



Cutting Edge AI and IoT for **Material Processing Optimizations**

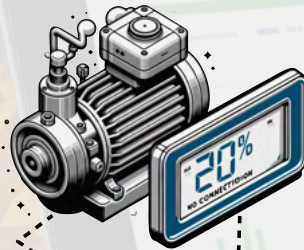
2026-05

Anton Bednár
Sales Manager

The problems we solve



Process monitoring,
Quality control



Low digitalization of assets

Only about **20%**
of industrial machinery
is digitized.

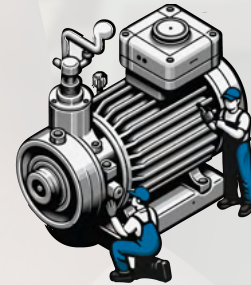
End-of-line testing
R&D, Innovation collaboration



Machine unplanned downtime

80% of companies experience
unplanned downtime each year,
yielding **€35 billion in losses a year.**

Condition monitoring,
Predictive maintenance



High maintenance cost

About **30% of maintenance costs** are related to
unnecessary expenditures.

Internationally acknowledged as an unparalleled innovator



130+ Installations on 3 Continents

9 Years of Development
and Testing

10+ International Awards
for Innovation



Top 5 innovators in
the world in the IoT



The Best IoT Startup
Central Europe



ABB Open Innovation
PDM Solution



Named as Mainstream in
"Acoustic Deep
Learning data processing"



The Best European
Manufacturing
Innovation & Technology
Startup



Top 5 in the world
AI-powered audio
diagnostics



Top 5 Digital
Maintenance Solution
Engineering Startup

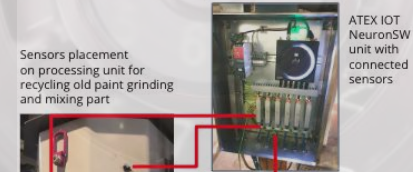
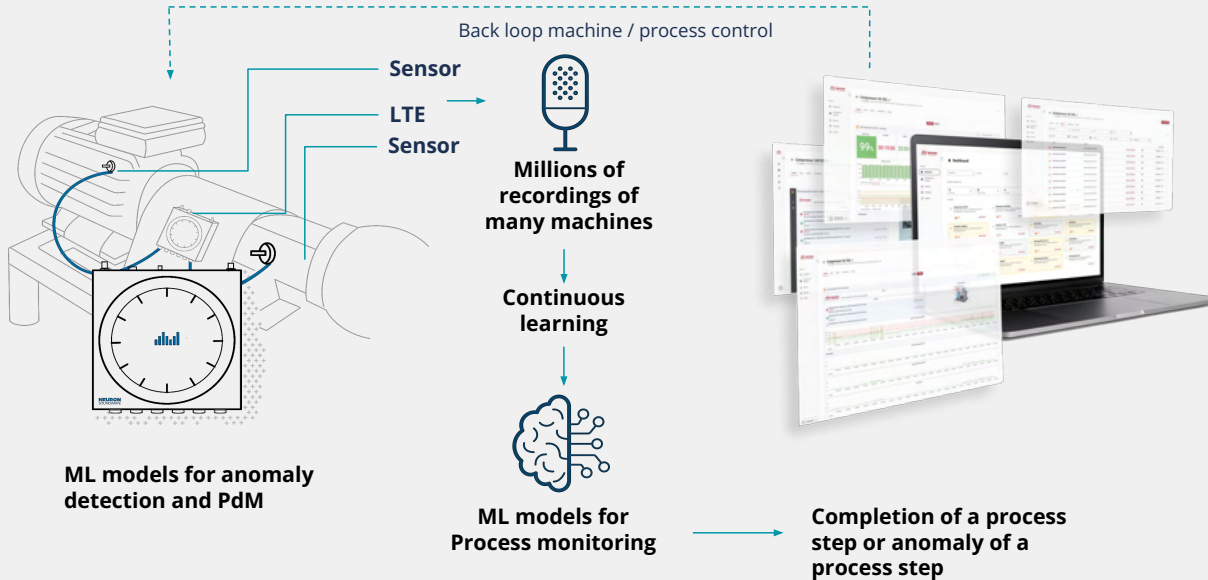


Cool Vendor in
Acoustic Technologies
for PdM

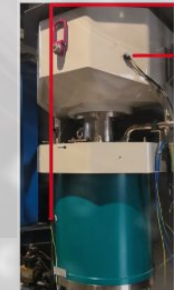
Fully customizable monitoring platform (TRL 8-9)



Complete solution with artificial intelligence for predictive maintenance, process control and predictive analytics



Sensors placement on processing unit for recycling old paint grinding and mixing part



Sensors placement on pump and filter for pumping processed old paint





nEdge™ IoT Hardware

Top 5 Global IoT Innovation

Edge computer

- Processes data locally
- AI on the edge device
- Instant machine health check
- LTE / LAN connectivity
- 4-32 sensor inputs



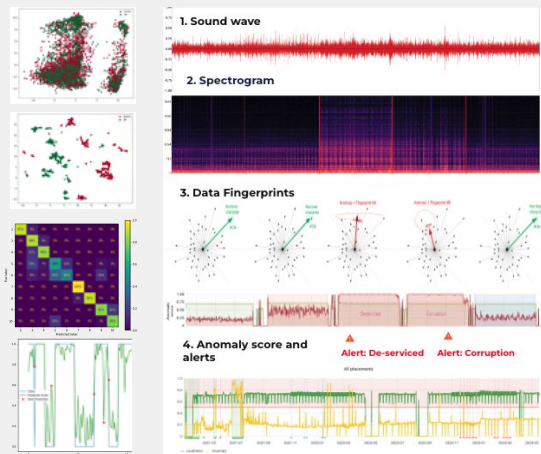
Sensors

- Per use case tailored selection
- Data correlation - Multiple parameters analysis
- Certified for explosive environments



AI & ML Algorithms

Top 10 World's AI Predictive Analytics



- 95 % accuracy on selected use cases
- One-click training for PdM
- Fast adoption to process monitoring or quality control

nGuard™ Analytical Tool

The Best European Manufacturing Innovation



- 24/7 continuous machine diagnostics
- Installation videos and manuals and quick time-to-service
- Combined state-of-the-art AI with traditional diagnostic methods
- Seamless integration into customer's systems

130 + References across industries



General manufacturing
(Robots, CNCs, Quality assurance, process monitoring)



Transportation & mobility, smart cities, Facility management



Energy, CleanTech, Power distribution



CNC metal working



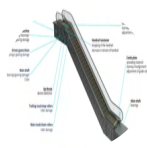
Welding, additive manufacturing



Robots



HVACs



Escalators



Facility management



Transformers



Wind turbines



CHP Units

Capabilities & Applications



Process Monitoring & Quality Control

Research & Development on process supervision projects



CNC metal material processing optimization



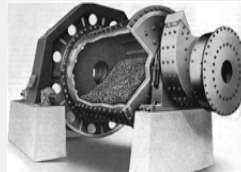
Welding process monitoring



Robotic painting quality control



Material handling monitoring



Milling & grinding: OEE



End-of-line quality control

Predictive Maintenance & Condition Monitoring

Predictive Analytics, Anomaly Detection, Condition Based Maintenance



Transformers monitoring



Compressors



Pumps, vacuum pumps



Power generation units monitoring



CHP units



Power generation, transmission monitoring



CNC Machines

Case studies overview

Overview of Real-time Monitoring Applications on Single-Purpose, Single-Tool Operations



Neuron Soundware brings significant value to **single-purpose, single-tool operations of CNC machines** by using **real-time acoustic data analysis** for **process optimization, predictive maintenance, and quality assurance**.

