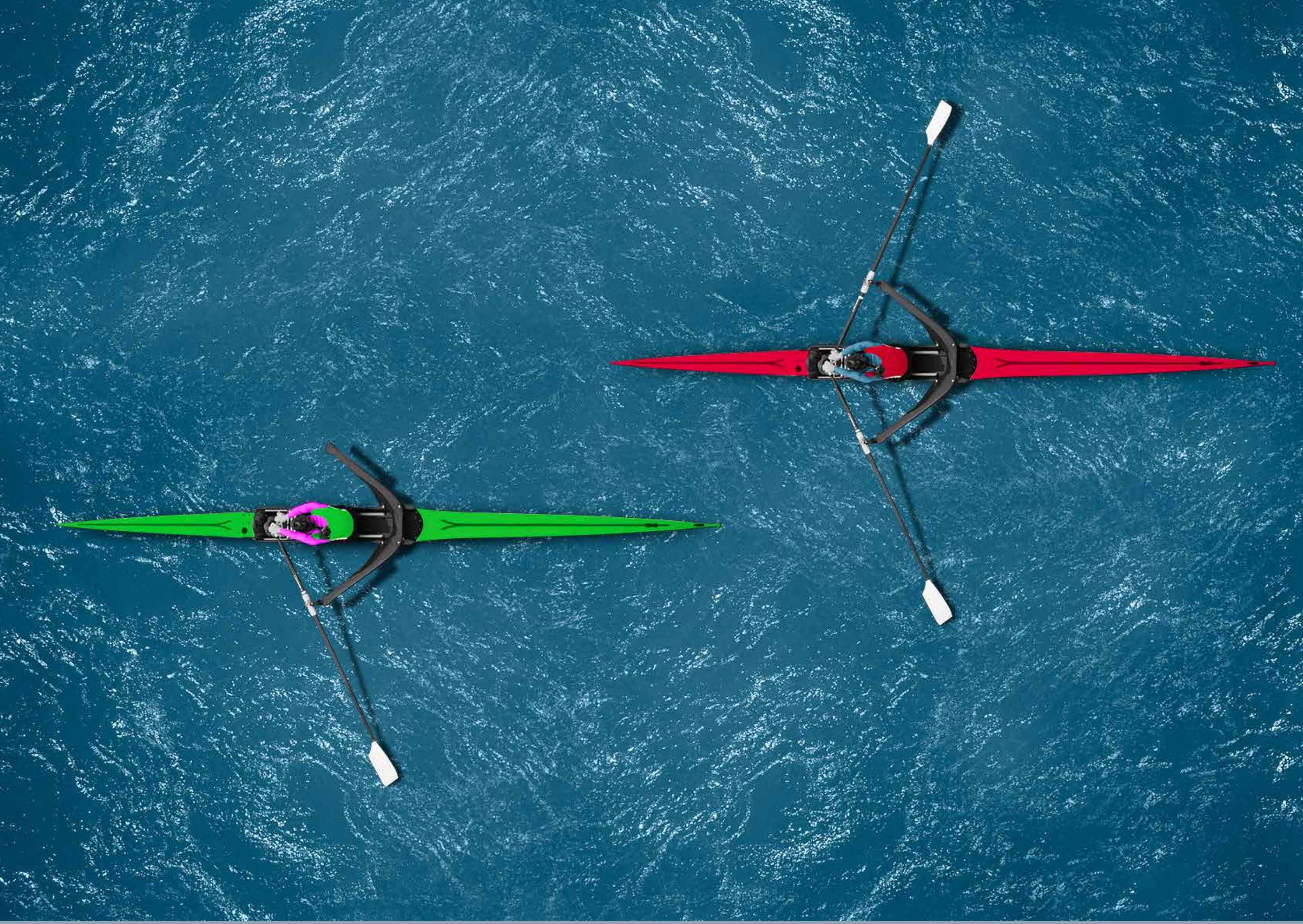


Automate halfway? Try rowing with one oar.

Six arguments for why you should fully automate your CAD/CAM processes

Useful arguments

tebis
CAD/CAM MES
Software & Services

Author: Torsten Fiedler, Tebis AG

In times of price increases and shorter product cycles, it is essential to utilize existing technologies and resources. CAD/CAM experts agree: This goal can only be achieved with complete, consistent automation of the CAD/CAM processes. However, many die, model and mold manufacturers and production machining companies only half-heartedly implement automation once they have started. They let the skeptics in their company slow them down. Their concerns are understandable.

Do you recognize these red flags?

- CAM programmers use their CAD/CAM templates with little or no consideration for generally applicable standards.
- It takes too long for new employees to learn to work with existing processes, despite the use of template technology.
- The system components stored in virtual databases, such as tools, machine centers or clamping devices, do not correspond to the actual manufacturing environment.
- The manufacturing environment is unstructured, and your employees spend too much time looking for suitable tools or clamping devices or free machines.

But have you also experienced reservations about comprehensive automation measures?

- They are expensive and time-consuming.
- It's not worth it for an operation of our size.
- Our geometries are far too complex.
- We are taking too much responsibility away from our employees.
- Automation moves us towards "average" and we lose our uniqueness.
- Are automated process flows really safe?

We have compiled six arguments to help you convince even the most die-hard skeptics of end-to-end automation of CAD/CAM process flows.

If you only automate halfway, you will lack the power you need – just like the rower in the green boat.
They are only rowing with one oar - and falling behind their competitors.

You can use these six arguments to convince the biggest skeptics of automation:

First an evaluation – three questions, three answers

What is automation all about?

In this context, CAD/CAM automation means combining repetitive activities entailing multiple individual work steps into templates in the CAD/CAM software. This enables these steps to be performed with a minimum number of instructions.

The goal is to send a complete collision-checked NC program to manufacturing, optimized for machining time and quality.

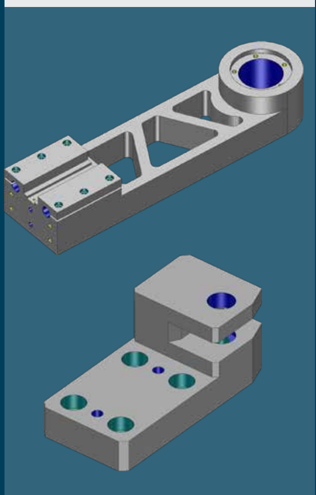
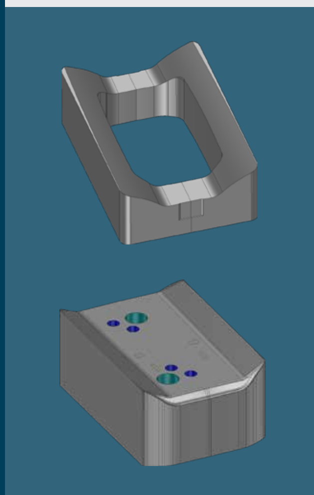
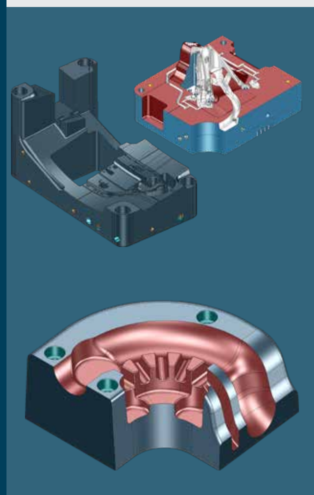
What role does the intelligent part play here?

