

Engineer	Object
Mechanical	Machines, manufacturing plants, transport systems...
Electrical	Computers, power generation, telecommunication systems...
Civil	Buildings, bridges, roads...
<i>Mathematical</i>	<i>Numerical algorithms, models, data structures,</i>

Mathematical engineering is the development and use of mathematical methods, techniques and models to solve industrial and business problems

Mathematical Engineering

MSc programmes popping up



The **Master in Mathematical Engineering** will equip you to with the fundamental expertise necessary to handle, optimise and control data for the application of solutions to contemporary problems.

The emphasis is not on abstract mathematical theory, but on the application, the design, analysis, implementation and use of mathematical models and algorithms in order to solve mathematical problems from industry.

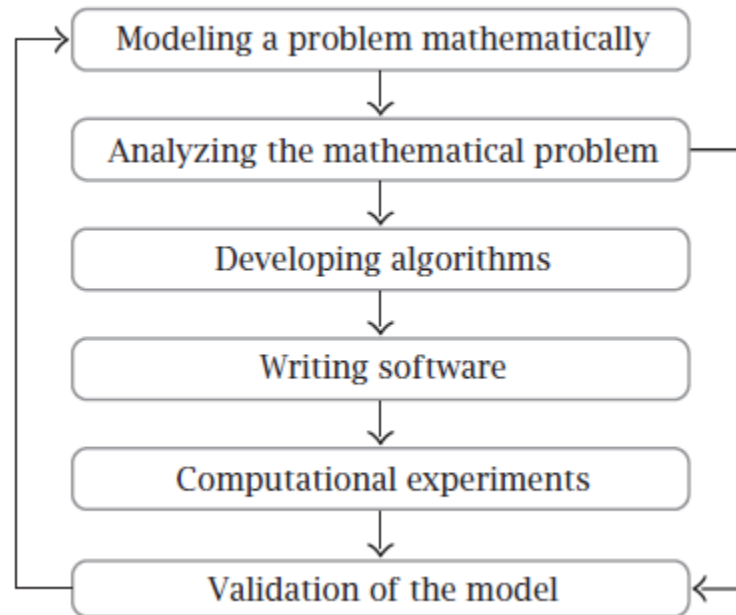


The **Master in Mathematical Engineering**, at Universidad Carlos III de Madrid, provides students with the necessary tools to address scientific and technological challenges using:

- A precise mathematical/physical/statistical foundation
- The formulation of a problem using a mathematical model
- Numerical and theoretical solutions to mathematical frameworks
- The interpretation of the solution to make it practical

Mathematical Engineering

The modeling workflow



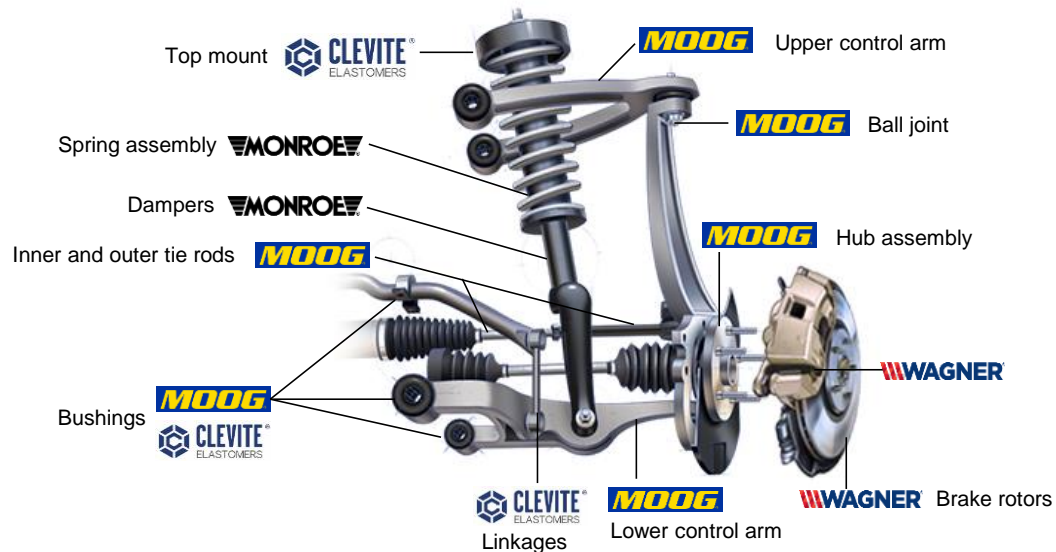
INTRODUCING DRiV™

A DRIVING FORCE TO 'MOVE' PEOPLE

With its world-leading stable of automotive brands ranging from the highest level of performance to the broadest everyday use, DRiV is dedicated to helping drivers experience the perfect ride.

