FLANDERS MAKE
MANUFACTURING INNOVATION NETWORK

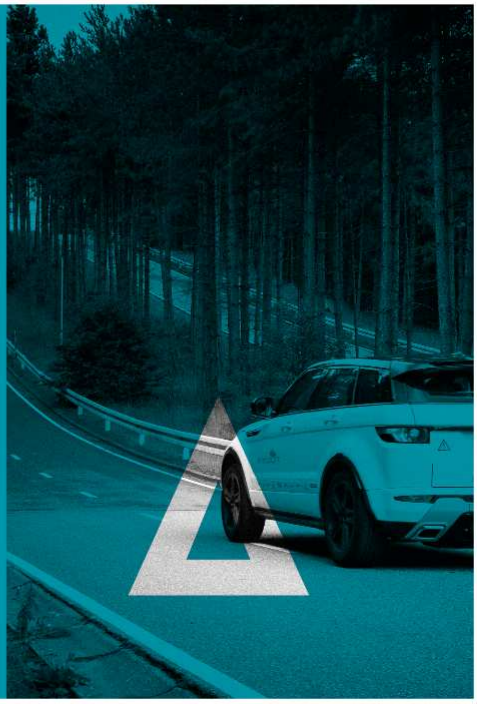
MANUFACTURING INNOVATION NETWORK

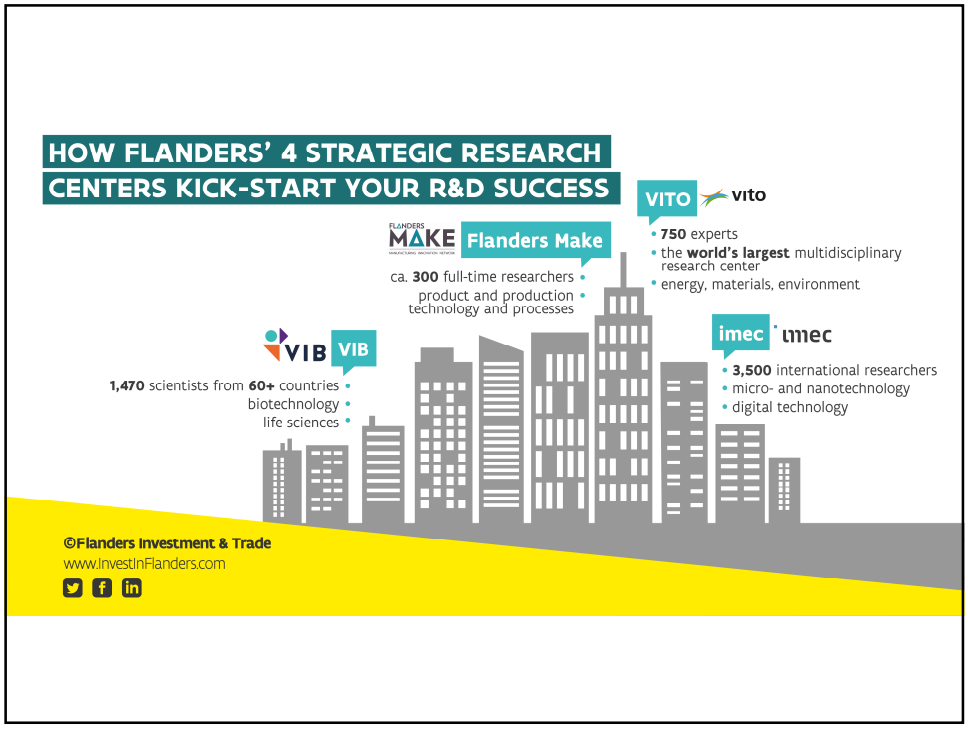
Flanders Make

Strategic research center for the manufacturing industry

Dr.ir. Dirk Torfs, CEO

August 2017





OUR MISSION

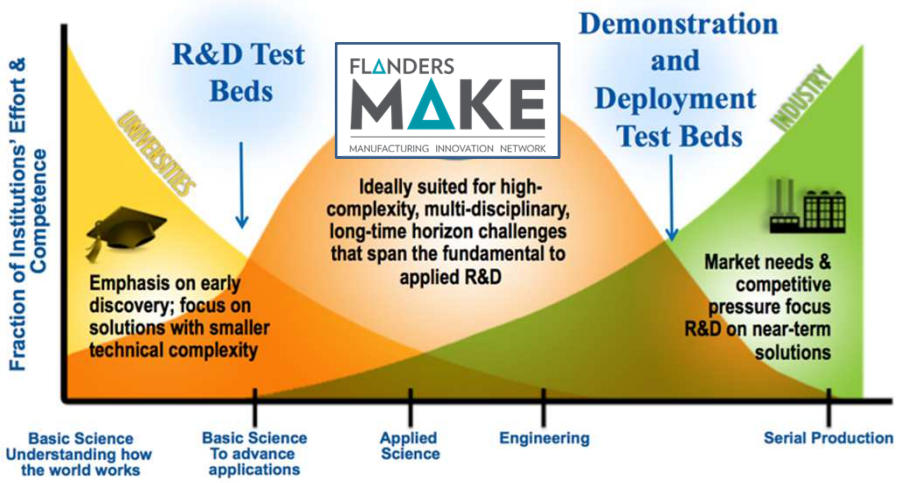
To strengthen the long-term international competitiveness of the Flemish manufacturing industry by carrying out excellent, industry-driven, pre-competitive research in the domains of

- **Mechatronics**
- **Product development methods**
- **Advanced manufacturing technologies**

Aiming at innovative technologies for



BRIDGING THE VALLEY OF DEATH



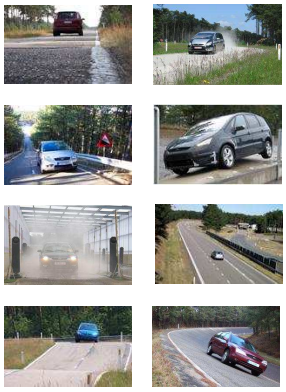
FLANDERS MAKE OFFERS YOU

- A strong international network
- Excellent technological research
- State-of-the-art research infrastructure

Joining forces, growing stronger!

FLANDERS MAKE IN FLANDERS

STRATEGIC LOCATION NEAR LOMMEL PROVING GROUND



