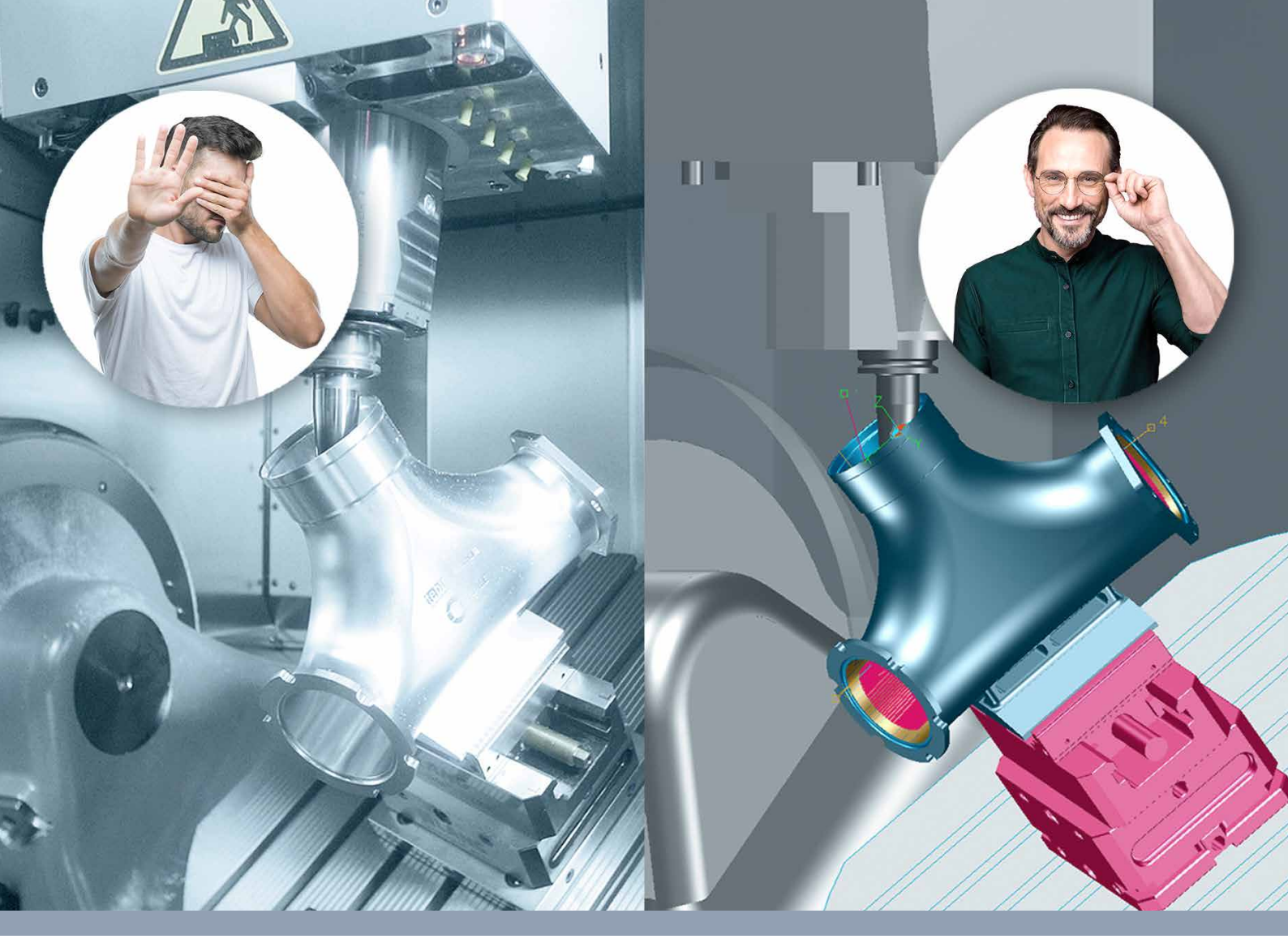

6 questions and answers about optimizing collision avoidance

tebis

CAD/CAM MES
Software & Services

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1. Why is it inadvisable to wait until the part is on the machine to correct potential collisions?

