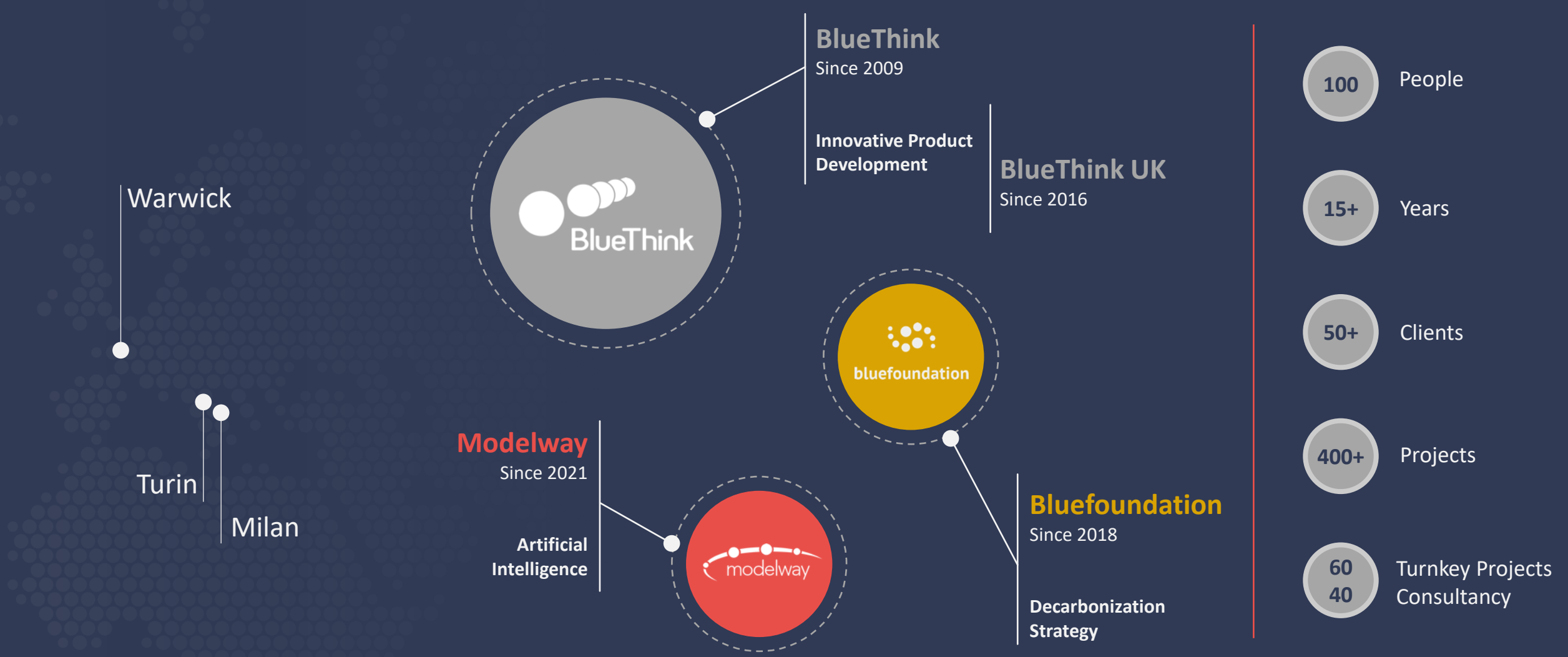
Integrating **AI, Controls** and **Engineering**

We are a team of engineers and data scientists committed to help our clients to face the digitalization revolution

- RECIPIENT
- Company Overview
- Francesco Pennaroli
- 13/03/2025

The BlueThink Group



Modelway: a small company with a deep expertise

Who We Are

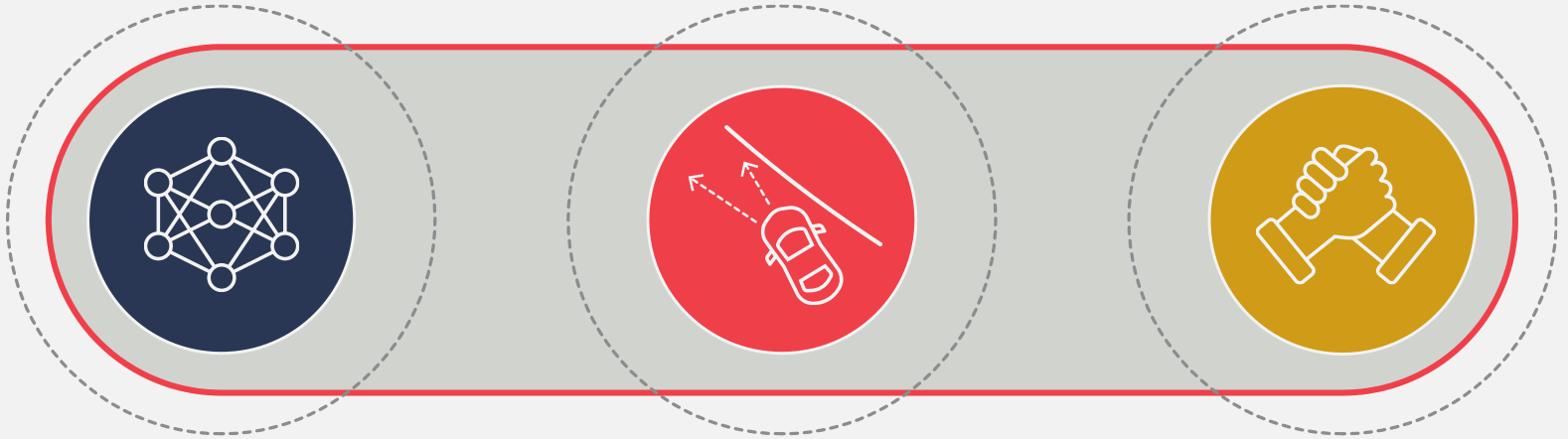
Founded as a spinoff of the Politecnico di Torino, Modelway invented a new algorithmic approach, which is now widespread in various industries. Today we are a fully private company, part of the BlueThink group. Our team is made up of highly skilled data scientists and control engineers, committed to building solutions for complex problems.

A unique expertise

With twenty years of experience in AI software solutions, Advanced Control, Optimization, Data Driven and Numerical Models working with OEM and TIER 1 Companies, we can guide you through the algorithmic landscape to identify the best solution for your needs, be it the integration of off-the-shelf libraries or the development of a brand-new algorithmic approach.

Network – Customers and partners

Three paths to innovation



AI, Controls and SW Development

Cutting-edge innovation from the ground up, for the maximum degree of customization.

Integrating Engineering

Fast and robust innovation via integration of tried and tested subsystems.

Consulting Competence Transfer

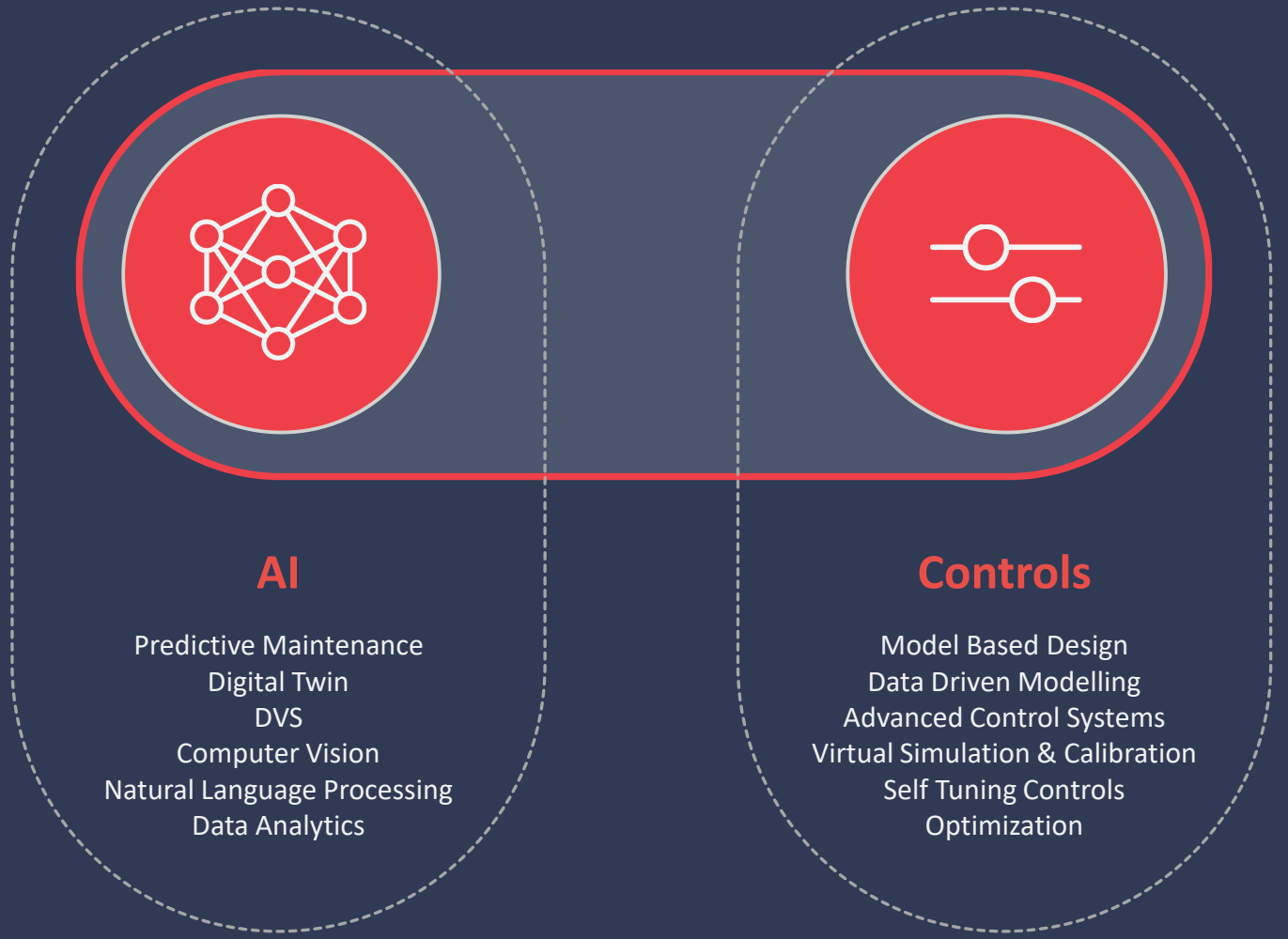
Inject our expertise into your team with our consulting services. Innovation, on your terms.

