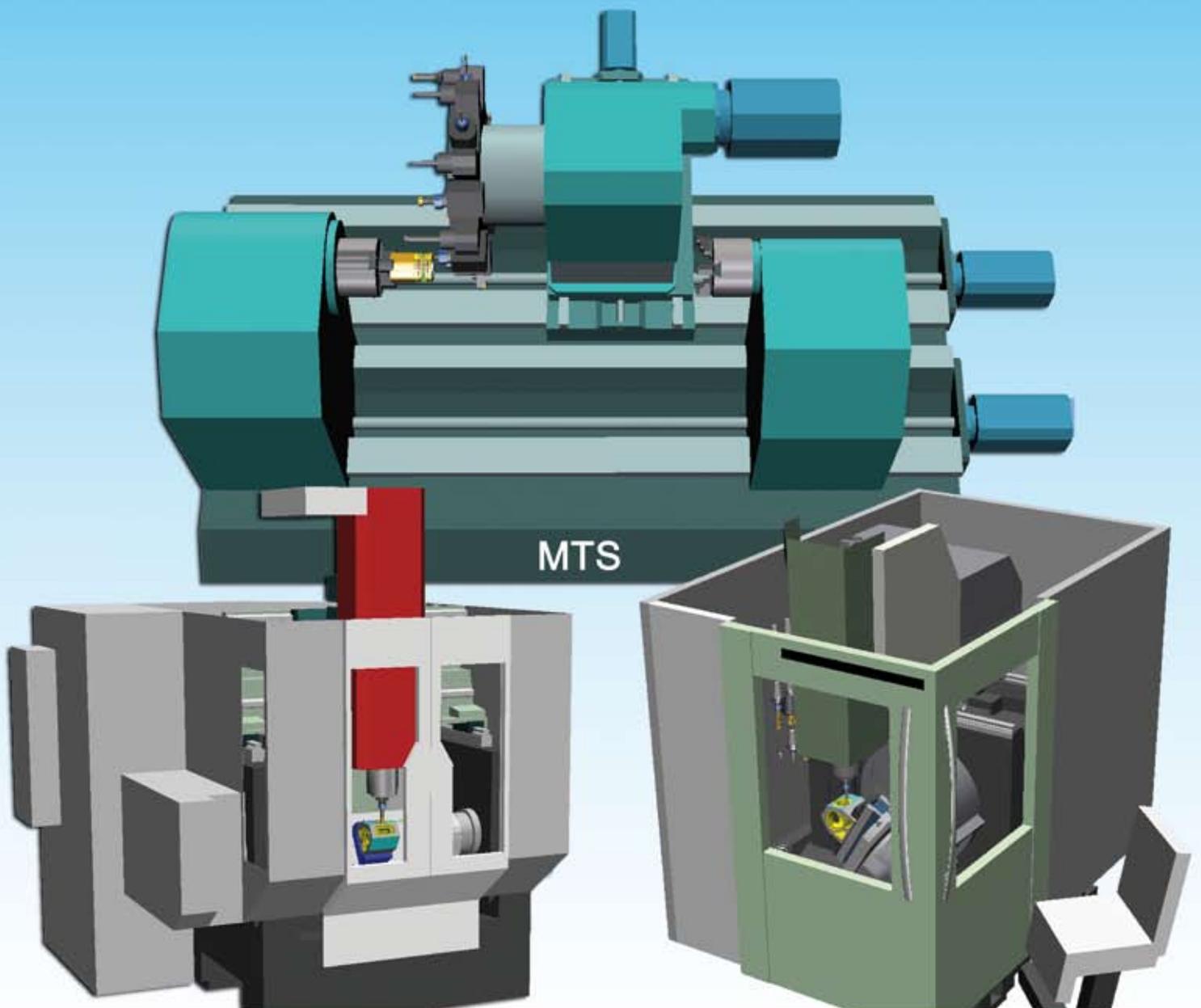


**MATHEMATISCH TECHNISCHE
SOFTWARE-ENTWICKLUNG GMBH**

TopMill • TopTurn

**Jobshop Programming & Simulation
for Multi-Side & Complete Mill-Turn Machining
for every CNC Control**



JOBSHOP PROGRAMMING FOR MULTI-SIDE AND COMPLETE MILL-TURN MACHINING WITH TOPMILL AND TOPTURN FOR EVERY CNC CONTROL

Programming methods that are specific to a particular CNC system and that are used to enter NC programs in the respective ISO/DIN NC dialect or in a CNC control specific plain text language on the basis of a workshop drawing via a dialogue user interface and graphic assistance are called shop-floor programming methods on account of the location where they are primarily used.

Both TopMill and TopTurn permit programming of comprehensive 2½ D milling processes in any desired machining planes on machining centers with up to 5 axes (milling with axes X, Y, Z and 2 of A, B, C; turning with axes Z, X and C, Y, B including counter-spindle). In addition, TopTurn can be used to program 2-axis turning with all turning machining cycles. MEKAMS can be used to convert programs of single-channel turning machining centers into programs for multi-channel machining centers.

