VERICUT

Smart Manufacturing for Sustainable Manufacturers

Vericut

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Contents

Summary

As global industries increasingly prioritise eco-friendly solutions, innovative software empowers manufacturers to achieve their productivity goals while reducing waste, conserving energy, and minimising their carbon footprint.

Cutting-edge CNC software offers real-time simulations, digital twin technology, and seamless integration with your existing systems, enabling manufacturers to streamline their processes with unparalleled accuracy and efficiency. By shifting from traditional machining practices to virtualised, digitally-driven workflows, manufacturers can significantly reduce the material waste associated with physical prototyping, tooling, and production.

Sustainability is not just an add-on feature—it's built into every aspect of virtual CNC software. With advanced optimisation, virtual software allows manufacturers to minimise energy consumption during operations, optimise material usage, and reduce scrap rates. The ability to simulate and test machining processes virtually ensures that only the most efficient and resource-saving production methods are applied on the shop floor.

As businesses move toward greener initiatives, choosing the right technology partner is crucial. Vericut CNC software helps clients meet their sustainability goals without compromising on quality, precision, or profitability. Through digital innovation and eco-friendly practices, manufacturers can drive long-term business growth while contributing to a more sustainable future.

Commitment

Manufacturing accounts for almost a quarter of direct carbon emissions in the US, while in Europe, the industry emits an annual total of 880 million tons of carbon dioxide equivalent. While a total of 49 countries around the world, plus the European Union, have pledged net-zero targets, it's not just up to global powers and world leaders to lead the change. Responsibility lies with businesses, particularly in the manufacturing sector, to review practices and reduce their carbon output.

At Vericut we have made a commitment to a more sustainable future - a future where sustainability is the result of what we do and is an integral part of the products and services we deliver. Our CNC software solutions will play a vital role in helping our customers achieve more efficient and sustainable machining operations.

Reducing the material used, energy spent, and time wasted on manual prove-outs by simulating and verifying NC programs in Vericut is a good starting point. Taking this a step further, using our NC optimisation software solutions, which include Force and Vericut Optimizer, can achieve manufacturing cycle time savings of between 10% and 40%. Depending upon the raw material and complexity of the parts, the savings on the wasted time and power consumed are truly significant. Producing more parts with existing capacity may even provide machine shops with the opportunity to avoid additional capital investment.

Finally, Vericut CNC Machine Connect allows users to connect with and utilise their machine's data, while with CNC Machine Monitoring software, they can track and live stream the data as it unfolds. When partnered together, they produce the most robust and hyper-accurate digital twins.

If energy-efficient manufacturing is done correctly, specific measures can be positioned within manufacturing processes and product design to reduce environmental impact. Virtual machining with Vericut really is the future of sustainable manufacturing.

Shin Voeks
Vericut President

Be Prepared

Frequently asked questions – Resilience & NC Simulation

Pandemics, new conflicts, resource shortages, climate change, and financial and economic crises: external shocks and disruptions have become the new normal. Businesses that adapt quickly are the ones that survive.

Sustainability, while still a relatively new demand in manufacturing, is not a passing trend, it is a necessity and the overwhelming warning to businesses across the globe is: “Be prepared.”

What is virtual CNC manufacturing, and how does it promote sustainable processes?

Virtual machining provides a medium to model and simulate machining processes on a computer prior to any real production. In doing so, it offers a sustainable way of testing, analysing and optimising NC programs and machining strategies without consuming materials and energy, or generating unnecessary waste.

How can CNC Software help manufacturers reduce material waste and lower energy consumption?

Virtually ‘proving out’ a new or modified component often negates the need to physically test run a part prior to production. It therefore avoids wasting raw materials needed to generate an erroneous part, as well as wasted production capacity and power consumed by the machine tool.

During the virtual machining process, errors and program inefficiencies are eliminated, to ensure a sustainable process, and machining parameters can be optimised. The selection of appropriate cutting parameters such as cutting speed, feed rate, and depth of cut can significantly reduce energy consumption and material waste, while also improving tool life and surface finish.

Can CNC software tools help in sustainable design and resource efficiency?

The first step in sustainable design is sustainable CNC machining process planning, which means taking into account the environmental impact of producing the product.

Simulating the exact movements of an entire operation will determine highly accurate and reliable cycle time estimations, which in turn aids precise scheduling and resource planning. While using a virtual environment to test different designs and machining strategies, not only means that there is no disruption or wastage on the shopfloor, but stakeholders can also identify opportunities to minimise resource consumption and establish the most sustainable design that saves time, energy and tooling.

