

OCSYGENE 6 (*)

L'optimisation mécatronique dans la boucle d'air et d'EGR
des moteurs à combustion interne à l'horizon €6

Journée Mécatronique
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(*) Optimisation dans la Conception de SYstèmes embarqués d'admission de Gaz d'Echappement et d'air pour la Norme Euro 6



OCSYGENE6

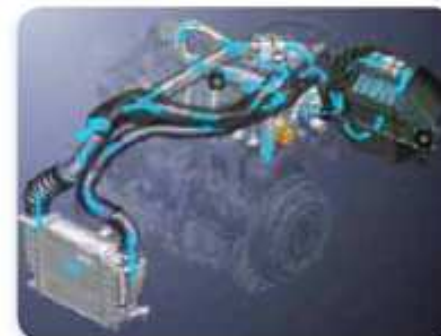
Optimization In Air Intake and EGR Systems to Euro6 Standard and CO₂ reduction

Project summary:

Developing a new air intake and EGR system for turbo engine that improves volumetric efficiency at low RPM which reduce emissions.

Main objectives and aims:

- Study pressure waves of air intake systems in turbocharged engines to use them to increase the volumetric efficiency at low rpm as a result decrease CO₂ emissions.
- Design an innovative multifunction module with a shutter that requires small amount of power to manage low pressure EGR for diesel engines with will reduce nitrogen oxides (NOx) emissions.
- Develop a method to minimize the energy requirements of an active system used in air and EGR path. This developed method will be used to design a new compact and low cost actuator with a smaller electrical consumption which will meet the needs of new emissions standards.



Main expected impact:

- Create new jobs with new product lines at MANN+HUMMEL France and Electricfil.
- New researcher positions in laboratories.
- Develop a better understanding of pressure waves phenomena in intake systems used for turbocharged engines.
- Reduce CO₂ and Nox with Internal combustion engines.

Progress status (September 2010):

- Project kick off.

Duration [3 years (beginning October 2010)

Budget [3 211 k€ (Public Funding:1 286 k€)

Project partners:

Ecole Centrale de Lyon/LMFA, Ecole Centrale de Nantes/LMF, Electricfil Automotive, ESTACA, GIE REGIENOV Renault Recherche et Innovation, Sherpa Engineering, Supélec / Département Énergie, Université Paul Sabatier, Mann+Hummel France.

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OCSYGENE 6 / Partners

Large Companies
Small Companies
Labs / Univs.