As a global leader serving both manufacturers and the aftermarket, DRiV is dedicated to help its customers innovate the ride experience in an emerging age of shared mobility and autonomous driving.

“AROUND THE WHEEL” PRODUCT OFFERING

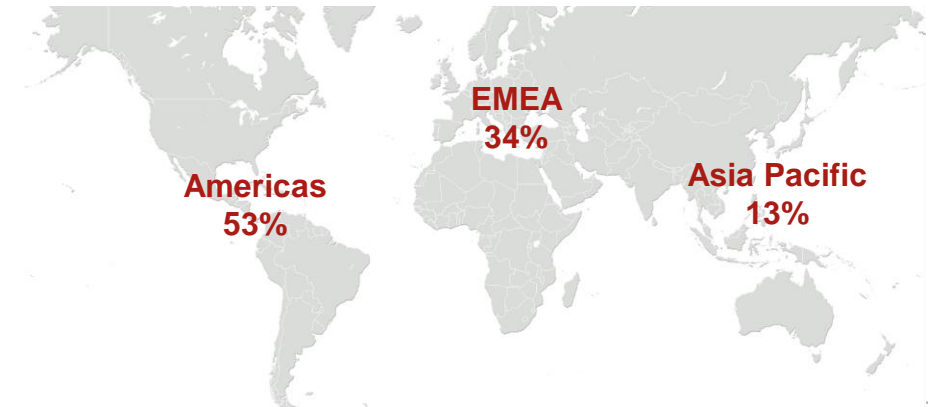


SOLUTIONS PROVIDED FOR



OUR DRIVING FORCE IS OUR PEOPLE

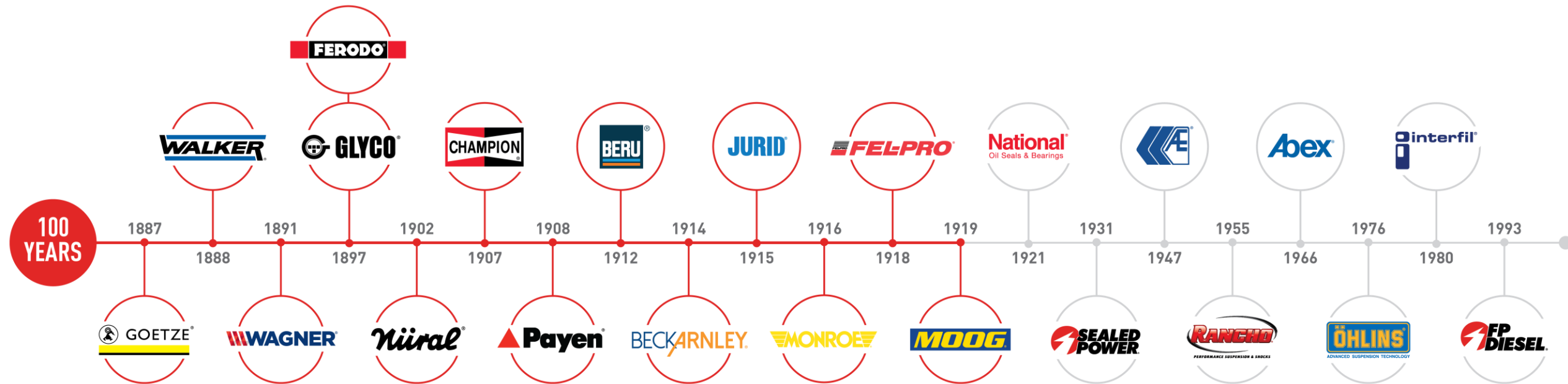
~31,000 Global Team Members % by Region