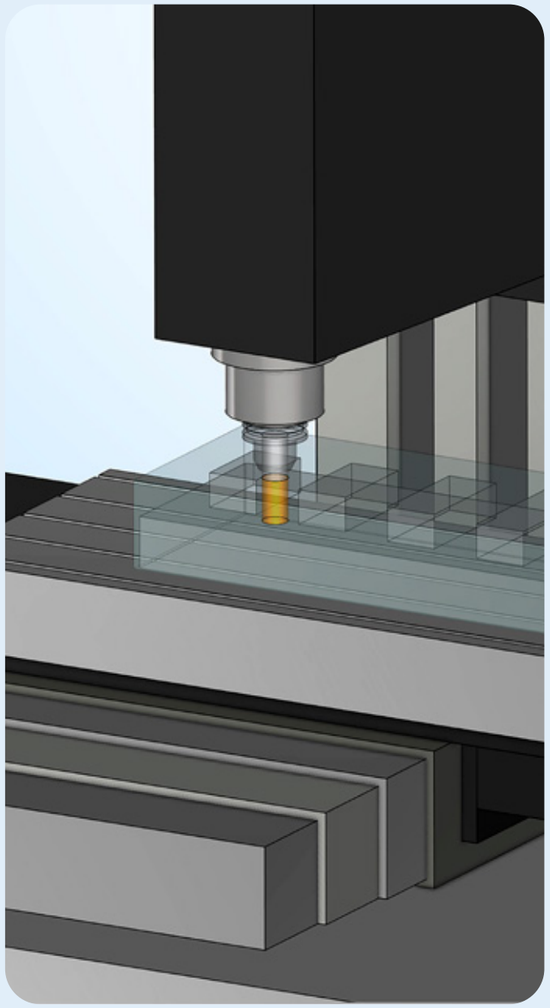
How do CNC systems contribute to sustainable product lifecycle management and the circular economy?

CNC simulations help stakeholders to assess the sustainability implications of different design decisions, such as material choices, energy usage, and recyclability. This enables organisations to develop more sustainable products and reduce their environmental footprint across the entire product life cycle.

The data and insights gained from virtual CNC machining can aid manufacturers plans for reuse, remanufacturing, and recycling of products, materials and equipment. Companies can thus incorporate more sustainable, circular approaches into the product life cycle.

How does CNC technology help in reducing tool wear and extending machine life?

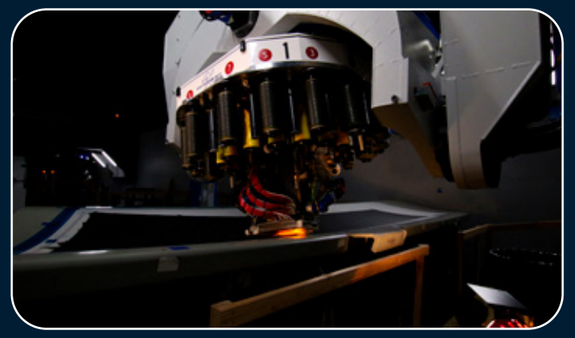
The machining quality and effectiveness of heavy-duty CNC machine tools are directly impacted by machining process parameters and CNC software analyses and optimises the entire machining process. Before beginning any actual machining, designers and engineers can test a wide range of characteristics of CNC machine tools and optimise



machining parameters to improve machine and tool performance. This will result in less wear and tear of the machine and tool, which in turn enables better maintenance planning, reducing the frequency of repairs, replacements, and downtime, which conserves resources.

What long-term sustainability advantages does virtual CNC manufacturing offer?

By continuously improving and optimising manufacturing processes, virtual CNC enables manufacturers to build resilient, environmentally friendly, and cost-effective production systems that align with future sustainability goals. The long-term sustainable benefits include resource conservation, energy efficiency, minimised waste, enhanced design for sustainability, and promotion of circular economy practices.



22 Challenges

Manufacturers are facing a complex set of sustainability challenges that span environmental, social, and economic dimensions.

As regulations tighten, consumer expectations rise, and environmental impacts become more scrutinised, manufacturers must adapt by adopting greener technologies, improving resource efficiency, ensuring ethical practices in their supply chains, and designing products with the full lifecycle in mind.

Manufacturers face a whole series of problems that intersect between CNC programming, planning, and production. Below is a summary of these challenges.

Requirements for product quality
Safety-critical components economic consideration.

Demands for higher process quality
Scrap and collisions versus high raw material and energy prices; delivery timelines; small profit margins.

Investing in technology with future perspective
Prompt return on investment even with small quantities; sustainability in financial & operational strategies.

Developing holistic process view
Based on the digital twin of machine, workpiece and machining process, the potential offered by the visualisation of future processes is to be developed.

Machining of new materials
Demand for safe, reliable, and high-quality processes.

Timely integration of new manufacturing processes
Integration of state-of-the-art technology during operation.

Personnel continuity and securing corporate know-how
Increased fluctuation, higher illness rates, lower motivation due to performance pressure and changing generations on the shop floor.

Reducing material costs
Proactive reduction of later operating costs.

Maintaining complete production documentation
Traceability of the product lifecycle for maintenance, material recycling

Business management manufacturing
Margin pressures especially when mitigating supply chain disruptions and shortages alongside fluctuations in demand.

Unconditional delivery reliability
Timely delivery of safety-critical products.

Digitalisation with future perspective
Prerequisites for industry 4.0 with artificial intelligence, machine learning, augmented reality, predictive maintenance etc.

Process transparency
Production and plant management need consistent data as a basis for planning.

Achieving zero waste and reducing scrap parts
High raw material costs, short tool life, managing chip thickness, loss of earnings, loss of reputation.

No broken tools & holders
High cost of spare parts, expensive downtime, loss of earnings, loss of reputation.

Reducing repair & replacement of fixtures
Required for lower expenses (time, personnel, spare parts etc.)

Reduce replacement of spindles
High spare parts costs, expensive downtime, loss of earnings, loss of reputation.

Shortening machine downtimes
Necessity to reduce production latency times.

Minimising schedule interruption
More problematic with longer cycle run times.

