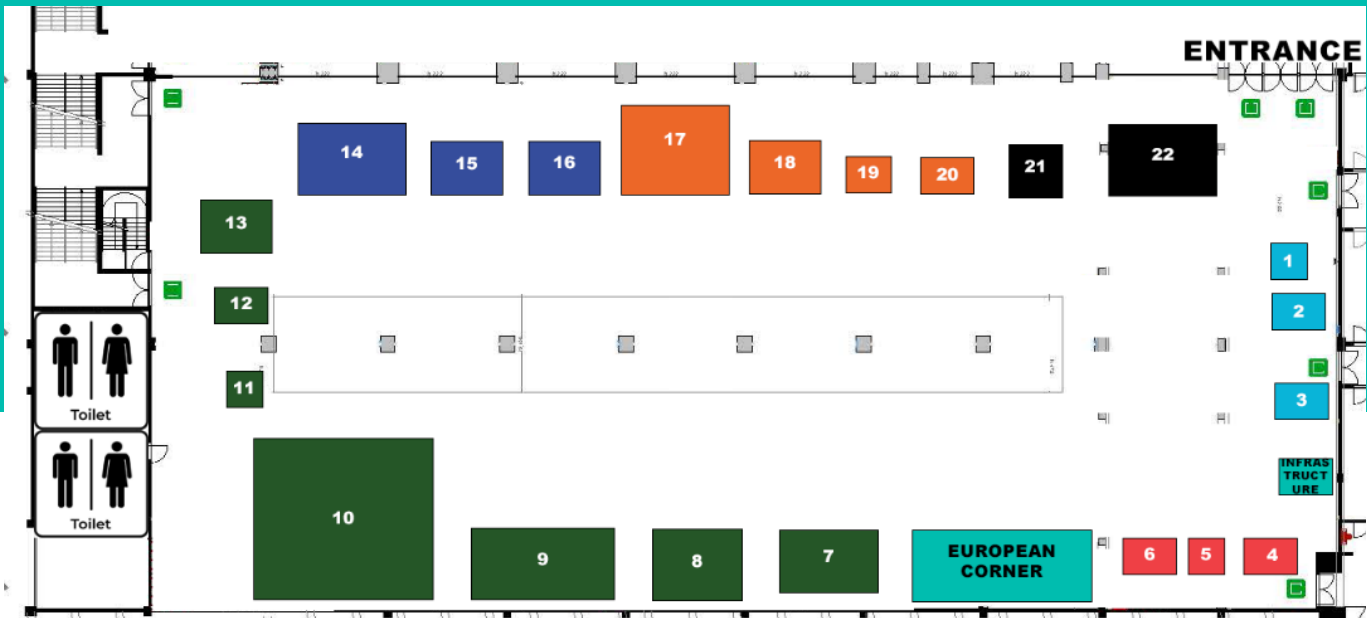
FLANDERS MAKE

DEMO ROOM



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DEMO 01

Measuring cognitive load in assembly through immersive eye tracking in VR

Understanding how operators experience **mental workload** is key to designing efficient and safe assembly processes. In this demonstrator, we showcase a **novel use of eye tracking** to measure **cognitive load** — not in a lab, but within realistic industrial assembly tasks, both physical and virtual.

Using **Magic Leap XR glasses** and a **gamified VR environment**, participants complete two contrasting assembly tasks: one relaxed and well-guided, and another more complex with minimal instruction. As they work, eye movements are tracked in real time to assess mental effort.

The data clearly distinguishes between high- and low-demand tasks, offering companies objective insights to **optimize task design, training, and workstation layout**.

Whether used in a **real environment** or a **virtual twin**, this approach provides a powerful, data-driven way to improve productivity, reduce errors, and make assembly work more human-centred and efficient.

DEMO 02

Competence-aware Training & Instruction Generation

At Flanders Make, we're developing intelligent tools to make operator training more efficient and personalized. This demonstrator presents our **automated toolchain** for generating tailored work instructions and trainings based on each operator's competency level.