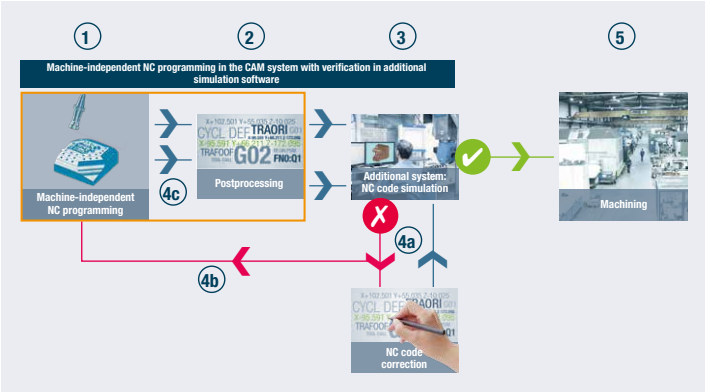
The key reasons for this are as follows:

- It relies too heavily on the experience and attention of individual employees.
- Machine stops delay the entire production and result in supply bottlenecks – no matter whether they are due to manual intervention or automatic machine protection mechanisms.
- The entire process chain is disrupted, which leads to further sources of errors and costs time: For example, additional interface iterations are necessary, as the program must also be corrected in the CAM software.
- Processes are more difficult to plan, and the machinery cannot be optimally utilized.
- It is nearly impossible to implement automation and lower-manpower production.

2. What procedures can be used for detecting collisions before manufacturing?

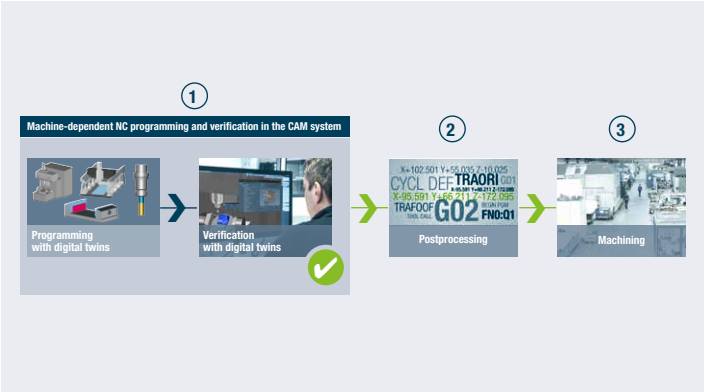
Various CAD/CAM and simulation software providers offer different approaches.

Procedure 1



In this approach, NC programming is performed in the CAM system independently of the machine. Only then is the machine information added. The toolpaths are verified using an **additional simulation software**.

Procedure 2



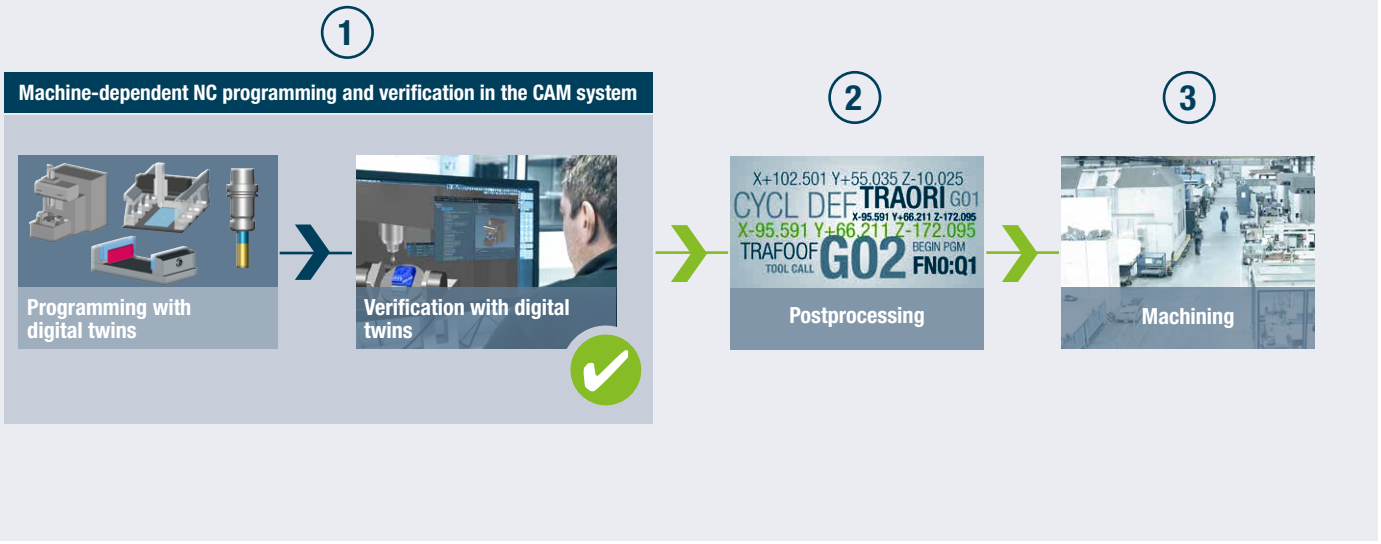
In the second approach, planning, programming and toolpath verification are performed in the CAM environment with digital twins of the real production environment, including all machine information: The NC programs are fully collision-checked **in the CAM system**.