Maintaining sufficient machine capacity
Have room for agility during order peaks without buying additional machines.

Maintain high-quality, timely processing
Reduce orders lost due to quality issues or slow time-to-market.

6 Grand Challenges for Sustainability

1. Energy Use and Emissions:

Manufacturers must find ways and technologies that support the reduction of energy consumption and carbon emissions.

Tip:

By optimising tool paths, cutting times, material usage, and machine operations, CNC simulation software helps manufacturers reduce energy consumption and carbon emissions. These optimisations lead to more efficient machining processes that require less power, produce less waste, and reduce the overall carbon footprint of manufacturing operations.

2. Circular Economy:

Designing parts that are easier to disassemble, reuse, or recycle in order to support the shift to circular economy models.

Tip:

Only through adopting methods of process design, product design, and operational concepts that reduce energy and material consumption, the goals of green manufacturing can be accomplished. Through simulation, manufacturers can apply sustainability metrics early in the design and machining process, aligning production strategies with environmental goals.

3. Sustainable Material Selection:

There is increasing demand to evaluate and select more sustainable raw materials, while ensuring compatibility with machining processes.

Tip:

Some materials might be more challenging to machine due to hardness, brittleness, or poor thermal conductivity. CNC simulations help in fine-tuning machining parameters like feed rates, spindle speeds, and coolant usage, ensuring that these materials are processed efficiently and without excessive waste. This can help manufacturers avoid inefficient cutting processes that lead to increased energy consumption and material waste, which would undermine sustainability efforts.

4. Minimising Waste:

Optimising cutting strategies, improving accuracy, and reducing rework in the machining process in order to reduce material waste.

Tip:

By modelling how different materials will behave during the machining process and simulating factors such as tool wear, cutting forces, heat generation, and surface finish quality, manufacturers can predict how alternative materials will perform under real machining conditions. The ability to visualise and fine-tune the process before physical machining takes place ensures that resources are used efficiently, resulting in higher precision and less wasted material.

5. Environmental Regulations:

Increasing pressures to ensure that machining processes comply with evolving environmental regulations.

Tip:

Staying ahead of evolving environmental regulations can be a challenge for manufacturers and CNC simulation can play a vital role. It does this by enabling proactive planning, process optimisation, and compliance with laws surrounding waste, energy use, emissions, and material consumption. By allowing manufacturers to model, test, and optimise their machining processes virtually, CNC simulation ensures that they can operate more sustainably while still maintaining high levels of efficiency and productivity.

6. Water and Coolant Usage:

Optimising water and coolant usage in machining processes to reduce waste and prevent pollution, while maintaining process efficiency.

Tip:

CNC simulation offers manufacturers the ability to model, analyse, and optimise coolant and water usage before physical machining begins. By accurately predicting the most efficient use of resources, manufacturers can reduce waste, lower environmental impact, and ensure that their processes remain both cost-effective and sustainable.

3 Facts About NC Simulation

1. Procedures in Profile

Wherever milling, drilling or turning is done based on NC programs, NC simulation tools simulate the original NC code after the post-processing. Checking and optimising toolpaths are among the best practices for sustainable manufacturing. For users, the only sure way is to simulate an actual machining situation with a “virtual machine tool on the desk”. Ideally, NC simulation works independently of the CAM programming system, CNC machine, and controls.

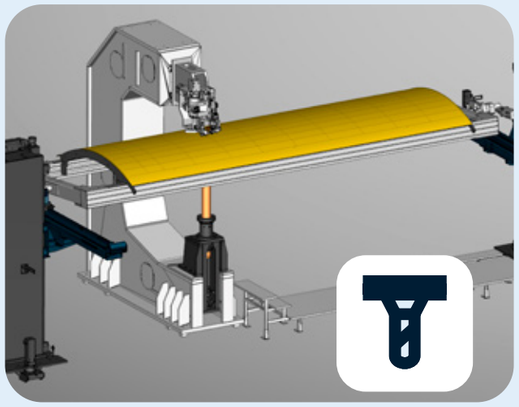
2. Present & Future

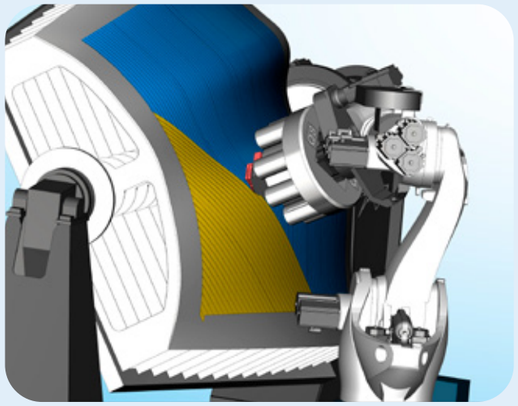
The simulation, verification, and optimisation of CNC machines allows for planning reliability by virtually mapping future processes in the present and eliminating potential errors and areas of inefficiency in the NC program before physically machining a workpiece.

The result - shorter cycle times and safe prove-outs, increased tool life, reduced tool breakage, no damaged fixtures, and no machine collisions. The fact that machining times are shorter, there is no more scrap and machining quality is significantly improved is of utmost importance in minimising waste and maximising sustainability.