Using **large language models**, the system first extracts the required skills and competencies from existing work instructions. Then, by linking this information to operator profiles in a learning management system, it adapts the content to match each person's experience and proficiency.

Finally, it automatically creates **targeted learning materials** — such as micro-trainings and quizzes — to close identified competence gaps.

The result is a dynamic and data-driven training environment that **boosts operator performance**, **shortens onboarding and training times**, and **reduces the effort needed** to create and maintain digital work instructions.

In short, smarter instructions for smarter manufacturing — tailored to every operator.

DEMO 05

Control for complex manoeuvring in agriculture a VR demo

Modern machines are becoming increasingly complex, with rising demands for **performance, efficiency, and safety**. To unlock their full potential, well-designed control algorithms are essential — yet advanced controllers are often **hard to tune**, **computationally demanding**, and **difficult to implement** in practice.

Our solution tackles these challenges by making the design of optimal controllers **straightforward and accessible**. It provides an intuitive interface to compute advanced controllers directly from **Simulink or Simscape models**, removing the need for handwritten equations.

The system then converts these complex optimal controllers into **easy-to-understand control blocks** – such as PID, feedforward, and filters – that can be quickly tuned and deployed in the field.

In this demonstrator, we show how intelligent control can assist operators during complex maneuvers, like steering a tractor and baler along a precise crop path.

The result: **advanced control made simple, explainable, and ready for real-world use.**

DEMO 06

Maximizing Test Quality Mutation Testing for Safety-Critical Simulink and Stateflow Models

In safety-critical industries, a single software defect can cost millions, lead to product recalls… or even endanger lives. And the later those defects are found, the higher the price – fixing them at the end of development can be up to a hundred times more expensive than catching them early.

Sectors like automotive and aerospace rely on increasingly complex embedded software. They invest heavily in testing, yet too often, critical issues are only discovered late in the process. And early on, teams struggle to understand how effective their tests really are. The result? Unpredictable release cycles, rising costs, and – in the worst cases – serious reputational risks.

That's why we're developing a **software solution** that helps engineering teams detect and fix defects early – before they become costly or unsafe. Think of it as an X-ray for your testing process: it reveals blind spots in your verification setup, ensuring your system is as safe as intended.

With our **software solution**, you achieve earlier defect detection, higher test confidence, more predictable release cycles, and up to 20 to 50 percent savings in testing and integration costs.

We're already working with major industry players. Pilots are running with **DUCO** in energy systems and **Alstom** in rail, and we're in active discussions with **Toyota** and **Stellantis**. DUCO reported a 7.5% improvement in test effectiveness – achieved in just three consecutive trials.

DEMO 07

Robot aided scaffold assembly

This demonstrator highlights Flanders Make's expertise in **complex automation**, combining robotics, computer vision, force sensing, and digital twins in one integrated system.

We've developed a **mobile robot for automated scaffold assembly** that brings safety, efficiency, and flexibility to construction sites. The system features a modular robot platform with two robotic arms on an omnidirectional platform, allowing precise movement in tight scaffold spaces.

Using **digital twin simulations**, the robot learns to operate safely in constantly changing environments. On-site, a central **Orchestrator** coordinates the robots, vertical material lifts, and human workers — who receive clear, step-by-step instructions through a mobile app.

Advanced sensors, including time-of-flight and depth cameras, enable the robot to perceive its surroundings, identify scaffold parts, and assemble them accurately with vision and force control.

By taking over the most dangerous and physically demanding tasks, this robotic system makes construction work **safer, more efficient, and more sustainable**.

DEMO 08

Vegetable Defect Detection without Manual Annotation

This demonstrator showcases an **end-to-end AI training pipeline** that removes the need for large amounts of manually labeled data — a major bottleneck in developing industrial AI applications.

Our solution combines two key technologies:
First, an **image-to-mesh algorithm** that reconstructs a 3D model of an object from a single image.
Second, a **generative AI model** that transforms synthetic renders of this model into highly realistic images.