Patents

Patent TO2014A000631 related to the DVS™ application in vehicle dynamics. Granted in Italy, EU, Japan, China, USA.

Patent 102016000098423 related to the DVS™ application in power train. Granted in Italy, EU, China, USA.

Our Competences



AI

Predictive Maintenance
Digital Twin
DVS
Computer Vision
Natural Language Processing
Data Analytics

Controls

Model Based Design
Data Driven Modelling
Advanced Control Systems
Virtual Simulation & Calibration
Self Tuning Controls
Optimization

A systematic approach

Our proprietary R&D methodologies enable a systematic approach to complex and non-linear systems.

Your need: Obtaining more information using the sensors already installed.

Our solution: DVS™ Direct Virtual Sensing.

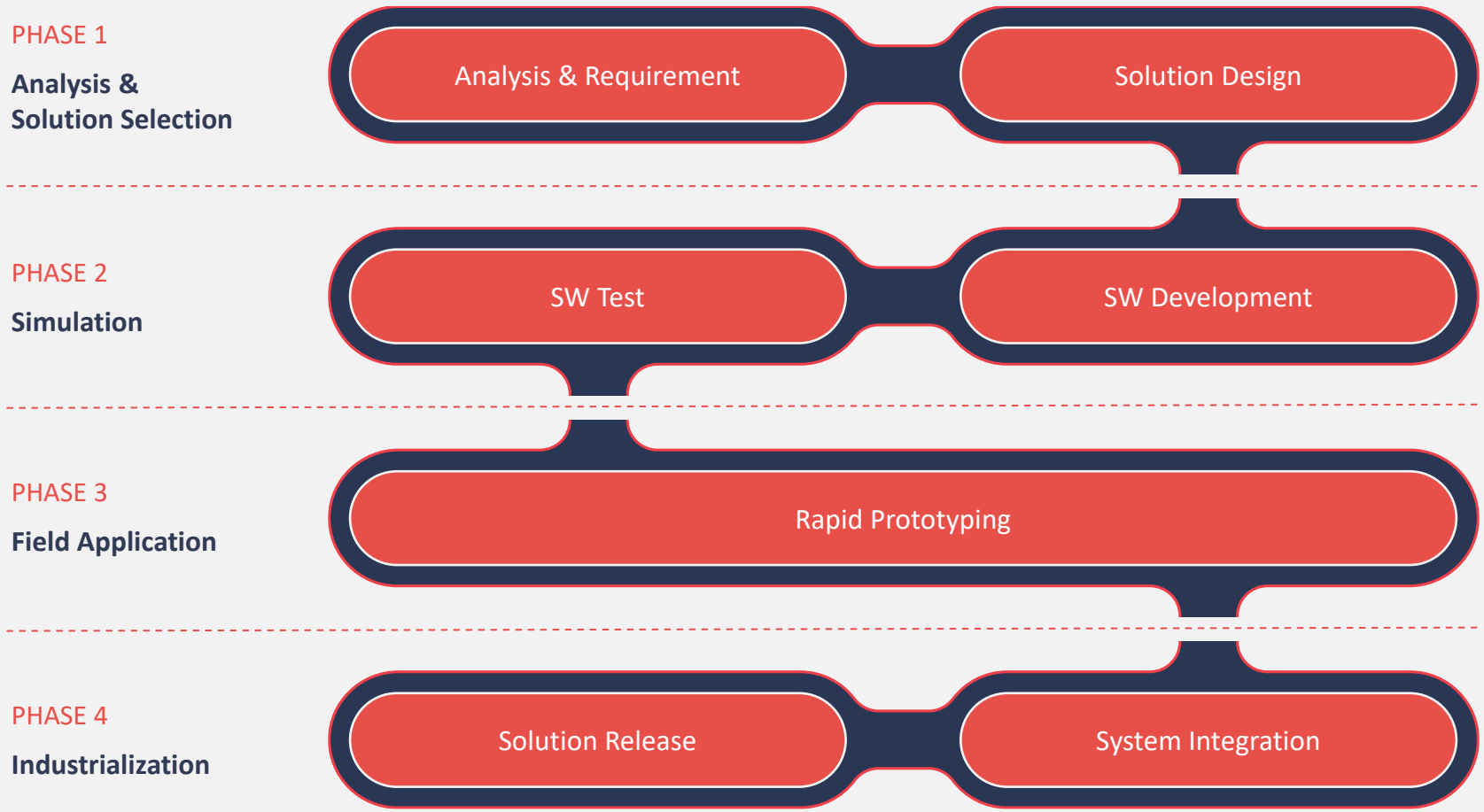
Your need: Controlling a complex system learning from past situations.

Our solution: STC™ Self-tuning Controls.

Your need: Rapidly adapting to unpredictable anomalies.

Our solution: NOSEM™ for hybrid modelling.

Levels of Intervention



Our Project Approach

We realise innovative solutions for Edge, Fog and Cloud Computing environments.

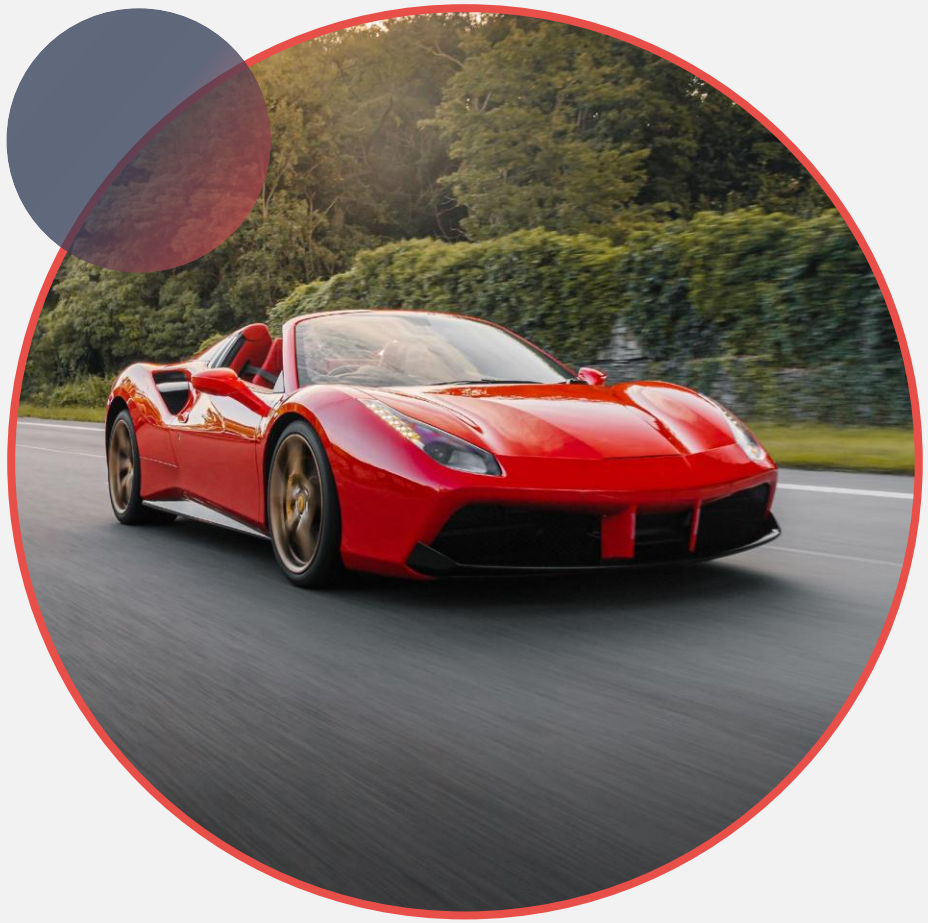
We can cover all project phases, from the scouting of the most suitable algorithm approach to the delivery of the solution in the customer's hardware. It is the customer who decides in which phase of the process we intervene.

Some of our success cases

Some of our success cases

Automotive

Sideslip Angle Estimation



Aim

Improving sports car performance.

Customer Needs

Real-Time Sideslip Angle (SA) estimation was not available on any production car at the time of execution of the project.

SA is a critical parameter for vehicle dynamics and its knowledge can dramatically improve a vehicle's performance and safety.

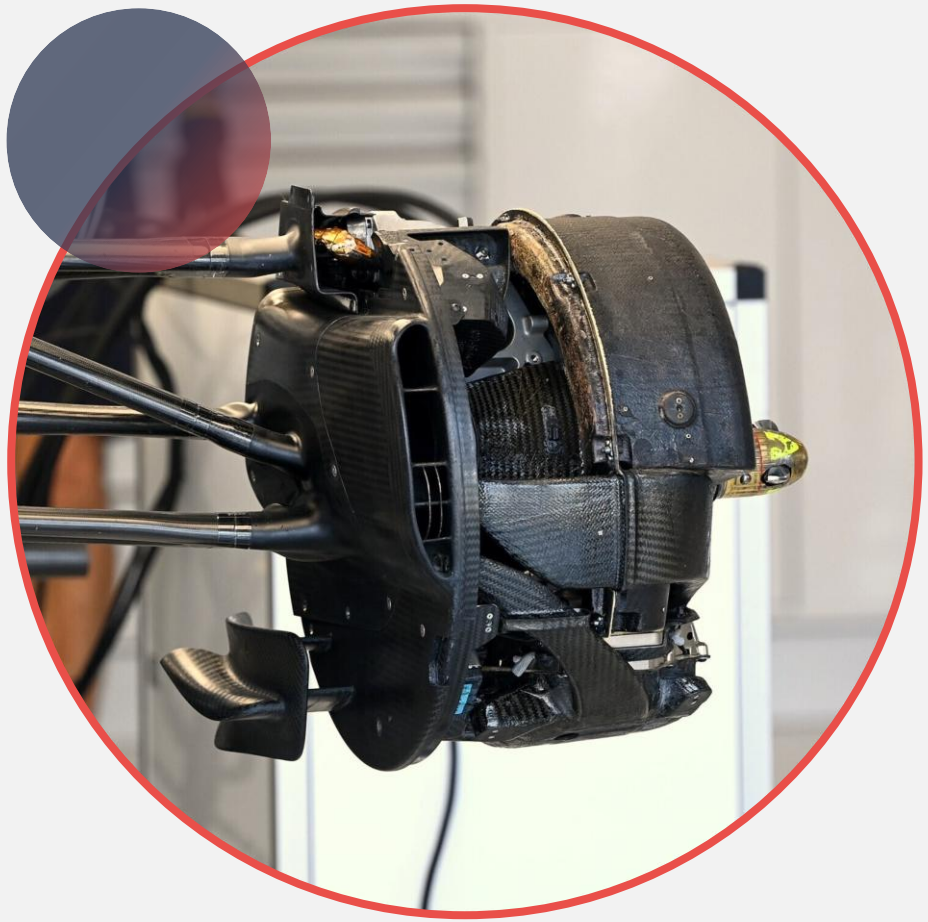
Solution and achievements

Patented data-driven DVS/SA provides an accurate real-time estimation of the Sideslip Angle.