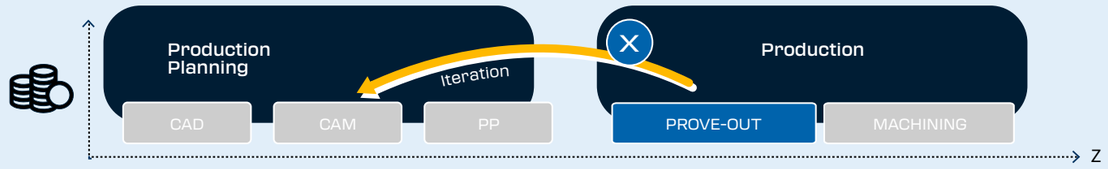
3. Resource Management

NC simulation creates a sense of certainty for production planning through the precise determination of manufacturing times. This makes it easier to optimise a traditionally sequential workflow in metal-cutting production and opens up the ability to run parallel projects. Simulation allows for better machine utilisation, employee relief from routine tasks and program rework, and fewer delays or rescheduling of production plans.

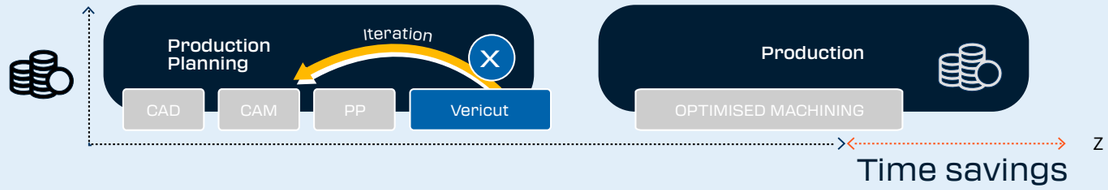




Conventional Process Chain



Process Chain with Vericut



Time savings

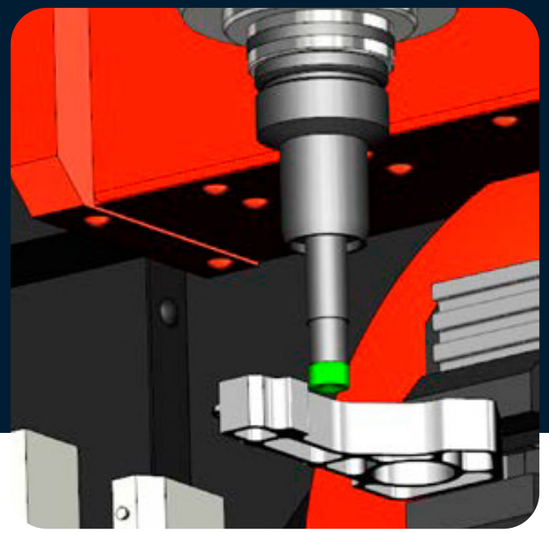
Capital Expenditures & Depreciation

NC SIMULATION

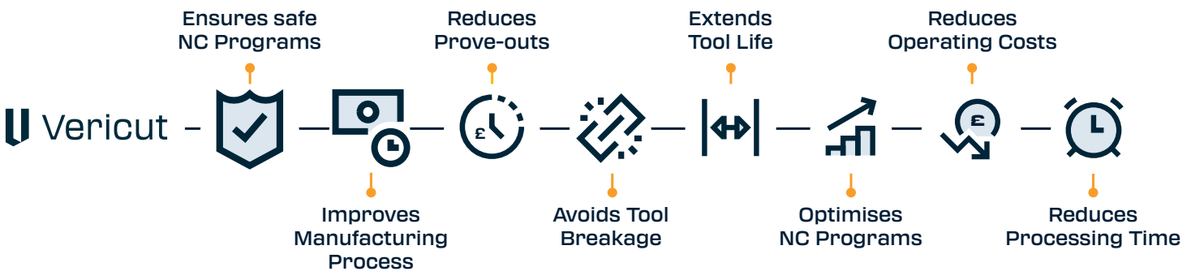
As industries shift and transform, both now and in the future, manufacturers need to persevere and face the challenge head on in order to survive, especially in their production. These processes are the operational heart of the business, where milestones in the value chain are often set and measured. Production processes are the key to driving innovation forward and enabling operational efficiency while achieving sustainability goals, creating and growing competitive advantages, and building resilience when faced with a new “normal.”

Manufacturing as a whole is under enormous pressure to be more sustainable, but this requires a balanced approach in financial and operational strategies. Implementing and utilising new technologies, new materials, and new manufacturing processes can pose large challenges for companies.

Nearly every budget set aside for innovation is the subject of intense discussion. An investment in NC simulation, however, is typically out of the question. A rough calculation of the return on investment with NC simulation is extraordinary and can be paid back in as short a time as machining a single workpiece. NC simulation has been used since the 1980s, utilising digital twins of the CNC machine, workpiece, and the NC program, making it one of the main players and a key investment in today’s sustainable initiatives.



What does Vericut do?



Example Return on Investment

Days / Weeks	5
Hours / Shift	8
Shifts / Day	2
Weeks / Year	48
Number of CNC machines	5
Hourly capacity / Year	19,200
Prove-out	5%
Reduction of prove-out time by a prior NC simulation	960 Hours/Year
Hourly rate of cnc machines	£80
Savings per year	£76,800

Calculation based on average data from Vericut

Why NC Simulation?