OUR FLYWHEEL IS TURNING AND ACCELERATING

100+ member companies

44 companies involved in projects

€ 100 million activated

50 I 50 knowledge centers

companies (also investing € 15 million)

42 projects

30 interdisciplinary cooperative research

8 strategic basis research

4 infrastructure

WHY COLLABORATING WITH FLANDERS MAKE?

- **Picanol:** smart solutions: industrial added value of the Flanders Make network, innovating together

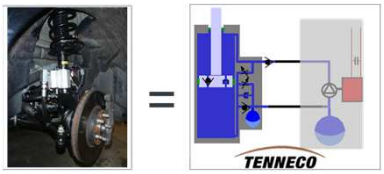
- **Benes:** helping to create new markets through product changes for new offerings

- **Octinion:** support of complementary multi-disciplinary knowledge for product development(s)

WHY COLLABORATING WITH FLANDERS MAKE?

- **dotOcean:** speeding up innovation and product launch

- **Tenneco:** Product development through cross fertilization via an ecosystem network



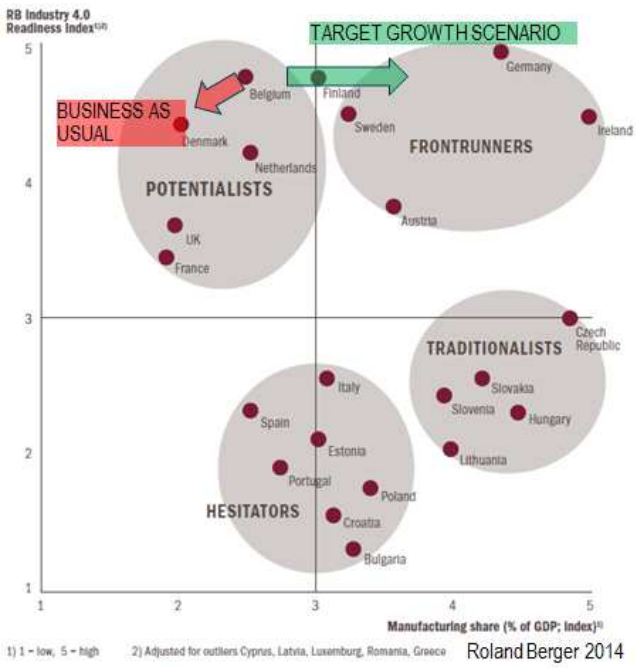
- **Materialise :** new applications for our technology

