

Predicting machining processes in real time through a mobile platform

07 August 2026, 18:20

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Sirris and VIVES combine proven models with live machine data on the shop floor

In recent years, research groups have developed a great many models to predict machining processes. In practice, these have often been confined to a lab or simulation environment. As part of the VLAIO COOCK+ 4.0 Maturity Acceleration project, Sirris and VIVES University of Applied Sciences are bringing this knowledge to the shop floor with a mobile platform that combines proven models with live sensor and machine data. This allows companies to experience for themselves, on their own machinery, the benefits of predictive machining.



Why use a mobile platform for predictive machining?

In recent years, various research groups have developed models to predict machining processes: cutting forces, surface roughness, deflection, tool wear, and stability. These models work but are often confined to a lab environment or a web application. The transition to the shop floor, with its own machinery, control systems, and individual characteristics, is rarely straightforward.

A mobile platform makes that step easier. It can be physically taken to a company and connected to an existing machine. During a trial period it collects data, feeds it into models and provides predictions to the operator. There is no need to install any infrastructure, purchase licences, or set up a lengthy implementation process.

The question the platform aims to answer is simple: what does the data tell us, and how can we apply that knowledge during the machining process itself? Variability in production is addressed using AI and statistical analysis, built on a foundation of proven physics.

Basic principles

When the platform was developed, a number of deliberate choices were made that make sure it can still be used even in less digitised companies.

The models form the basis. Simulations and analytical formulas (such as Taylor’s formula, a service life equation for tool life or classic roughness formulas) are the starting point and immediately provide a prediction, even without a single sensor.

If a company does have a modern control system or additional sensors, that data is fed into the system to refine the forecast. If not, the platform will simply operate on the basis of manual input and parameters.

The dashboard has a simplified mode for operators and an advanced mode for programmers and engineers. Furthermore, its design is modular: new models or sensors can be added without having to revise the existing architecture. External, commercial tools can also be used where this makes sense.

Finally, this is not a proof-of-concept on a laptop, but a setup designed to withstand on-site testing.

Structure of the mobile platform

The mobile platform consists of a number of interlinked building blocks.

Basic knowledge as the starting point

The platform has reference data on materials, tools, and machinery. This basic knowledge is supplemented with the options and settings that change during the process. For each calculation, the correct parameters are automatically retrieved to feed into the simulation.

Data from various sources

Data is received through two channels. High-frequency sensor measurements, such as vibrations or spindle power, are pre-processed and utilised in real time. Status information, such as machine status or programme number, is read in at specific intervals. Both data flows can be switched on or off on a modular basis, depending on what is available on a machine.

One module per prediction

There is a separate module for every issue that arises on the shop floor: surface roughness, wear, stability, dimensional deviation, and machining times. Each module performs its calculations independently and delivers its own result. As the architecture is modular in design, new modules or external tools can easily be added later on.

Dashboard for operators and experts

The user interface contains various tabs for input, results, and feedback. In simplified mode, the operator sees only what is necessary to make a decision. In expert mode, the underlying calculations, parameters and trends are visible to anyone who wishes to delve deeper.

What the platform already predicts today

To validate the platform, five generic cases were selected, each one representative of a common issue encountered on the shop floor.

Surface quality and dimensional accuracy

Surface roughness and dimensional deviations can be determined from a combination of parameters, live data, and calculations. This provides an initial indication during an operation as to whether the product will be finished within specifications.

Tool monitoring

A comprehensive theoretical formula can be configured on the basis of actual measurements (via spindle power), and of input provided by the operator. A visual inspection of the tool, combined with an AI-based wear prediction derived from this, can also be incorporated.

Unstable process conditions

Stability predictions – the classic stability lobes – can be compared with actual measurement results. This means that the operator receives not just a calculated prediction, but empirical confirmation based on what the machine actually shows.

Optimisation of process parameters

The platform allows you to simulate the effect of parameter changes either before or during a machining operation: what happens to the cycle time, surface roughness, or tool life if, for example, the feed rate is increased by ten per cent?

General KPIs and machine status

Start and stop times are automatically derived from the sensor signals, such as energy consumption, acceleration and spindle rotation.

What benefits does predictive machining offer your business?

The mobile platform isn't a finished product that a company purchases and installs, but a tool for answering specific questions on site. There are three possible scenarios today.

In the first scenario, a company has Sirris carry out tests on its combinations of materials, tools and machinery. The results are reported and can serve as the basis for an investment decision.

In a second scenario, the platform is brought to the company for an agreed period, is connected to one or more machines, and operates alongside them during normal production. Together with the researchers, we then take a look at which models have yielded valuable predictions and where the data has fallen short. After this, companies that wish to continue developing their own solution can receive support through guided programmes, paid input, or additional support channels.

This allows companies to gain experience with predictive machining without having to make a large initial investment. The barrier to entry is deliberately kept low, because the first question is usually not 'how much does this cost?', but 'will this work for us?'.

Testing predictive machining on your own machines

The platform is up and running and is now being used in industrial test sessions. Over the coming months, the focus will be on three areas: fine-tuning the generic use cases, integrating commercial tools – such as smart tool holders or dedicated vibration sensors – and launching specific ROI projects with companies from the support group. These projects will help to substantiate the economic impact of predictive machining with figures drawn from real-world practice in Flanders.

Sirris and VIVES are continuing to build practical solutions

In the Vlaio-COOCK+ 4.0 Maturity Acceleration project, Sirris and VIVES University of Applied Sciences are developing methods together for predicting and optimising machining processes. One of the key outcomes is the mobile platform: a tool that allows you to experience for yourself the benefits of hybrid, model-based process monitoring. Feasibility studies are possible.

Discover the project

Conclusion

Combining models, real-time data and a modular architecture within a mobile platform makes predictive machining tangible. The mobile platform offers a practical solution if you are unsure whether data-driven production is feasible: it allows you to carry out tests on your own machines, using your own materials, and provides results that indicate what your specific process requires.

Want to know more?

Would you like to know what the mobile platform would display on your machines, or are you interested in an on-site feasibility test? Contact Sirris or your contact person within the VLAIO COOCK+ 4.0 Maturity Acceleration project.

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