The intelligent part, i.e. the CAD model file, essentially "knows" how it has to be set up and manufactured: With which machine, with which zero point, with which clamping devices, with which tools and cutting data and with which strategies.
Because it knows the precise real and structured manufacturing environment, it only accesses parts that are actually available.

What requirements should be met?

Parts and activities should be categorized
Parts of similar complexity and structure that are manufactured using comparable strategies and machining sequences and using comparable tools and cutting data can be categorized and combined in part classes. The work steps required to manufacture these classes are automated to the extent possible on this basis. Possible part classes in die and mold manufacturing are mold cores, mold inserts, trim and coining steels or guides. Part classes in production machining are structural parts with simpler prismatic geometries such as planar surfaces, pockets and bores.

Examples of part classes:

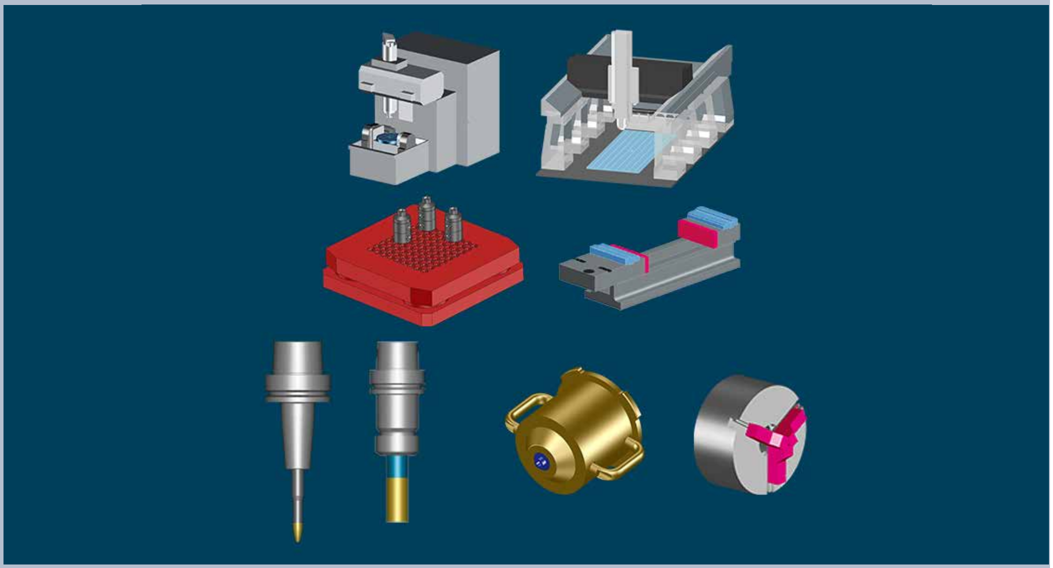
Class 1	*Class 2*	*Class 3*
		
Simple prismatic geometries	*Simple geometries with free-form section*	*Complex geometries*

What requirements should be met?

All process participants should access the same knowledge and should use templates in a uniform and standardized manner
Suitable templates are stored for these part classes. Despite standardized templates, CAM programmers should be able to intervene interactively at any time. This enables automation of up to 40 percent of the activities – even for complex parts.

The actual manufacturing environment should be represented true to detail in digital databases

- All machines with all kinematics and auxiliary equipment such as pallets, heads or tool measurement systems.
- All component-based tools with cutting edges, holders and intermediate holders, including the manufacturer's recommended cutting data for each available material.
- All clamping devices, from simple vises to zero-point clamping systems and complex clamping devices.



1 We can deliver faster because we save so much time along the entire process chain

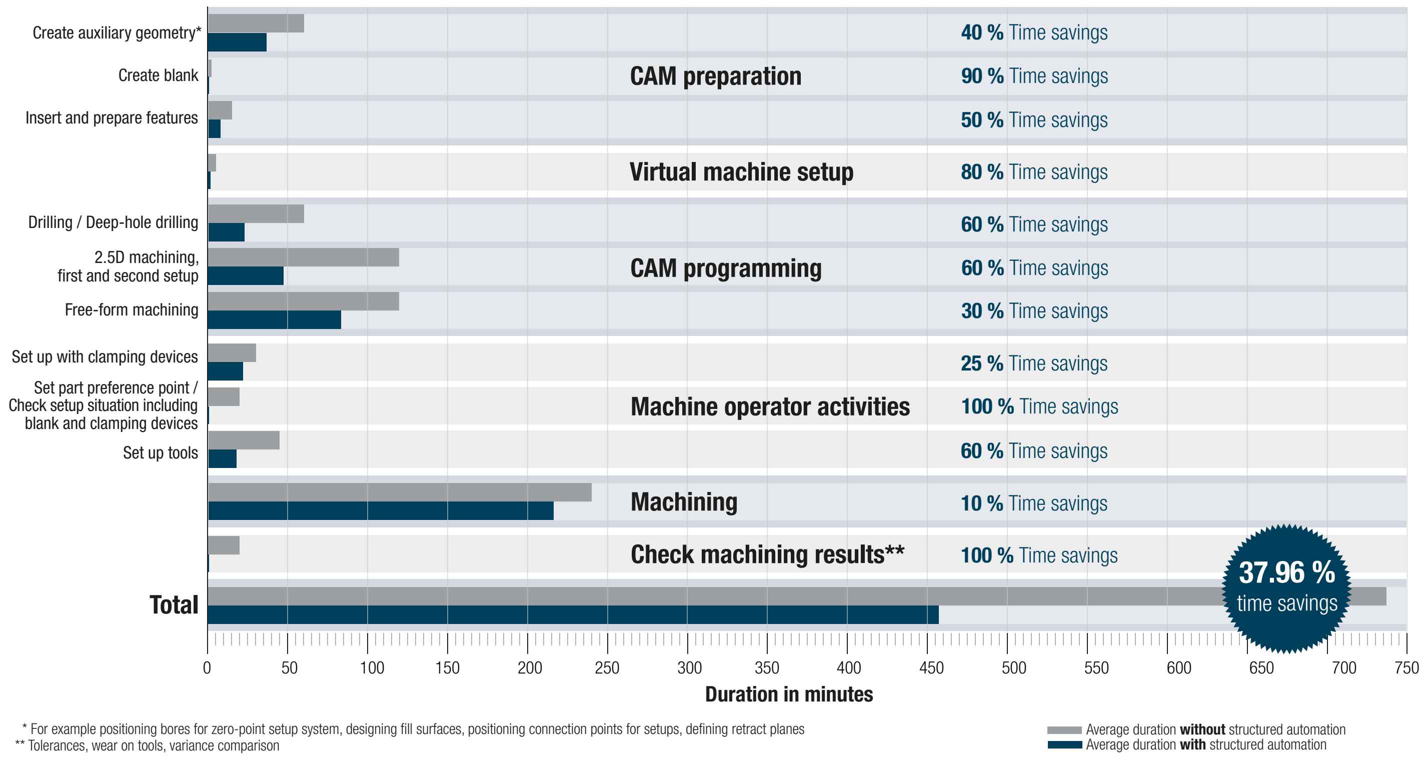
Expected delivery times now play an extremely important role in contract awards. Some die and mold manufacturers strive for a timeframe of six weeks, hardly a magical number. If they can produce molds and dies within six weeks, they are awarded the contract – even if their price is 30 to 40 percent higher than that of the competition.

