Scope of functions of a machine simulation

Purpose of a simulation

The purpose of a machine simulation is to check the machining on an NC machine in advance and to determine any collisions or exceeding of the travel limits of the machine. By changing / adapting tools, clamping devices or clamping positions, it can be determined in advance whether all the necessary tools/means for machining are available and whether, for example, the clamping position of a component must be at a certain position on the machine table in order to completely machine the component with as few stresses as possible.

ISV - Integrated simulation and verification

In NX CAM there several ways for simulation of the NC program

Verification:

After programming a turning or milling operation, the machining is only checked with the tool. If a machine model exists, it will not move with this type of verification. Verification only serves to quickly check the previously programmed machining operations, for example to identify the unmachined areas more easily in the case of complex workpieces or to obtain an overview of whether the machining sequence would function in this way in reality.

Simulation of the tool path within machine kinematics:

The toolpath is checked using a machine model. The model is provided by the customer and then provided with kinematics by JANUS. In order to create the kinematic model correctly, the customer must provide the information about the machine zero point, the start position of the axes and the limit switch positions.

The simulation then represents the internally calculated tool paths and moves the machine components according to the programming. Additional machine movements such as approaching a tool change point or a retraction movement generated by the postprocessor are not displayed here.

For machines with several tool carriers (multi-channel machines), the simulation of the tool path is not available. The number of axes to be controlled is also limited to a maximum of 3 linear and 2 rotary axes..

There limitations of possible machine kinematics!

Simulation des machinencodes:

As with toolpath simulation, operations are checked using a machine model. The model is provided by the customer and then provided with kinematics by JANUS. In order to create the kinematic model correctly, the customer must provide the information about the machine zero point, the start position of the axes and the limit switch positions.

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The simulation is then usually created on the basis of a CSE driver based on the postprocessed output!

If no suitable driver is available or the driver does not cover special functions of the controller, the simulation can also be carried out using MTD drivers. Since this driver is the older driver model of NX, JANUS generally prefers to use the CSE driver model, the MTD driver is only used if this is technically necessary. The final decision, however, is up to the JANUS Engineering AG.

In addition, an archive file of the machine can be included, if available, for CSE-based simulations. This file then contains additional information such as rapid traverse speeds or acceleration or deceleration ramps of machine axes. This information is then stored in the machine model in order to achieve a more precise time output in the simulation.

It will not be possible to achieve a 100% perfect time output. An example is the tool change. If the machine has a chain magazine, for example, the tool change time will differ depending on the position of the tools on the chain. If the tools sit directly next to each other, the changeover time is shorter than if the chain has to be rotated by 50 magazine positions first. For such cases, an average tool change time can be entered in the tool change subprogram.

The content of subprograms can also be simulated in CSE-based simulations. If a subprogram is called up in the main program, the CSE simulation jumps to a predefined folder and then displays the movements of the program contents.

If available, available subprograms are then technically necessary and can be implemented in the JANUS simulation. If necessary, the subprograms are simplified, e.g. if a tool is changed, only the approach before the changer flap is simulated and then the tool is changed in this position. The movements within the changer are to be regarded as a "black box" and are not simulated.

If the contents of a subprogram are not relevant for the simulation or cannot be implemented technically, the subprogram is created as an empty file. In this case, no movement is displayed and the corresponding subprogram is skipped in the simulation.

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Preparation of the machine model:

The provision and preparation of the machine model is carried out by the customer. The customer requests the machine model from the manufacturer in a standard CAD format (NX, Step, Parasolid) and checks it for completeness. The machine model is then checked for completeness by the customer and elements that are not required are deleted or simplified. Only the required components should be present in the machine model, screws or elements not relevant to collisions, such as ball bearing balls in a spindle, only lead to a loss of performance in the ISV and should therefore be deleted. Likewise, the machine model must consist of individual assemblies and not of a single, solid body, but the individual components must contain a solid body and not a planar body. An STL body is not supported.