DVS/SA has been implemented on five supercar models.

DVS/SA surpassed the performance of other estimation platforms, like OXTS.

Wheel Hub Forces Estimation



Aim

Improving car driveability and safety.

Customer Needs

The estimation of wheel-hub forces is fundamental for the vehicle's stability control system. Wheel hub is a highly non-linear system operating in high-noise conditions. Real-Time availability of accurate wheel-hub forces information were not assured.

Solution and achievements

DVS/WHF is a solution based on Modelway patented DVS technology, estimating the forces on each hub using ESC and powertrain data already available from on-board vehicle dynamics control unit. An estimation accuracy of 90% has been achieved.

Onboard Weighing

Aim

Truck compliance cost reduction.

Customer Needs

On-board truck weight estimation is yet mandatory in many countries (USA, Canada, EU).

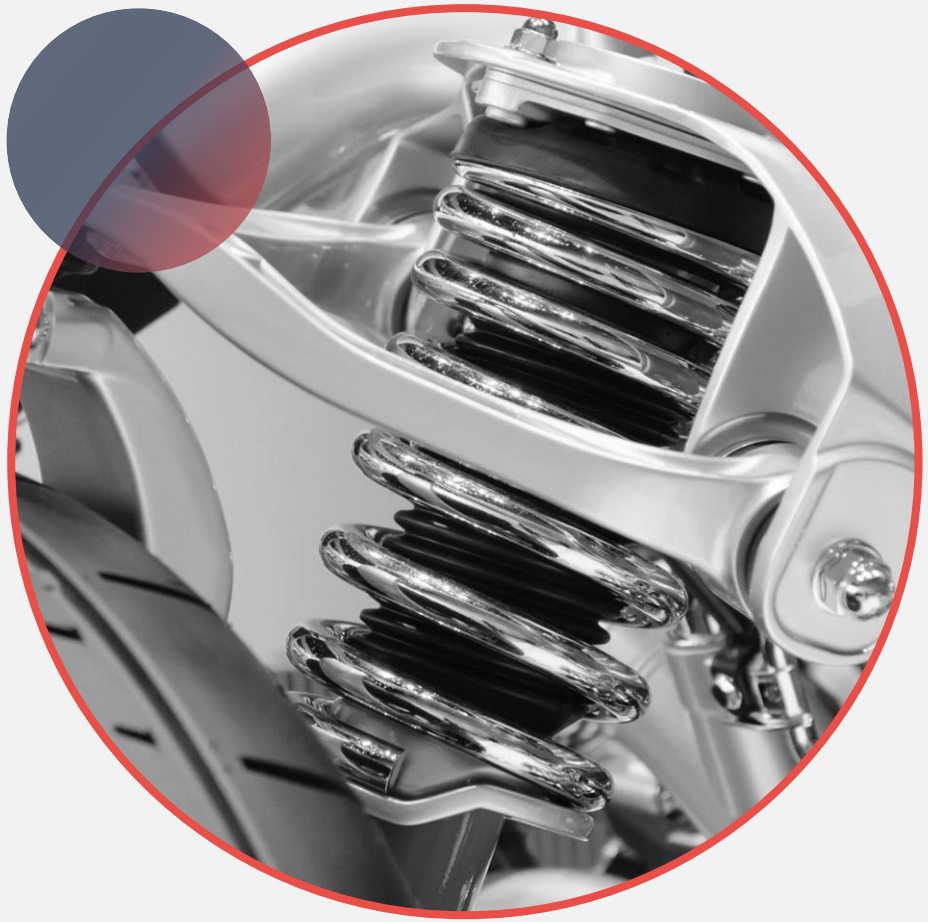
Current solutions are based on expensive hardware sensors requiring installation on the suspension systems of each truck axle (~ €800/€ 1.000 per axle).

Solution and achievements

DVS/OBW is a solution based on Modelway patented DVS technology, which estimates truck weight from data already available on on-board vehicle dynamics control unit.

DVS/OBW is a “dynamic OBW” equipment compliant with EU Directive 2015/719 without requiring to install any sensor on suspension systems.

Semi-Active Suspension Control



Aim

Significant attenuation of “large” chassis accelerations.

Customer Needs

Control for the vertical dynamic of a vehicle with semi-active suspensions.

The typical control strategies present limits in achievable performances.

Solution and achievements

AI NOSEM Nonlinear multivariable model* of vehicle semi-active suspensions .

The experimental data used for the model design are measured on a segment C car.

The measurements are obtained from the onboard accelerometers needed by the suspension control system.

Model building effort reduced vs. physical modelling.

Motorbike Roll Angle Estimation

Aim

Real-time Roll Angle Estimation for safety purpose

Customer Needs

Real-Time roll angle is critical to be measured on production motorbikes.

It is needed for a better management of vehicle dynamics.

Solution and achievements

Stability performances improvement in cornering control, traction control and lateral dynamics.

Robustness in race track vs. different drive styles.

The input data for estimation are the standard ESP acquisitions.

Autonomous Vehicle Lane Keeping

Aim

Lane-keeping system for lateral dynamics control by Electric Power Steering.

Customer Needs

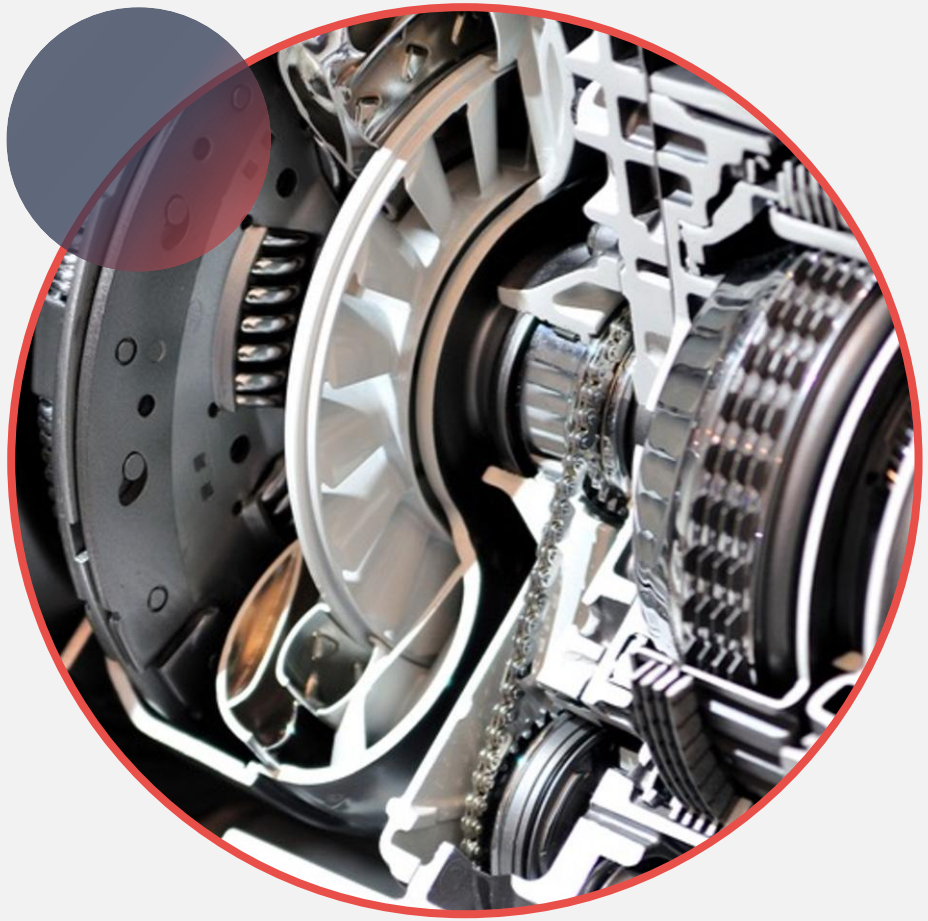
No switching strategy between human and autonomous is used.

Solution and achievements

When the driver makes a lane change, the lane keeping control is not switched-off, but its action is smoothly canceled.

When the driver releases the steering wheel, the lane keeping control tracks the car to the lane center.

On-Board Engine Torque Estimation



Aim

Improvement in vehicle driveability.

Customer Needs

An accurate engine out torque estimation is difficult to achieve with present approaches.

The automatic gearshift rating obtained with specific drivability tests is not satisfactory.

The torque estimation must be reliable for specific ECU safety tests.

Solution and achievements

DVS/ET: data-driven DVS technology to improve the engine torque estimation accuracy (and so the gearshift and safety ratings) with respect to present approaches.

DVS/ET estimates engine torque using data available on the on-board ECU's.

Battery State-of-Health (SOH) State of Charge (SOC)

Aim

Improving electric cars performance and range.

Customer Needs

There are no SOC and SOH sensors available on the market.

Look up table and current solutions are inaccurate over large operative conditions, due to difficulty in modelling system non linearities.

Solution and achievements

Direct Virtual Sensor exploits hybrid modeling approach.

Merging data driven and physical model-based technology, allows to better model system complexities over extended operative condition.

The prediction is guided by physics and accuracy improved by data driven approach, for higher performance and robustness in estimation.

Gearbox Position Estimation

Aim

Data Driven Position Estimation and Fault Detection .

Customer Needs

The GB device is an electric motor responsible for shifting between two operating conditions the electric powertrain.

The rotor position during the shifting maneuver is a critical variable for the system.

Evaluate the possibility of closing the control loop by replacing the proximity sensors installed on the device with a virtual sensor (DVS).