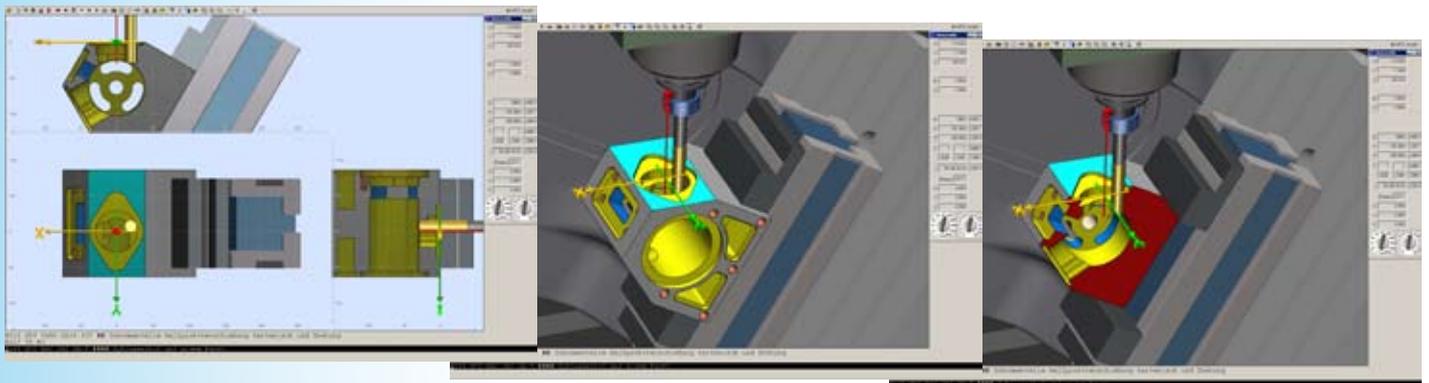
The NC dialect used for TopMill and TopTurn workshop programming can be set to any DIN/ISO NC dialect or to a so-called plain text language and the user interface dialog with its graphic aids can be adapted correspondingly (there are quite a number of suitable examples on the demo version that can be downloaded from the internet). CAD data can be imported via an interface.

To achieve this adaptation, a CNC command code can be activated which converts the programming commands of the respective control system into the MTS internal displacement commands and very powerful machining cycles. Our standard command codes can model the standardized path commands as defined in ISO/DIN as well as almost all machining cycles of any control system. To achieve an adaptation which is very close to the features of a particular machine tool (e. g. with the integration of internal procedures in tool-change macros or workpiece transfers to the counter-spindle), an extension of the command code is needed, but this can be done for all types of machine tools.

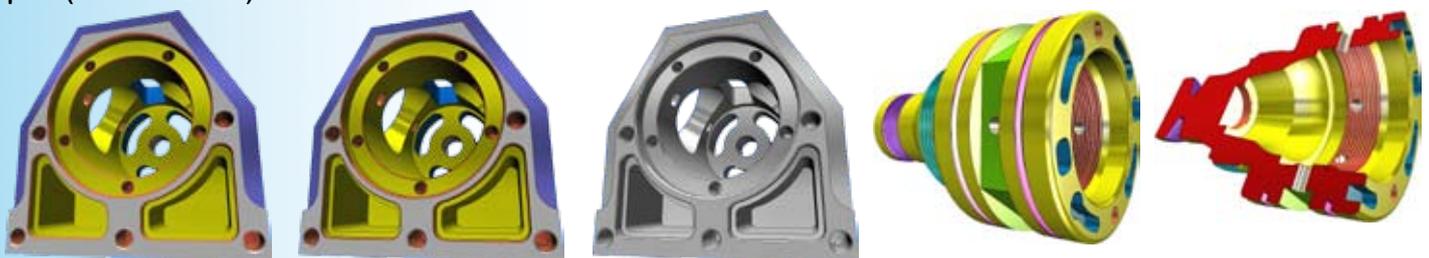
In particular, the new German PAL2007 examination control system with 5-axis, multi-face machining is available for turning and milling machining in CNC training.

Another special TopMill and TopTurn feature is the integrated MillTurnSim machining space and material removal simulation, which actively runs simultaneously with the entire programming phase and also includes collision monitoring between all moving and fixed machine components including chucking devices and workpieces and also exact machining time calculations. It takes into account the accelerations, torque limitations and tool change times for the respective machine tool. MillTurnSim is also available as stand-alone software tool.

For graphical display of the machine tool operation the 3D machine room simulation with 3D material removal simulation and 3D collision detection MillTurnSim is available besides the standard 2D display of workpart machining simulation with workpart top views and workpart sections views.



With the conventional navigation functions (zoom, rotate, shift etc.), the 3D graphical displays can be modified, parts of the machine tool can be blanked out and parts of the workpiece can be cut away to enable viewing of internal machining processes. As an optional feature, a graphic representation showing the workpiece edges can be called up for display. Different colors can be used to identify machined surfaces of particular tools and of the original workpart (material color).



For quality control, the machined workpiece can be measured at any time precisely on cross-sections, for example to find programming faults or workpiece deviations caused by the tools themselves. A roughness calculator is provided for checking the surface quality that is specific to the tool to be used and depends on the feed rate; this can also be used to calculate the necessary feed rates.

Collision detection places high demands on simulation. But this makes sense only if it is possible to accurately determine the geometry of those machine objects which have the highest collision risk: This demand for accurate descriptions apply to the tools, the chucking devices and, in particular, to the workpiece in the corresponding machining condition, which is continually changing as material is removed by the machining process.