3. Which of these two procedures is the safest?

Both procedures use digital twins of the real manufacturing environment to verify the toolpaths. However, the second one – the fully integrated solution – has many advantages, especially in terms of saving time and eliminating further sources of errors.

- The required number of interface and correction iterations is reduced.
- Depending on the focus, collisions are detected and avoided during work preparation, programming and simulation – always accessing the same “digital pool of manufacturing resources” stored in the system.
- Generally, the manufacturing processes can be more easily automated and the potential of the manufacturing equipment can be better exploited – in the dynamics of individual machines as well as the utilization of overall production.

As a basic prerequisite, the virtual and real world must be identical. Simplified geometric substitutes entail the risk of incorrect verification results.



4. Which manufacturing resources should be represented in the virtual CAM environment and accounted for in collision checking?

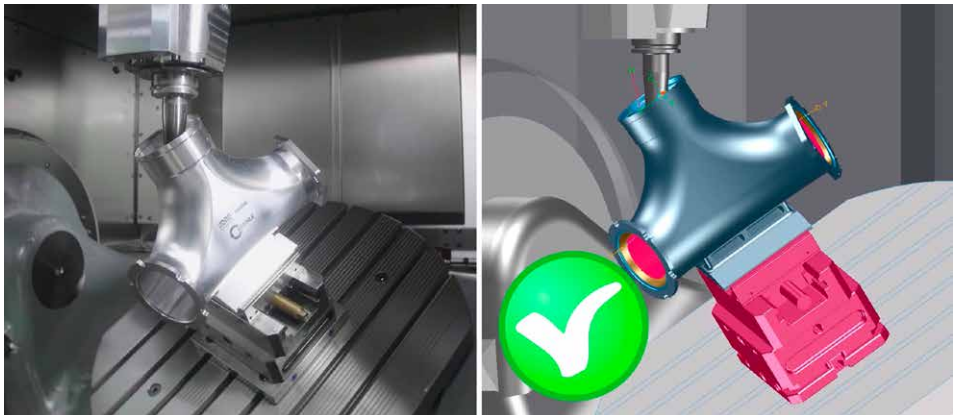
Without exception, **all** manufacturing resources the company uses:

- **All** machines including all interference geometries and supplemental equipment: For example, the flanged Z enclosure for gun drilling machines, laser measuring systems or tool grip arms.
- **All** component-based milling, drilling and 3D turning tools with cutting edges, holders and intermediate holders, including the manufacturer's recommended cutting data.
- **All** units such as the steady rest and tailstock for turning or drill bushes for deep-hole drilling.
- **All** clamping devices, from simple vices to complex zero point clamping systems.

This is supplemented by kinematic information, i.e. reference points, tool change positions and traverse movements. For example, if the collision check is performed using designed machine heads, only the head movements are accounted for, **but not the machine movements**.

Collision checking with designed machine head.

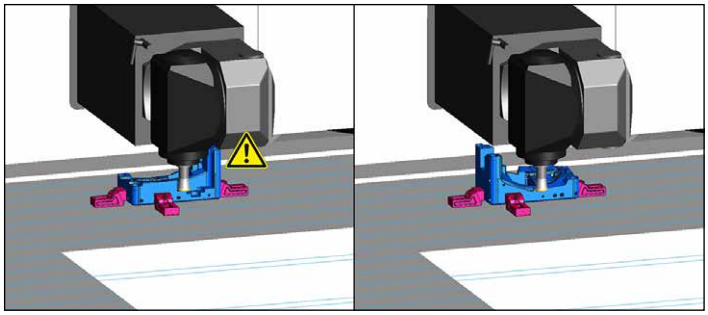
Collision checking accounting for machine kinematics.