Solution and achievements

The GB motor actuation current signals can be acquired on the device in real time.

The DVS/position estimates the occurrence of anomalies as well as the rotor position from the actuation current signals.

Engine Temperature Estimation

Aim

Cooling system optimal dimensioning.

Customer Needs

MultiAir actuator oil temperature estimation from ECU measures.

Redundancy of mission critical physical sensor.

Solution and achievements

DVS input variables: engine rpm, cooling water temperature .

Accuracy robustness for the whole range of pressure (1 to 200 bar) and temperature (-20 to 120 °C) .

DVS is available to be embedded on-board the vehicle .

Clean Street Index

Aim

Evaluation of an index to quantify street cleanliness.

Customer Needs

Detecting the variation in the presence of waste on the road surface and its extent.

Implementation and standardization of the clean street index on different road surfaces.

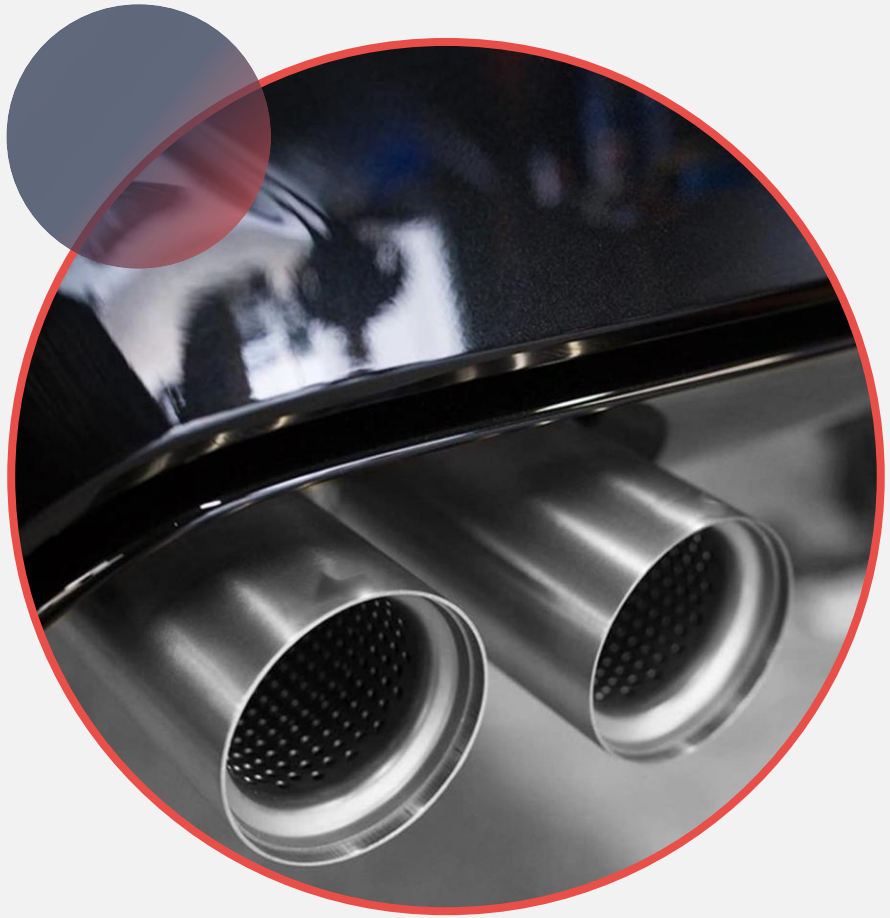
Adjustment of vacuum actuators based on estimated cleaning performance.

Solution and achievements

Application based on AI computer vision technology, object detection and sequential change detection.

Street cleaning index implementation and performance measurement of sweepers.

NOx/CO2/Soot Emission Estimation



Aim

Physical sensor replacement, redundancy and diagnosis.

Customer Needs

Estimate vehicle emissions while saving physical sensor cost.

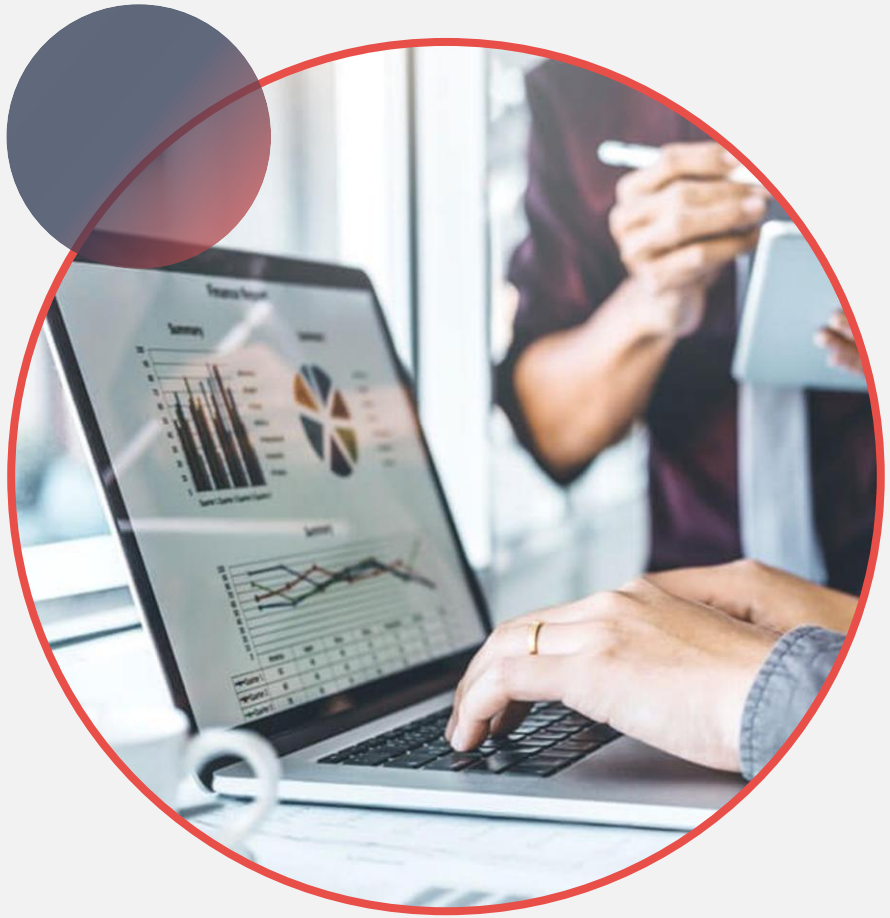
Diagnosis of malfunctions and anomaly.

Solution and achievements

Direct Virtual Sensing technology to estimate chemical emission exploiting available real time data from combustion and driving conditions.

Solution applicable to biomass, biogas and fossil fuel production plants.

A.R.C.A. | Automated Root Cause Analysis



Aim

Supporting operators in Root Cause Analysis.

Customer Needs

On-line analysis of a complex system such as an automotive engine.

Failures are usually identified too late because fleet analytics require to identify different groups of comparable situations depending on:

- Environmental conditions
- Driver styles and habits

Solution and achievements

Smart visualization of complex system status and aging;

Early identification of ongoing issues or potential failures;

Automatic analysis of all variables that includes a specific anomaly and the root cause analysis.

Battery Thermal Runaway Prediction

Aim

Avoiding sudden battery thermal runaway.

Customer Needs

Lithium-Ion batteries can suddenly burn or explode with great risk for passengers, vehicles and infrastructures. Predicting the onset of thermal runaway would allow to schedule replacement interventions and avoid damages.

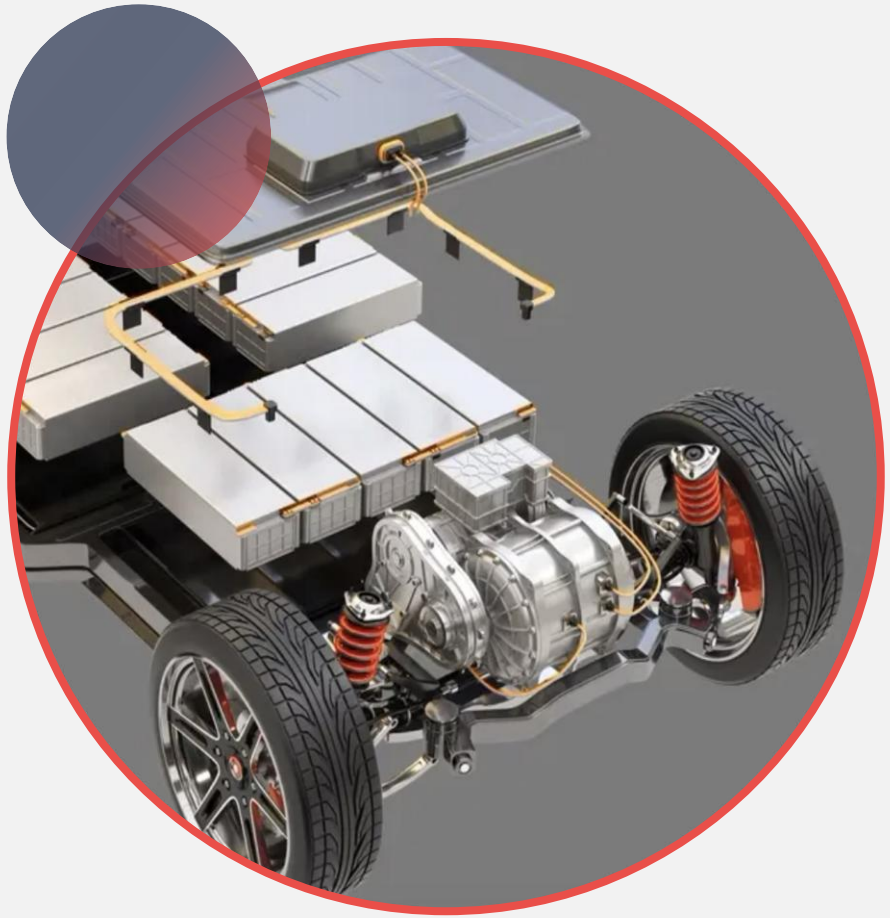
Solution and achievements

Direct Virtual Sensor exploits hybrid modeling approach.

Merging data driven and physical model-based technology allows to model system complexities effectively over extended operative conditions.

The prediction of thermal runaway onset and root causes allows owners and operators to schedule maintenance, avoid damages to people and infrastructures and ensure the vehicle’s reliability.