- Avoid machine collisions
- Safe prove-outs, even with complex clamping set ups
- Reduce prove-out times
- Increase tool life
- Faster NC programs
- Improved part quality
- Reduced machining times
- Detect differences between design model & simulated part
- Increased machine capacities
- Problem-free setup of new parts
- Avoidance of scrap
- No rework, schedule deviations, or delivery delays
- Reduced stress level
- Relief of employees
- Protect expensive production equipment
- Reduce production costs
- Easy integration into digital ecosystems

Mirror Worlds

THE DIGITAL TWIN IN NC SIMULATION
Digital twins are the basis of every NC simulation. They are the logical starting point of any digitisation initiative and the interface between NC programming to work planning and production.

Digital Twin History

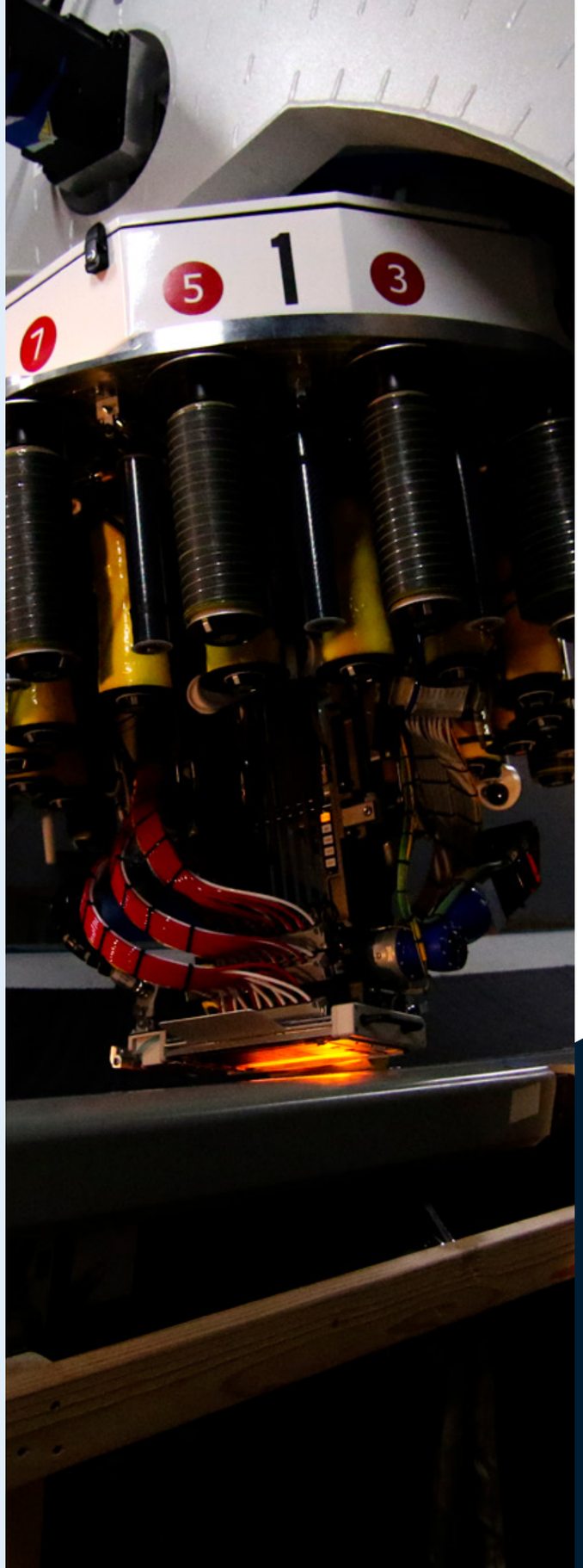
In 1991, David Gelernter is said to have written Mirror Worlds: Or the Day Software Puts the Universe in a Shoebox (Oxford University Press,1991), which first announced the technological idea of the digital twin. Dr. Michael Grieves (University of Michigan) applied the concept of digital twins to manufacturing and also addressed corresponding software. NASA's John Vickers is said to have coined the term "digital twin" in 2010.

Definition

Digital twins are representatives of real objects in the digital world. The real objects, the physical twins, can be material (machines, workpieces) or immaterial (processes).

Features & Benefits

What is the real benefit of utilising digital twins? Digital twins of process plants can be crashed and then restored and optimised with a single push of a button. Using digital twins enables more efficient interaction between assets. Matching data between digital machines and physical machines is also productive, bridging the present and the future. These simulations are considered a real part of the present that can be used to anticipate future physical states of machines and parts to make better-informed business decisions. Digital twins are an excellent source of knowledge around insight, avoidance, prediction, and optimisation.



Twins in NC Simulation

In digital form in order to be able to simulate, verify or optimise

- Machines, geometries, and movement
- NC Program
- Fixtures
- Stock
- Design Model

Set Up of Digital Twin

What needs to be considered when setting up a digital twin? It's best to understand what the digital twin will be used for. In NC simulation, this is often based on its intended task such as monitoring, simulating, and optimising NC programs prior to machining. They can also be used to collect data from the machine for predictive maintenance or other condition-based monitoring. It's best to start small and expand the capabilities of digital twins as needed.

Building a digital twin for your machines often requires detailed knowledge of the CNC machine. Designing digital machine models requires experience, data, and information from machine tool builders. Connecting digital twins to CAD/CAM systems makes it easier to access and reuse data and information from previous projects.

Three Level Approach

NC simulation is based on three levels of digitised information.