5. What possibilities are available for collision avoidance in the fully integrated solution?

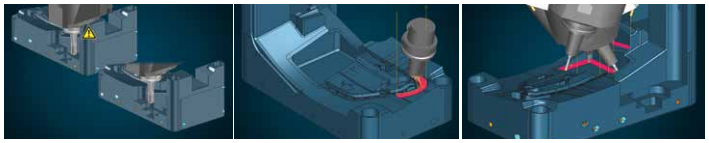
In general, collisions can be avoided in the process chain during **work preparation**, in **NC calculation** during CAM programming or in **NC simulation**. The following applies here: As much automation as possible, as much flexibility as necessary.

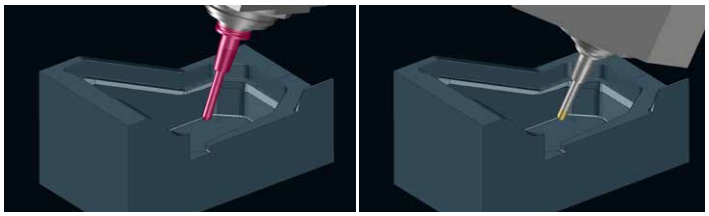
Work preparation



In **work preparation**, checks are performed to determine whether the part can be manufactured without collisions on the selected machine.
For example, if the clamping situation is critical due to the head geometry, the table – or in this case the part – can be rotated interactively.

NC calculation

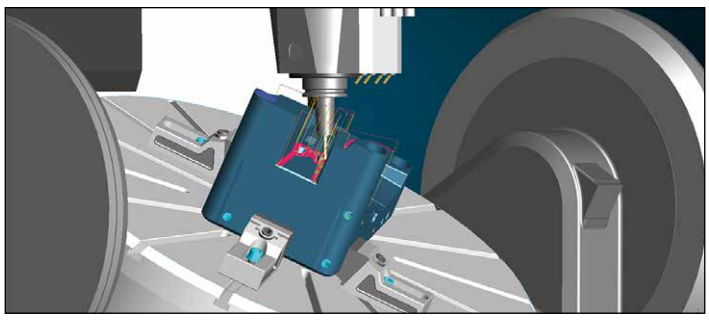




Depending on the part geometry, the machining task and the machine used, three automated collision avoidance strategies are available when **calculating the toolpaths**: Automatic area reduction, 5-axis simultaneous avoidance milling or indexed collision avoidance.

Tool movements can be controlled specifically as desired, for instance with vectors in 5-axis simultaneous avoidance movements.