The tools and chucking devices needed for NC program simulation are provided by the universal tool and chucking device management system TopCAT (computer-aided tooling) which permits users to add individual extensions. It is also possible to integrate machine-tool components for assembling machine-tool models in order to be able to simulate the machining space of specific real machine tools.

TopMill and TopTurn can be used not only as NC programming systems, but also to simulate externally produced NC programs in control specific command codes.

The shop-floor programming systems TopTurn and TopMill offer three distinct operating modes:

- set-up
- programming
- automatic mode

complemented by the quality assurance functions:

- workpiece measurement in cross-sections
- 3D workpiece intersections
- 3D workpiece comparison with a reference workpiece
- roughness calculations

MEASURING OF WORKPIECE

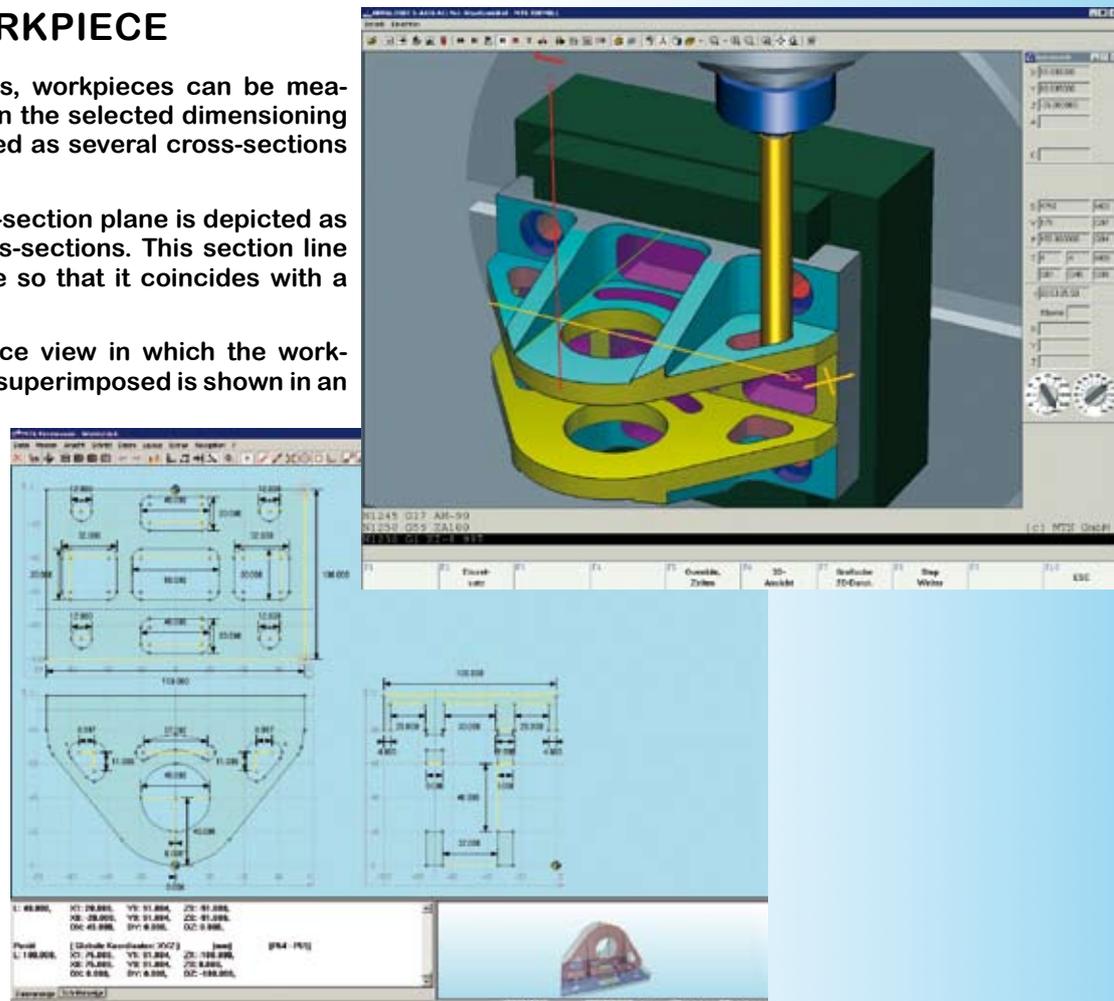
For quality assurance purposes, workpieces can be measured at any time. Depending on the selected dimensioning layout, the workpiece is depicted as several cross-sections of any desired orientation.

The position of any given cross-section plane is depicted as a section line in the other cross-sections. This section line can be moved using the mouse so that it coincides with a specific point.

The “transparent” 3-D workpiece view in which the workpiece cross-section planes are superimposed is shown in an additional window.