Technical Plastic Parts Manuf.
Electronic Parts Manuf.
OEMs

Mechatronics

Optimization
Control

CFD simulations

Turbo Chargers
Air intake systems

Measurement / Engine bench

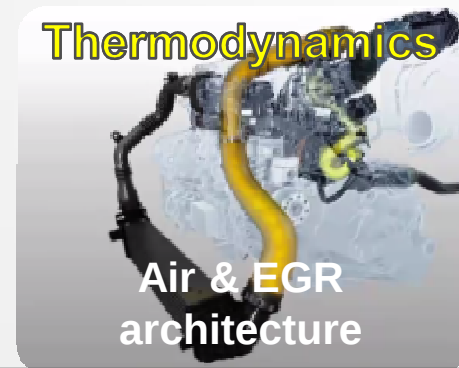


OCSYGENE 6 consortium description

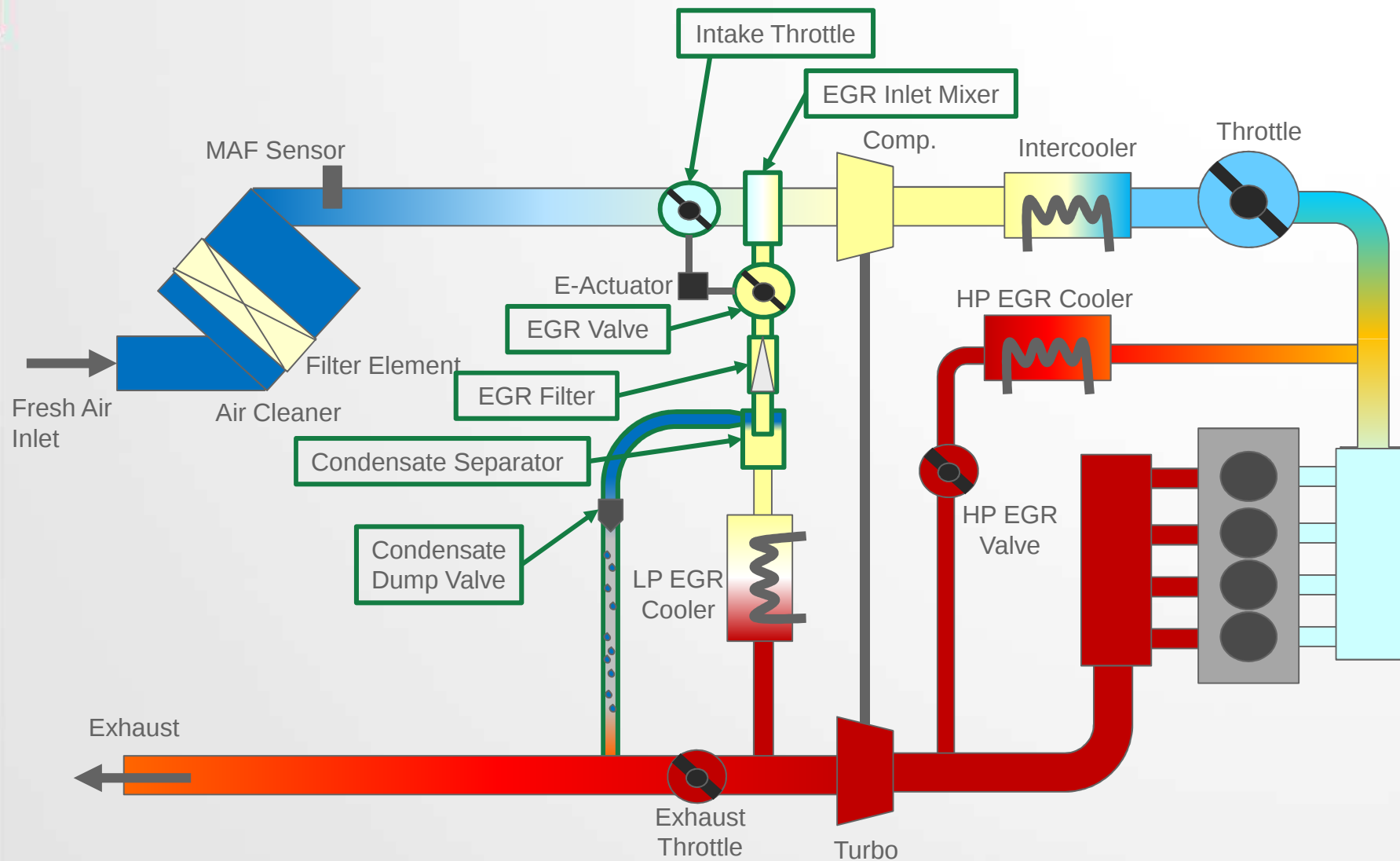
FUI10, 3 years, 9 partners, 3.2 M€



OCSYGENE + (low end torque increase)



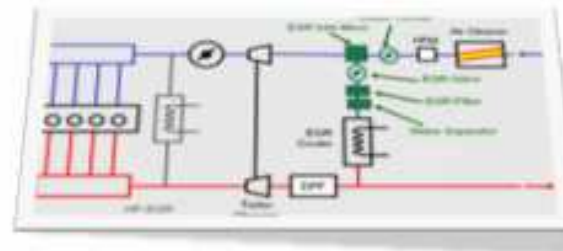
General architecture for LP EGR



OCSYGENE C : a modular & compact approach integrating Mechatronics



MANN+HUMMEL Vision

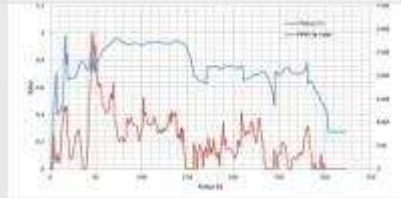


1. EGR-inlet
2. Condensate separator
3. Condensate outlet
4. EGR particulate filter
5. EGR-valve
6. Actuator
7. EGR inlet mixer
8. Air-inlet
9. Air intake throttle
10. Blow-by inlet
11. Outlet to compressor housing