Single-purpose CNC operations with a single tool are typically fast, repetitive tasks that require high precision and where even slight tool wear or process instability has a major impact on quality.



1. Drilling



2. Grinding



3. Milling – Simple Grooving/Pocketing



4. Turning



5. Cutting and Sawing



6. Honing and Lapping



7. Forming



8. Welding and Soldering



9. Punching and Stamping

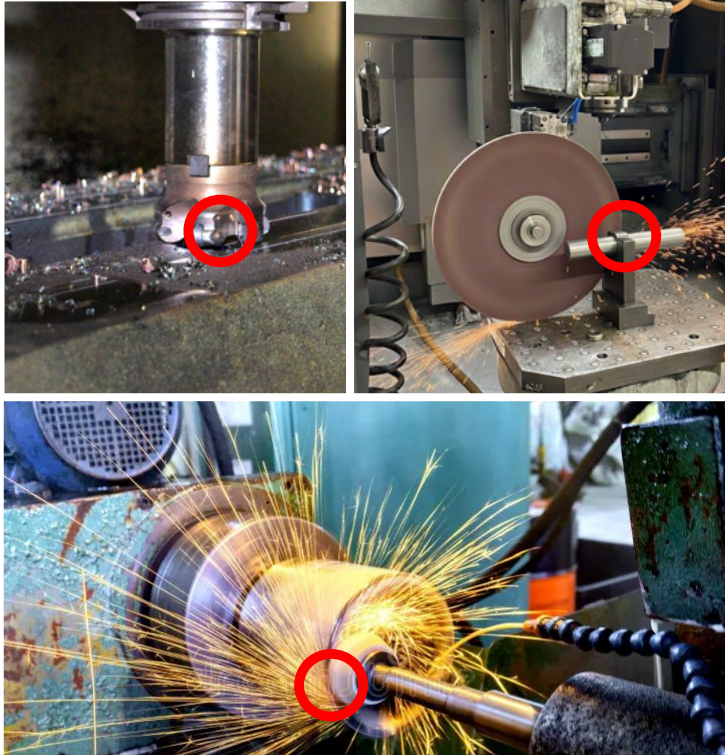


10. Rolling and Rewinding



11. Deburring and Finishing

Real-time monitoring of machine tool quality deterioration



20%

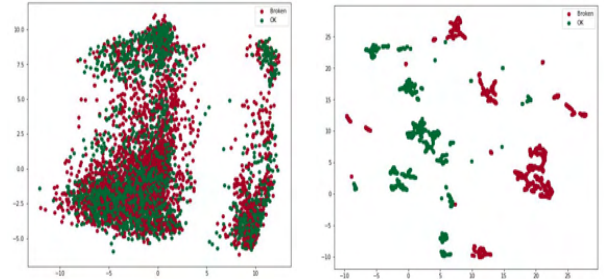
Improvement of
operational
efficiency

800

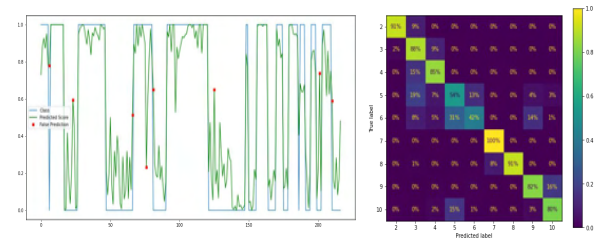
Product pieces
saved per day

€180

Savings in production
losses and material waste
per year



The feature extractors show clear differences between the data – complete heads and heads with missing teeth



Best model: FE2, combined channels: 95.1% accuracy

A blue-tinted background image showing a close-up of a milling process. A metal workpiece is being machined by a rotating tool, creating a large spray of bright sparks. The scene is industrial and focused on the manufacturing process.

Milling Process Optimisation Use Case

Milling process optimization



Challenge

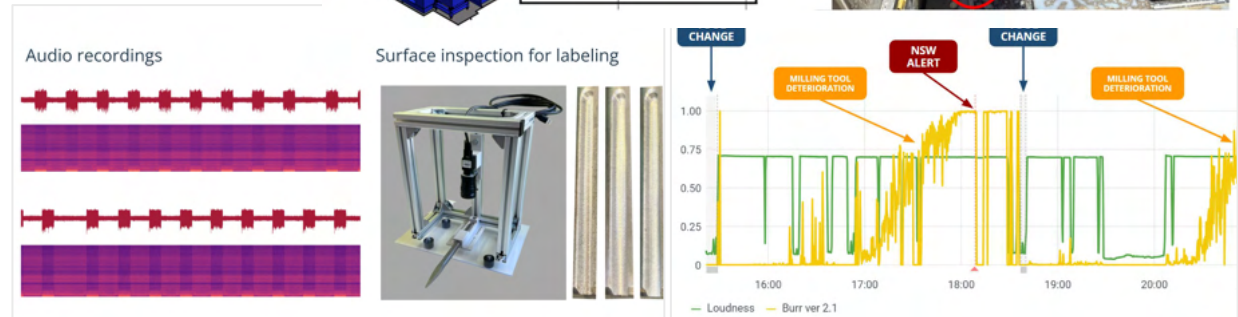
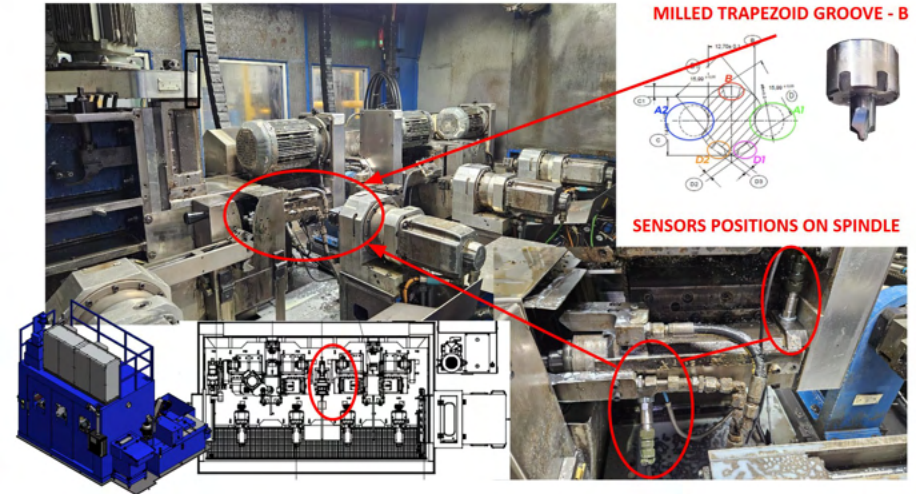
The aim was to **predict the remaining tool life before the breakage of milling tools** used for SDS Max chisels/drill bits. Monitoring the surface quality of the milled groove, which reflects the sharpness of the milling tool, is crucial for maintaining production quality. The operators were to record the burr level on the products produced, using a scale from 0 to 5, based on their judgment. The data were used for the training of the model predicting tool deterioration - Burr level.

Solution

The models can currently be used to **standardize the tool change**, without the need for operator judgement. The first model detects when milling is taking place by the sound, the second model detects the condition of the burr and the third model detects the occurrence of the broken tool.