Electrical Motor/Actuator Predictive Maintenance



Aim

Monitor the State Of Health in terms of anomaly detection, condition monitoring and remaining useful life, predicting anomalies and failures and scheduling decision-making actions.

Customer Needs

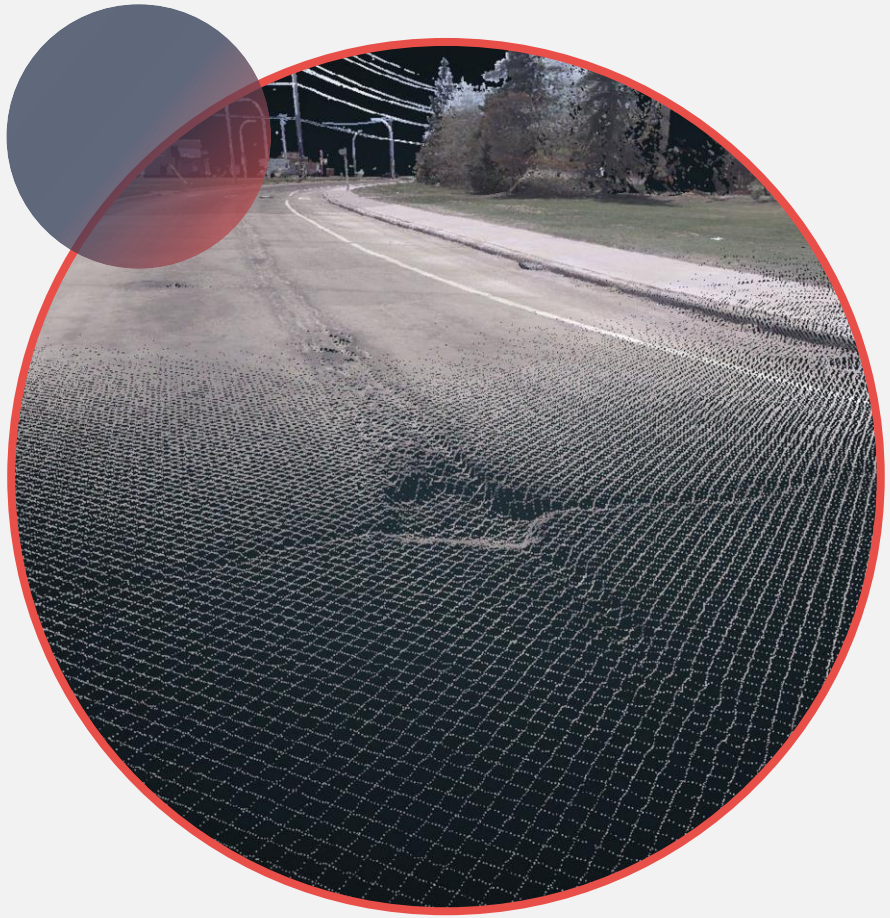
Reduce production line stopping or product functionality for DC/AC motors and PMSM.

Solution and achievements

Direct Virtual Sensor exploits hybrid modeling approach.

Merging data driven and physical model-based technology, allows to better detect SOH of electric (i.e. windings) and mechanical systems (i.e. bearing) exploiting data such as Current, Voltage, Power, Torque, Vibration, Temperature,… and implement decision making actions.

Road Type and Conditions Detection



Aim

Recognizing the road type (asphalt, gravel, etc..) or maintenance state is useful for vehicle dynamics management and to monitor road conditions.

Customer Needs

Manage vehicle dynamics (suspension, braking, throttle) basing on an automatic recognition of the kind of road without using cameras

Solution and achievements

Direct Virtual Sensor Modelway DVSR is based on a machine learning algorithm that uses data from the vehicle dynamics platform to recognise the type of road the car is driving on.

Some of our success cases

Home Appliances

Induction Hob Water Temperature Estimation

Aim

Water boiling point estimation for induction hob.

Customer Needs

Temperature estimation and boiling point reaching is crucial for automated cooking and power management of induction hob.

Solution and achievements

An estimation algorithm has been delivered to implement water boiling point.

Some of our success cases

Marine

Energy management System

Aim

Development of an energy management system for hybrid propulsion ships

Customer Needs

The ship must be operated with the most suitable energy source according to the situation.

Solution and achievements

Modelway is developing a modular solution to meet the project need allowing the integration of new and different project sources when needed.

The system is provided with an AI Module to automatically improve performances thanks to machine learning.

GPS-denied navigation for UxVs

Aim

Increase the capabilities of uncrewed vehicles to perform long range and long duration missions for maintenance, reconnaissance and defence purposes even in the absence of GNSS signal.

Customer Needs

Mitigate the drift suffered by current state-of-the-art Inertial Navigation Systems in the absence of reliable GNSS data.

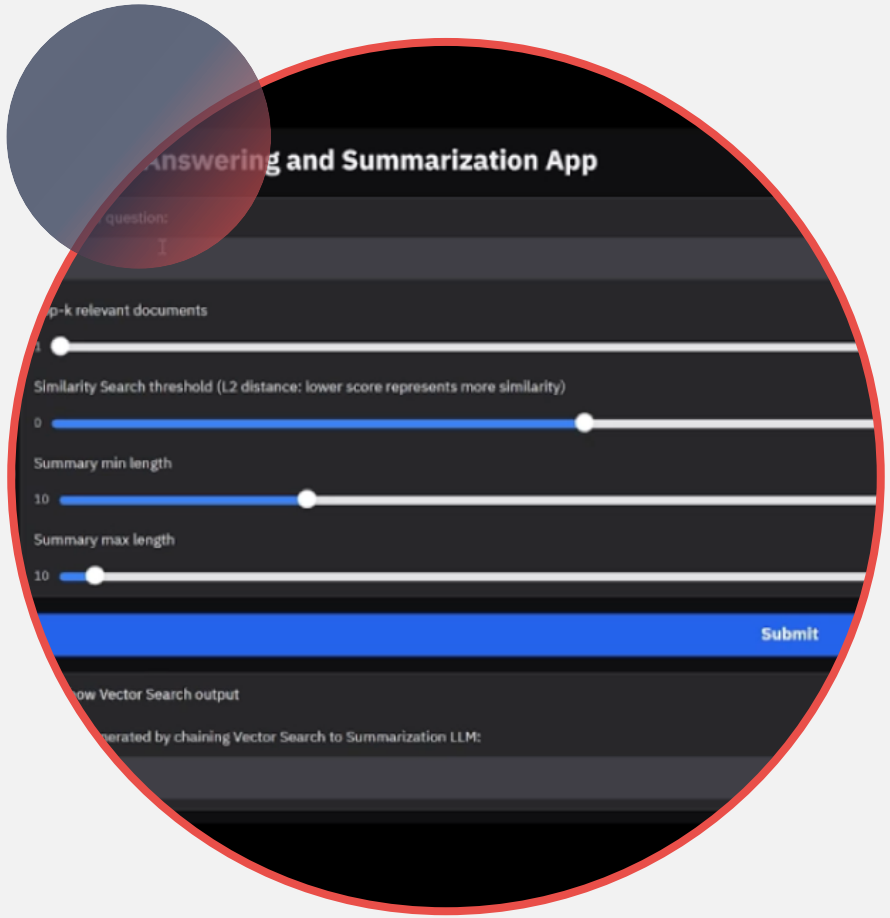
Solution and achievements

The desired navigation accuracy was obtained by adopting an innovative hybrid approach that combines a lightweight physical model with an AI-based data fusion layer.

Some of our success cases

Industry 4.0

Information Retrieval Tool



Aim

Support employees in analyzing and managing large volumes of knowledge and business data.

Customer Needs

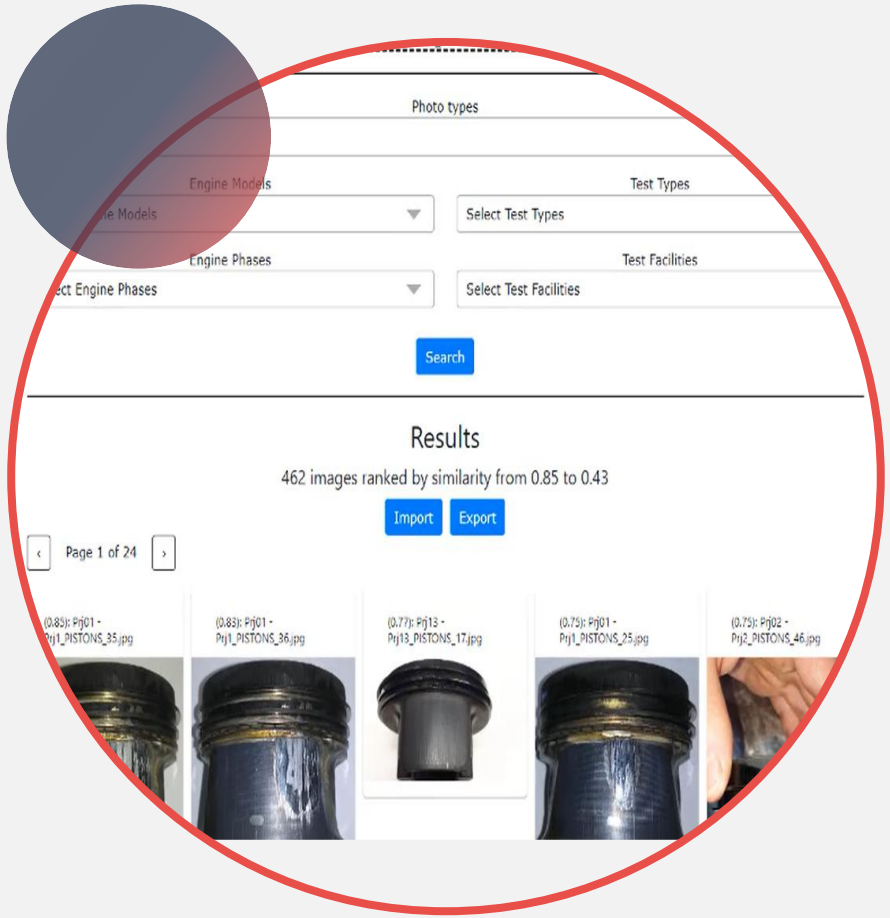
Consider many company documents such as papers, reports, presentations on which is necessary to extract strategic information thought summarization, statistic and trend allowing user interaction with questions and asks.