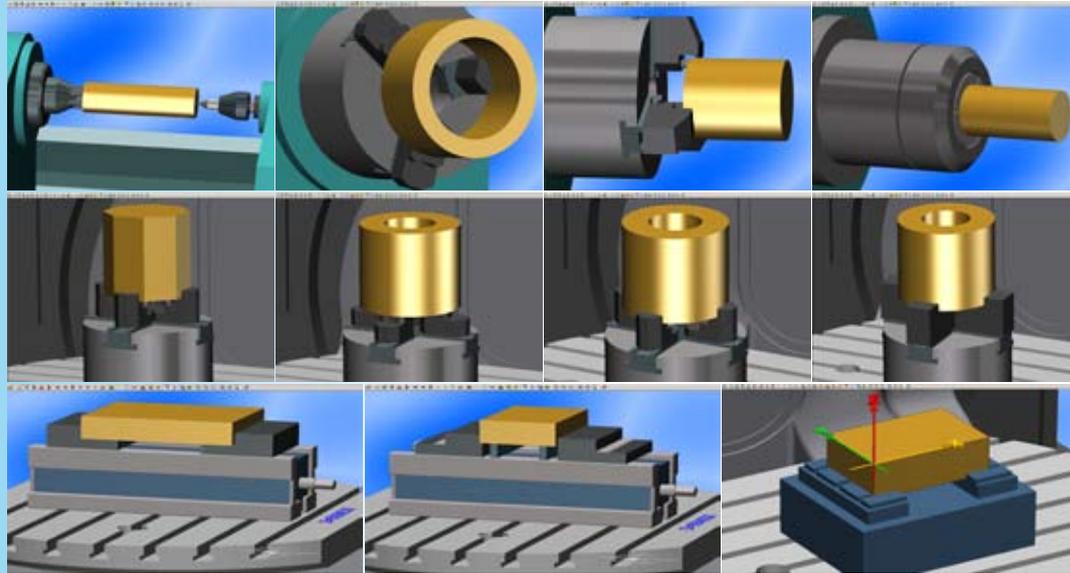
The 3-D workpiece model can be cut into any desired sections to allow visual inspection.

A variety of functions is provided for displaying dimensions, measurement reports and logs (dimensions to origin, chained dimensions, workpiece coordinates, contour element dimensions). When entering dimensions, it is possible to configure the type of reference point (contour point, centre, axis-intersection etc. ...). Navigation and zoom functions are provided for navigating in the views.



TOPMILL AND TOPTURN FAST SET-UP AND TOOLING

As on a real machine tool TopMill and TopTurn have to be set-up for machining.



The workpiece to be machined is defined in an easy-to-follow dialog, together with the chucking devices and a tool magazine allocation plan. Apart from being able to select the standard raw shapes cube, cylinder, tube and n-edged body, the user can import a pre-machined workpiece from a workpiece file or as an STL-format import file with chucking depth, orientation and position on the machine table. The standard chucking devices provided include machine vises and chucks with 2 to 4 jaws of various types (stepped, prismatic and/or soft) as well as a modular chucking system.

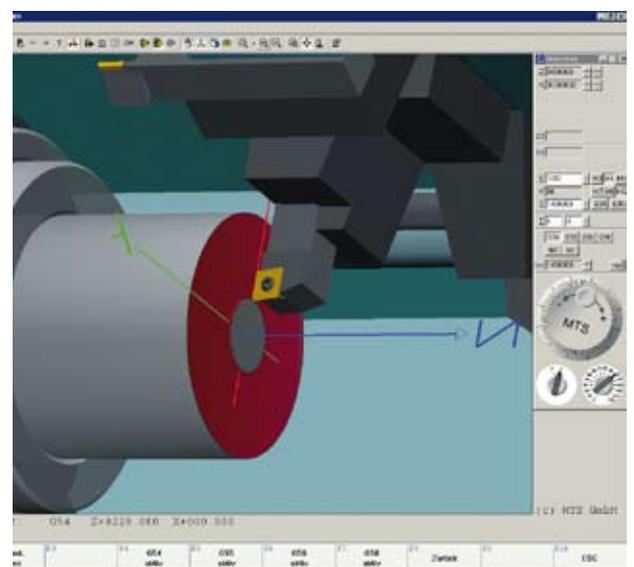
To define the tool magazine allocation, TopCAT permits the utilization of all standard tool types in parameter-defined form (as templates). When the user selects one of the presetted tools, the (different) correction value data records are automatically selected as well. If no suitable tool is yet available, it can be composed of its components tool holder, holder and insert, or tool chuck, collet and drill, end mill or milling head, presetted and mounted into the magazine.



The workpiece dimension origin can then be calculated from the defaults and information on the respective chucking devices. In set-up mode the motions of TopTurn and TopMill can be controlled manually allowing manual machining of the workpiece. This can also be used to determine the workpart zero point or tool offsets by touch probe operations.

Of course, the CNC simulators can also be set up automatically using a set-up sheet included in the header of the NC program. Conversely, it is possible to save the actual set-up state in a set-up sheet. For this set-up sheet the MTS set-up format with keywords is available.

This universal tooling set-up mode meets both the industrial NC programming requirements as well as the requirement that CNC operator training be oriented to real-life applications and to independent, task-oriented work.