Flanders Make 2018-2022

Together, we
Excel and
Accelerate in
Manufacturing

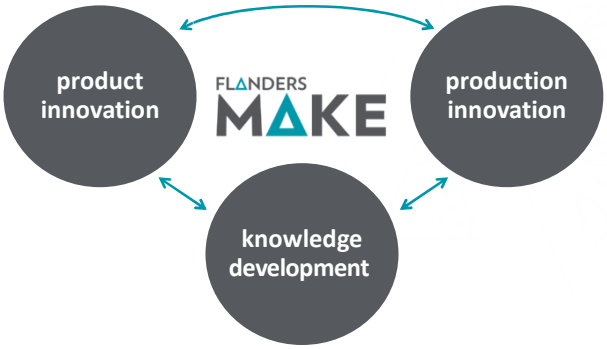
INSTITUTE STRATEGY & CORE PROCESSES

Flanders Make 2018 - 2022

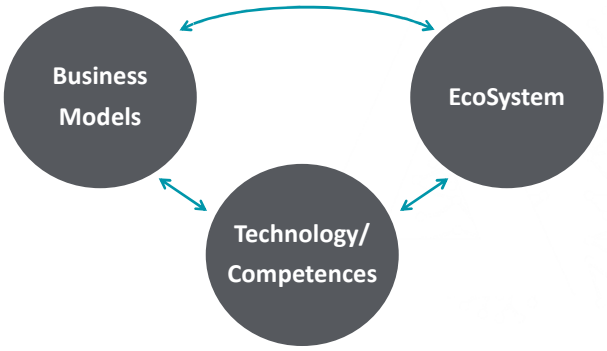


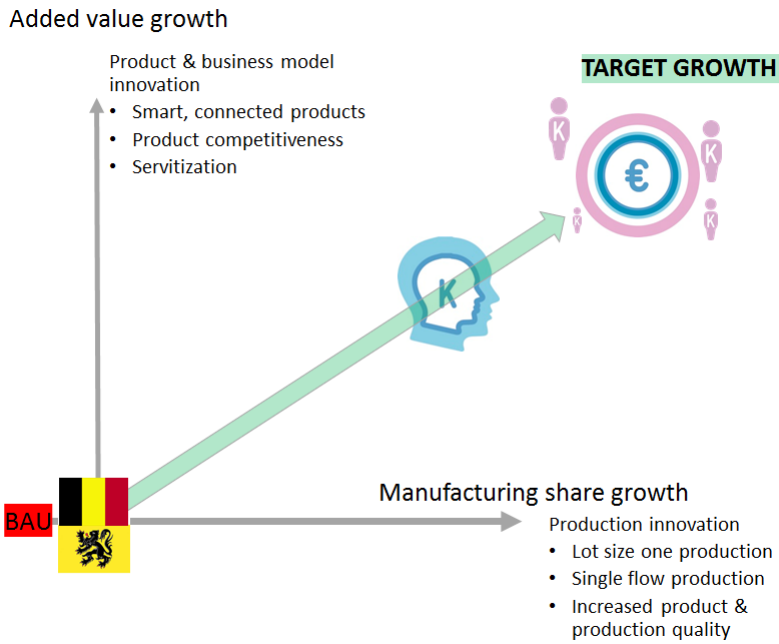
SUSTAINABLE MANUFACTURING

- Strengthening product and production innovation in the manufacturing industry : closing the loop!



ELEMENTS FOR INNOVATION & INDUSTRY GROWTH





RESEARCH STRATEGY : An integrated strategic focus

Flanders Make 2018 - 2022

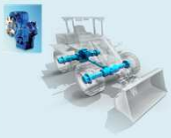
DRIVING MARKET FORCES

1. Smart, interconnected products and production systems
2. Customized products at the cost of series production
3. Human centered & sustainable manufacturing

taking into account i.e. cost, energy consumption and material recycling constraints

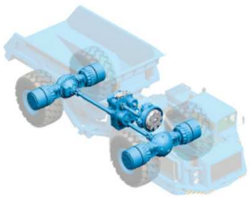
FLANDERS MAKE FOCUS: MACHINE / PRODUCT RESEARCH

Systems with increasing smartness and interconnectivity

Performance	Robustness and safety	Adaptability	Multi-context Adaptability
System topology			
			
Green energy-efficient drivetrain	*Dynamic control of mechatronics systems*	*Self optimizing of shedding system*	*Interconnected machines*