Solution and achievements

A user-friendly platform equipped with Graphical User Interface allows to extract strategic information in a wide set of documents exploiting customized AI algorithm. The solution:

- Doesn’t expose the company documents to the net, protecting the data
- Reduced answer time to perform the required analysis
- Fast algorithm update on custom documentations to avoid errors and hallucinations

Engineering Knowledge Management Tool



Aim

Supporting operators to archive and similarity data extraction based on text and images.

Customer Needs

Data must be collected and stored in the Knowledge Management Tool, where:

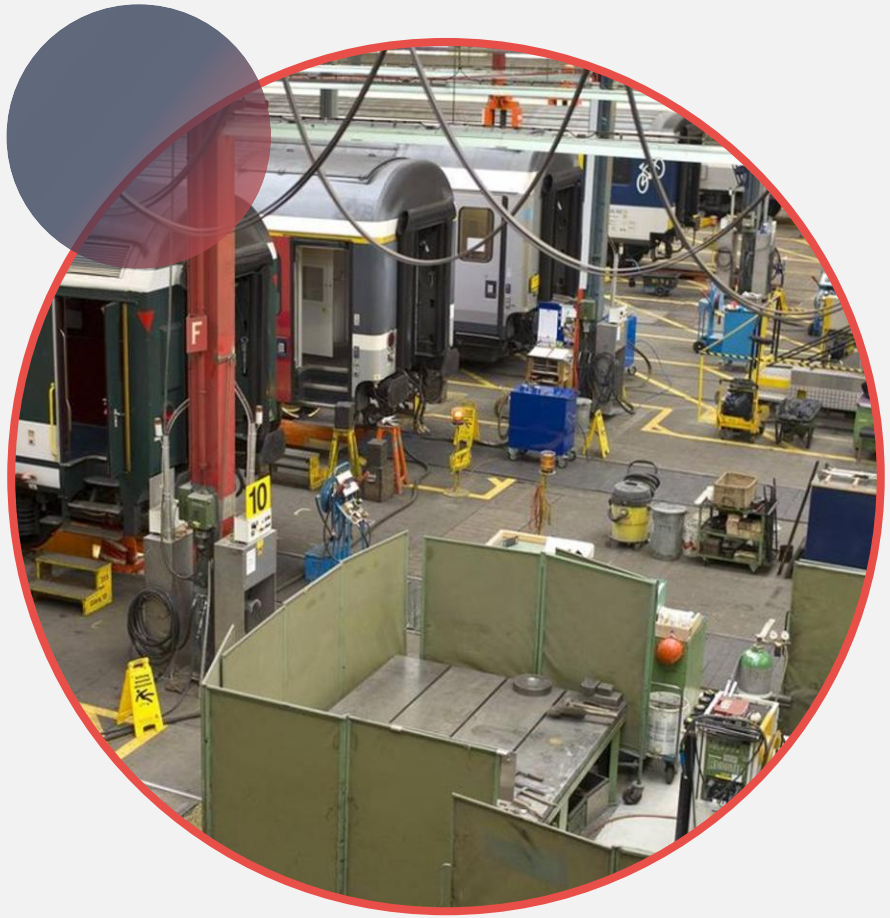
- It is possible to catalog, categorize and store data by similarity in manual way by user to create a dataset
- It is possible to load an image or text related to a fault and launch a search to retrieve all similar cases and related fault category / root cause

Solution and achievements

A user-friendly platform equipped with Graphical User Interface allows to extract texts or images similar to the search topic select. Selected documents are summarized and synthetized automatically on a report. The user can analyze similar path or event to the current one.

As new data arrives, it is possible to refine and update the deep learning algorithm to improve the performances.

Railway Predictive Maintenance



Aim

Predictive maintenance of train cars.

Customer Needs

Maintenance processes are under pressure to optimize intervention time and costs.

Notable amount of data are typically available but are not translated in useful information for decision-making.

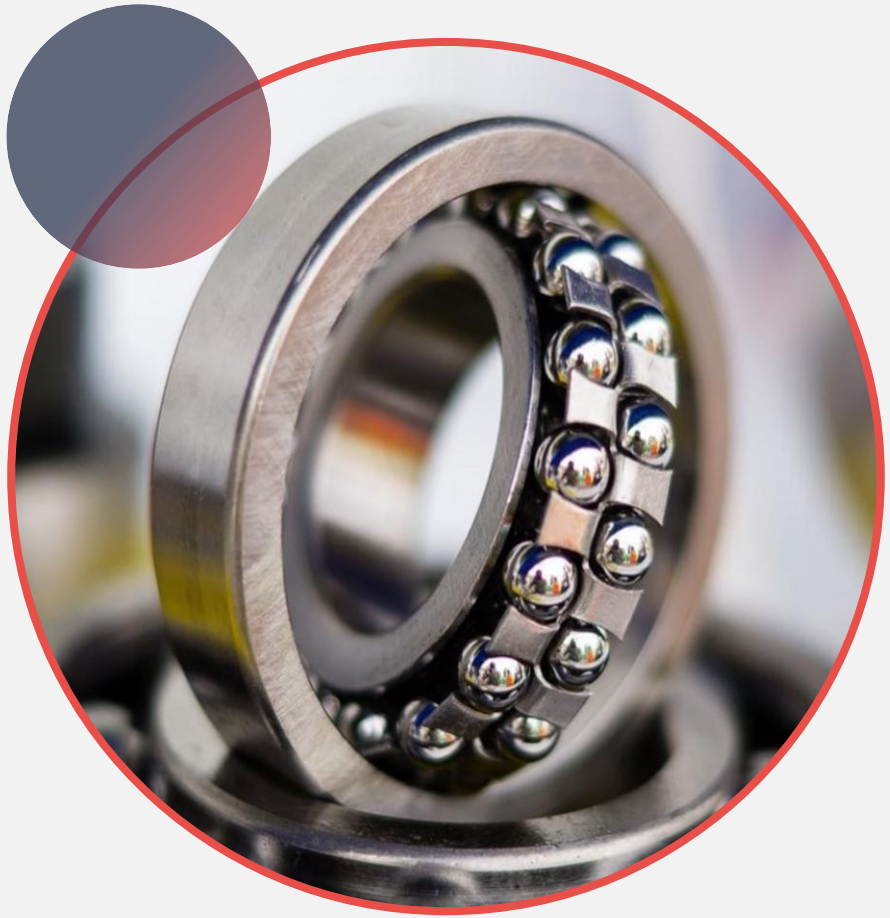
Anomalies impact customer experience and company's reputation.

Solution and achievements

Predictive maintenance tool based on virtual sensing for anomaly detection allowing optimization of operations and reduction of costs of interventions.

Realization of dashboard to monitor the effective maintenance of critical items.

Bearing Condition Monitoring



Aim

Predictive maintenance of automotive bearings.

Customer Needs

Bearings industry is facing the digital transition challenge.

The product can incorporate service content, integrating early detection of wear problems. Maintenance or replacement of the part can be scheduled before it can cause damage to the vehicle.

Solution and achievements

Patented data-driven DVS/CM provides an accurate real-time wear condition monitoring.

DVS/CM has been implemented on customer's lab car.

Mechanical Press Predictive Maintenance

Aim

Detection of components decay from real-time data.

Customer Needs

Degradation of some components can damage the mechanical press.

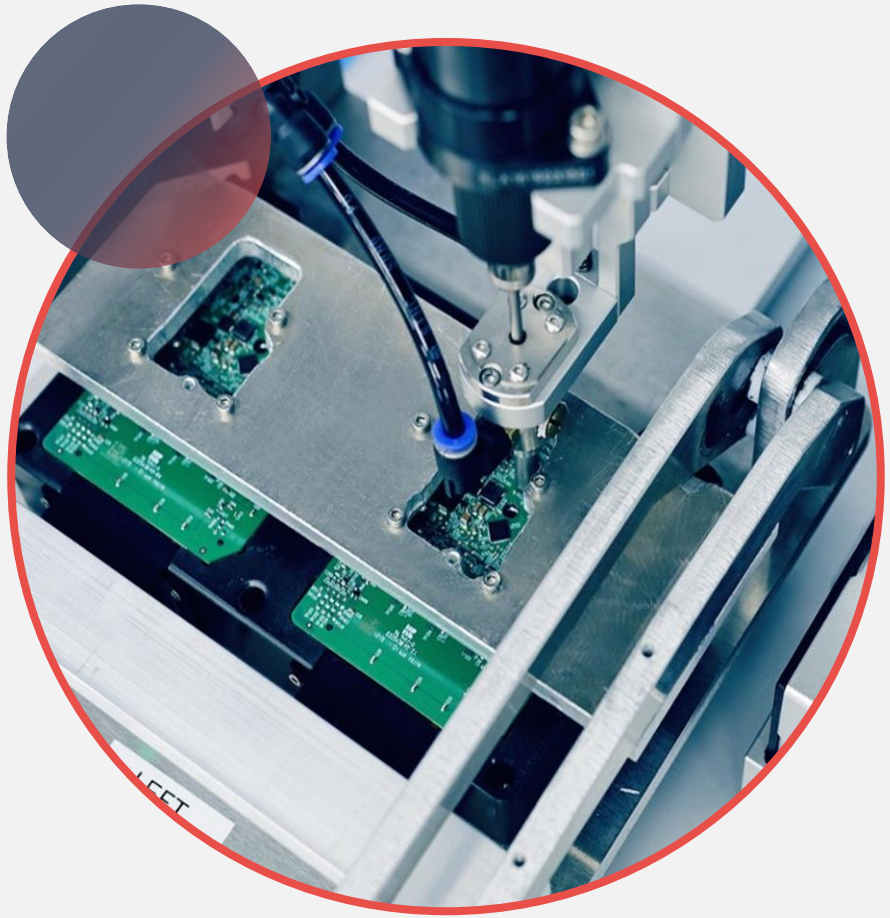
Wear of the press guides is a critical element for the breakdown of the mechanical fuses and therefore of the press itself.

Solution and achievements

Machinery wear status estimation through predictive maintenance algorithm.

Estimation algorithm uses as inputs data already available on the machinery.

Validation Of Working Line Operations (PFTC)



Aim

Improvement of pneumatic fastener certifications, using industry 4.0 smart integrated system.

Customer Needs

Automatic online production quality check; Untracked failure operations reduction and false negatives limitations.

