VIRTUAL PRODUCT DEVELOPMENT
Case New Holland
Gennaro Monacelli

Agricultural & Construction Equipment
Design Analysis & Simulation Competence Centre
CNH Product Development Organization

**AG Product Development**

- Tractor Platform
- Equipment Platform
- Combine Platform
- Forage and Grape Harvester Platform

30 platforms

**Product Development common functions**

- **Electrical & Electronics (Telematics, ..)**
- **Driveline and Engine Installation**
- **Hydraulics**
- **Cab and external trim**
- **Design Analysis and Simulation**

- **Styling (Fiat Group)**

**CE Product Development**

6 platforms

- Excavators and Telehandler
- Dozer and Wheel Loader
- Grader
- Tractor Loader Backhoe
- Skid Steer Load CTL Wholegoods Platform

Vehicle Integration
Goals of VPD

- Use advanced tools and methodologies (modeling and simulation) in order to have a complete representation of the new product (geometry and functions) in order to:
  - reduce decisional risks
  - minimize time and costs
  - reduce the number of physical prototypes
  - Increase quality

The approach is

- Complete digital representation of the Product (Digital Mock-Up) and the Plant (Virtual Manufacturing)
- From Field to bench (mission identification and testing)
- From the bench to the math (mission simulation)
WW Design Analysis and Simulation

Design Analysis
- Structural Analysis
- Transmission & Fuel Efficiency
- NVH Simulation
- Dynamic Analysis
- Fatigue

Digital Prototyping & Simulation
- CAD, DMU, VR, DMH
- System Simulation
- Thermo Fluid Dynamics
- Vehicle Dynamics
- Particle Flow Modelling
- Product & Process Integration Simulation

FIAT Group Intersectorial Projects
Virtual Product Development Process

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Target setting approach in Product Development

Methods/Tools for target setting, deployment and achieving

**PERFORMANCE OBJECTIVE MEASUREMENTS**

**CARRY-OVER CONSTRAINTS**

**ARCHITECTURAL ADVANCED DESIGN**

**TARGET DEPLOYMENT**

**TARGET ACHIEVING Modeling & Virtual Validation**

**PHYSICAL VALIDATION**

**VIRTUAL ANALYSIS**

**PRODUCT DEVELOPMENT PROCEDURES**

**Target Management**

PRODUCT TARGET (TLR/CVP)  TARGET SETTING (VTS)
Design Procedures

CAE Standards

Acceptance Criteria

Test Procedures
Digital Mock Up & Virtual Reality

Styling Reviews, Design Reviews, Commercial Publications, Tolerance analysis, Ergonomics, Cab Visibility, Serviceability, Marketing & Sales, Human Machine Interface
Component structural analyses

Testing of components and products under different working conditions and loads

Good correlation with experimental data and possibility to implement different loading conditions
Simulate and Evaluate cab behavior under shock load homologation test.
Virtual and Experimental Correlation

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Topology Optimization

- Optimized structural configuration based on specified loads.
- Applied in the early stages of product development

The combine rear frame was designed using topology optimization. The loading capacity was increased by 40% without cost increase.
Fatigue life prediction - Bump Test

Comparison with on PMU field critical areas

Right strut - Outer side

Left strut - Outer side

Serial #1150302
3.720 hrs

Serial #1174018
3.387 hrs
Transmission and Fuel Efficiency

- Evaluate stress, strain and fatigue life of all transmission components, taking into account the efficiency and power flows
- Predict gears fatigue life and simulate meshing loads and vibrations

Powertrain & Transmissions, Bearings
Vehicle dynamics behavior simulation under different working conditions and grounds, including implements and cab.
Underhood cooling, engine cooling, Cabin HVAC, 3D hydraulics
SPL (Sound Pressure Level)
total noise level registered internally to the cabin due to the combined action of all these sources

Transmission of energy from sources to driver follows two paths:
- Structure borne
- Airborne
### Factors of Noise Generation

<table>
<thead>
<tr>
<th>Factor of noise generation</th>
<th>Countermeasures</th>
<th>Test tracks</th>
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<tbody>
<tr>
<td>Air-borne noise [500 Hz → 10KHz]</td>
<td>Engine combustion noise Mechanical noise</td>
<td>Addition of sound-insulating sheet and sound absorbing material Laminated glasses</td>
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<tr>
<td></td>
<td>Suction and exhaust noise Fan noise Airflow noise</td>
<td></td>
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<tr>
<td>Structural-borne noise [&lt; 500 Hz]</td>
<td>Noise emitting from panel</td>
<td>Prevention of resonance, dynamic stiffer, tuning by anti-vibration rubber mount</td>
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**Deterministic approach**
- BEM
- FEM

**Statistical approach**
- SEA

The table above outlines various factors of noise generation and their corresponding countermeasures. The test tracks are depicted in the diagram at the bottom.
Simulate crop, soil and seeds interactions with the specific machine in order to evaluate velocity and projection.

**Applications:** Hay and forage, Combines, Cotton Picker, Grape harvester, Sugarcane harvester, ripper, harrow/discer, Seeder, Planter, Vertical Tillage.

Design of Experiments of elevator grain flow for grape harvester.
combine tailing system
Simulate vehicle system performance under different dynamics scenarios in order to evaluate and improve our products.

**Applications:** Design Optimization, Efficiency/Fuel Consumptions, Hydraulics circuits, Transmission design, What-If analysis.
Why VPD is important?

- World wide organization

- Agricultural (EU, NA, LAR)
  - 5 lead Design Centers (2 NA, 2 EU, 1 South America)
  - 20 Plants (9 NA, 9 EU, 2 South America)
  - 50 Product lines (14 Tractors, 7 Harvesters, 16 Crop Production, 13 Hay and Forage)

- Construction Equipment (EU, NA, LAR)
  - 3 lead Design Centers (1 NA, 2 EU)
  - 11 Plants (4 NA, 5 EU, 2 South America)
Conclusions

• **Virtual Product Development allows effective and quick “Design Reviews”, including partners and suppliers also from remote locations.**

• **The communication process among all the actors involved in the product development process becomes more effective**

• **The product quality and project robustness are improved, minimizing costs at the same time**

Thank You!

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