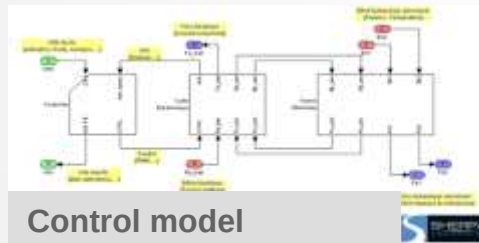
OCSYGENE C – From system to product design



Driving cycles / Duty cycle from OEMs
System simulations
OEMs specifications
Benchmark activities

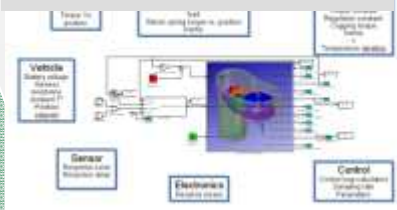


Système Model

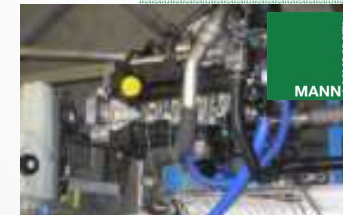


Control model

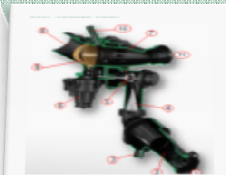
Component Model



Engine Test

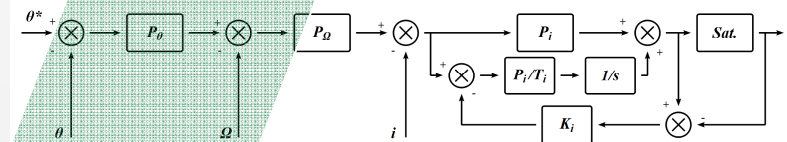


Organic test bench



SubSystem Specifications

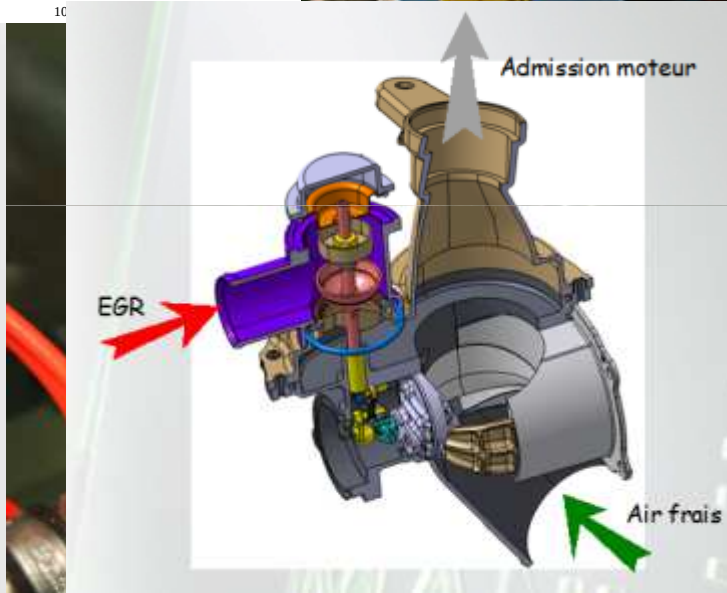
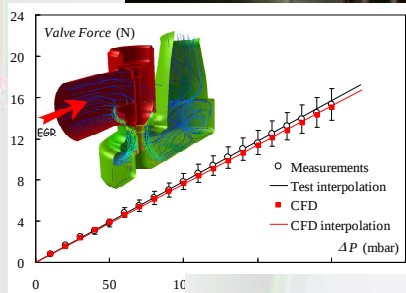
Prototyping (HW / SW)