BENEFITS OF MULTI-CONTEXT ADAPTABILITY

Wheel Loaders, Telehandlers, Wheeled Excavators



DANA

FLANDERS MAKE FOCUS: VEHICLE / PRODUCT RESEARCH

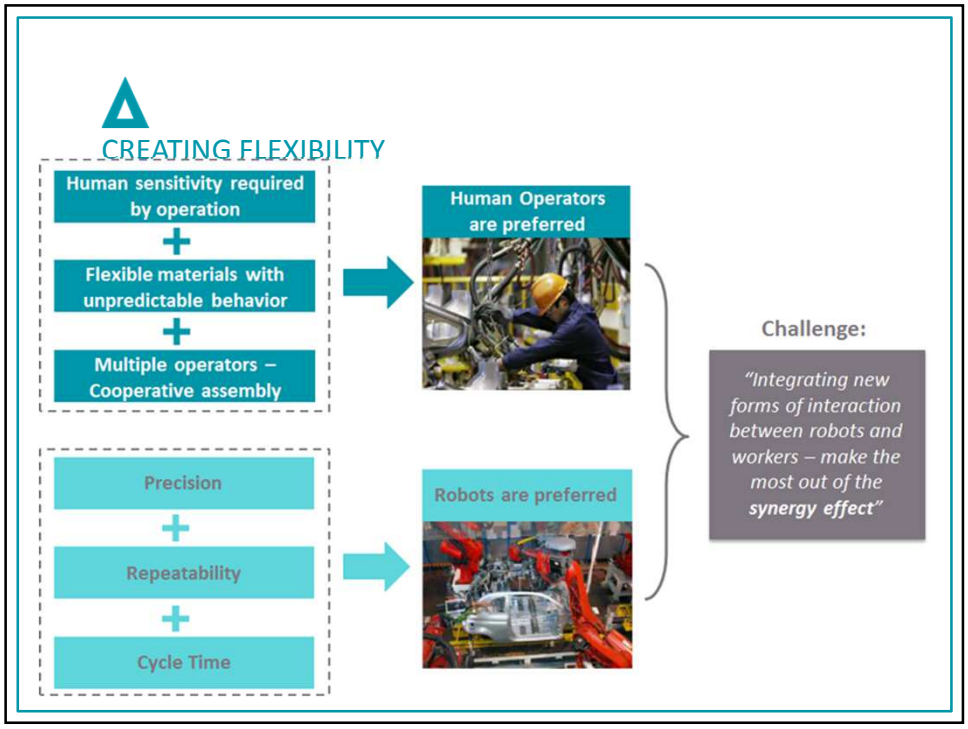
Systems with increasing smartness and interconnectivity

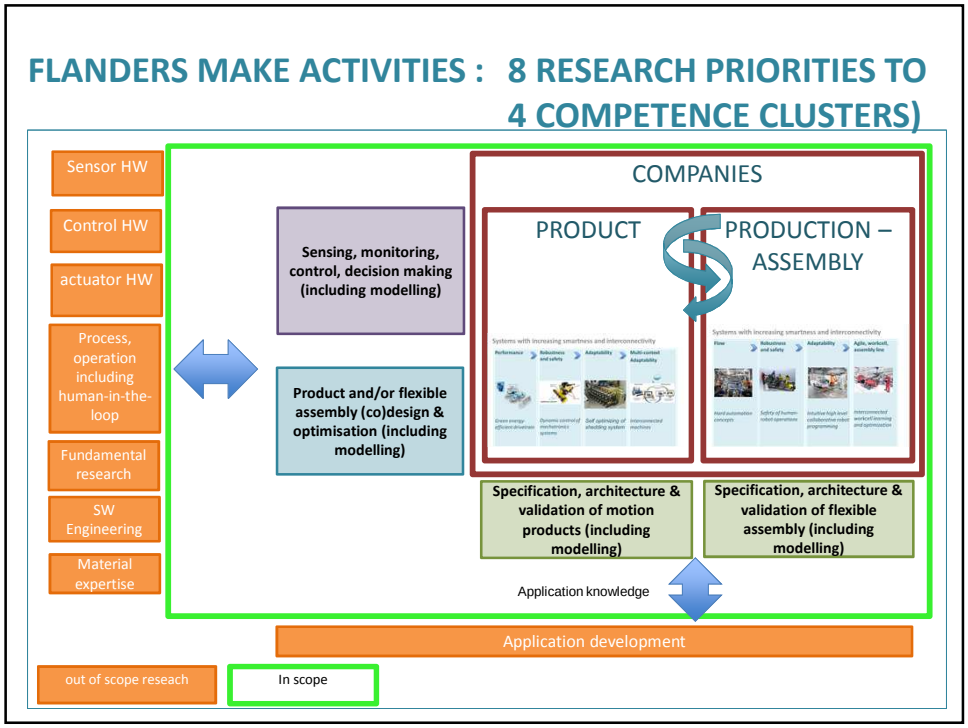
Performance System topology	Robustness and safety	Adaptability	Multi-context Adaptability
			