The good news: These tight deadlines can be achieved with structured automation solutions.

This generally enables simple 3D parts with a high prismatic fraction to be programmed and manufactured automatically. However, structured automation solutions can save a lot of time, even for complex parts with a large fraction of free-form elements. This assumption has been confirmed by the analysis of many customer projects.

Overview*: This analysis includes small and medium-sized companies who already implemented initial automation measures, but may have only partially fulfilled the above three prerequisites.

Result: After implementing structuring measures, the project partners achieved an average time savings potential of nearly 40 percent. As can be seen in the following table, the results account for all process steps, from importing the CAD data to machining on the machine.



* For example positioning bores for zero-point setup system, designing fill surfaces, positioning connection points for setups, defining retract planes
** Tolerances, wear on tools, variance comparison

** The analysis is based on approximately 350 customer projects supported by Tebis Implementation from 2010 to 2021.*

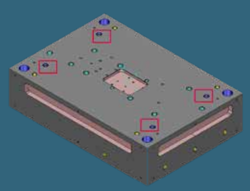
Analyzing the process

Practical examples of how these time savings can be achieved are considered below.

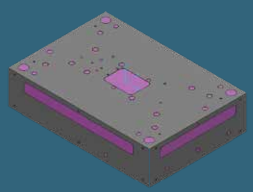
Generating auxiliary geometries and blanks*.

Placing bores for clamping systems, designing fill surfaces for roughing, generating blanks, generating connection points for various setups, specifying retract planes – these are all typical examples of repetitive activities in CAM preparation that can be summarized in CAD templates. The CAD templates can be extended as necessary.

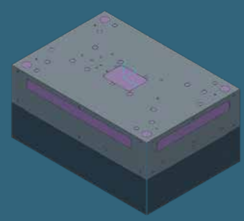
Placing bores for zero point clamping system



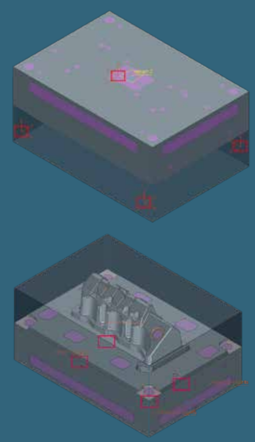
Designing fill surfaces



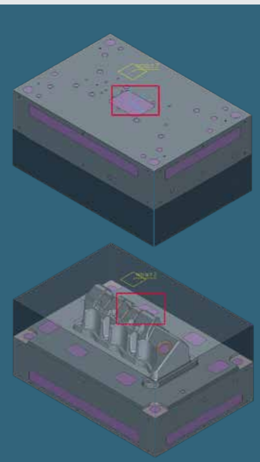
Creating the blank



Creating connection points for the first and second setups



Specifying retract planes for the first and second setups

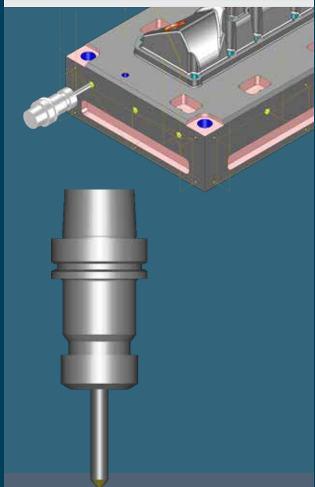


Inserting features

Features hold the manufacturing information. They link ruled geometries like bores, pockets and prismatic elements to standardized NC sequences that can be stored in automated CAM templates. Based on its geometric properties and the characteristics of the processing machine, the CAD/CAM system independently determines how the individual geometries are to be manufactured – with which tools, with which cutting data and in which logical processing sequence.

For example:

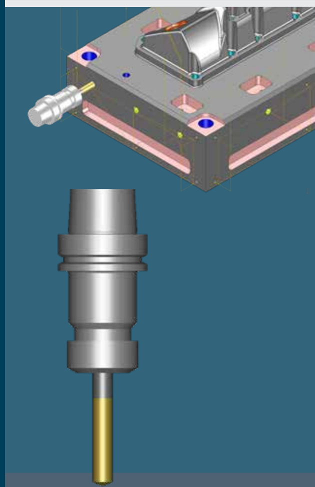
1. Centering



Technology values

Technology group	machine group 2
Category	drilling
Material	steel
RPM	1094
Feed rate standard	109
Feed rate spot drilling	54
Feed rate start-up	33
Feed rate retract	164
Cooling	No cooling

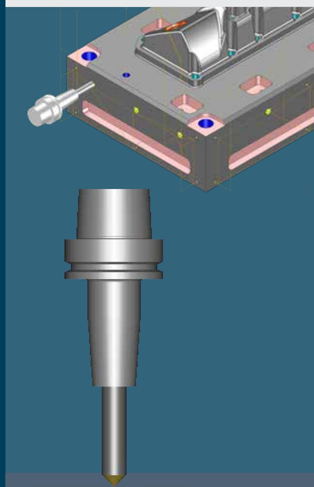
2. Tap hole drilling



Technology values

Technology group	machine group 2
Category	drilling
Material	steel
RPM	1137
Feed rate standard	171
Feed rate spot drilling	85
Feed rate start-up	51
Feed rate retract	256
Cooling	Outside water

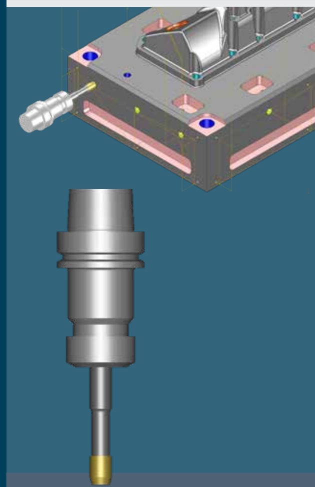
3. Chamfering



Technology values

Technology group	machine group 2
Category	drilling
Material	steel
RPM	1094
Feed rate standard	109
Feed rate stepover	109
Plunge feed	109
Feed rate ramp	109
Full-cut feed	109
Feed rate corner	109
Feed rate positioning	2500
Cooling	No cooling