Solution and achievements

Using AI solutions, the mechanical variable data of device during its activity, are analyzed, to certify the positive or negative outcome of the operation by dashboard.

Continuous online recalibration tools over incoming production data.

Wearable AI for Man Down Detection

Aim

Real-time safety of operators working in isolated or dangerous environments.

Customer Needs

The customer needed a Man Down Detection for three different activity profiles.

Solution and achievements

Modelway developed a smartwatch app for man down detection based on a machine learning algorithm detecting specific gestures for each worker profile (besides health parameters collected through smartwatch sensors).

The solution only needs a smartwatch and a smartphone, for quick and simple implementation, allowing OTA recalibration.

Air Quality Predictive Control

Aim

Industrial HVAC systems are complex to be modeled and controlled.

Customer Needs

System controls were tuned by the experience, but could be not optimal in the whole working range.

Solution and achievements

Modelway developed a data driven model, allowing predictive control performing real-time HVAC optimization, based on the actual working conditions.

As a benefit the optimization allowed energy savings higher than 20%.

Some of our success cases

Biomedical

Antibiotic Susceptibility Identification

Aim

Improving accuracy in antibiotic susceptibility evaluation.

Customer Needs

Quickly identify the resistant or susceptible character of bacteria to a certain antibiotic.

Management of large data arrays (Big Data).

High sensitivity algorithm.

Solution and achievements

Real time AI Classification algorithm for bacteria character based on nano-motion of fast and slow growing bacteria.

Intensive data mining and feature extraction through signal filtering and processing.

Fast tool adaptability and customization to bacteria and antibiotic variants.

Some of our success cases

Industry Digitalization

R.A.I.L. | Relax, Artificial Intelligence is Looking

Aim

Allowing predictive maintenance of cortical protections over railroad tracks.

Customer Needs

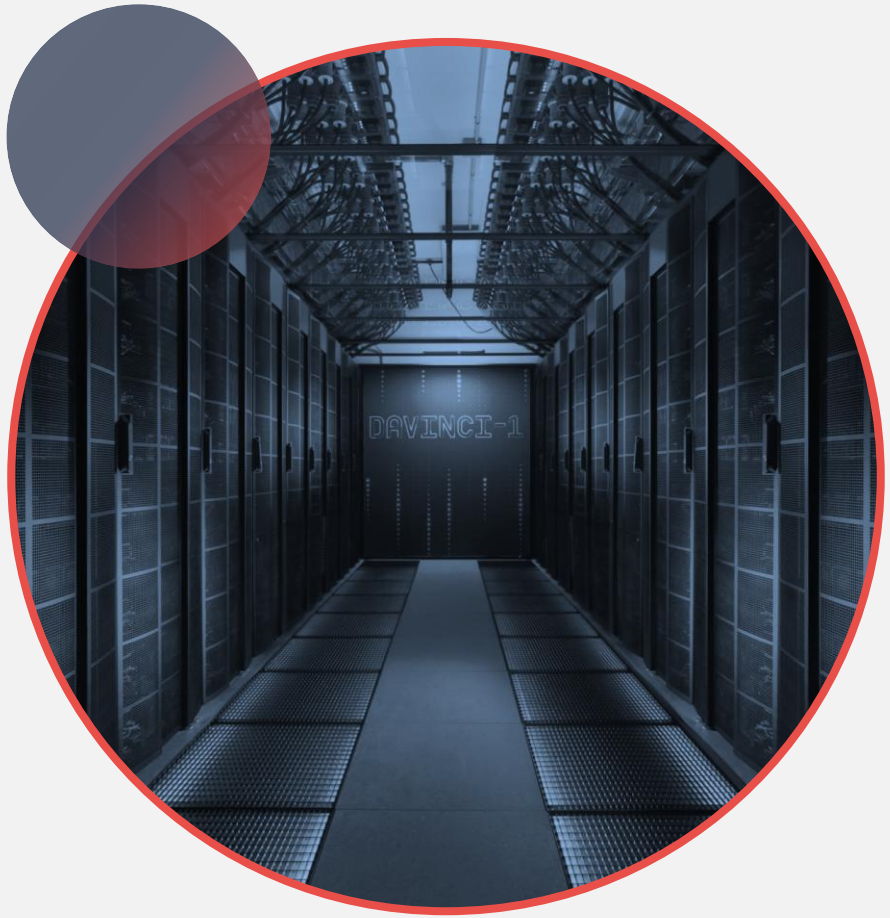
Maintenance of cortical protections is now done through unstructured visual inspection.

The possibility of developing an app that automates the process could allow interventions to be scheduled by priority.

Solution and achievements

A computer vision app has been developed that can recognize protection elements (nets, ropes, and nails) and detect their alterations over time.

HPC | Energy Consumption Optimization



Aim

Reduction of sustainability impact.

Customer Needs

Implement a model capable of predicting HPC power consumption by having available data on CPU and GPU temperatures and their loads.

Green coding: include correlation between codes executed on HPC and energy consumption in the model.

Development and implementation of a shutdown optimization policy of the idle nodes, depending on the extent of the code to be executed.

Solution and achievements

Development of a A.I. based model for consumption prediction by considering the extent of the code executed as well.

Evaluation of the performance of the model on test data.

Electric Load Forecasting

Aim

Optimizing exposure to risk.

Customer Needs

Production and consumption of electricity need to be perfectly matched at any time. Overcommitment of stand-by resources is expensive, while undercommitment leads to excessive exposure to blackouts and grid collapse.

Solution and achievements

Our NOSEM-based solution exploited the client's vast database of electric load time series, merging it with key physical and engineering insights of high-voltage power transmission lines.

Our NOSEM-based solution provides an optimal day-ahead forecast of electric loads, together with tight uncertainty bounds.

Oil Production Optimization

Aim

Maximizing the Net Present Value of an oilfield’s production.

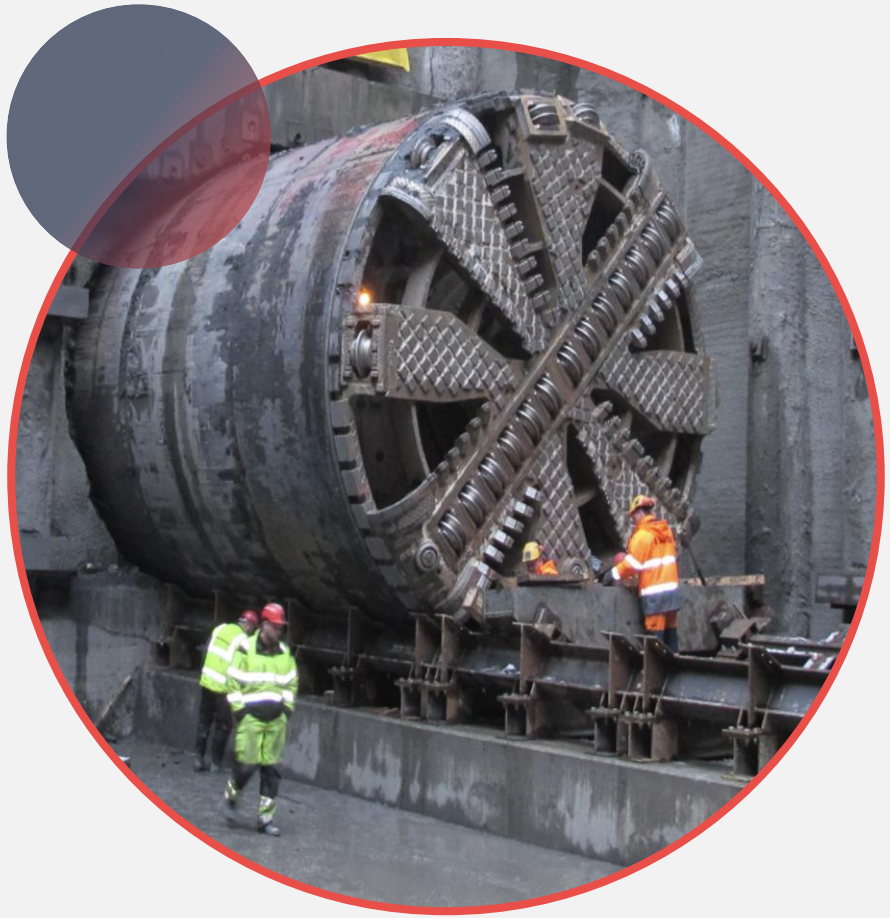
Customer Needs

Production optimization is carried out with the help of expensive and time-consuming numerical models. The client wants a faster, yet reliable, tool to characterize the optimal production strategy.

Solution and achievements

We are working to integrate the client database of geological and geophysical measurements characterizing the subsurface with sensor data recording the performance of its surface infrastructure.

Soil Consistency Prediction



Aim

Optimizing boring timing and worksite equipment.

Customer Needs

Unreliability of the prediction of soil consistency to be excavated in the next sections is a considerable risk in meeting the timetable agreed with the client.

Solution and achievements

Our NOSEM-based solution exploits ground pressure data to extimate the soil consistency in the next 20 to 50 meters, allowing to update reinforcement equipment and to schedule boring timing. This means a remarkable cost saving for worksite load and TBM management.

Aerospace

Living Wall @ Space

Aim

Design and prototyping of an autonomous greenhouse suitable for feeding moon base personnel.