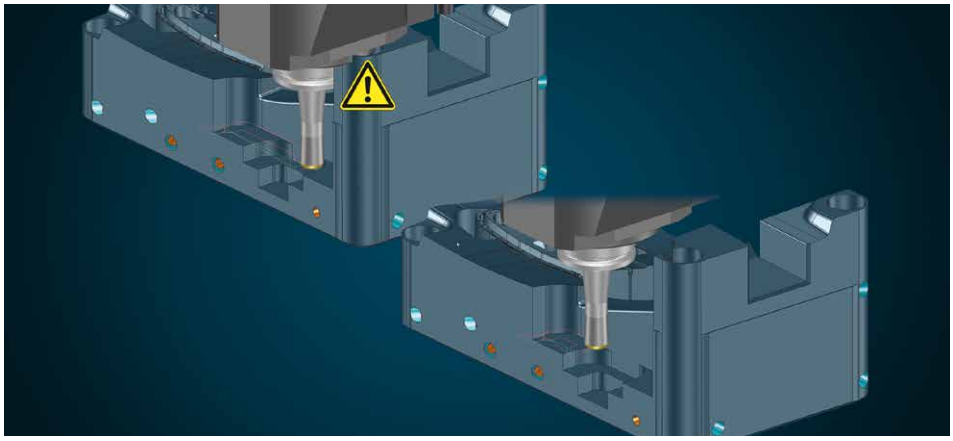
NC simulation



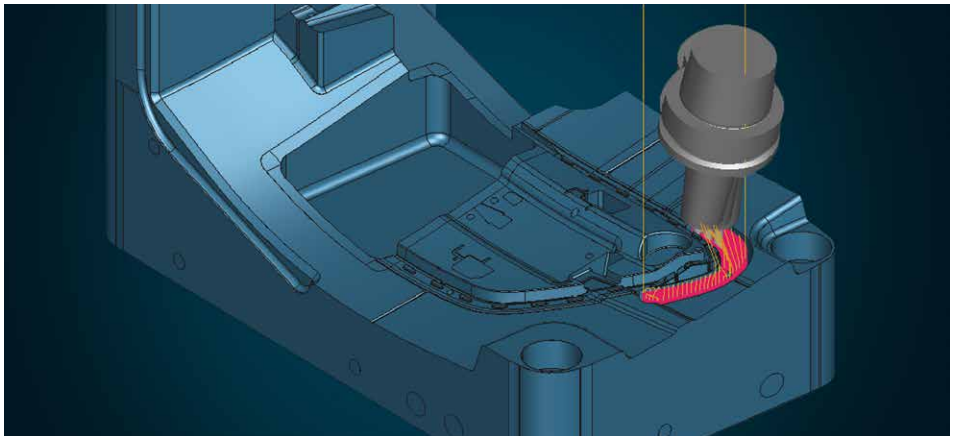
As an additional option, once all strategies have been calculated, the entire manufacturing process can be fully **simulated** and optimized interactively with the entire machining area and all intermediate movements in batch mode. For example, retract movements can be individually adapted.

6. How are automated collision avoidance strategies applied to programming?

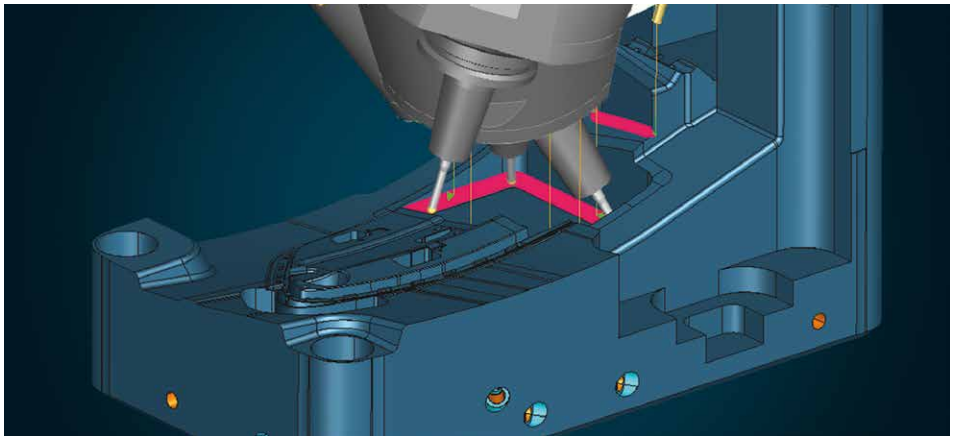
Automatic area reduction is generally used in 3-axis roughing: Milling areas that can't be machined with the tool in use – because of a collision with the machine head, for example – are automatically deactivated.



For optimum surface quality in finishing, it's best to use a short tool throughout the process, if possible. If the machine kinematics permit, **5-axis simultaneous avoidance milling** is a suitable strategy to prevent collisions.



Machining of residual stock areas is frequently indexed. **Indexed collision avoidance** is recommended, for example, for multi-axis machines that are unsuitable for 5-axis simultaneous machining because of their dynamics.



Conclusion

Virtual process libraries are elementary for safe and efficient manufacturing. But beyond collision avoidance, work preparation and CAM programming also benefit from exact digital twins. This starts with useful features such as the ability to store dynamic parameters from the manufacturer's specifications in the virtual machine, enabling the automatic calculation of machine run times.
The component-based clamping device library enables significant simplification of setup processes, and the cutting data stored in the tool library ensure optimal cutting conditions. And much more! In particular, the digital twins serve as the basis for automated CAM programming with standardized NC templates.

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.
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