Together, they enable the **automatic creation of large, perfectly labeled datasets** featuring varied lighting, textures, and defect types — all without manual annotation. The same generative AI also supports **inpainting**, adding realistic defects such as cracks or bruises to clean images.

In this demonstrator, we apply the approach to quality inspection in the food industry — separating stones from potatoes and detecting cracks in carrots — but the technology is fully adaptable to any sector where **realistic, labeled data is limited**.

DEMO 09

Process quality tracking and correction using machine vision and a digital twin illustrated on a winding machine

In many manufacturing processes — such as laser cutting or CNC machining — product quality depends on how precisely the machine executes its motion profile on the material. Yet real systems face unavoidable challenges: nonlinear friction, backlash, flexibility, and other unwanted dynamics that can compromise performance.

At Flanders Make, we address these issues with an **augmented digital twin** that combines **physics-based simulation, machine vision, and AI**. Starting from a co-simulation of the machine's CAD model, we integrate models of its dynamic behaviour and visualize everything in a **game engine**, creating an intuitive, real-time view of the process.

Machine vision evaluates the product using **quality descriptors** that measure how accurately the process is performed. AI then links motion data to product quality, enabling prediction and correction.

The result: a **self-optimizing manufacturing system** that continuously learns, adapts, and ensures consistent process quality.

DEMO 10

Multiple hypothesis tracking for robot navigation

In large, repetitive environments such as warehouses, orchards, or greenhouses, it can be difficult for autonomous robots to determine exactly where they are — especially after a restart or power loss. Our team has developed an **algorithm that enables reliable localization** without the need for external markers or GPS.

Starting from a **semantic map** of the environment, the robot identifies elements such as walls, racks, and doors using onboard sensors. Based on these observations, it generates several possible location hypotheses. As it moves, it continuously refines these by comparing what it sees with the map, gradually eliminating incorrect options until its true position is known.

In short, our approach enables **accurate robot positioning** without the need for additional **global positioning systems**.

DEMO 11

Digital Twin for End-to-End Demand Forecasting in Complex Supply Chains

Every company faces challenges with **demand volatility** and limited **visibility beyond tier-one suppliers**. Disruptions elsewhere in the supply chain often go unnoticed until it's too late. Sharing information could help — but exchanging strategic data such as demand and inventories raises confidentiality concerns that hinder collaboration.

This demonstrator presents a **digital twin of multi-tier manufacturing supply chains** that provides a **secure, structural forecast of true demand** across all tiers. Using **system dynamics**, it models how demand evolves through the network, while **multi-**

party computation ensures that data from each partner remains confidential and cannot be reverse-engineered.

The result is a safe and collaborative forecasting tool that helps companies **understand demand evolution**, **test macro-scenarios**, and **complement traditional statistical forecasts** — all without revealing sensitive information.

In short, it enables smarter, more transparent, and more resilient supply chain management.

DEMO 12

Make RCA faster by combining pFMEA's expert knowledge with data collected from the factory floor

PFMEA — or Process Failure Mode and Effects Analysis — is a systematic method used to identify, evaluate, and prevent potential failures in manufacturing processes. At Flanders Make, we've developed a **data-supported extension** of PFMEA that brings objectivity and cost-effectiveness to quality risk management.

Our solution combines existing PFMEA documentation with quality control and production data through hierarchical modeling. As new data becomes available, the system automatically updates risk assessments, prioritizes failure modes and causes, and reveals the trade-offs between mitigation cost and impact.

In essence, it transforms a static PFMEA into a **living, data-driven system** — one that evolves with every new data point. This enables more informed, evidence-based decisions during corrective and preventive action meetings, helping manufacturers move from intuition-driven discussions to continuous, data-backed improvement.

DEMO 13

Hybrid bearing load and condition monitoring using optical fibers

This demonstrator presents an innovative approach to **monitoring bearing loads and lifetime** using just a **single optical fiber**.