Green energy-efficient drivetrain	*Active suspension*	*Path planning*	*Fully autonomous vehicles*

FLANDERS MAKE FOCUS: ASSEMBLY OF COMPLEX PRODUCTS

Systems with increasing smartness and interconnectivity

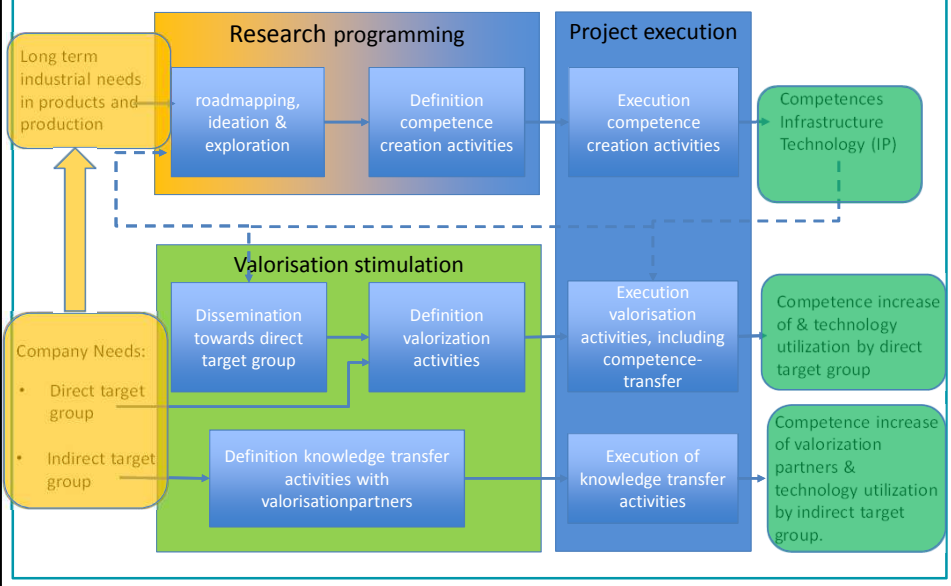
Flow System topology	Robustness and safety	Adaptability	Agile, workcell, assembly line
			
Hard automation concepts	*Safety of human-robot operations*	*Intuitive high level collaborative robot programming*	*Interconnected workcell learning and optimization*


CREATING FLEXIBILITY
Human sensitivity required by operation
+
Flexible materials with unpredictable behavior
+
Multiple operators – Cooperative assembly
Human Operators are preferred
Precision
+
Repeatability
+
Cycle Time
Robots are preferred
Challenge:
"Integrating new forms of interaction between robots and workers – make the most out of the synergy effect"

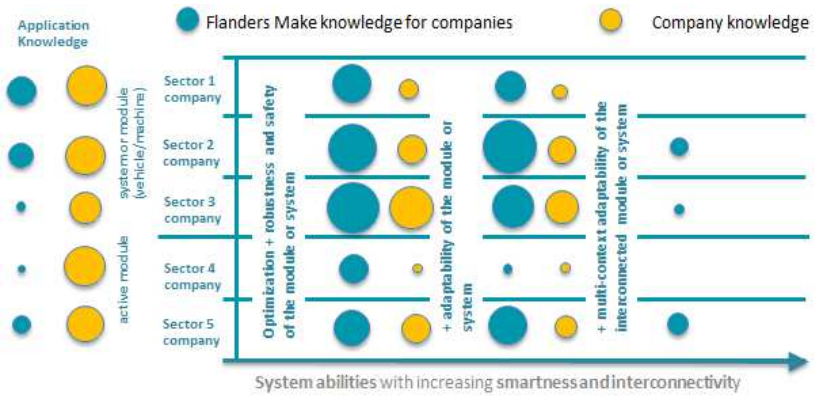

FLANDERS MAKE ACTIVITIES : 8 RESEARCH PRIORITIES TO 4 COMPETENCE CLUSTERS)
Sensor HW
Control HW
actuator HW
Process, operation including human-in-the-loop
Fundamental research
SW Engineering
Material expertise
Sensing, monitoring, control, decision making (including modelling)
Product and/or flexible assembly (co)design & optimisation (including modelling)
COMPANIES
PRODUCT
PRODUCTION – ASSEMBLY
Specification, architecture & validation of motion products (including modelling)
Specification, architecture & validation of flexible assembly (including modelling)
Application knowledge
Application development
out of scope reseach
In scope