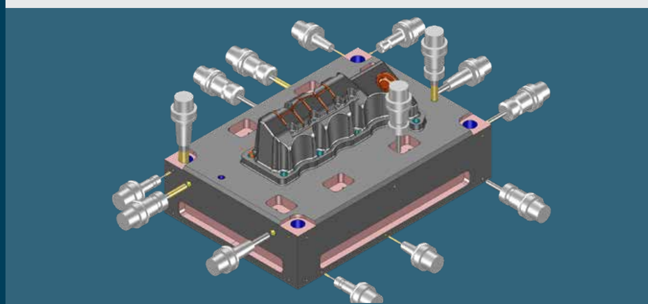
4. Thread cutting



Technology values

Technology group	machine group 2
Category	drilling
Material	steel
RPM	398
Feed rate standard	40
Feed rate spot drilling	20
Feed rate start-up	12
Feed rate retract	60
Cooling	Outside water

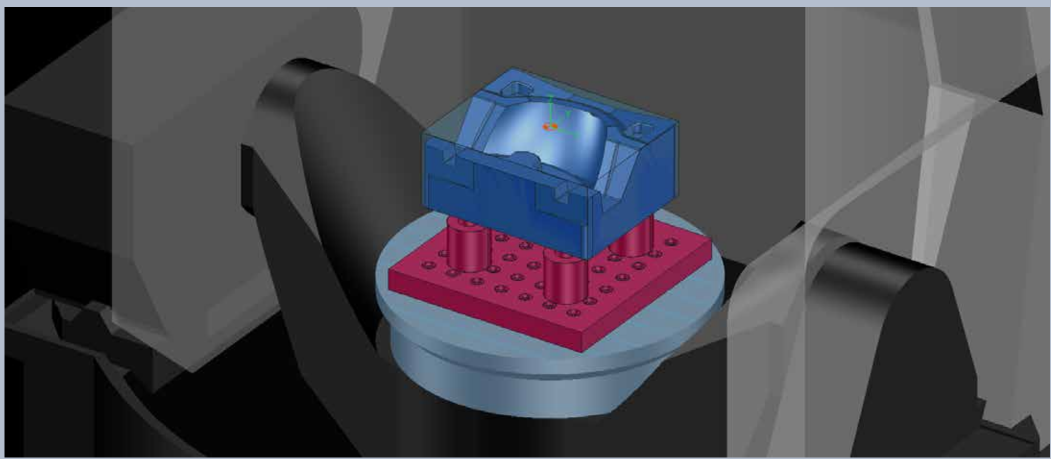
Features can also be sorted by machining direction, saving even more time.



Virtual machine setup

In the virtual setup of the machine, the appropriate clamping devices are now positioned automatically, based on the connection points generated in preparation. The integrated plausibility check accounts for the specific parts, the stability requirements of the machine and machining at the maximum possible cutting performance.

The clamping devices and clamping device groups, from simple vices and zero-point clamping systems to complex clamping systems with various fixtures, are managed in a virtual clamping device library.



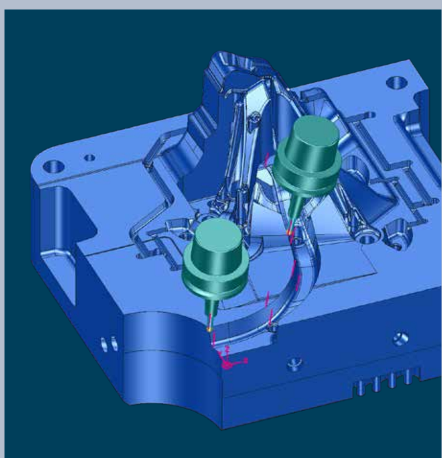
Generating CAM programs

The toolpaths for multi-sided machining of all ruled geometries can be generated fully automatically in a single CAM program with NC templates based on the manufacturing information contained in the features.

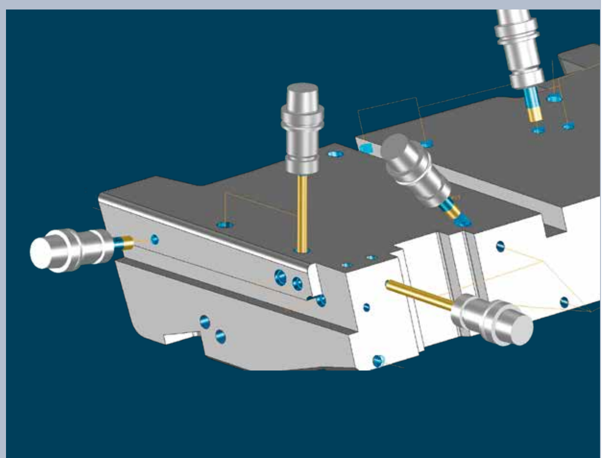
A suitable alternative strategy is automatically assigned in the event of subsequent changes, such as because tools are missing.

Machining of free-form geometries can also be automated successfully, often up to 100 percent for roughing.

The following applies for finishing and residual stock machining of complex geometries in single-part production: If there are stringent requirements for surface quality, dimensional accuracy and precise tolerances, the programmer needs to optimize the automatically generated CAM program. For example: The CAM template can indicate whether to automatically convert 3+2-axis toolpaths to 5-axis simultaneous toolpaths in the event of potential collisions. The programmer subsequently perfects the resulting milling pattern: Vectors are positioned for targeted changes to traverse movements and tool tilt direction.



Optimizing tool approach via vectors



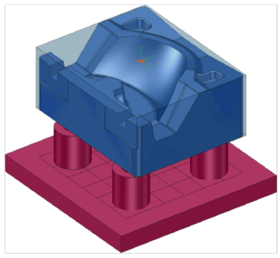
Fully automated multi-sided machining

Realistic setup

The virtual setup results reach the setup station with no loss of information. Precise and detailed NC documentation is automatically generated with clear component designations on NC output. The person responsible for setup can immediately see which tools and clamping devices are needed and how the clamping devices are to be positioned.

Pre-machining_soft_DMU_65mB

Commission	Tebis V4.1
Part designation	Mold part
Part number	03A
Change date	1.1
Job No.	6789
Creation date	04.11.2020
Change date	04.11.2020
Responsible	Joe Miller
Machining sequence	
Remarks	Manufacture faster
Comment	
CAD file	fcs_setup.cad



List of required clamping devices

Number	Clamp Elements	Comment
4	BODY-M16-H80	
1	BASE-GAUGE-M16-TR-400X400	
4	BODY-M16-M10-H25	

List of small parts required

Number	Small parts	Comment
4	0001-00501	
4	0001-00800	
4	0002-01200	
4	0002-01600	

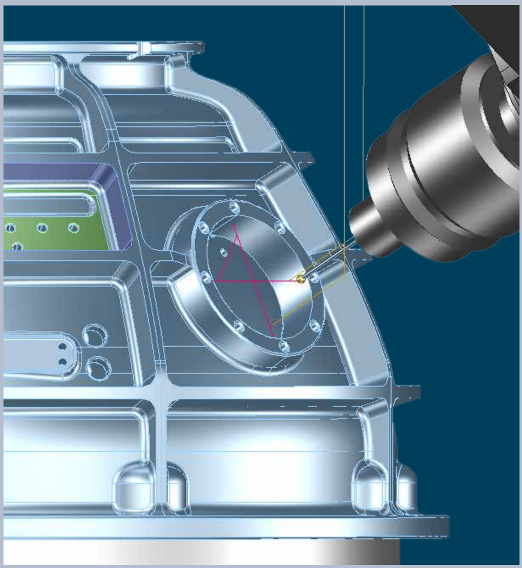
The NC program also relieves the machine operator of all checking tasks:
Measurement probes automatically calibrate the workpiece zero point, and the NC program directly controls checking of the clamping situation, accounting for the blank and the clamping device.