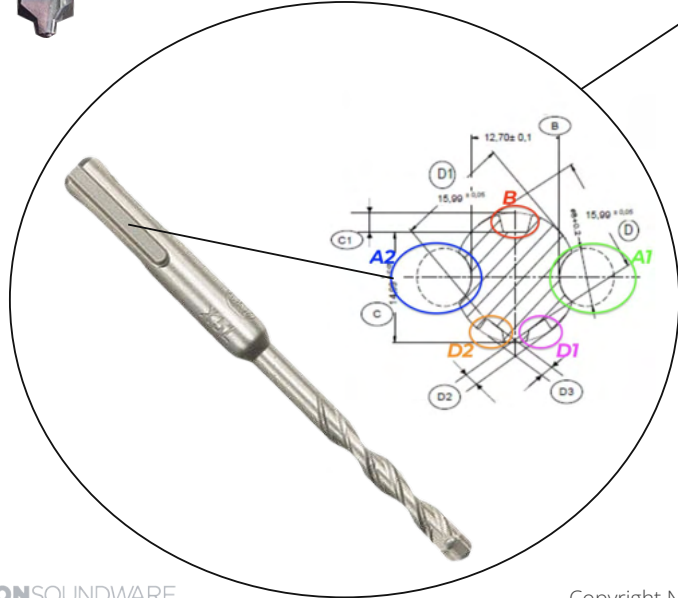
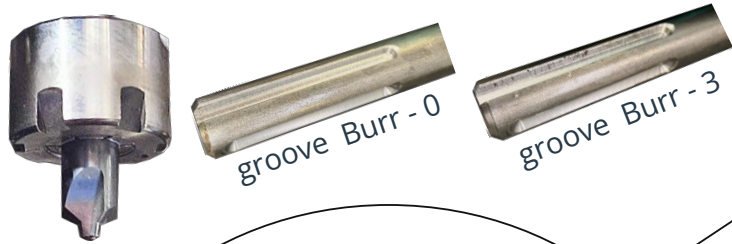
Benefits

Reduced reworks and boosted productivity benefits **120k EUR per year/station**.

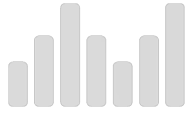


HW SDS Max Drill Bit Use Case

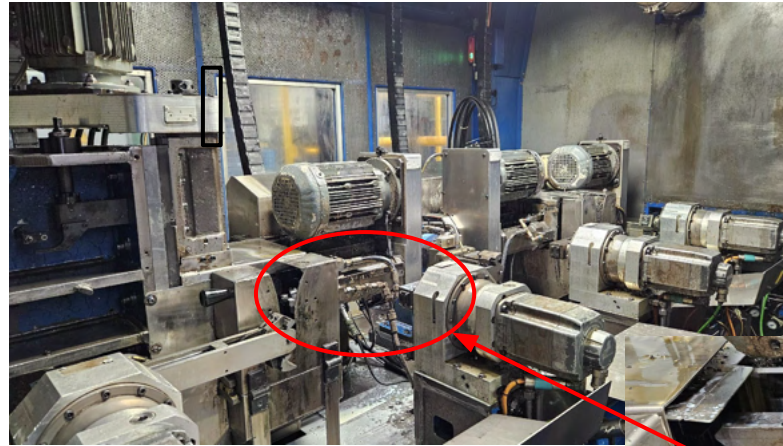
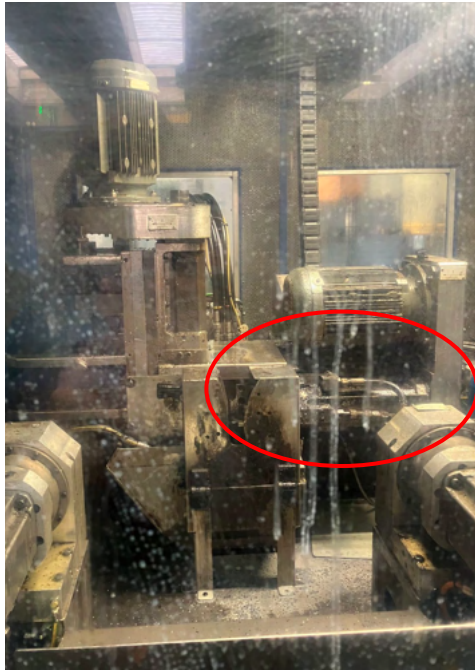
The goal: optimize groove milling process by monitoring tool quality. Reduce scrap, minimize reworks



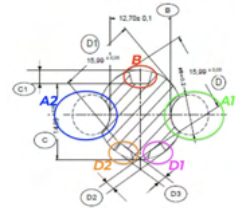
[1] HW installation



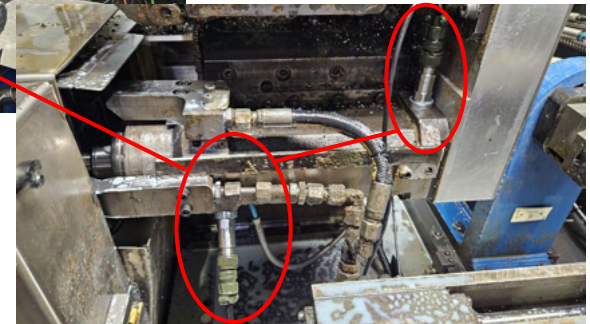
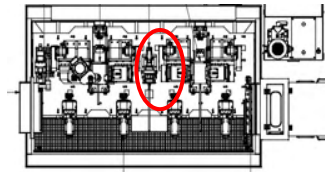
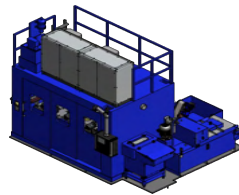
Installed NSW acoustic/vibration sensors on the tool spindle:



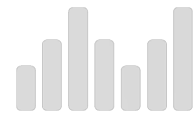
Monitored tool



Monitored product



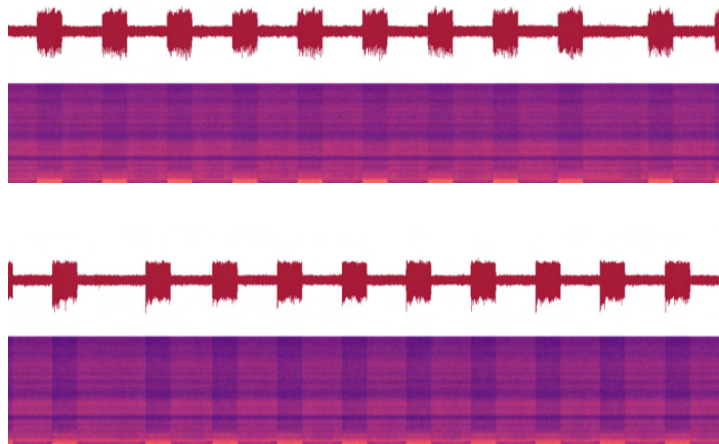
SENSORS POSITIONS ON SPINDLE



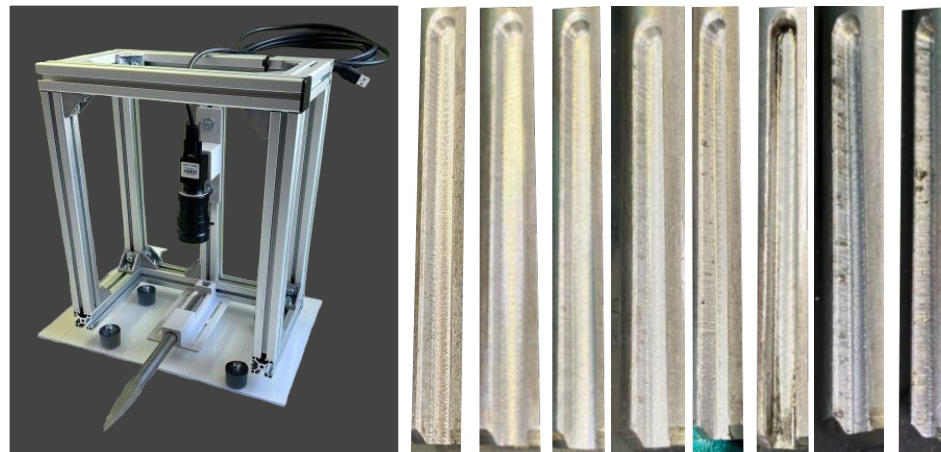
[2] Data collection

Initial Model Training: Collect audiovisual datasets representing various stages of tool wear. Train the model to correlate acoustic signatures with specific tool conditions.