ORGANISATION, PROCESSES

CORE PROCESSES FOR THE KEY ACTIVITIES



COMPETENCE TRANSFER TO/FROM COMPANIES

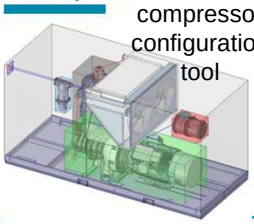


PROJECTS LEAD TO TECHNOLOGY UTILISATIONS …

Design & control of print feeder

Atlas Copco

Optimal compressor configuration tool



DANA

Optimal gearshift control

al structural design of a bike carrier

STRAWBERRY PICKING ROBOT

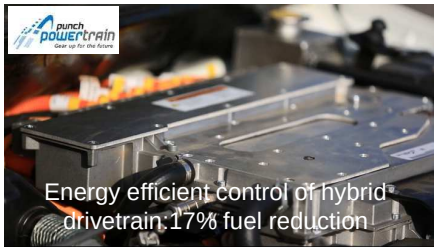
OCTINION
Engineering the future

Strawberry picking robot

In collaboration with FLANDERS MAKE PROEFCENTRUM HOOGSTRATEN KU LEUVEN

With support of AGENTSCHAP INNOVEREN & ONDERNEME

… AND MORE TECHNOLOGY UTILISATIONS



Use of Design For Manufacturing and Assembly

FLAME Content & process

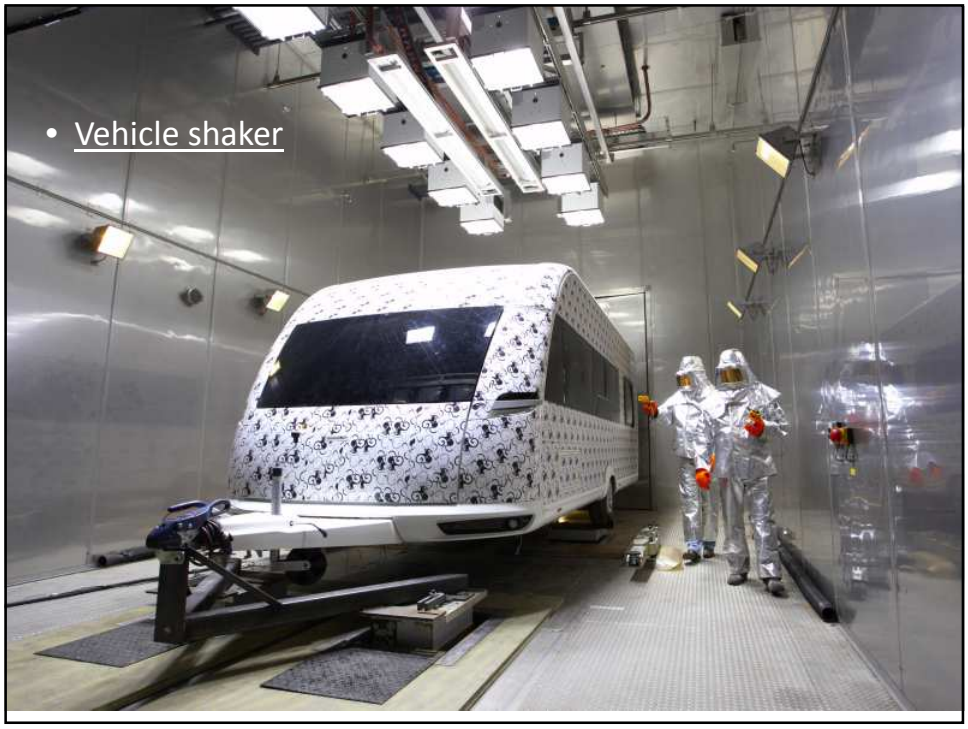
Scale to ISO 25119

Add Grammer processes

Specific Grammer FLAME

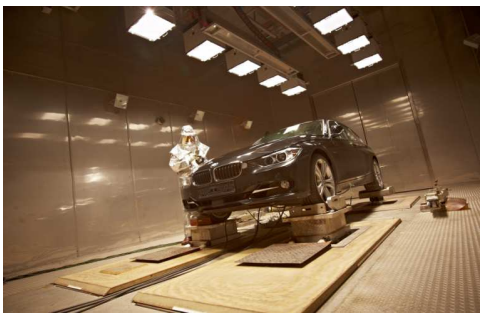
Safety Critical System Design Proces

SOME OF OUR INFRASTRUCTURE



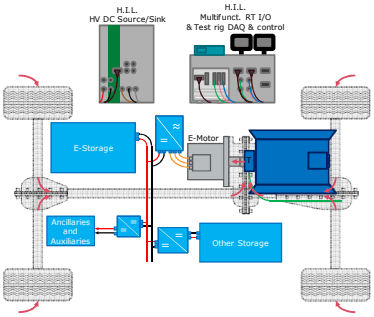
ENVIRONMENTAL AND VIBRATION TESTING

- **Vibration**
  - **Full vehicle size 4+2 poster**
    - 4 individual controllable vertical hydraulic actuators
    - 2 individual controllable horizontal actuators
    - Pay loads up to 500 kg per actuator
- **Combined with climate chamber**
  - **Full vehicle size**
    - 10m x 6m x 6m (lxwxh)
    - Temperature range (-40°C to +70°C, ΔT 0.3 °C/min)
    - Humidity range (15 to 70% RV)
    - Sunlight simulation according to DIN 75220 up to 1100 W/m²



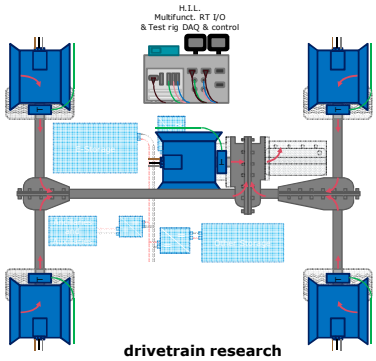
FLANDERS MAKE
MANUFACTURING INNOVATION NETWORK

DRIVE AND POWERTRAIN INFRASTRUCTURE



HEV powertrain research
Intelligent & efficient sourcing / sinking of power

R&D:
- HEV component integration (motors, invertors, batteries, …)
- Full HEV powertrains & control
- Electric loading and ICE emulation for hybrid