INTRODUCING DRiV™

ICONIC BRANDS THAT HAVE STOOD THE TEST OF TIME

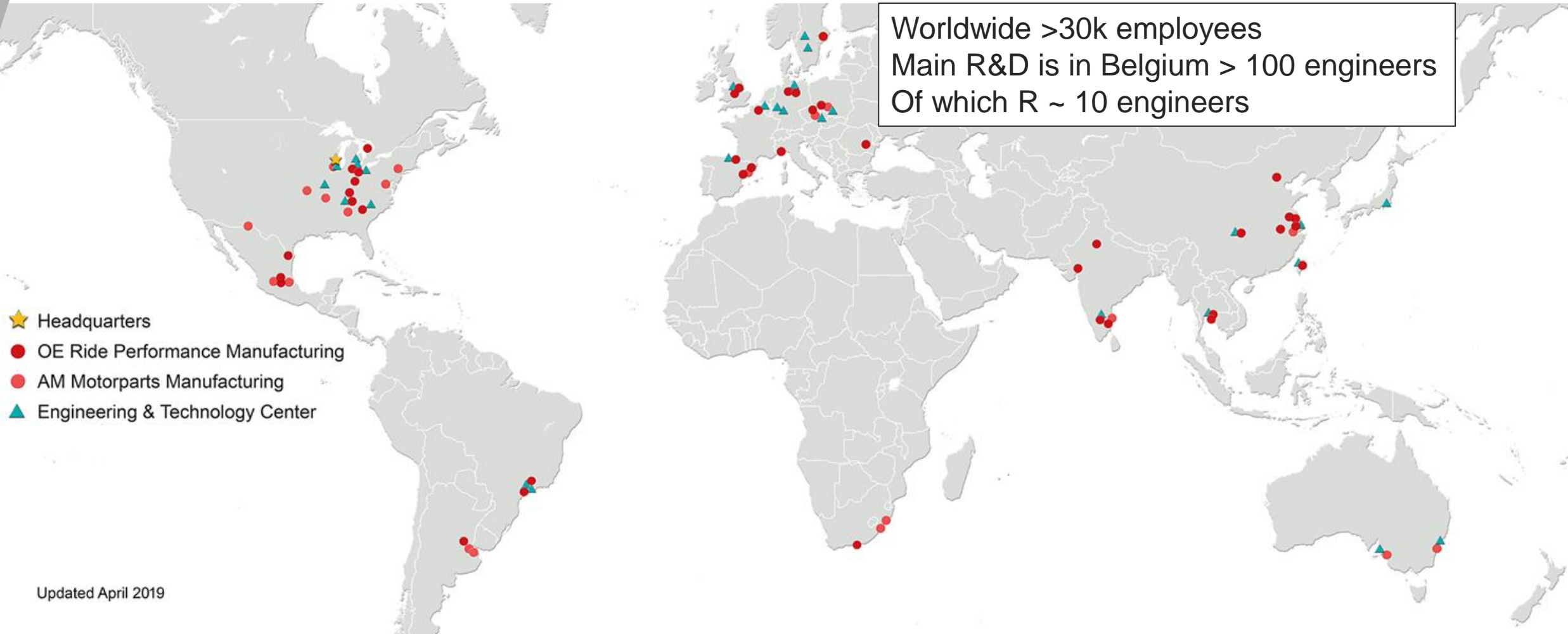
We're brand new, but have a foundation that reaches from the Model T to the Model E, and includes 31 of the best known and respected aftermarket brands, including MOOG®, Monroe®, Champion®, Ferodo® and 10 other brands 100 years or older.



"Beru® is a registered trademark of BorgWarner"