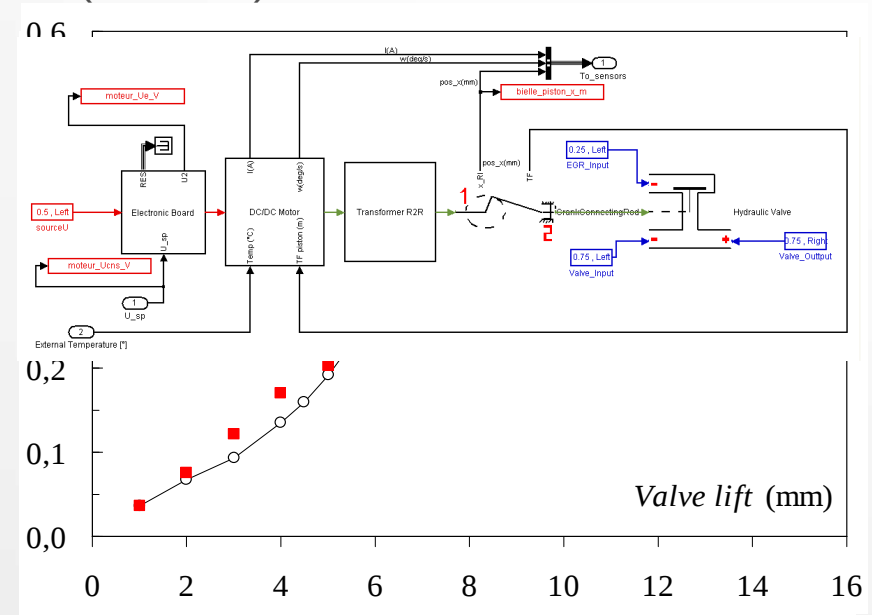
Position Control Strategy + ECU



From thermodynamics to mechatronics



- ❑ A compensation chamber has been designed to reduce torque requirement
- ❑ A prototype has been built and tested
- ❑ CFD simulation has been made in same conditions for correlation
- ❑ Simplified model has been built and used for mechatronics simulation (Simulink)





Valve

Torque Vs
position

Transmission

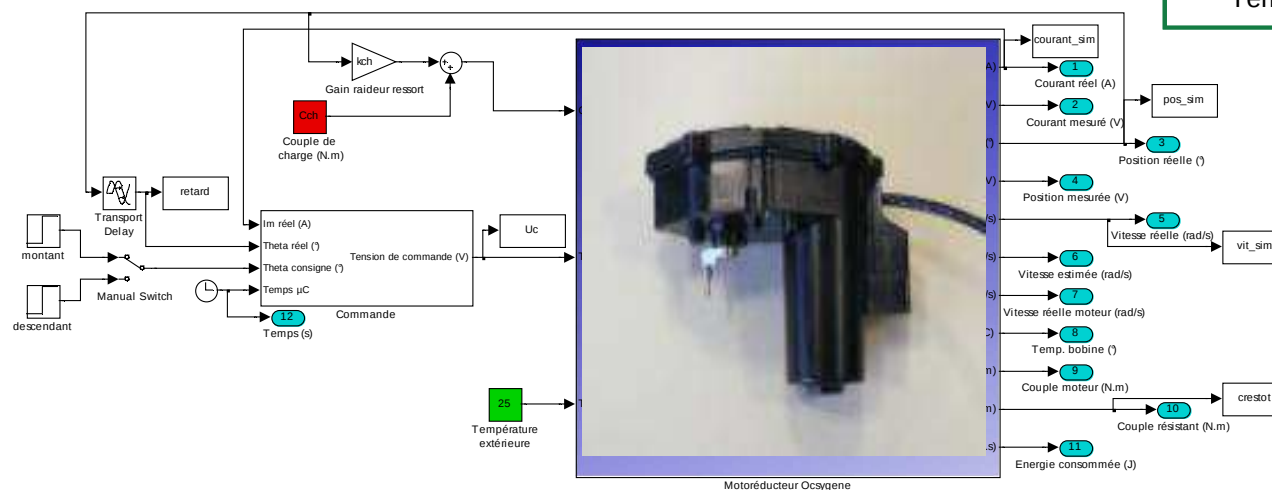
Friction vs. load
Friction Oscillation vs. position and load
Return spring torque vs. position
Inertia

Motor

Resistance & Inductance
Torque constant
Regulation constant
Cogging torque
Inertia
+
Temperature derating