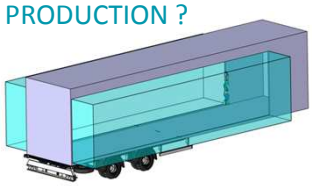
drivetrain research
Intelligent & efficient transfer of power

R&D:
- Drivetrain components (transmissions, gearboxes, RDU, pumps, CVT, FW, multiple loads,….)
- Full drivetrains & control
- Hydraulic, electric, mechanic & pneumatic

HUMAN-CENTERED LAB WITH COLLABORATIVE ROBOTS

MOBILE LAB FOR HUMAN CENTERED PRODUCTION ?

Turning operators into knowledge workers



- Augmented based work instructions
- Virtual based training

Assisting humans with robots

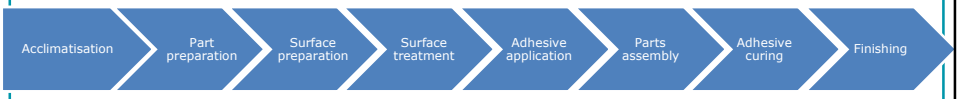
JOINING TECHNIQUES FOR MULTI-MATERIALS LAB

MULTI – MATERIAL JOINING LAB

- Infrastructure extension

Equipped lab for the preparation of assembled parts mimicking **real production process, environment** and **manufacturability**

▲ Adhesive bonding



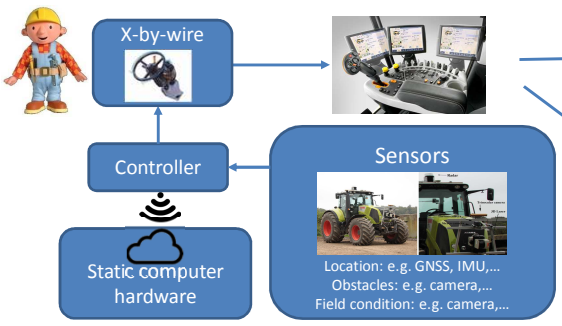
▲ Mechanical fasteners: SPR (self piercing rivet), blind rivet, clinching,

▲ Combination of the two, hybrid joints

▲ Assembled part of considerable dimensions (~1,5*1,0*0,8m) and weight (~40kg)

OFF-HIGHWAY MACHINE AUTOMATION

- Typical tests:
  - Validate novel **monitoring** and **control** strategies for **autonomous** field driving and bale collection
- Changes to tractor
  - X-by-wire
  - Sensors: location, obstacles and field conditions
  - Open controller platform



International research projects and cooperation

CLEAN AND ENERGY EFFICIENT VEHICLES

Rear driveline development
BMS improvement
Individual brake system
Integration
Validation 4WD 600V
Torque vectoring control algorithms

e-vect.or

Multi-actuated ground vehicles (MAGV)
MAGV integration
Green MAGV
MAGV driving environment

iTEAM

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018

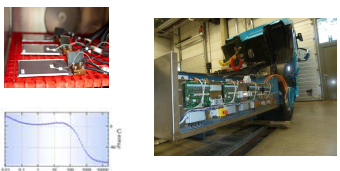
Energy Storage
Cell characterization
BMS + Software
Battery Pack design
Ageing models ...