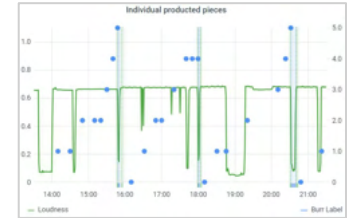
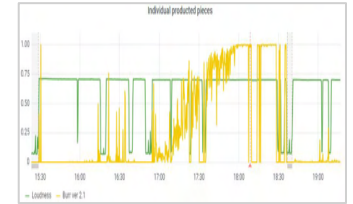
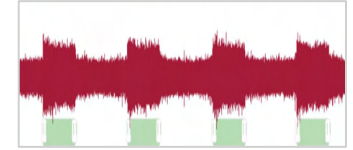
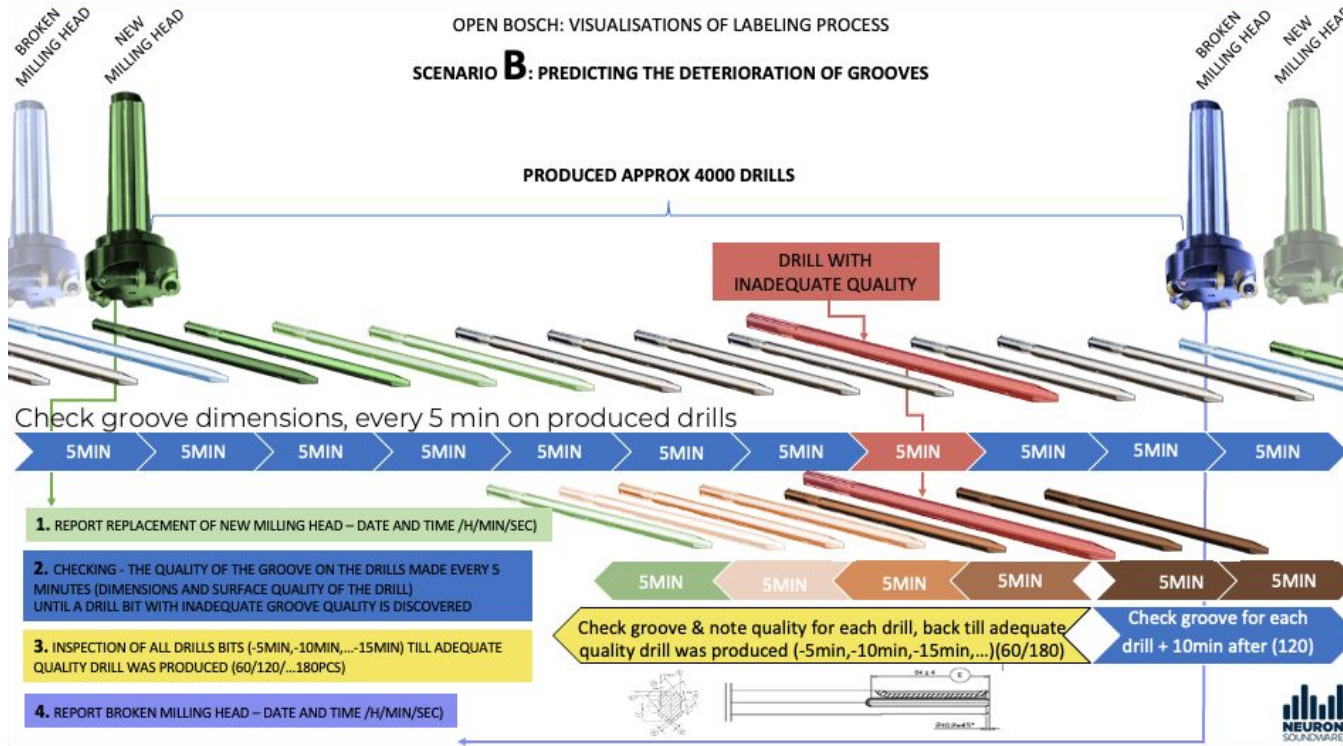
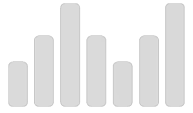
Audio recordings



Surface inspection for labeling



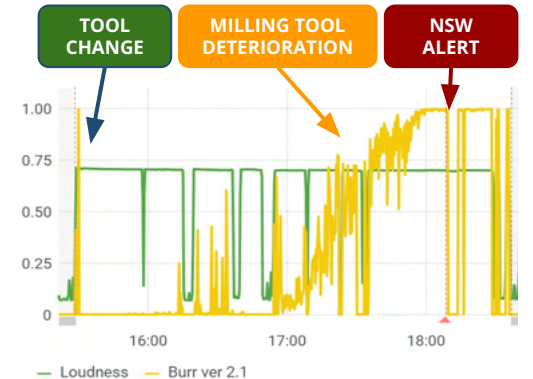
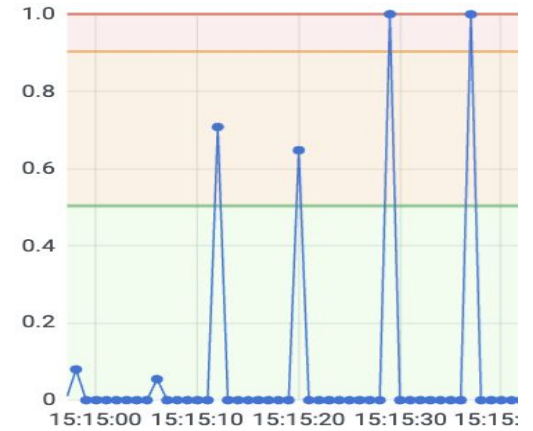
[3] Data labeling, Algorithm development



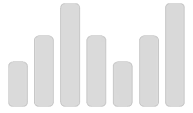
[4] Data Analysis Real Time Visualisation

The AI model detects each product and assesses the tool state based on the machining sound. The results are displayed on this panel.

- < 0.5: **tool OK**
- 0.5-0.9: **tool is wearing out**
- > 0.9: **tool is worn out - replacement needed (end of a lifetime)**



[5] Benefits



20%

Operational efficiency
improvement

800

Product pieces
saved per day

€180.000

Savings on material
wastage per year

A blue-tinted background image showing a grinding process. A grinding wheel is in contact with a workpiece, creating a large spray of bright sparks. The scene is industrial, with various mechanical parts and tools visible in the background.

Grinding Process Optimisation Use Case

Grinding process optimization



Challenge

Acoustic analysis can significantly **improve first touch detection accuracy**, potentially enhancing grinding process control and machine productivity.