Vehicle

Battery voltage
Harness resistance
Ambient T°
Position setpoint



Sensor

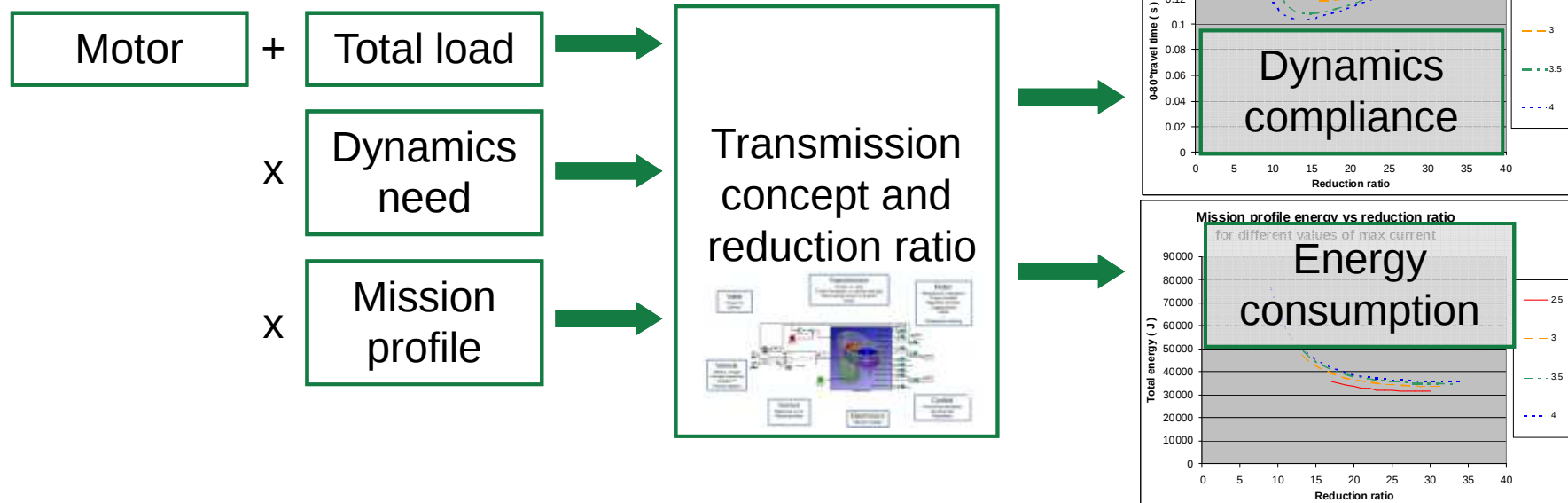
Response curve
Response delay

Electronics

Resistive losses

Control

Control loop calculation
Sampling rate
Parameters

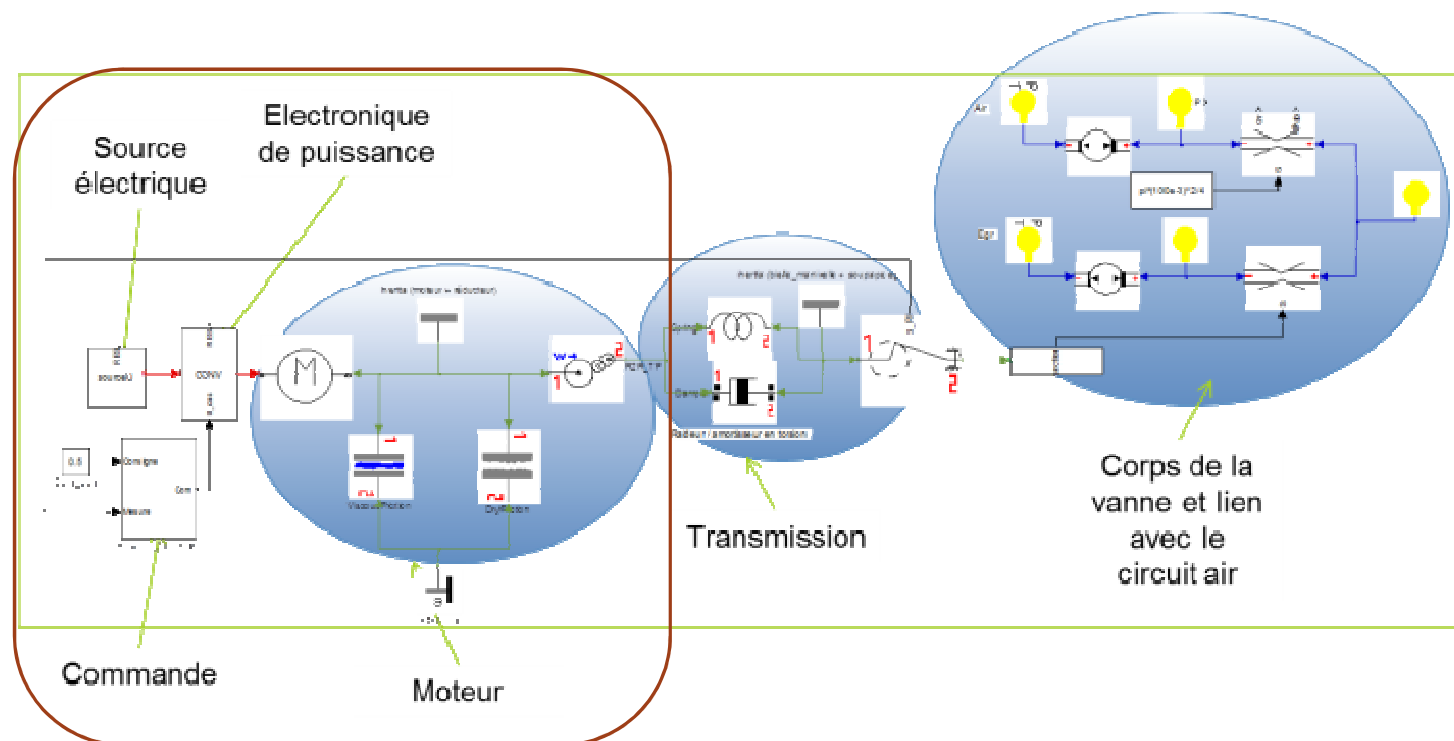


- In order to improve transmission efficiency spur gear is preferred.
- Increasing reduction ratio is suitable for lower current consumption and higher torque margin but not for dynamics.
- Energetic approach is the best way for system optimization and reduction ratio choice.
- Analytical method has been built for transmission optimization