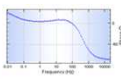
Electric Powertrain
Open SW system architecture
Subsystem design
Driveline assembly
Integration
Validation 2WD 400V

Multi-core ECU
Semi autonomous driving
Optimizing energy efficiency

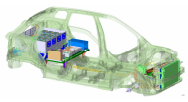
COMODO
Multi-level modelling of EV
Adaptive control of BMS

WHR
heat 2 heat in a FEV





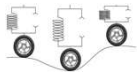
MoForM
Estimate tyre forces based on vehicle sensor data combined with motor models and vehicle models



Profensto
Validation of electromagnetic active suspension

71

INTELLIGENT DRIVER AND TRAFFIC SYSTEMS



Multi-core ECU
Semi autonomous driving
Optimizing energy efficiency

Multi-actuated ground vehicles (MAGV)
MAGV integration
Green MAGV
MAGV driving environment

2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018

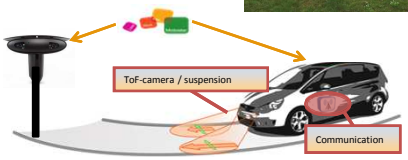
Active suspension
Fully active, low power consumption suspension system that provides ultimate comfort combined with excellent handling

Vision
Camera-based vision system with which the vehicle with active suspension can anticipate the road profile

GPS POSITIONING
Low cost absolute and relative localization techniques
Fusion of multiple techniques

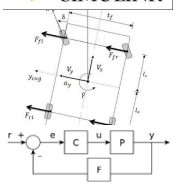
AUTODRIVE
Highly and fully automated driving
Fail-aware, fail-safe, fail-operational integrated electronic components

EMDAS
Validation of adaptive cruise control with sensor fusion of radar and vision systems
Longitudinal automation



72

EXAMPLE: DEVELOPMENT AND TESTING OF A LONGITUDINAL CONTROLLER



Controller **development** and system **simulation**

Scale up

Experimental testing on **rolling road**

Iteration

Experimental testing on **test track**

Developing new controller methods or testing and comparing different approaches on system level is possible !
Due to the open structure and the scalability of the platform, relevant testing can be done for a variety of vehicles

73

COLLABORATION WITH FLANDERS MAKE

Flanders Make today and tomorrow

PROJECTS LEAD TO TECHNOLOGY UTILISATIONS …

Many project movies available at www.flandersmake.be


Flanders Make - iCompose - EN

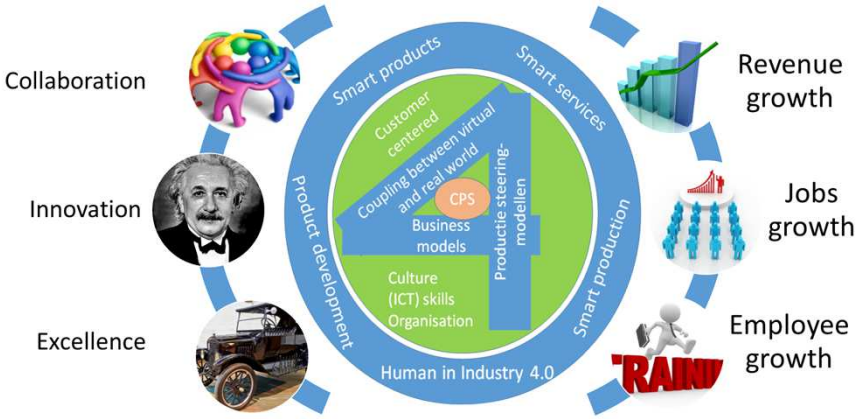

Flanders Make - SITcontrol ENG

Flanders Make - Autocon - EN

CONCLUSION

Flanders Make 2018 - 2022

CONCLUSION



CONCLUSION

- Industrial focus for strenghtening **product developments** and **production/assembly developments**
- An **integrated focus** for research in line with CPS trend and contributing to **Industry 4.0 transformation** needs
- Organisational changes based on previous learnings with collaborative research environment to **excel and accelerate**
- Significant anticipated **impact**

Thank you for your time!

Kind regards,

Dirk Torfs, dirk.torfs@flandersmake.be