LEVEL 1:
CNC MACHINE

- Machine kinematics
- Travel limits, number of axes, how far, how fast
- Machine model and specifications
- CNC control and parameters

LEVEL 2: PART SET-UP & MATERIALS

- Size and shape of the stock
- Fixtures
- Clamping, vices, bolts
- Design model and stock
- Impact material on tooling etc. parameters

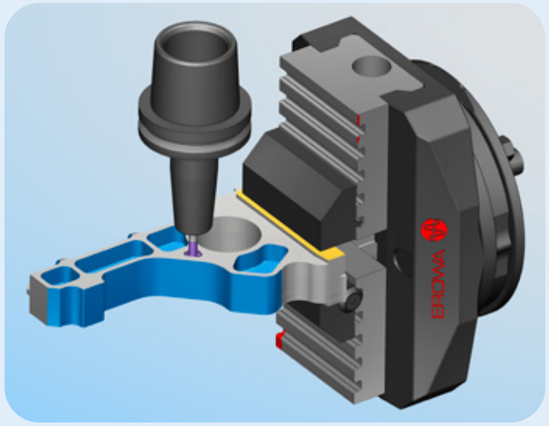
LEVEL 3:
CUTTING TOOLS

- Information on cutting tools and process dynamics during machining
- Length of cutting tools, influence of the tool path on tool and material
- Data from the tool management system

Sense & Nonsense

EXTERNAL PROGRAM CHECK
VS. INTERNAL PROGRAM CHECK

Should you use an external, dedicated NC simulation software or the integrated verification of the CAM system? The ability to visually inspect the machining process within an internal program is considered an add-on, while the verification of the NC programs through dedicated simulation and verification software outside of the CAD/CAM system is a must-have. After all, a single overlooked error can ruin a workpiece, damage the tool, or lead to a machine collision.



What is checked by an internal verification system?

Integrated verification systems are limited to checking the internal CAM file. The problem is that this file will be translated one or more times before going to the machine. An internal check is really just one part of the programming process – it does not replace the need for real simulation of the post-processed NC code!

Are internal verification systems trustworthy?

A CAM system checking its own tool path is like a student grading their own test. There is too much on the line when you send a new program to the shop floor. Would you trust it to do an internal check? As it can track and optimise shop throughout.

Where does integrated verification software come from?

CAD/CAM systems often “license“ other companies‘ inspection technology. Development of this technology is usually out of their hands. Errors in the program are not subject to their control, and they have little or no influence on optimisations and enhancements.

Can the internal system simulate real situations?

Unlike internal systems, external tools simulate specific, actual machine movement, and any programmed machining processes. External simulation software should simulate your exact machining environment, including multiple axes of movement, rapid motion, multiple setups, complex tool shapes, holder collisions, fixture collisions, machine kinematics, complex controller functions, and more. Anything that can influence how a part is machined should be included in simulation.

What about flexibility and consistency?

Internal verification programs often lack flexibility and consistency. Internal verifications cannot verify outputs from other CAM systems. These verifications also can’t be used to check any code modified outside the CAM program. Utilising an external software enables you to use the same system to check tool paths from any CAM system, as well as any manually programmed G-codes. You achieve systems consistent, trustworthy verification across all your CAM systems.

Tools and Benefits NC Simulation Offers

Simulation of complete CNCs to detect collisions

In a way, complete simulation allows companies to look to the future. Simulations use the same control logic and data from the machines. This means that what happens on screen should be precisely what happens on the machine.

Compare the virtually manufactured workpiece with the original model of design

This way, you can be sure that the machined workpiece corresponds exactly to the designed part.

Tool path optimisation

Optimise the feed rates and spindle speeds in your NC program. Faster and more efficient tool paths cause less wear on the tool and produce higher quality surface finishes.

Export the virtually manufactured CAD model

Close the loop of the manufacturing process by loading the manufactured part you are working on back into your CAD system to design any matching parts, determine additional downstream processes, and more.

STEP 1
CAM interface sends data to the external simulation software.

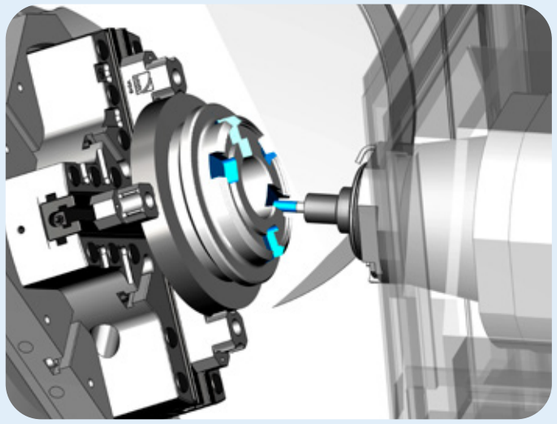
STEP 2
External simulation software validates the NC program.

STEP 3
Review simulation results immediately.

STEP 4
Document the process.