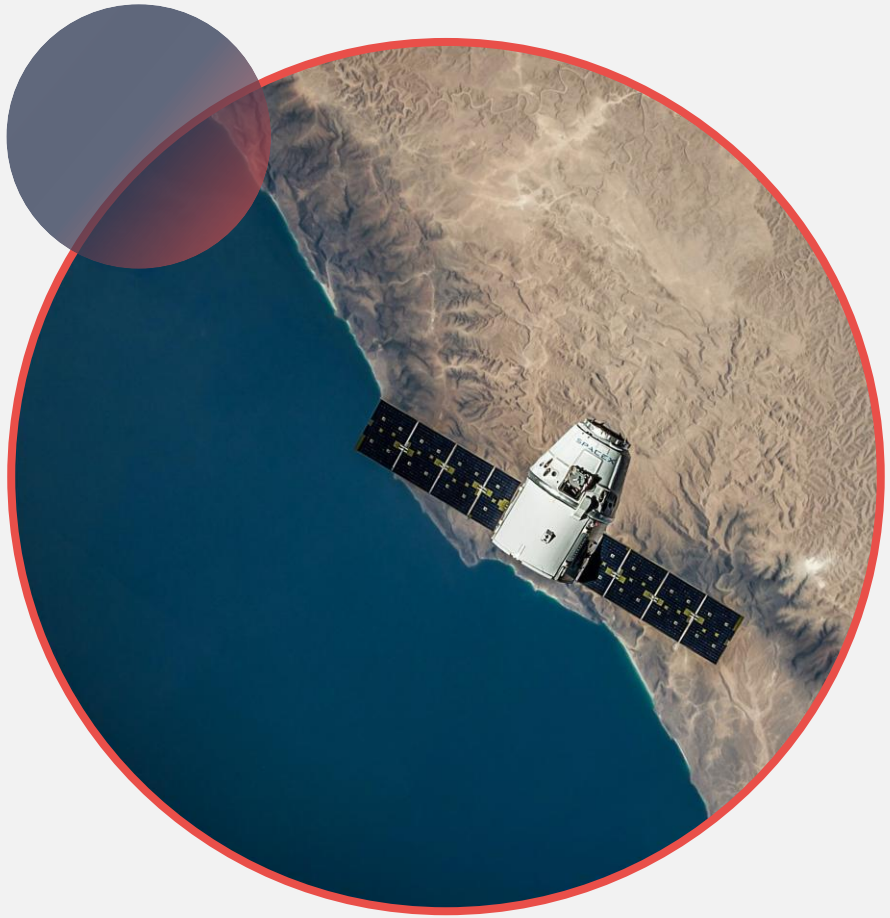
Customer Needs

Design, prototyping and testing of a living green wall (Living Wall) in space, suitable for housing on pressurised habitable modules in microgravity conditions, which will be installed at the SpaceHOME living module.

Solution and achievements

Computer vision combined with AI algorithms for the detection of water, nutrient and medicaments requirements based on plant needs.

Satellite Attitude Control Debris Hooking



Aim

Optimizing satellite control during deorbiting.

Customer Needs

The aim is to control the satellite rotations with respect to a celestial frame, using the satellite thrusters.

Solution and achievements

The specific mission considered in this study is to hook space debris.

Currently, state estimators (Kalman Filters, Particle Filters, ...), collectively indicated here as KF estimators, are the standard in satellite attitude control.

Designing robust KF estimators is difficult even for the linear case and not known for nonlinear systems.

Robust estimators C(DVS) for linear and nonlinear systems can be designed using the Modelway's DVS technology, achieving significant robust performance improvements respect to C(KF) approach.

UAV Fault Tolerant Control

Aim

Control the trajectory of a UAV exploiting seven actuation surfaces, to improve the LQR Reopt NASA solution.

Customer Needs

Manage the actuator faults, reconfiguring the control system to maintain the performance without the faulty actuators.

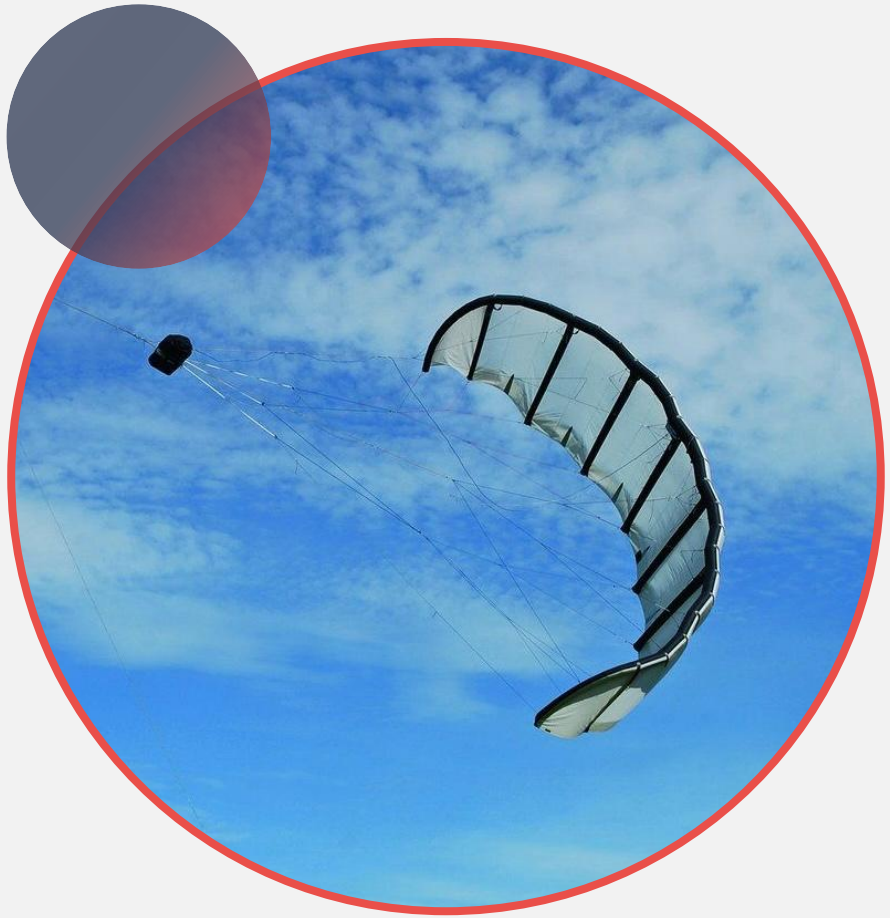
Solution and achievements

MPC control guarantees optimal control actuations over a defined future horizon and high performance in turning manoeuvres.

Two steps control re-optimization strategy of the command in presence of actuator failures.

High recovery performance in presence of failures and high robustness versus wind disturbances.

Kite Generator Predictive Maintenance



Aim

Kite parts Model Based predictive maintenance.

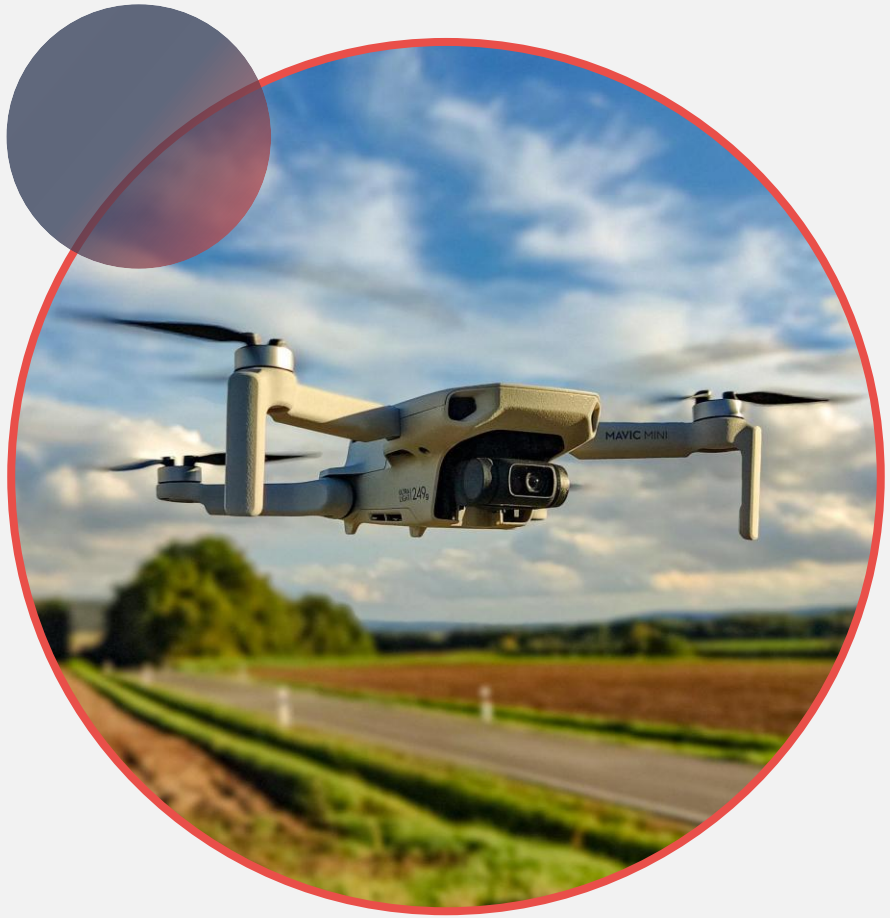
Customer Needs

An effective predictive maintenance system is needed for the early detection of possible degradations/damages, and for kite recovery before more serious damages occur.

Solution and achievements

The kite dynamic is predicted using the DVS technology and is equipped with guaranteed and tight signal bounds, derived by means of the NOSEM methodology developed by Modelway.

GPS-denied navigation for UxVs



Aim

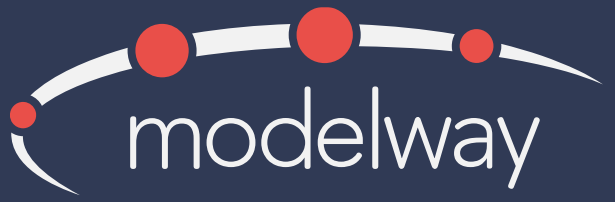
Increase the capabilities of uncrewed vehicles to perform long range and long duration missions for maintenance, reconnaissance and defence purposes even in the absence of GNSS signal.

Customer Needs

Mitigate the drift suffered by current state-of-the-art Inertial Navigation Systems in the absence of reliable GNSS data.

Solution and achievements

The desired navigation accuracy was obtained by adopting an innovative hybrid approach that combines a lightweight physical model with an AI-based data fusion layer.



Headquarter

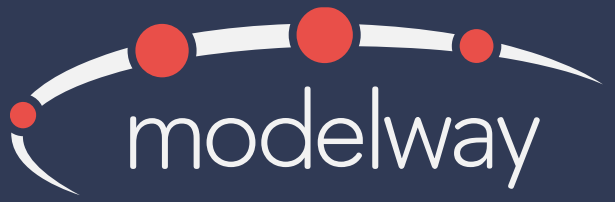
Piazza San Carlo, 197
10123 Turin – Italy
+39 011 19118615
www.modelway.it

Turin Office

Via Pietro Micca, 21
10121 – Turin
+39 011 19118615
www.modelway.it

Milan Office

Via Fabio Filzi, 5
20124 Milan – Italy
+39 023 952 1100
www.bluethink.it



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