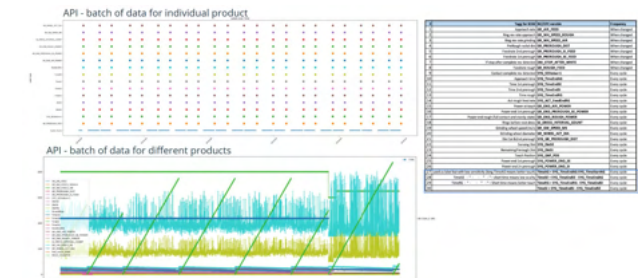
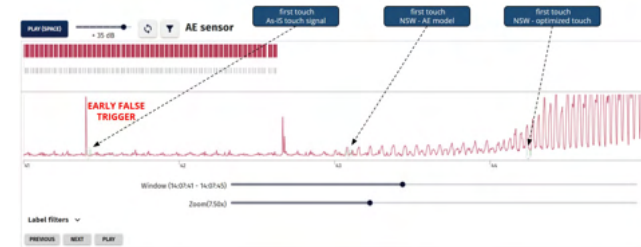
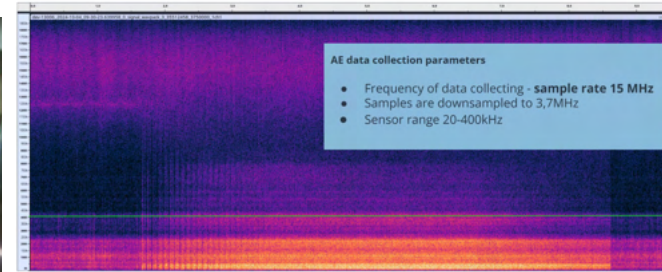
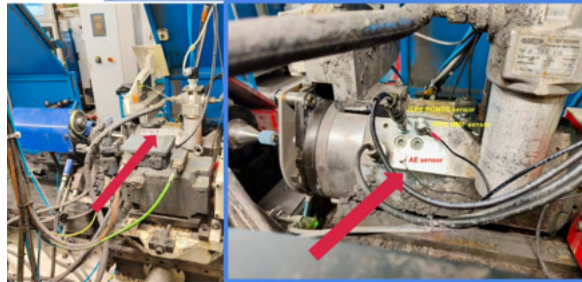
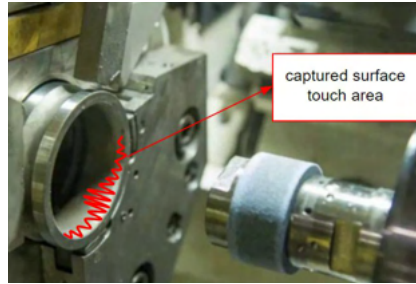
The reliable detection of the first touch between the workpiece and the tool in milliseconds is key parameter to **optimally control the machine speed and save production time**.

Solution

The reliable detection of the first touch allows to **speed-up the manufacturing process**. The further benefits are coming from the need of the **tools replacement and product quality optimization**.

Benefits

Production efficiency increased by 15%. That brings about more than 1.2 million EUR worth of production.





Cutting Process Optimisation Use Case

Cutting process optimization



Challenge

Improper cutting speed and inappropriate contact between the cutting wheel and the material can result in damage or burning of the workpiece. This necessitates heightened operator attention and manual monitoring to prevent material loss and scrap.

Solution

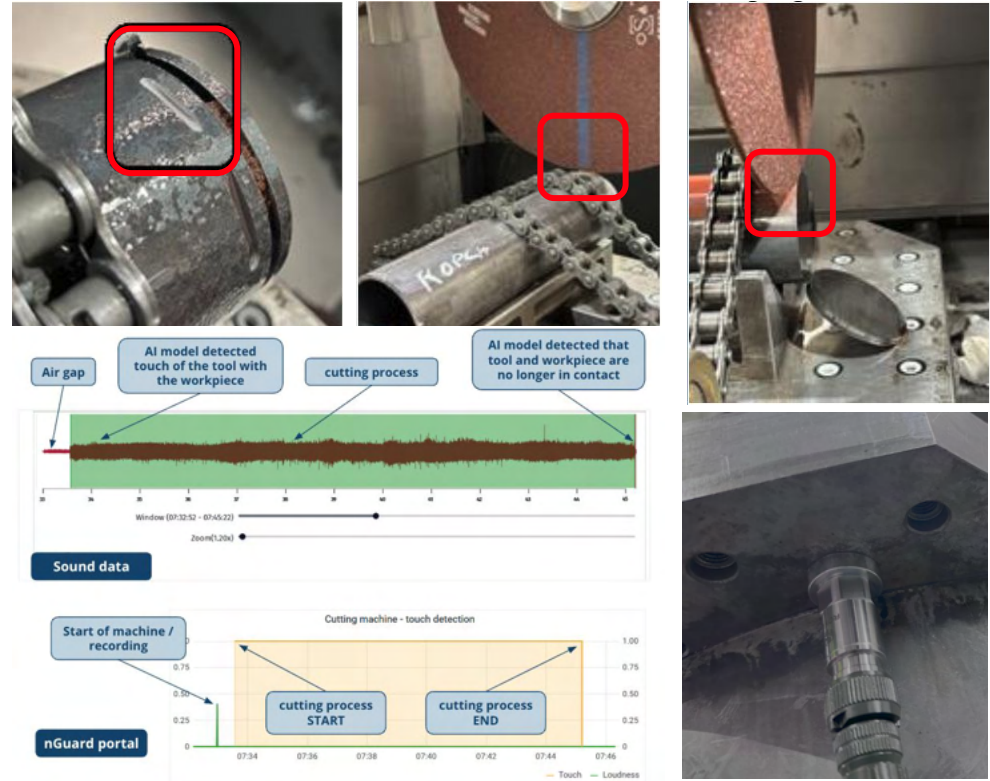
Automated **error-free touch detection, cut termination and ejection** system based on **acoustic monitoring** (Neuron Soundware nEdge IoT equipment) to **detect the point of contact** of the cutting tool (wheel) with the material/end of the cut.

Benefits

Process Optimization: Enable the **optimization of cutting conditions.**

Efficiency: Allow for the **acceleration of sampling.**

Automation: Enable the **automation of the cutting process** (specifically, touch detection and cut termination).





Material Processing

Sanding process optimization



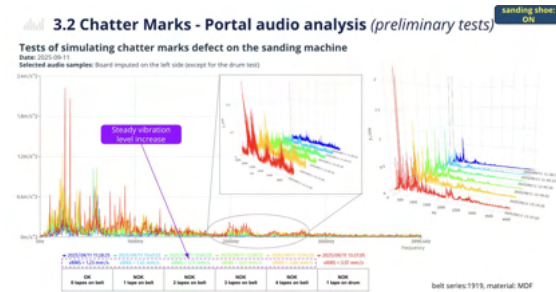
Detection of Chattermarks



Chattermarks defect can be **easily detected within a shoe-present sanding process**. For a shoe-less sanding process more data need to be collected.



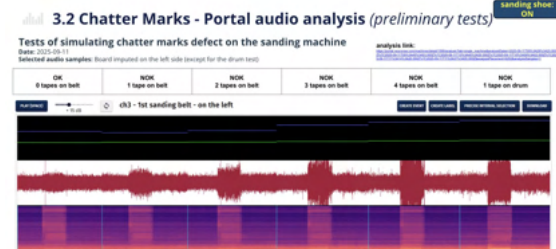
1st sanding belt - profile holding the shoe



Detection of Belt Clogging



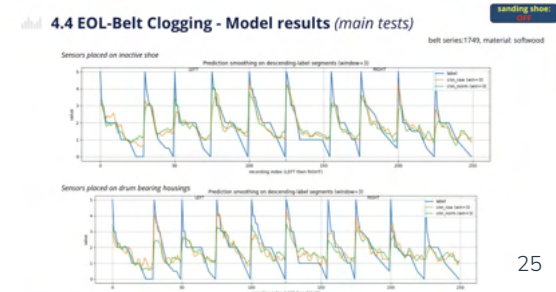
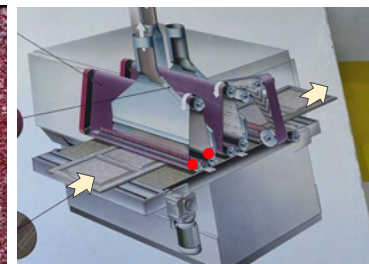
Neural networks models showed **good capability to detect clogged belt** along with clogging level even with shoe-less sanding setups.