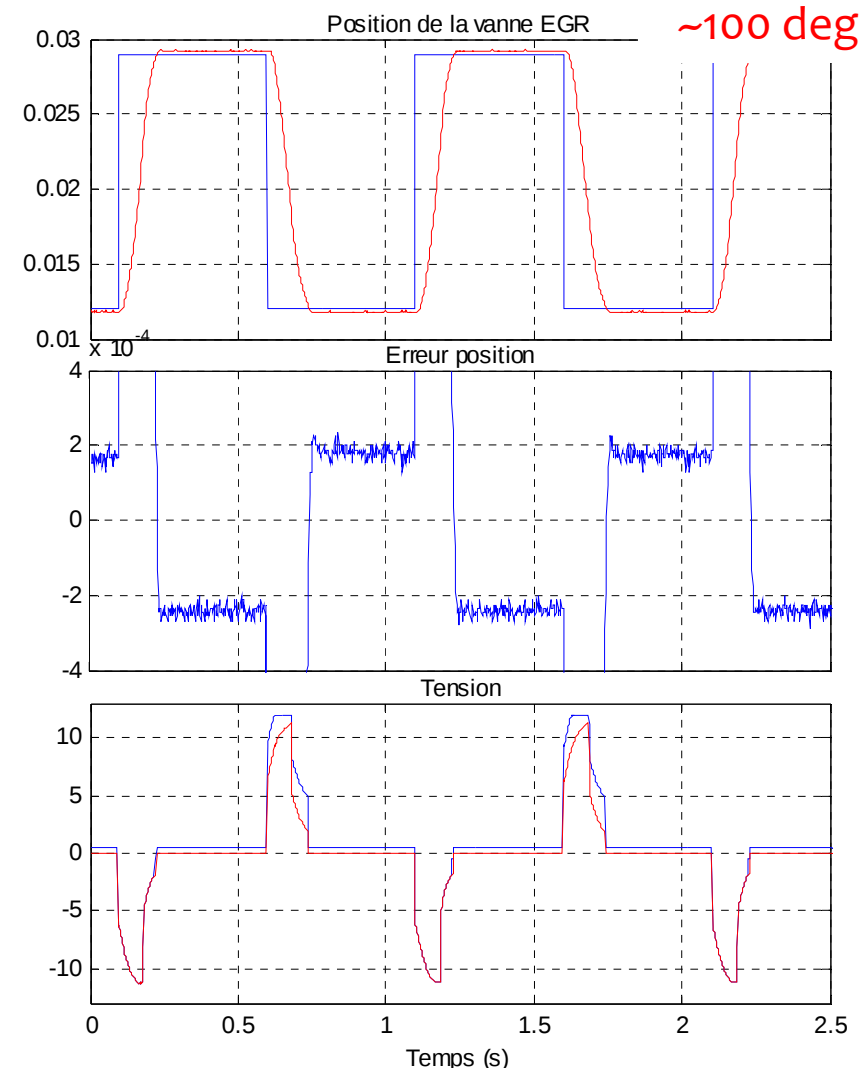
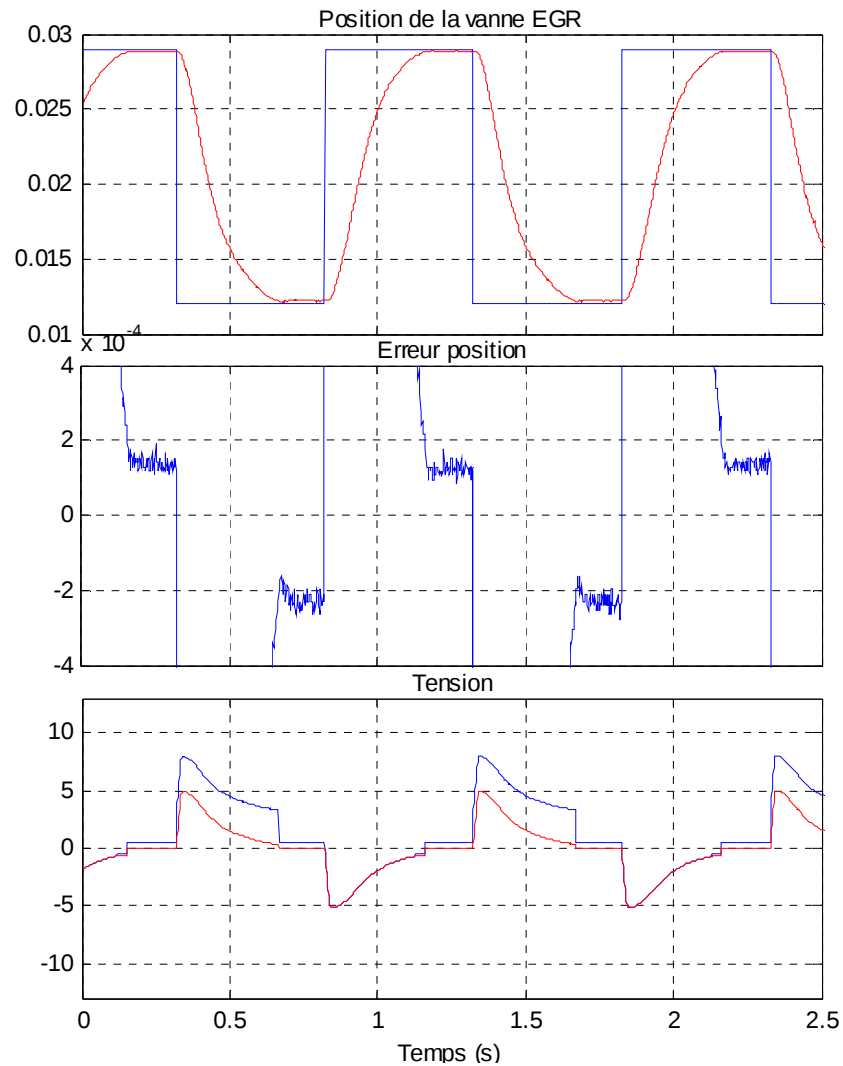
Position Control Strategy

From Single actuator to EGR Valve

- Position control strategy synthesis
- Rapid Prototyping
- Set-up and Calibration



Position Control Strategy optimization



Conclusion



- ❑ Thanks to ID4CARS, Regions Pays de la Loire and FUI / OSEO for their Help and financial support to this project
- ❑ A network of competencies around Engine knowledge, fluid dynamics and mechatronics activities has been founded.
- ❑ In OCSYGENE 6 program, Focus is to meet new challenges in air loop on New Engines to meet next Euro 6 regulation.
- ❑ A methodology has been created to optimized mechatronics concerning packaging, future functions, electrical consumption and cost.
- ❑ Durability and engines tests are in progress on prototypes based on concrete work achieved with OCSYGENE 6.

Thank You For Your Attention !