PROGRAMMING

TopTurn and TopMill offer different jobshop programming modes. It is possible to switch over from any of these modes to another while programming in order to suit the task at hand. These modes are:

- Interactive programming
- Use of an NC editor
- Dialog mode programming
- Use of a geometry editor
- Teach-in operation

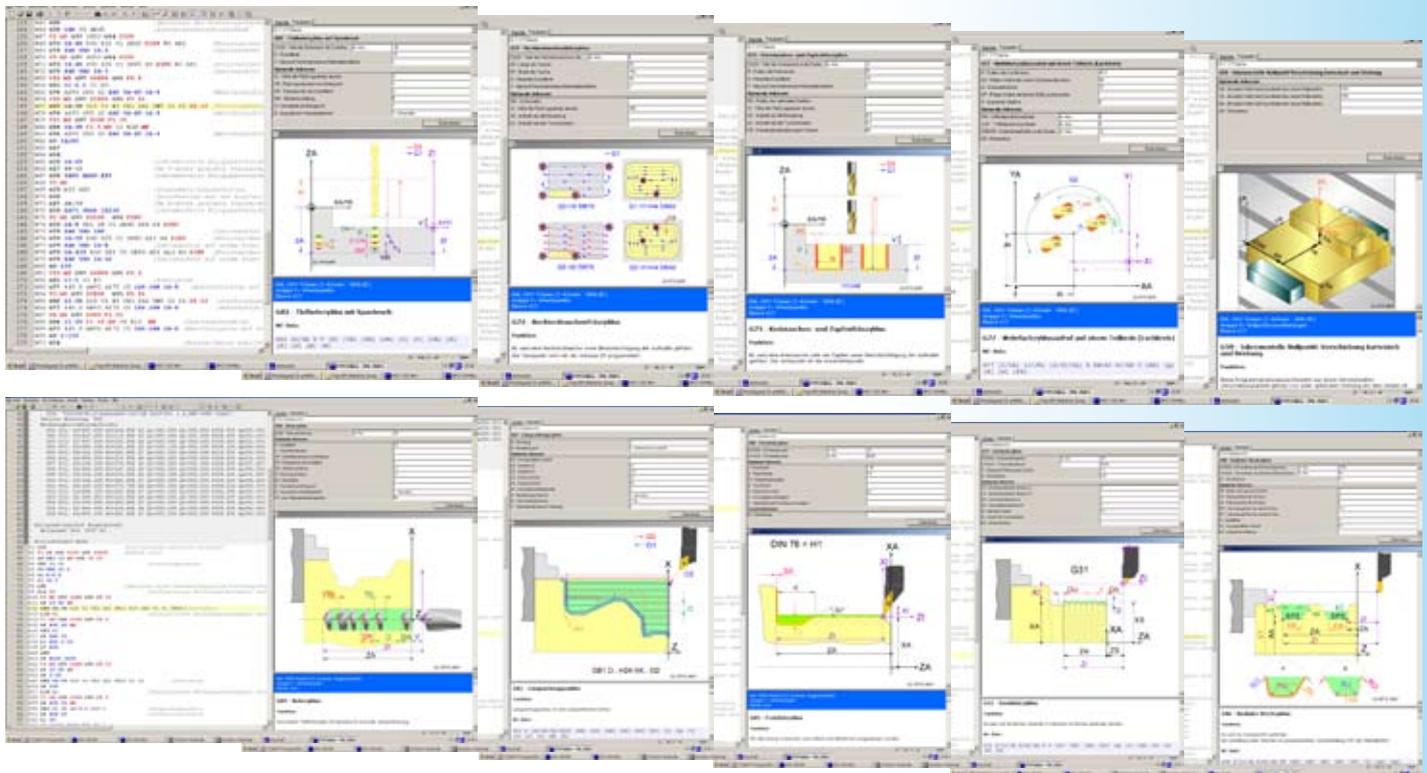
The first two programming modes involve the input of NC blocks by the programmer; in the others, the NC blocks are created automatically from user inputs.

In **interactive programming**, NC editing and automatic mode are used in combination. Once an NC block or cycle has been programmed, the corresponding machining procedure is simulated, thus allowing immediate testing of an NC block by simulation at the input stage. After each block input the programmer can decide if he wants to accept or to modify the block. This permits an intermediate NC block verification after the user input (e.g collision texts and workpart measuring).

Dialog programming mode provides easy input of complex machining operations. One or several related input screens being filled in by the user with graphical assistance. The input is checked for validity of combinations, value ranges and alternatives with logical combination functions.

Dialog programming can be used to create and edit NC programs in the respective programming code without having to resort to explicit editing of NC blocks. Dialog steps are selected individually, starting from the overview of the machining functions arranged in a tree structure.

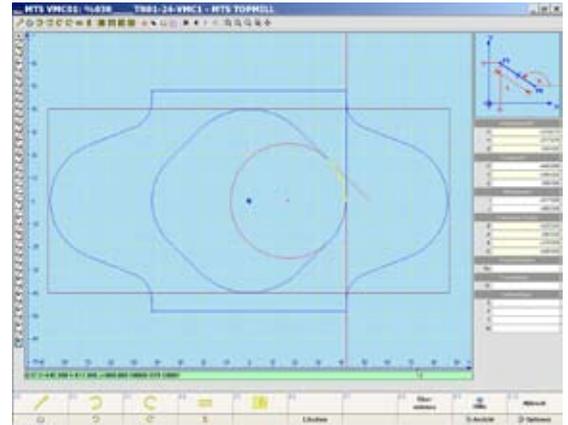
Example dialog programming of the new PAL2007 turning and milling control



The user can customize the form, contents and functions of a dialog input. He can also add new input screens, e. g. to complete user-specific machining cycles. At this point it must be stressed that shop-floor programming can be extended by an adapted, graphics-supported dialog programming mode for every TopTurn or TopMill programming code.