Machining

If strategies, tools and their cutting data are precisely adapted to the manufacturing task and the tool paths are collision checked, the machine can reach its full potential – with highly dynamic and fast traverse movements, short tools, the maximum possible feed rates and minimum retract movements.

Checking machining results

Final checking of the machining results is also integrated in the NC program and runs automatically.
This includes checks such as the variance comparison of the virtual and real finished parts, determination of tool wear and checking of the specified tolerances.



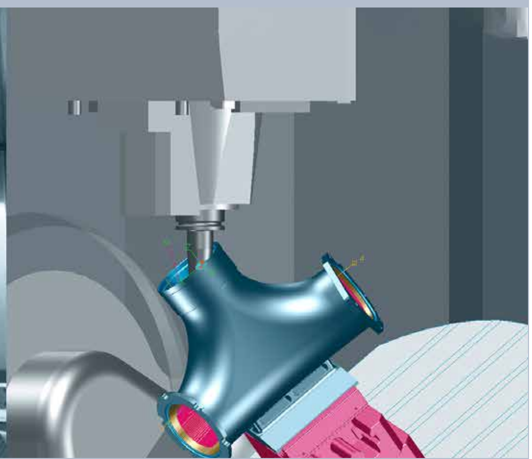
2

Our manufacturing is safer

Automation has a strong basis in trust. You have to be able to trust 100 percent that your manufacturing is absolutely safe. Only then can you fully capitalize on the potential of your expensive, high-performance machines with automatically generated toolpaths and machining situations that are often very “close.”

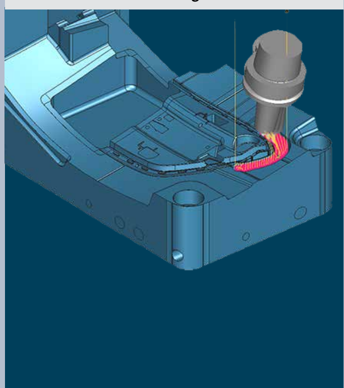
This safety is ensured with precise digital twins. True digital twins are not based on simplified faceted equivalent geometries. Instead, just like the real manufacturing situation, they reflect the real manufacturing environment on a one-to-one basis in the virtual world. This enables integrated, time-saving verification of the toolpaths, i.e. simulation and collision checking directly in the CAD/CAM environment even before NC output while fully accounting for reference points, tool change positions and traverse and head movements.

This simultaneously fulfills the most important prerequisite for multi-machine operation: The more automated and safe your manufacturing is, the fewer machine operators you will need to operate your machines efficiently.

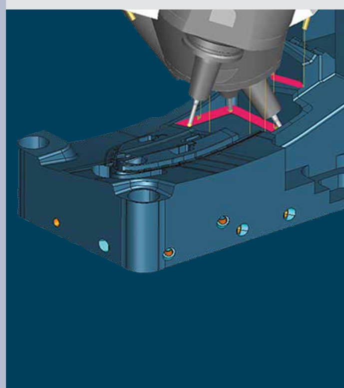


Furthermore, collisions can be automatically avoided already in the CAM calculation. This saves more time and reduces user errors, since these strategies can of course also be stored directly in CAM templates, based on the machining task and machine kinematics. These include automatic 5-axis simultaneous avoidance milling, automatic indexed avoidance milling and automatic area reduction, fully accounting for the machine head.

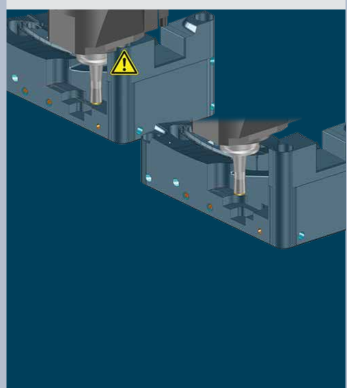
5-axis simultaneous avoidance milling



Indexed avoidance milling



Area reduction



3 We can consistently achieve the optimum surface quality

The topic of surface quality is highly complex – too complex to be left to the expertise of individual specialists. It should be possible for all CAM programmers to reproduce the desired result at any time. This requires that this knowledge also be included in the CAM templates.

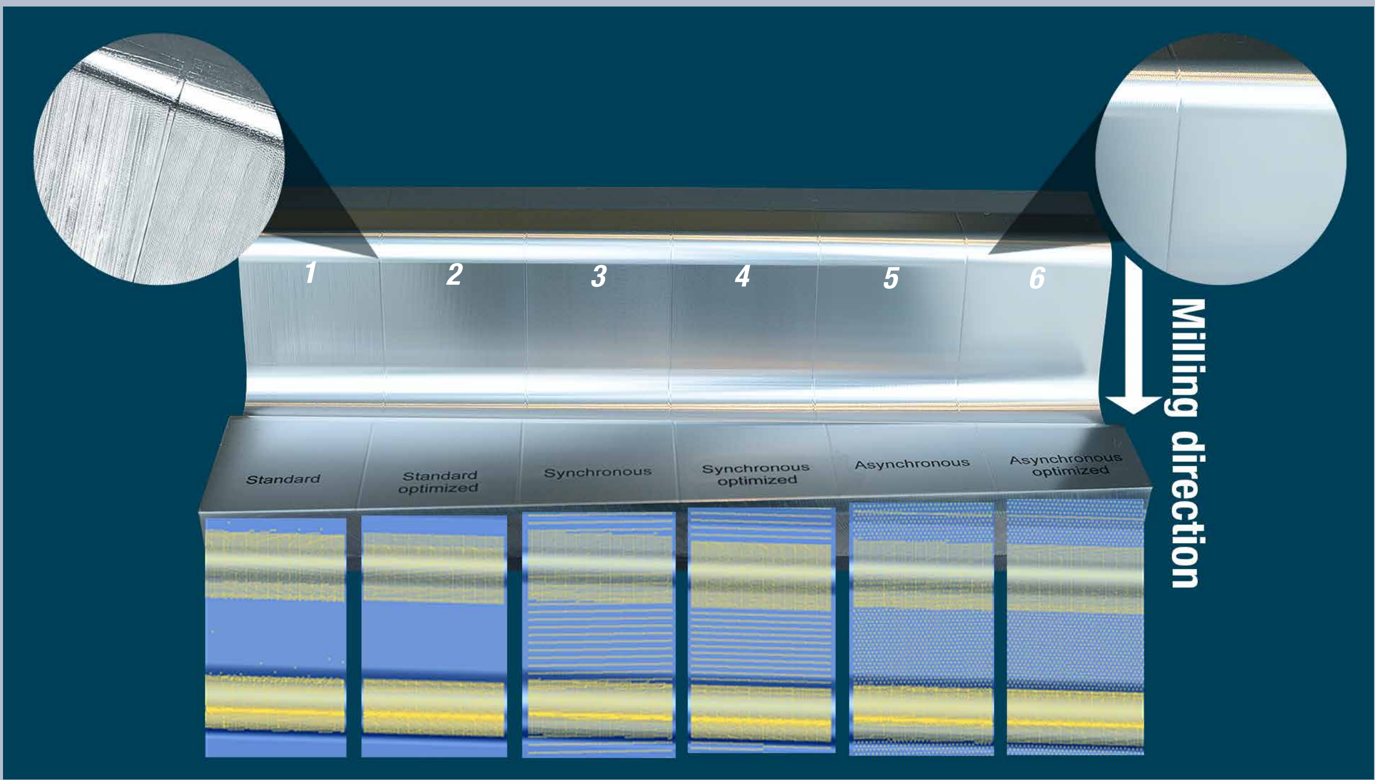
Here are a few examples of questions the user no longer has to ask – because the automated templates essentially relieve them of the need:

- Which feed rates should I use?