Detection of Belt Grain Wear



Grain wear is partly visible in the raw data and neural networks model is able to differentiate between belt conditions.



Wire drawing process optimization



Challenge

Welding wire coated with copper is pulled through a drawing die at a speed of 24 meters per second.

This **drawing wire is extremely sensitive to damage**, and any harm inflicted upon it leads to the rejection of the entire production batch, resulting in **substantial losses of both time and materials**.

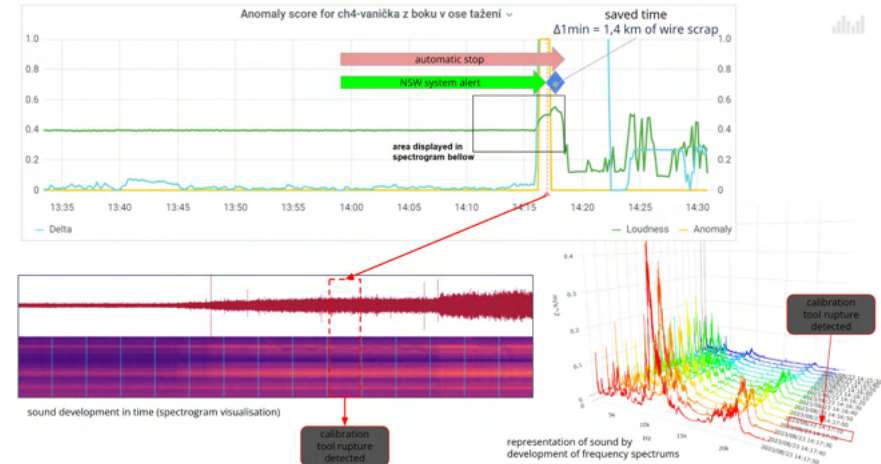
Solution

NSW solution **monitors the drawing mechanism and the integrity of the die**.

NSW correlates the data obtained with the production specification and in case of any deviations from the pre-set specification, **the line is stopped, and the problem areas are corrected**.

Benefits

Significant material savings (30t of material per year per production line). Dramatically reduced unplanned downtime. Improved productivity. Increased reputation as a reliable supplier.



The background is a blue-tinted photograph of an industrial environment. In the center, a large piece of machinery is emitting a bright, starburst-like spray of sparks, suggesting a grinding or welding process. To the right, a person wearing a white shirt and dark pants is partially visible, holding a tool or part of the machinery. The overall scene is dimly lit, with the primary light source being the sparks from the machinery.

Predictive maintenance

CNC Machines - Main areas of interest:



COMPONENT-BASED MONITORING SYSTEM:

- Spindle
- Rotary Equipment: bearings, pumps, motors
- Linear Axes/Guides



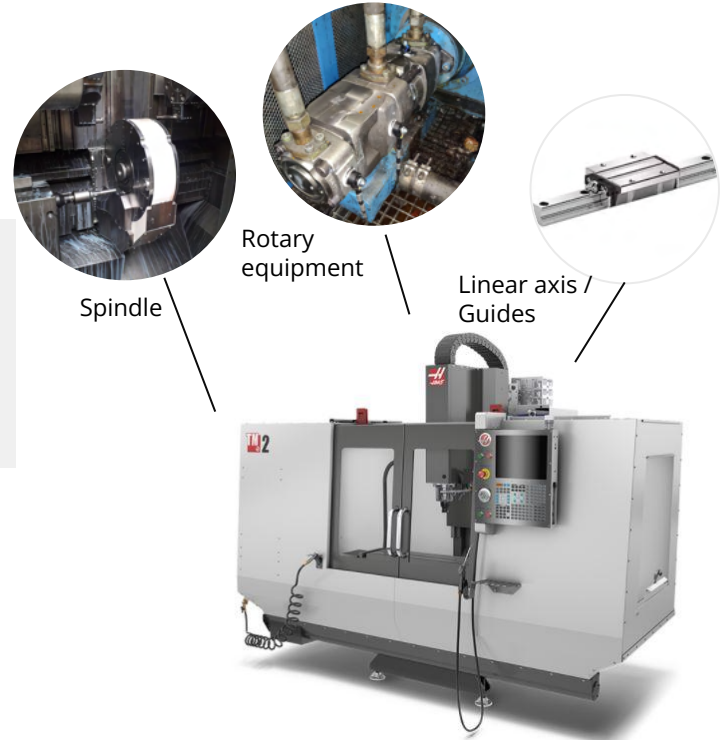
SOLUTION:

- Online monitoring with IoT device
- Results visualisation in nGuard portal
- Alerts via email/SMS



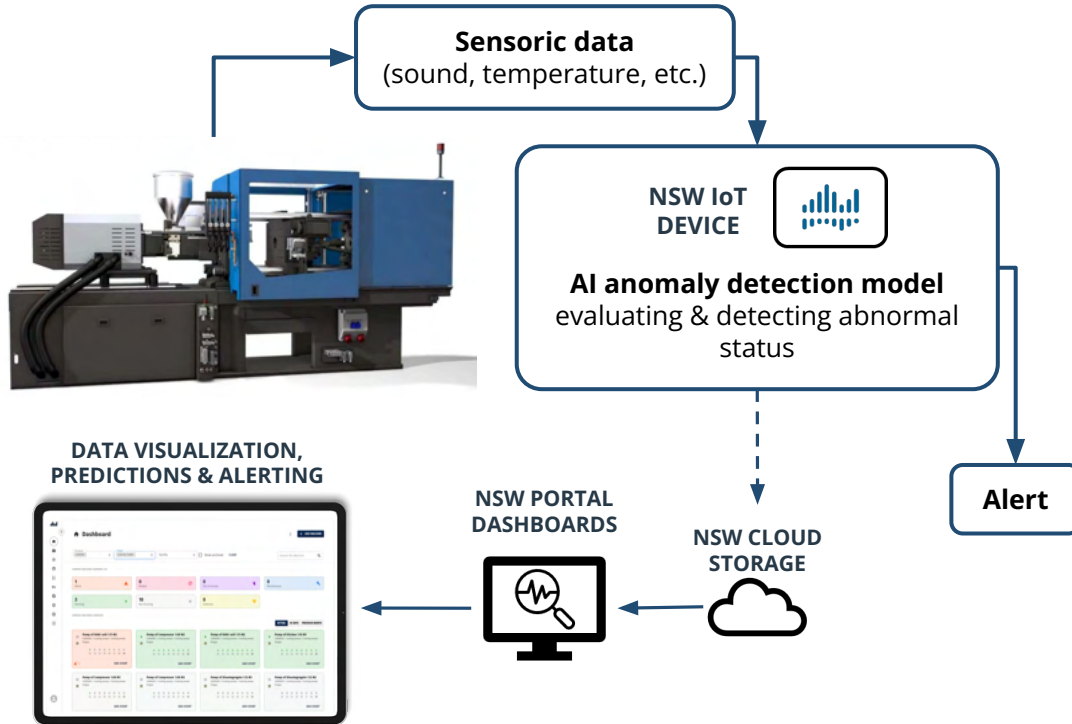
BENEFITS:

- Prevents unexpected downtime
- Helps optimize maintenance procedures
- Increases safety and productivity
- Improves spare parts inventory management



Predictive maintenance

Acoustic sensing

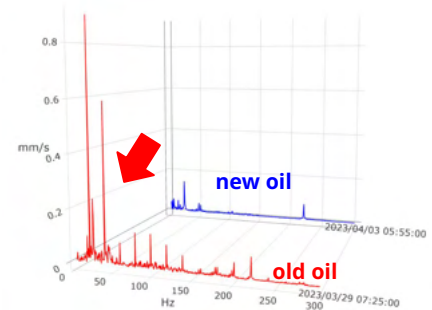


AI models for Predictive Maintenance can detect various range of defect on the machine and inform the personnel to perform corrective actions.