Since it is possible to create a corresponding MTS-CNC simulation programming code for any given CNC control, one specific application is to use the combination of these capabilities as a modern, easy-to-use dialog for programming elderly CNC controls.

The Geometry editor makes programming of even the most complex contours easy and requires no separate mathematical calculations. The dimensions taken from the drawings are entered in the dialog and are then converted to contour path commands (extensions to the standard ISO/DIN command set). The transition points, circle centers, roundings and chamfers are calculated automatically during this procedure. If there is a control programming code which does not have a contour programming, the contours will be automatically converted in the corresponding ISO movements consisting of straight lines (G1) and circle segments (G2/G3).



The most efficient method of creating a program is to combine dialog programming with the geometry editor and interactive programming, whereby the NC editor can be used to display the resulting NC program at any time.

In teach-in mode, the workpiece can be machined under manual control. The resulting tool paths are translated into ISO/DIN commands (G00 and G01) and then inserted into the NC program. The machining is done with cursor keys or by virtual handwheel. As practical application teach-in-mode can be used for facing or for first roughing operations.

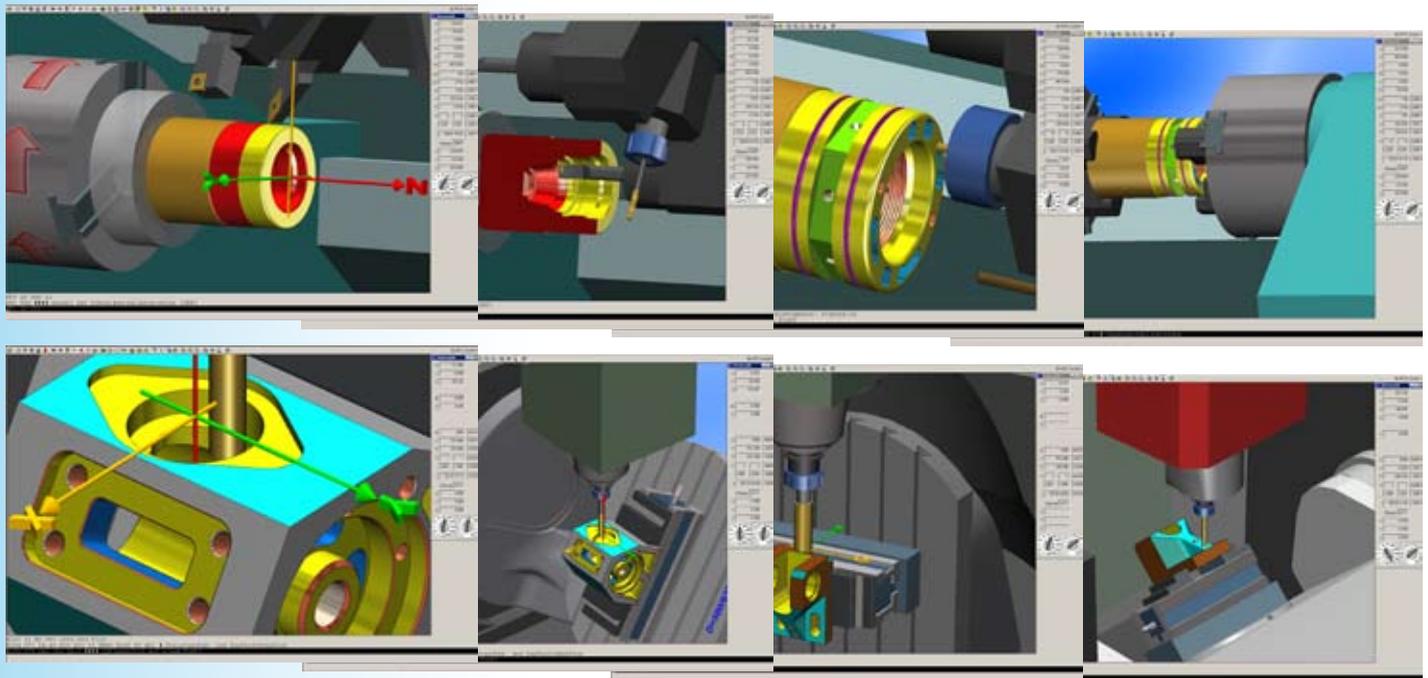
AUTOMATIC MODE AND SIMULATION OF EXTERNAL PROGRAMS

In automatic mode, NC programs can be simulated in continuous sequence or block by block in real time with override function, or in an accelerated test run. Dynamic simulation is displayed graphically in two dimensional or optionally three dimensional views. The manufacturing, feed and tool usage times as well as the volume of workpiece material removed by machining are calculated concurrently.

The comprehensive collision detection calculations between all fixed and all moving parts of machine room support the run-in of NC programs, especially in tight workspaces, complicated chucking situations or critical tool location combinations (danger of collision with neighbour tools or collisions with rotational axes).