> Feed rates are automatically reduced in areas such as sensitive radii.

- How should the NC points be distributed on the surfaces?

> The distribution of the NC points affects precision and path quality and machining time: The more points, the better the result, but the longer the machine runs. The point distribution in the templates is precisely matched to the machining type (such as roughing or finishing) and to the required surface quality, the machine dynamics and the settings in the control.

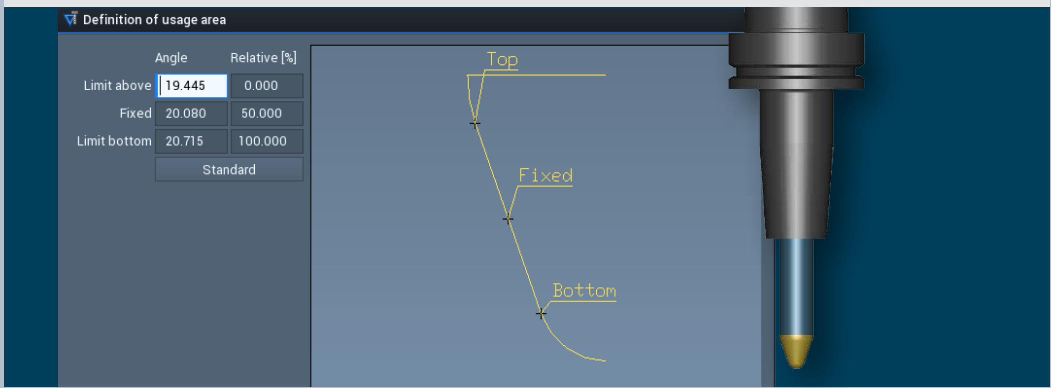


The higher the required surface quality, the higher the selected quality level needs to be. This figure shows the spectrum of possible point distributions on prefinishing and finishing and how the point distribution affects the milling result. The standard setting (1 or 2) is usually sufficient for prefinishing.
1. Standard: Accounting for chord error
2. Standard with additional accounting for curvature
3. Synchronized: Accounting for chord error and point distance
4. Synchronous with additional accounting for curvature
5. Asynchronous: Accounting for chord error, point spacing and point offset
6. Asynchronous with additional accounting for curvature

- Which tools should I use for prefinishing and finishing?

> It doesn't always have to be the ball cutter. Circle-segment cutters can also be used to quickly and efficiently achieve high surface quality with large path distances in finishing and prefinishing – especially if the virtual cutting edge corresponds exactly to the real contour and the contact point, height and angle can be precisely specified.

The NC templates specify the optimal tool and the optimal contact point and angle.

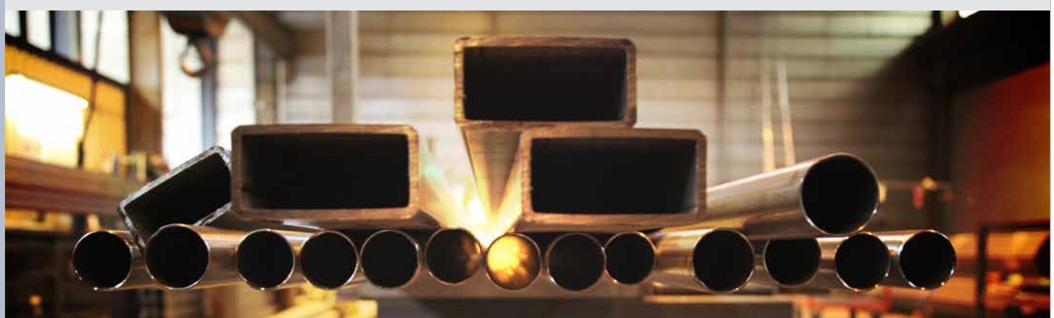


4 We can better manage different products and variants and react more quickly to changes

Regardless of whether it's vehicles, consumer goods, electronics or medical devices: Modern products are demanded and offered in many variants. They differ in geometric areas, in their size, in colors or in materials.
CAD/CAM automation enables you to maintain control even for small lot sizes.

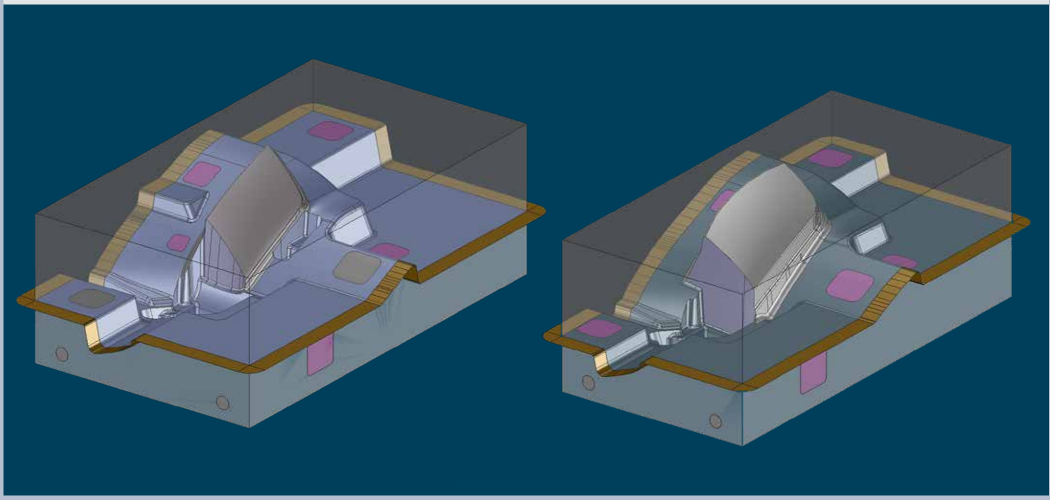
Only parameters that must be specified for the respective variant are modified In the machining templates for similar groups of parts.

For example, soft, medium and hard steel grades can be machined using the same strategy but at different feed rates. In contrast, a different strategy is necessary for machining very hard materials. The material groups stored in the templates ensure that the correct cutting data are always assigned.