Proportional valve example



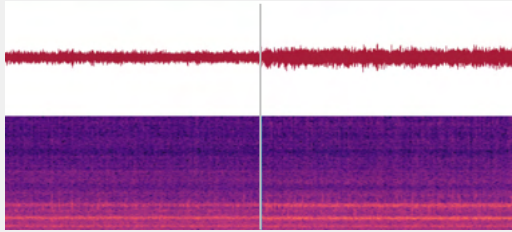
Old hydraulic oil causing vibrations of the valve resulting in product being not in tolerance.



CNC Machines - Predictive maintenance applications

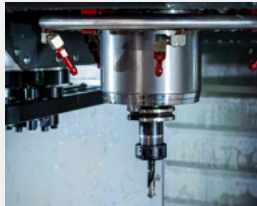
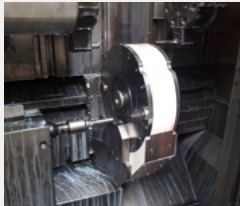


Spindle Monitoring



**ORIGINAL
STATE**

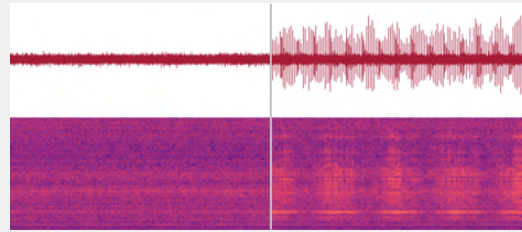
**DEFECT
STATE**



THE MOST COMMON PROBLEMS:

- misalignment
- insufficient lubrication
- imbalance
- bearing failures
- looseness

Rotary Equipment Monitoring



**ORIGINAL
STATE**

**DEFECT
STATE**



THE MOST COMMON PROBLEMS:

- Imbalance
- bearing failures,
- misalignment
- pump cavitation
- overheating

Linear Axes/Guides Monitoring



**OK
STATE**

**DEFECT
STATE**



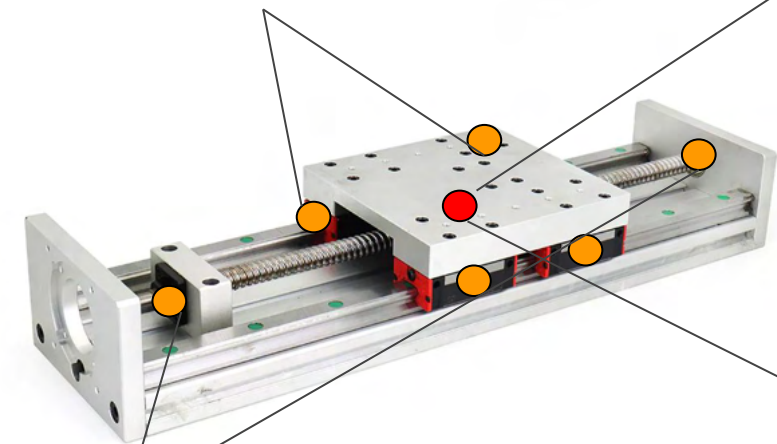
THE MOST COMMON PROBLEMS:

- Insufficient lubrication,
- corrosion,
- flaking,
- damaged ball
- indentions,
- recirculation parts

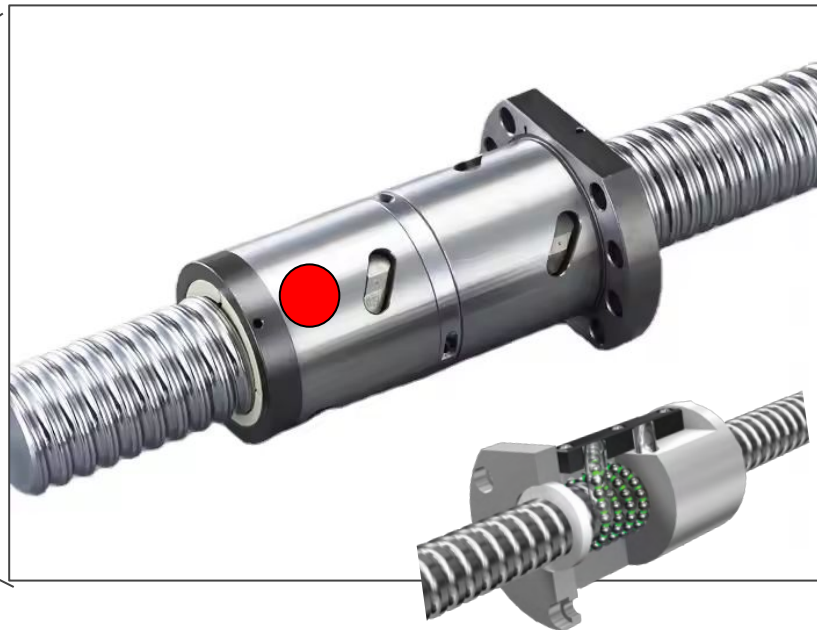
Monitoring the correct operation of axes: predictive maintenance