Unlike conventional methods that rely on strain gauges or accelerometers mounted on the drivetrain housing, our solution places one fiber — with multiple sensing points — **directly on the bearing surface**, on both the stationary and rotating parts.

These optical signals, fully **immune to electromagnetic interference**, capture detailed strain information across the bearing. Advanced algorithms then process the data to **estimate loads**, **detect early signs of damage**, and **predict the remaining useful lifetime** of the component.

The result is a compact, robust, and highly sensitive sensing solution that provides valuable insights for **prototype development**, **condition monitoring**, and **predictive maintenance** — paving the way for smarter, more reliable rotating machinery.

DEMO 14

Advancing Gearbox Reliability: Vision-Assisted Condition Monitoring

Continuous gearbox monitoring is vital to **prevent unexpected failures** and costly downtime. Traditional vibration-based methods often fall short — they can detect anomalies but rarely capture the **detailed, quantitative characteristics of gear degradation**.

This demonstrator presents a **hybrid gearbox monitoring solution** that combines the strengths of **vision-based** and **vibration-based** approaches.

The **vision system** directly measures gear surface degradation, continuously tracking defect evolution and extracting quantitative data. Meanwhile, **advanced signal processing and AI** enhance vibration analysis to detect faults earlier, pinpoint their location, and estimate defect size.

Together, these methods provide a **comprehensive diagnostic tool**: the vision data establishes a quantitative ground truth for prototype testing, while improved vibration indicators enable faster, more targeted maintenance.

The result is **smarter, data-driven gearbox monitoring** — enabling earlier detection, deeper insight, and greater reliability in industrial applications.

DEMO 15

Resonant testing for product control

Quality inspection in high-volume production is often slow, expensive, and difficult to scale — often leading to lower quality products or higher scrap rates. At Flanders Make, we're rethinking this process with an **AI-driven, vibration-based quality control system** that enables fast and fully automated inspection.

In this demonstrator, a part is simply placed on a custom jig. The system captures a **unique vibration fingerprint**, links it to a **digital twin**, and uses **artificial intelligence** to instantly detect defects such as cracks, voids, or creep — across metals, ceramics, and polymers alike.

Within seconds, it provides a clear pass-or-fail decision, enabling **100% inspection rates** even in demanding production environments. By also integrating contextual data like temperature and humidity, the system supports **long-term process monitoring** and continuous improvement.

The result: a **fast, reliable, and cost-effective** approach to quality control — built for the factories of the future.

DEMO 16

Assessment tool for bearing current mitigation strategies

High-frequency components from the inverter are coupled onto the motor shaft, creating a voltage across the bearings. When this voltage becomes too high, it discharges through the lubricant — generating damaging electrical currents known as EDM currents.

Over time, these discharges can lead to increased maintenance needs… or even premature bearing failure.

At Flanders Make, we developed a **predictive model** that estimates the voltage across motor bearings caused by the inverter.

This system-level model takes into account all components of the drivetrain. It's built from high-frequency models of each element, derived from precise impedance measurements.

Within the model, we can test various **mitigation techniques** — both hardware and software-based — to identify the most effective solutions to reduce bearing voltage. And all of this can be done virtually, without costly experimental trial and error.

In short, our **assessment tool** helps engineers evaluate bearing voltages for a specific drivetrain setup and explore effective strategies to protect motor bearings — ensuring higher reliability and longer lifetime for electric drivetrains.

DEMO 17

Novel concept for electrical excitation of the rotor in a synchronous machine

This demonstrator showcases a new generation of electric motors developed at Flanders Make. Traditional high-performance motors rely on rare-earth magnets—costly components that also pose geopolitical risk, as highlighted by recent Chinese export restrictions.

Magnet-free solutions are already appearing in electric vehicles from Renault, Nissan, and BMW. Many of these designs, however, still require brushes and slip rings to feed power to the rotor's electromagnets—parts that introduce friction, wear, and maintenance. In wind energy, for example, these brushes often need replacement every six to twelve months.