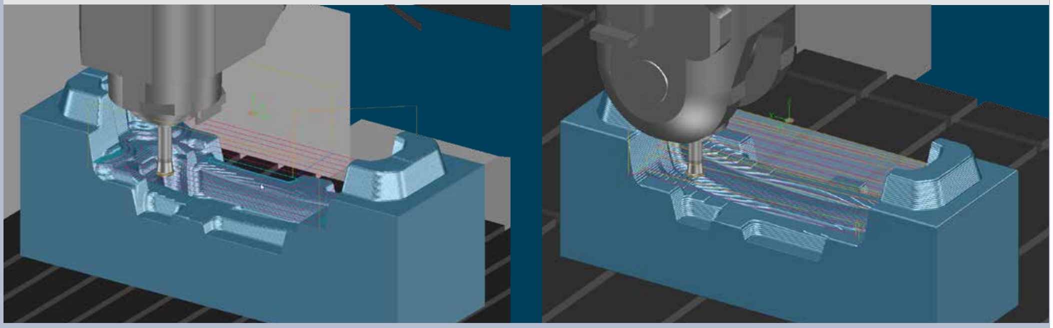
The auxiliary geometries and the blank are automatically adjusted, based on the stored **parametric CAD templates**, to accommodate any change in the dimensions of the part.

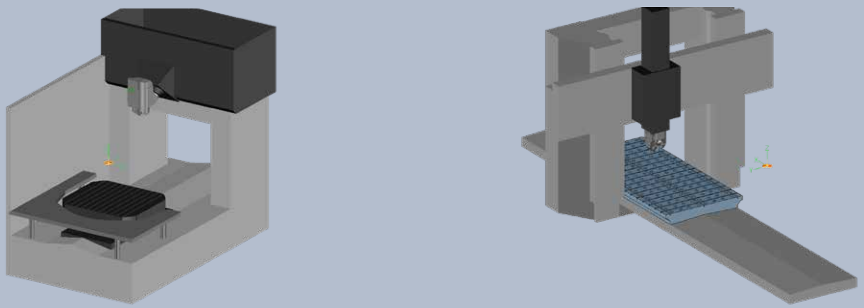
If the size of the part changes, parameters such as the blank, the position of the cover surfaces and the attachment surfaces are also automatically adjusted.



The machining of this bumper provides an example of the flexibility of **CAM templates**: Suppose you have two machines in your production that are suitable for the roughing operation: one dynamic machine and one older machine. Your first choice is the dynamic machine on which you normally use concentric roughing for parts of this type. If this is not available, you switch to the older machine, the dynamics of which, however, necessitate axis-parallel roughing. For this, you only need to change the machine and the strategy in the CAM template; the stored parameter settings such as speed, feed rate, depth and stepover are automatically assigned.

A change of machine requires only that the strategy be changed – everything else is accomplished automatically.





5 We mitigate the shortage of qualified personnel while enhancing employee satisfaction

The logical conclusion from the above arguments is that standardization and automation are **the** keys to effectively countering the shortage of qualified personnel.
CAM programmers quickly deliver complete machining programs, and multi-machine operation is possible: Overall, you reach your goals faster with fewer employees.

Small wonder, then, that such changes often meet with resistance from employees. They fear a loss of responsibility and are concerned that there will be less demand for their expertise in the future.
If there is only half-hearted implementation of automation, additional conflicts will arise – for instance if the machine operator cannot rely on the (automatically!) generated CAM programs from the programmer and still has to intervene manually. Because these programs cannot be used in practice and do not fit the manufacturing task and/or the manufacturing environment.

If it is implemented correctly, your employees will quickly learn to appreciate the benefits of automation:

Without automation and digitally stored manufacturing expertise, the **machine operator** has tremendous responsibility and resulting stress. Operators who have to manually slow down feed rates with the potentiometer need to constantly focus their attention on this. In addition, it's hardly efficient to be spending too much time on machine setup or checking processes.

Automation and digitally stored manufacturing expertise let the machine operator know precisely how to set up the machine and how to clamp the workpiece. The part is brought to the machine with essentially no loss of time, and a collision-free program with ideal traverse movements and cutting conditions can begin immediately. The operator does not have to constantly monitor the machining or correct errors from previous process stations – such as CAM programming. The operator instead becomes a logistician and optimizes the details of the process flow: He or she ensures that tools and materials are in the right place and coordinates long and short job runs. Or they can even be retrained as a CAM programmer. They can draw on their enormous experience here.

The **CAM programmer** is also more satisfied: He or she makes fast progress on standard tasks and targets the solutions for "tricky" challenges like determining the optimal collision-free tilt direction for machining complex free-form surfaces with the shortest possible tools.

New employees quickly feel themselves to be part of the team as they are making a productive contribution to the success of the company after only a very short time.

WE ARE LOOKING FOR A
CAD/CAM programmer

To strengthen our team, we are looking for a CAD/CAM programmer to start as soon as possible

What you can expect
- Generating and simulating multi-axis milling programs using modern CAD/CAM software
- Managing CAM programs
- Checking CAM programs
- Generating manufacturing documentation
- Designing manufacturing strategies
- Designing manufacturing fixtures
- Detecting and correcting faults
- Optimizing work processes

Your skills
- Completed professional training as a machinist, industrial mechanic or similar training
- Several years' professional experience in CNC manufacturing and in programming and controlling 5-axis CNC milling machines
- Outstanding CAD/CAM knowledge
- Precise, independent, goal-oriented and careful work methods
- High quality awareness

WE ARE LOOKING FOR A
CNC machinist

To strengthen our team, we are looking for a CNC machinist to start as soon as possible

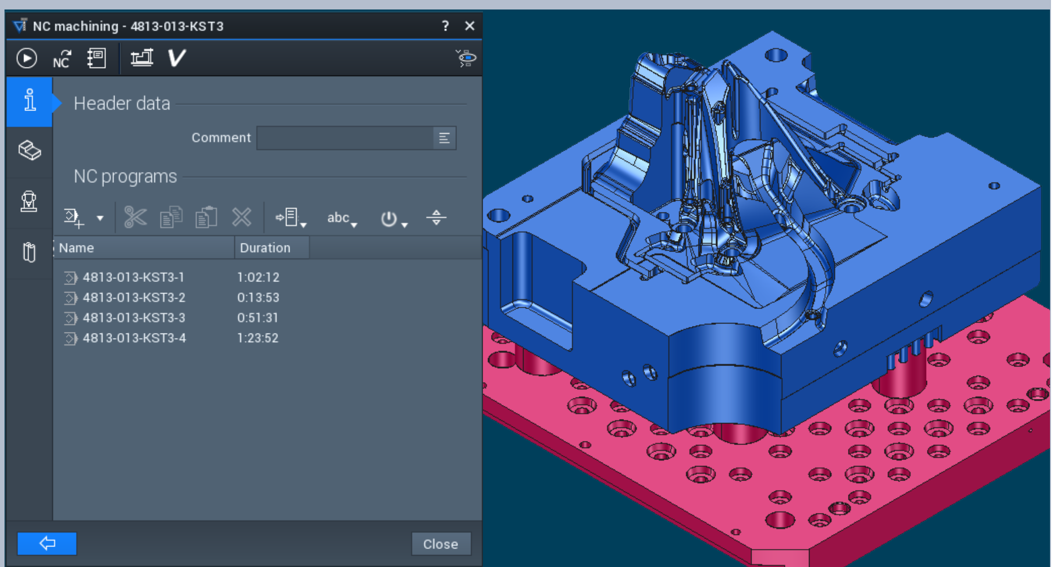
Your activities
- Setting up milling machines
- Operating multi-axis CNC milling machines, including control
- CNC program testing
- Fabricating single parts based on Job Manager and monitoring fabrication
- Analyzing and correcting sources of faults
- Service and maintenance work on the machines, tool maintenance
- Optimizingworkflows