4x carrier (runner block) / housing

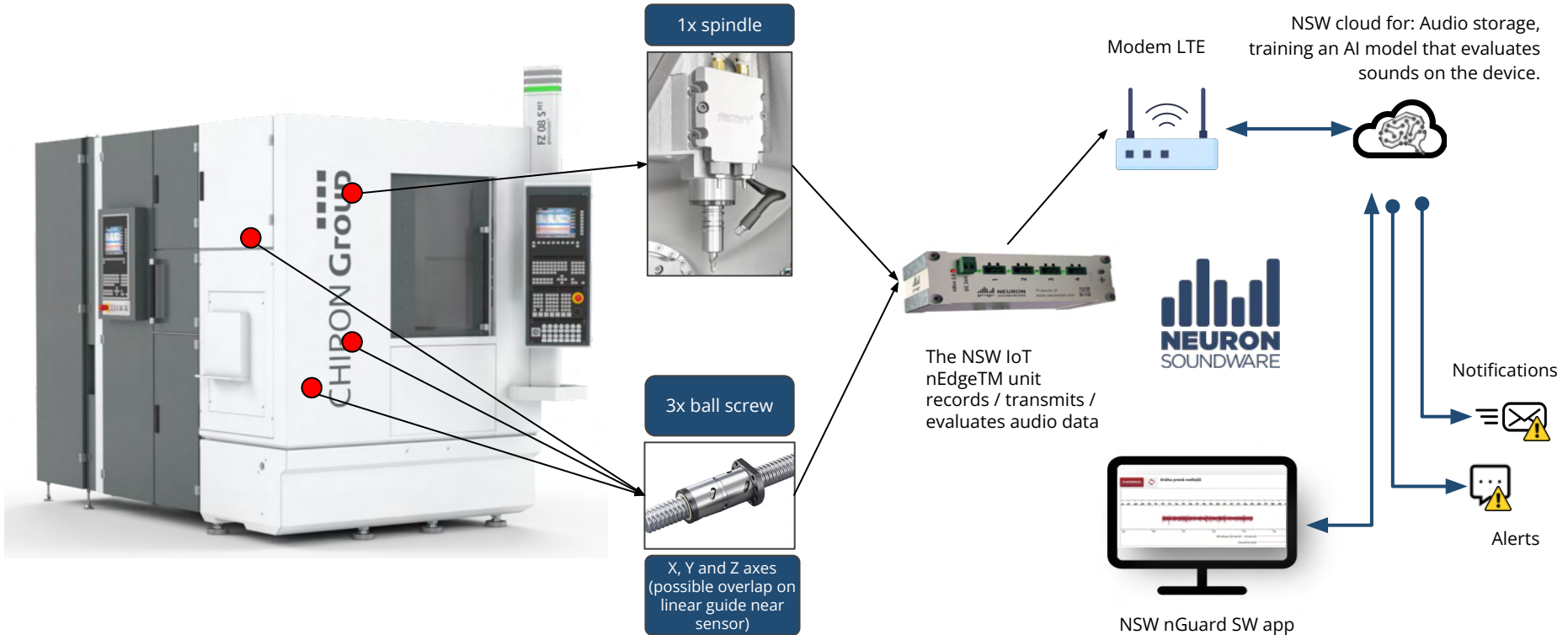


2x ball screw end bearing



Sensor location Ideally on the nut, or as close to the nut as possible

Monitoring the correct operation of the spindle and axes (predictive maintenance)





CNC Machines

R&D Twist grant summary

Twist Grant Project one-pager :

Neuron Soundware: AI + IoT for CNC optimization

Goal: **Optimize CNC machining in real time** by application of an advanced **Artificial Intelligence** (Reinforcement Learning, Anomaly detection, LLM ~ Techniques) + **IoT edge computing device**.

Core pillars of the technology:

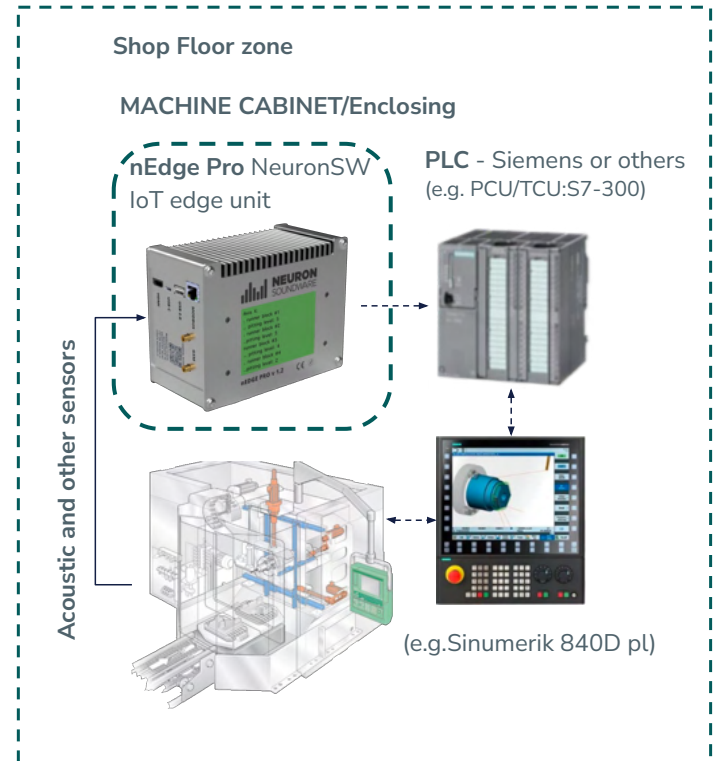
- **Automated process planning & G-code generation:** Heuristics + LLMs to speed up CAM prep (up to ~90%) and optimize sequences (15–25% faster).
- **Real-time anomaly detection & correction** — acoustic/vibration monitoring to detect chatter, collisions; ms-level reaction to prevent damage and cut downtime (~50%).
- **Adaptive real-time control** (Reinforcement Learning) — dynamic sensor feed/speed adjustment to shorten cycle times (≈20–30%), reduce defects and extend tool life.

Hardware & edge:

- nEdge PRO IoT unit (edge inferencing, multi-channel A/D, high-freq acoustic capture up to MHz, Jetson modules) for low-latency (<100 ms) local processing.

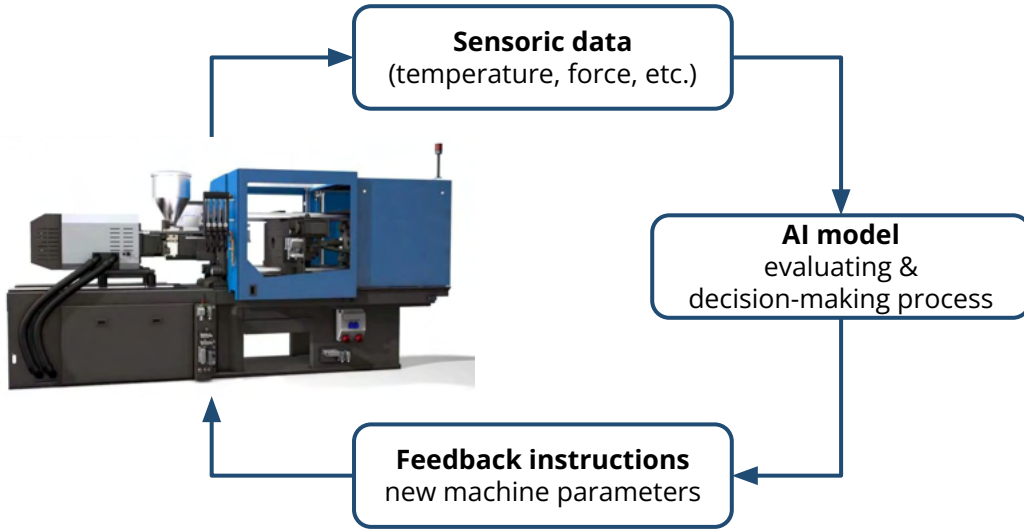
Deliverables (two-year plan): Firstly, use virtual CNC simulator & generate training data, nEdge PRO AE module, RL control models, anomaly detection models, G-code generator prototype. The solution will be tested with the industrial partners (CEITEC VUT, INTEMAC, TECHSOFT), simulation (Ansys), cloud/edge compute and iterative real→sim→real training.

Expected impacts: Faster setups, fewer rejects, energy/material savings (5–10%), scalable modular platform for broader industrial adoption.



Reinforcement learning

Real-time adjustments



In the high-precision world of manufacturing, Reinforcement Learning (RL) acts as an "intelligent pilot" that constantly adapts to the physical decline of hardware. Unlike traditional static controllers, an RL agent treats the injection molding process as a dynamic environment where it learns through trial and error. As components like the screw, barrel, or check valve experience gradual wear—leading to fluctuations in pressure and melt temperature—the RL algorithm observes these deviations in real-time. By receiving a "reward" signal based on the final part's dimensional accuracy and weight, the agent autonomously recalibrates parameters like injection speed, holding pressure, and cooling time to compensate for the mechanical fatigue.

How RL Counters Machine Wear

- Adaptive Compensation: It detects subtle shifts in friction or leakage caused by worn seals and automatically adjusts the pressure profile to maintain consistency.
- Predictive Optimization: Instead of waiting for a part to fail inspection, the agent learns the "signature" of a degrading machine and proactively tweaks settings.
- Reduced Downtime: By squeezing optimal performance out of aging equipment, RL extends the usable life of the hardware before a full mechanical overhaul is required.



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Anton Bednár

Sales Manager

+420 778 737 199

anton.bednar@neuronsw.com

www.neuronsw.com