Workflow CNC Machining with Vericut

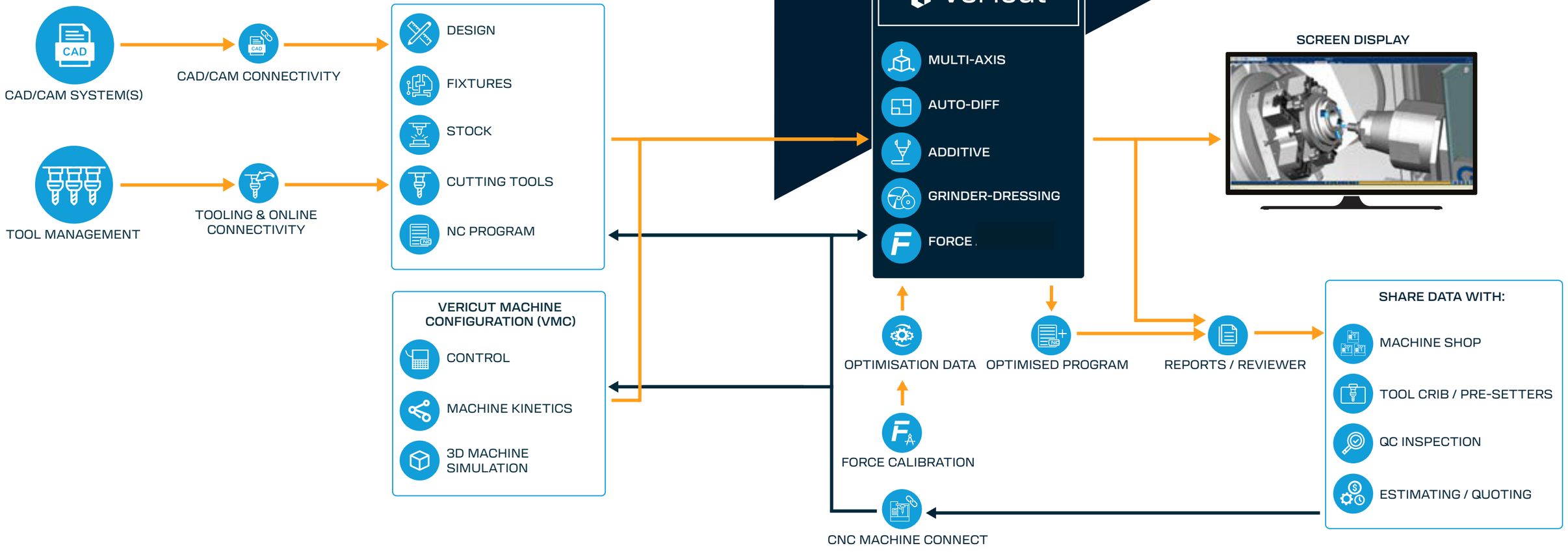
Process at a glance.



“”

Set up the machine. Insert workpiece.
Press button. Done.

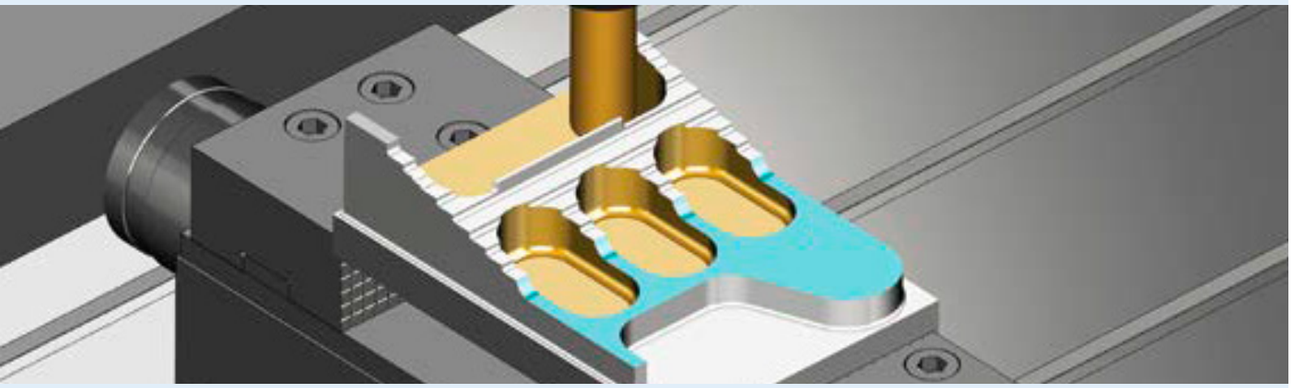
If you can work in this relaxed manner, you have eliminated damaged setups, rejected parts, or tool breakage even before the actual machining operation. Simulation solutions like Vericut are made to achieve this. Vericut is the worldwide industry standard in NC program simulation, allowing users to virtually machine their workpiece to verify and optimise their NC programs prior to running them on the shop floor. Only tested, error-free NC programs are sent to your machines.



Vericut Optimisation

Unoptimised Optimised

- Reduce machining time by 15-25% or more
- Increase cutter life and improve surface finish
- Optimise any CAM or manually generated tool path



The Maximum Reliable Feed Rate

VERICUT FORCE

Force calculates the maximum reliable feed rate. The technology was co-developed by United Technology Corporation (UTC) and CGTech for more than seven years. Force is ideally suited for difficult-to-machine materials and complex multi-axis operations. Force determines the feedrate for a particular cutting condition based on four factors; maximum chip thickness, cutting force, spindle power, and maximum permissible feed.