Our alternative removes that weakness. The rotor's electromagnets are powered via **inductive wireless power transfer**, so no physical contacts are needed. And unlike other brushless approaches, our machine integrates the excitation function inside the original motor without increasing its size.

The result is **compact, robust, and cost-effective operation**, with smooth performance and far less downtime. In short: magnet-free, brushless, and built for reliable, scalable electrification. The same technology also offers huge potential for wind turbines, industrial machinery, and agricultural applications — wherever reliability and efficiency matter most.

DEMO 18

Energy Management System (EMS) for Hybrid Energy Storage Systems (HESS)

This demonstrator showcases a **hybrid battery system and sizing tool** that combine high-energy and high-power cells to deliver both **continuous energy** and **rapid bursts of power** — a balance that traditional single-chemistry batteries struggle to achieve.

The hybrid pack unites **NMC cells**, known for high energy density, with **LTO cells**, valued for their power capability. Together, they handle demanding load profiles efficiently, without oversizing the battery or increasing cost and weight.

Our **battery sizing tool** starts from a load profile or powertrain model and optimizes the design for cost, volume, or weight — helping determine whether a hybrid configuration is the best fit for your application.

Beyond sizing, our **energy management system** actively controls cooling and operating strategies to maximize performance and lifetime, using techniques such as **immersion cooling** and **validated system models**.

The result: **better performance at lower cost, weight, and volume — combining energy and power in one intelligent solution.**

DEMO 19

Digital Twin of a continuous manufacturing process to support decision making and energy usage optimisation

This demonstrator presents a **validated workflow** for building and deploying digital twins in continuous manufacturing processes — environments where operators must carefully select the right process settings to balance quality, productivity, and efficiency.

The workflow is illustrated using a **medium-density fiberboard (MDF)** production use case. By combining **data-driven models** with **physical insights**, the digital twin predicts key performance indicators such as product quality and energy consumption based on process parameters.

Operators can simulate different scenarios before applying changes in the real plant, allowing them to identify the **optimal process settings** that maximize overall equipment effectiveness while reducing waste and downtime.

The workflow can also be integrated into **optimisation routines**, automatically finding the best balance between energy use, quality, and throughput.

In short, this digital twin brings **data, physics, and operations together** — empowering smarter, more sustainable manufacturing decisions.

DEMO 21

Smart Electromagnetic Gripper for Flexible Metal Sheet Handling

Manipulating sheet metal plates is a common but challenging task across many industries — from automotive manufacturing to bending, punching, and pressing operations. Picking exactly one sheet from an unstructured bin is especially difficult.

Traditional magnetic grippers can't tell if they've lifted more than one plate, and often rely on costly vision systems for guidance. Suction-based grippers, on the other hand, struggle with greasy, perforated, or uneven surfaces.

Our solution, **SMARTGrip**, is an automated and sensorised electromagnetic gripper designed for precision without the need for vision systems. With integrated sensors and intelligent control, SMARTGrip automatically adjusts its magnetic force to match the sheet's thickness and geometry — even when handling plates thinner than one millimetre.

It performs reliably on oily or contaminated materials and can pick exactly one or multiple sheets on demand. The result: **faster, safer, and more flexible material handling** in even the toughest industrial environments.

DEMO 22

Robotic inspection of highly reflective painted surfaces using deflectometry

Inspecting glossy, painted surfaces is a notorious challenge for vision-based systems. Reflections and glare often hide small scratches, dents, or other surface defects that the human eye — and standard cameras — struggle to detect.

This demonstrator presents an **innovative solution** developed at Flanders Make: a combination of a **custom deflectometry sensor** and an **AI-based analysis model** that makes the invisible visible.

The sensor projects a precise grid of light onto the surface and captures its reflection. The reflected pattern is distorted by even the smallest irregularities. These distortions are then analysed by the AI model to accurately identify and characterize defects — including their size and severity.

Integrated with a robotic system, this technology enables **fully automated inspection** of complex glossy objects, such as car bumpers, delivering fast, objective, and repeatable results — and setting a new standard for surface quality control.