DRiV™ GLOBAL FOOTPRINT – MANUFACTURING AND ENGINEERING AND TECHNOLOGY CENTERS



SERVING CUSTOMERS FROM 60 MANUFACTURING LOCATIONS AND 27 ENGINEERING & TECHNOLOGY CENTERS

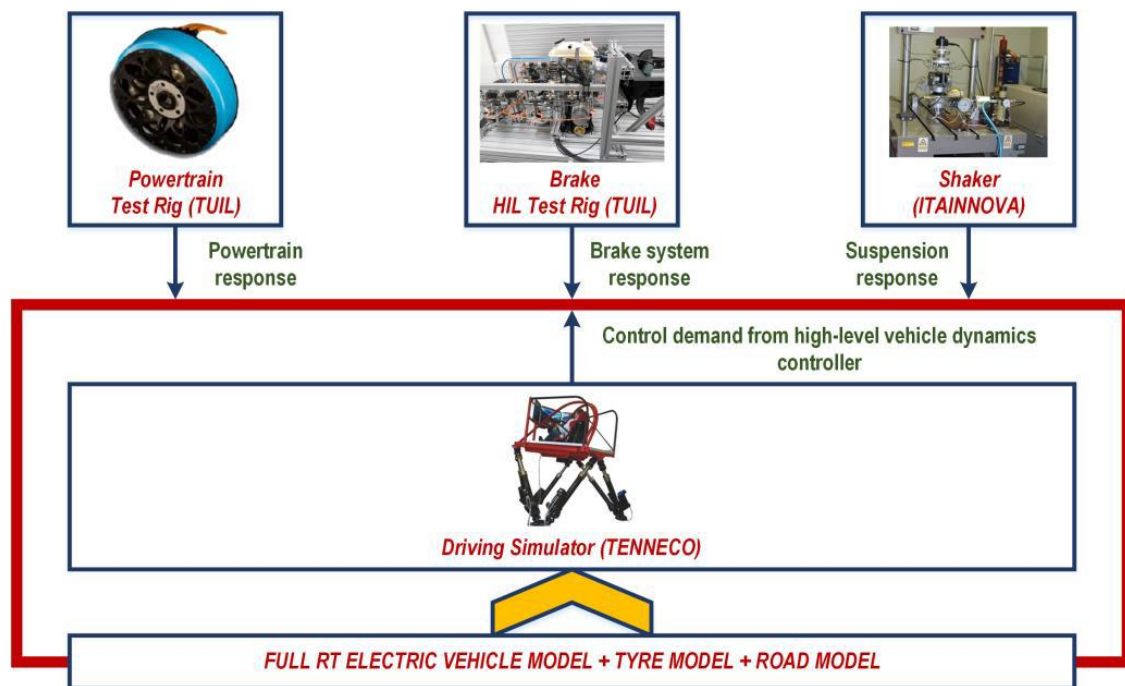
My duties at the Research Team

- Research Project Management
 - Publicly funded research: grant preparation, work package lead, technical reporting...
 - Privately funded research: project definition, guidance & collaboration, transfer...
- Mathematical engineering tasks
 - Modeling, simulations, calculation tool development, design of experiments & testing, signal processing, system identification, validation...
- Relations with Academia
 - Supervision of MSc and PhD interns.

DRiV

EU project example

Connected and Shared X-in-the-loop Environment for Electric Vehicles Development



Project information

XILforEV

Grant agreement ID: 824333

Status

Ongoing project

Start date

1 January 2019

End date

31 December 2021

Funded under:

H2020-EU.3.4.

Overall budget:

€ 3 575 078,75

EU contribution

€ 3 575 078,75



Coordinated by:

TECHNISCHE UNIVERSITAET ILMENAU

Germany

AUDI AKTIENGESELLSCHAFT

Germany

ELAPHE POGONSKA TEHNOLOGIJE DOO

Slovenia

INSTITUTO TECNOLOGICO DE ARAGON

Spain

SIEMENS INDUSTRY SOFTWARE NV

Belgium

SIEMENS INDUSTRY SOFTWARE SAS

France

TENNECO AUTOMOTIVE EUROPE BVBA

Belgium

Working in the industry

Transitioning from the Academia to the Industry

- No more exams, but:
 - Yearly objectives.
 - Performance reviews.
 - Development plans.
- Most crucial difference: working with (many!) others
 - Other team members
 - Different expertise: mechanical, electrical, control, vehicle dynamics, materials, manufacturing engineers.
 - Different seniority.
 - Other departments
 - Engineering: systems, vehicle dynamics, simulations, CAD, testing, functional expertise (valves, tubes...)
 - Support: IT, HR, marketing, communications...
 - Other companies: clients VS suppliers

Working in the industry

Industry VS Academia

ADVANTAGES	WHAT I MISS
Salary	Teaching Job security
Greater responsibility	Working freedom
Diversity of tasks	Depth of tasks
Budget for good ideas	Public interest

Let's math!