PRACTICAL OPTIMISATION

With Force, interactive charts make it easy to identify and improve sub-optimal cutting conditions in the NC program. The user then has two options:

- Allow Force to automatically choose ideal feedrates on the basis of chip thickness, cutting force or spindle power.
- Modify the NC programs by re-

FAST RESULTS

- No expert user knowledge necessary
- No complicated software tests necessary
- No reprogramming necessary
- Functions perfectly with aggressive material removal

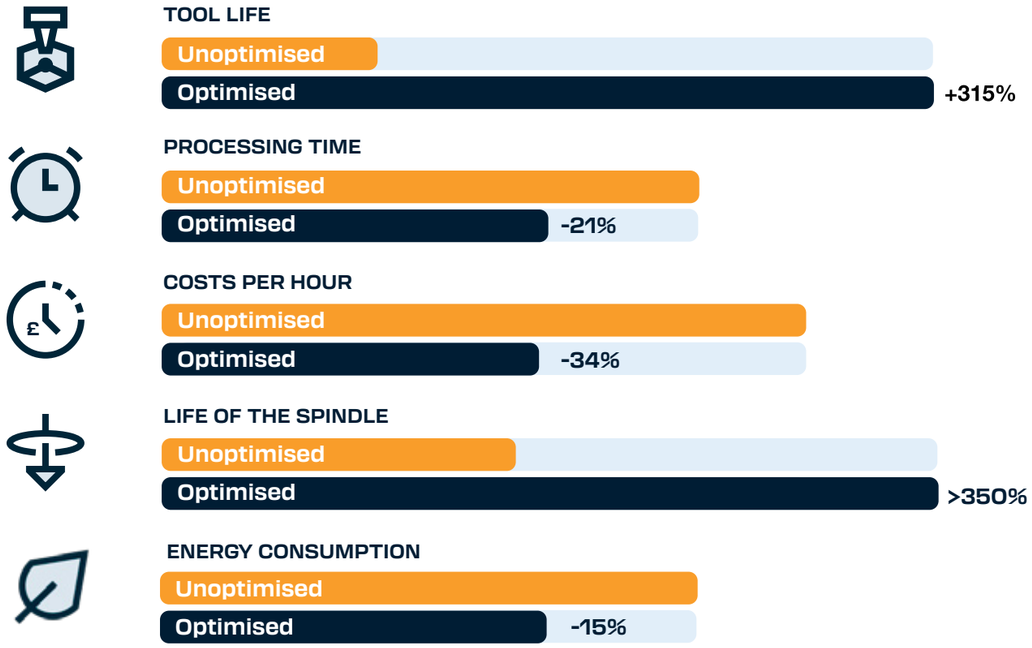
INCREASED PRODUCTIVITY

- Shorter machining times
- Improved part quality
- Less tool wear
- Constant cutting conditions

VERICUT OPTIMIZER

Vericut optimisation capabilities are also available as a standalone solution. Vericut Optimizer does not need Vericut verification and is designed to integrate with all software on the shopfloor.

Vericut Optimisation Calculation Example



Comparison test: Performed with SANDVIK Coromant

How NC simulation Supports the Three Pillars of Sustainability

ECONOMY

- Reduce prove-out times
- Prevent machine collisions
- Increase machine capacities
- Shorter set-up times for new parts
- No rework
- No deviations from the plan
- Shorter production cycles due to:
  - Feed rate optimisation
  - Improved part quality
- Reduce tool wear
  - Avoids tool breakage
  - No damaged fixtures
- Increase productivity through smart use of freed up capacities for both employees & machines
- Shorter time to market
- Reputation gained through reliable delivery and use of the industry standard of NC simulation
- Simulate complex clamping and fixture setups
- Faster time-to-market
- Reliable prove-outs
  - Use faster, optimised NC programs
  - Protect expensive production equipment

ECOLOGY

- Reduce scrap during prove-outs
- Lower resource consumption and CO2 footprint
- Increase energy savings thanks to shorter machining, avoiding unnecessarily long cycle times
- Avoid producing faulty or flawed batches
- Paperless, with end-to-end digital processes - within the company and in exchange with customers and partners
- Energy and material savings by eliminating non-essential processes (travel, waiting, latency times)
- Increase in tool life
- Reduced expenses for maintenance

SOCIAL

- Maximum operational reliability of feedrates increases occupational safety
- Prevent machine-related accidents at work
- Protect employee health by sustainably reducing complexity and increasing employee motivation in CAM programming and manufacturing
- More relaxed employees with less anxiety over collisions, scrap, tool breakage, faulty, inefficient machining, etc.
- Personnel-independent process
- Knowledge transfer through software facilitates training of new employees
- Securing corporate knowledge through digitalisation of machine models, tool, fixtures, and stock material

Testimonials

> Sustainability is a fundamental necessity across all industries, and manufacturers, in particular, should be installing practices, strategies, and innovations that encourage responsible resource management and streamline processes.
>
> Software can play a vita role, and Vericut truly is leading the way in sustainability with its software solutions. By verifying and optimising NC programs in the Vericut virtual environment, manufacturers can achieve safe, efficient, and optimal manufacturing processes that mitigate waste and reduce energy consumption, while increasing capacity.

Mats Lundberg
Head of Sustainability, Sandvik Group

> When running Vericut Force optimisation we saw a 15% reduction in energy consumption: that was our bottom-line result for the whole machining process.

Björn Ljunggren
Sandvik Coromant

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System requirements are subject to change.
See the Vericut website for the most up-to-date product information and system requirements.