Unnecessary elements such as cooling channels or hydraulic bores are not relevant for the collision check and should be deleted from the model as they have a negative effect on the performance of the ISV.

Ideally, the machine model is divided equally into individual subassemblies (machine base, housing, X-slide, Y-slide, etc.).

If required, we are happy to take over the preparation for the corresponding expense.

Purpose of a machine code based simulation

As already described in the introduction, the main function of machine code-based simulation is to check the machining process on an NC machine in advance and to determine any collisions or exceeding of the machine's travel limits. This enables collisions to be detected in advance or special tools to be ordered in good time.

The CSE can also check whether, for example, the milling spindle is switched on. If an attempt is made to mill or drill with the tool stationary, the simulation issues a collision warning. The interference contour of a jaw chuck on a mill-turn machine is also covered: If the turning spindle rotates, then the jaw chuck is displayed as turned geometry, if the turning spindle is stopped, then machining can be carried out with a milling or drilling operation between the jaws without triggering a collision.

After the simulation, the removal result can be checked according to the possibilities of the currently used NX version. The simulation is not suitable for displaying geometric deviations such as the deflection of a long workpiece on a lathe. Likewise, no surface quality can be derived from the ablation result; the influences present on the real machine, such as temperature fluctuations or vibrations, are not covered by the ISV.

If required, machine-specific special cycles can also be incorporated, such as measuring subprograms or the movement of additional units such as steady rests or tailstocks.

A steady rest or a tailstock is then displayed in the machining position in the simulation according to the available subprogram.

Measuring subprograms are normally not displayed.

A simplified display is possible, but the probe will not return a result. Since there are different measuring cycles on each machine and the insertion in the machine simulation is relatively complex, this is only done after prior consultation and calculated according to the corresponding effort.

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Information about INDEX machine simulation

For a machine simulation (and also postprocessor) to be prepared for INDEX machines, the machine number is mandatory. Further helpful information is the Index order confirmation (without prices) and the electronic machine documentation sent by Index. These documents contain important details about the machine, which may also be required for inquiries to Index. A machine simulation for an Index machine is only possible after completion of the corresponding postprocessor, since a machine archive of the corresponding machine is only available at that time. This machine archive contains important subprograms that are essential for machine simulation.

Addon Parts

Within many simulations additional addon parts will be used. E.g. utilization of Mill/Drilling tools for face operations on a turning machine with a turret. As the turret has a fixed working direction of the tools, a device for different tool direction (angle) is needed. Those devices need to be provided by the customer if they should be used in simulation for determining certain settings, approaches and hints on how to use it in NX ISV.
Janus will provide a sample device entry in the ASCII library for implementation purposes.
If further devices need to be implemented it can be done with additional effort.
We prefer to enable the users with additional consulting, so they can later implement those devices themselves.

Usage of 3D tool models

In NX CAM the tools are created in the part as 3 D models from the parameters defining the tool in the according tool object.
If the customer provides 3D models of the tools by himself, we can use these for testing purposes.
Otherwise we use the 3D parameterized tools.
Using external 3D tool models requires that the customer will provide those native NX 3D models of the tools and the according ASCII tables for usage as retrievable tools in NX CAM.
Mainly for turning tools this approach can be recommended as the used turning tool holders are not represented as parameterized tools.

Testpart

Janus will provide a testpart for making tests during simulation development. This part will be also used as acceptance part at installation.
If the customer wants specific part from his application he has to provide this NX Part with all used subassemblies/-parts, tools and operations.
If only simulation will be developed by JANUS, a postprocessed program(s) must be provided, containing all code types, cycles and structures, which need to be simulated.
Will the Janus testpart be used for acceptance test, Janus will provide the 3D part with according operations prior to installation, so the customer can prepare blank part and tools for this acceptance.

If a customer specific testpart should be used, it should be considered that the required functions like operation types, inclination positions, cylces, etc. are contained in it.
All additional

Are there further things to consider, we ask for this information prior to the installation date.

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