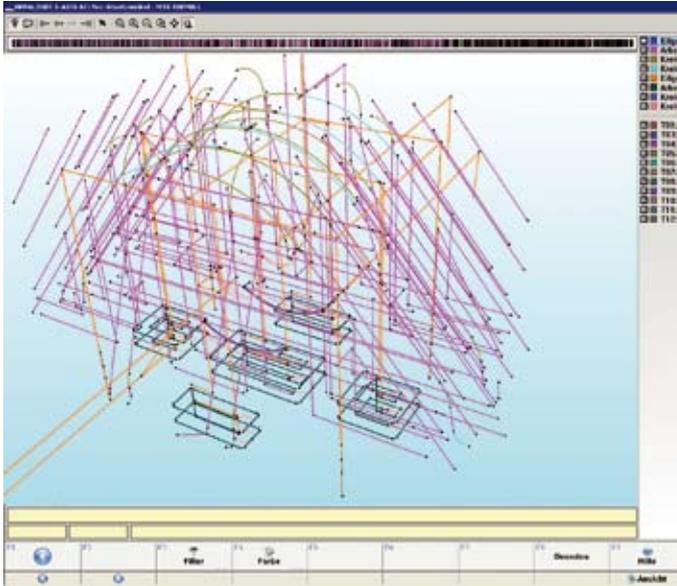
Quality and dimensional accuracy of the workpiece being machined can be monitored at any time in the course of the simulation using the 'measure' and 3D workpiece display functions.

The MTS-CAD/CAM-System TopCAM uses TopTurn and TopMill as test machine tools for a first NC program test run (machining time, collision detection) whether in a neutral NC format before postprocessing or after postprocessing in the target control code format.

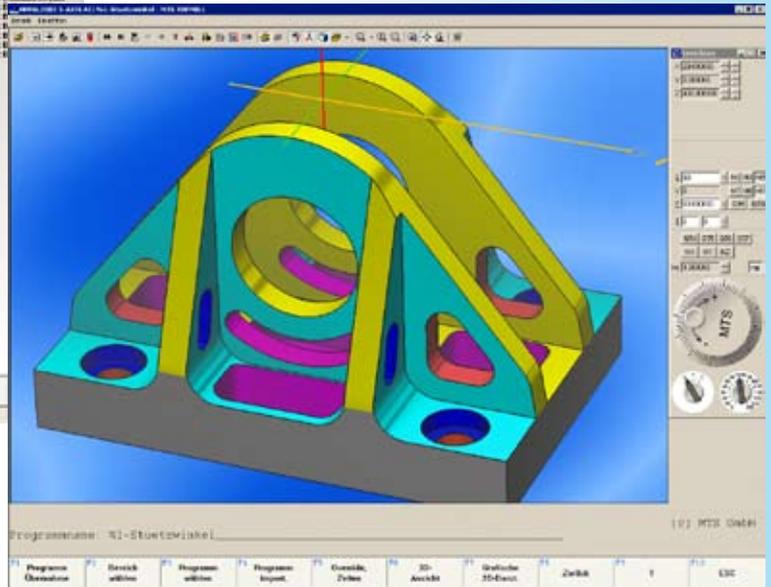


TOOL TRAVEL DISPLAY

TopTurn and TopMill provide a tool path display to enable analysis of tool movements; this display is in the form of either a schematic 2-D representation or a 3-D representation, optionally the transparent workpiece being superimposed on this view.



The tool paths are shown in the colour selected for the respective tool or in a freely-selected colour scheme. It is also possible to select tool path views for individual tools or machining planes. Clicking on a tool path calls up a display of the NC block that generates this path.

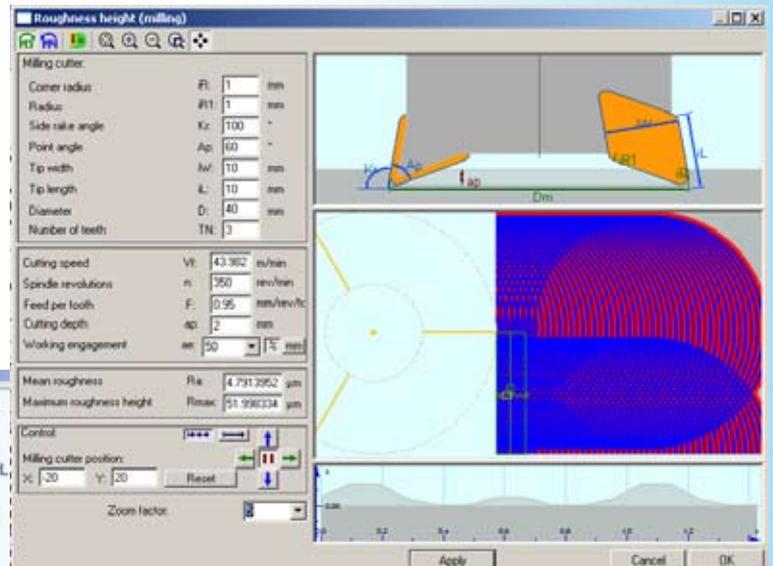
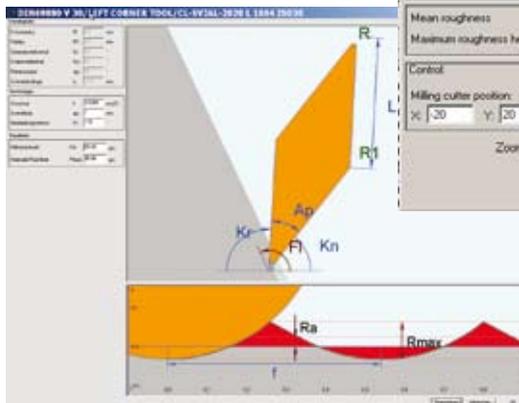