Your qualifications
- Completed professional training as a machinist/ industrial mechanic, CNC machinist and/or technician
- Experience in CNC milling
- Basic knowledge in CAM programming
- High quality awareness
- Willingness to work different shifts

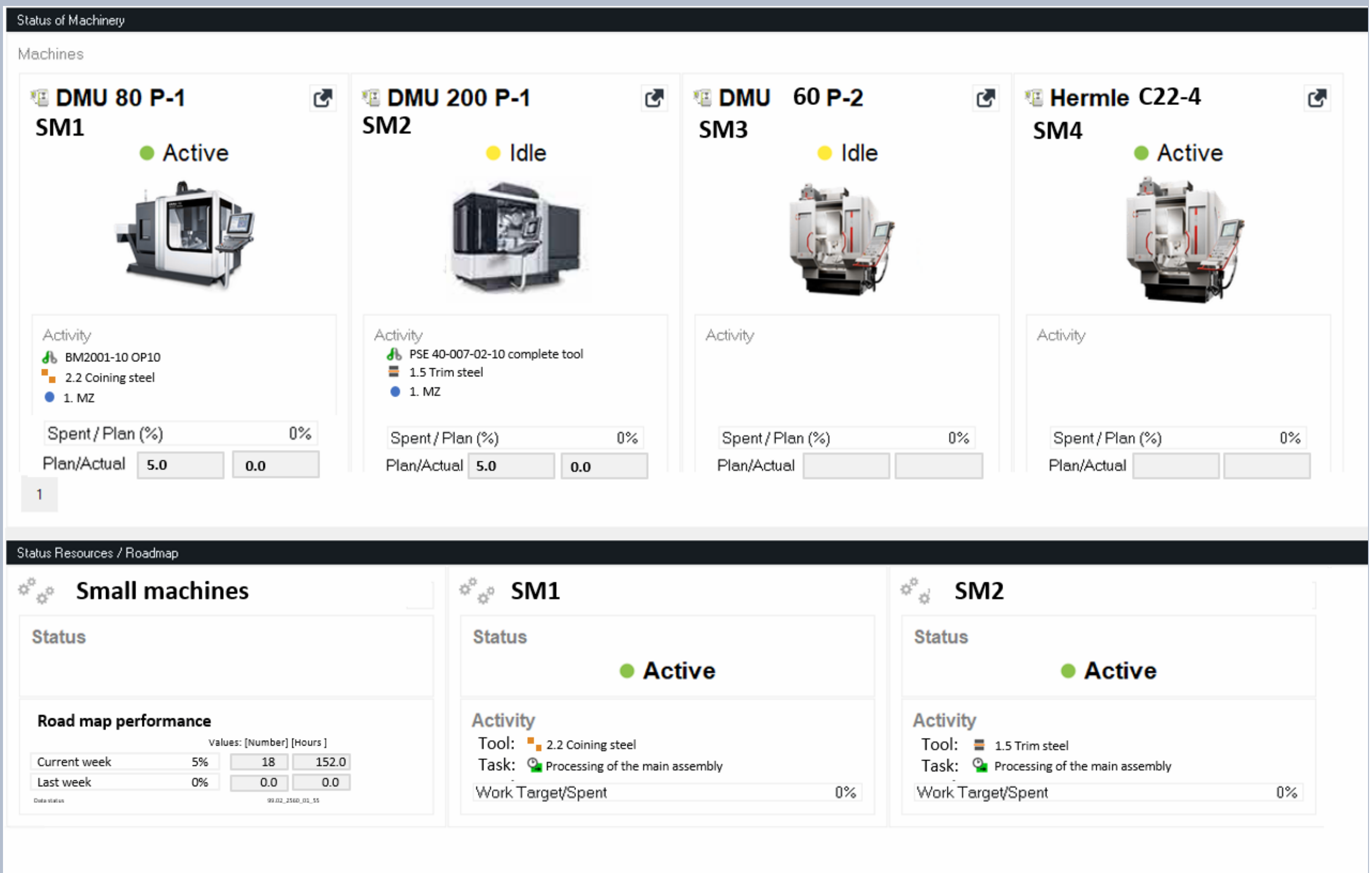
6 Our project planners benefit from automated and digitized CAD/CAM processes

Automated process sequences in which the same or similar activities are repeatedly combined in a standardized way simplifies planning as errors are reduced and "unforeseen" events such as unintentional machine idle times are rare. In addition, since you are using the "real" digital twins of machines, tools and clamping devices for planning, programming and verification, you can quickly and reliably see which resources are actually in use – while maintaining full control over your production environment.

A further advantage: Actual machine runtime can be determined with 95 percent accuracy in the CAM environment. This is because the calculation not only accounts for normal and rapid feed rates but also the acceleration and jerk parameters of the machine used.



Structured automation and digital representation of your manufacturing expertise and your manufacturing environment can also be used to optimally integrate the MES software for end-to-end planning and control of your manufacturing projects. You can create appropriate processing templates for the specific part categories in the MES software: Linking one of these to the CAD/CAM model file automatically assigns the appropriate milling template.



Conclusion

Automated and standardized process flows should in no way be viewed as a simple panacea for all companies. Rather, your company's specific manufacturing knowledge is stored in the CAD/CAM templates. They include the combined expertise of your best CAM programmers and machine operators and the results of discussions and joint projects with CAD/CAM software providers and with tool, machine and clamping device manufacturers.
This enables you to deliver high-quality results quickly, reliably and continuously, even for ranges of parts that are technically highly demanding – and even if your best people leave the company or you have to get by with less personnel.

Companies have many excuses for not consistently implementing the automation of their CAD/CAM process flows. The resulting damage can be detrimental.

We advise you: Take action and learn what you can do if you spot one or more of these red flags in your company:

- CAM programmers use their CAD/CAM templates with little or no consideration for generally applicable standards.
- New employees take too long to learn to work with existing processes, despite the use of template technology.
- The system components stored in virtual databases, such as tools, machine centers or clamping devices, do not correspond to the actual manufacturing environment.
- The manufacturing environment is unstructured, and your employees spend too much time looking for suitable tools or clamping devices or free machines.

Would you like to learn more how Tebis CADCAM can optimise your CNC machining processes and automate CAM programming? Also, would you like to reduce your CAM work costs as well as cutting tool and machining costs? Then please don't hesitate to contact the Tebis UK team for more information.
paul.scally@tebis.co.uk • Tel: 024 7623 6412

Tebis (UK) Ltd.
Coventry CV1 2TT
United Kingdom

Phone +442476236413
info@tebis.co.uk
www.tebis.com