SURFACE ROUGHNESS CALCULATOR

In case of turning, the maximum roughness height R_{max} , the surface roughness R_a and the average roughness allowance are calculated from the tool edge geometry, machining direction and from the infeed per revolution. Conversely, the feedrate can be calculated for a given maximum roughness height.

For milling operations, the maximum roughness height R_{max} and the surface roughness R_a of the boundary surfaces are calculated from the cutting-edge geometry and the infeed per edge (i. e. tooth).

For the profile sections of the maximum roughness R_{max} , R_z and R_a of the bottom surfaces in milling direction and at right angle to this direction, the tool path overlaps in the milling direction are used in the calculation too. This is done for all the different test surfaces generated by the overlapping tool paths.



ABOUT MTS

MTS was founded in Berlin in 1980 by Dr. Hans-Joachim Pfeiffer. Its corporate mission is to develop software for technical applications, using mathematical methods.

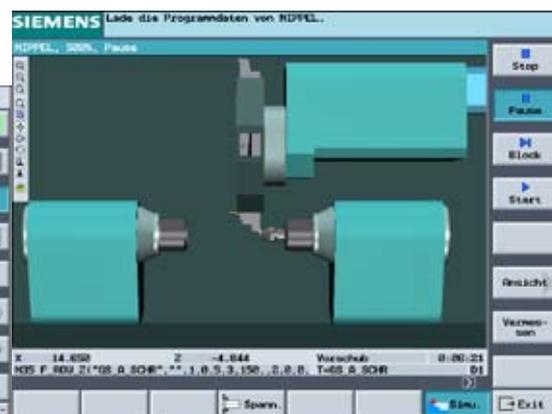
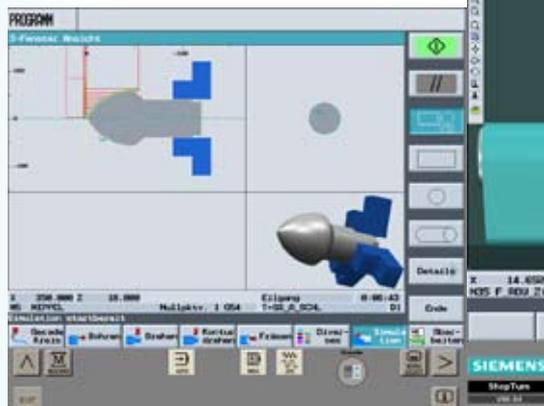
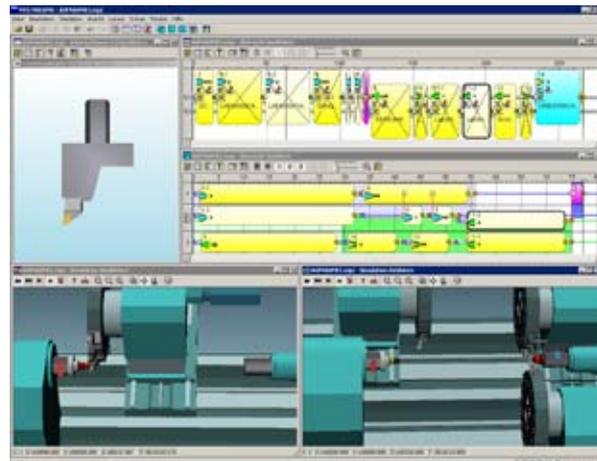
We have been specializing in the development of CAD/CAM and CNC software for more than 25 years.

Our activities focus firstly on the software packages presented here: MEKAMS, MillTurnSim, TopCAM, TopCAT, TopTurn and Top-Mill, representing the results of 25 years continued further development, and secondly, on project-oriented development work on contract for third parties. The latter mainly involves extensive adaptations of our standard software for major manufacturers of CNC controls and machine tools, e.g. in the projects:

- CNC simulation of multi-channel Swiss type CNC lathes (10 axes in 3 channels with axes superimposition)
- CNC simulation of complete machining on lathes and mill-turn centers (7 axes)
- Programming and simulation of multi-spindle CNC machine tools (24 or more axes in 8 channels)
- Universal machining cycles for turning and milling
- CNC simulation for 5 axes millturn machining centers

Another important sphere of our activities involves software-related training of our clients' staff.

We hold regular training courses on our standard software and also provide a telephone hotline service.



SYSTEMS REQUIREMENTS

MTS Software runs under Windows 2000/XP and VISTA.

You can also order our software in the following languages:

Chinese (simplex & traditional), Croatian, Czech, English, French, German, Hungarian, Italian, Polish, Portuguese, Russian, Slovakian, Spanish, Swedish, Thai, Turkish and Vietnamese.

