



**HEIDENHAIN**

61 + 06/2015

# Klartext

News from the World of HEIDENHAIN Controls

## The TNC in the Process Chain

Direct access to manufacturing and process data

**New Software Version with New Cycles:**

- ▶ Gear hobbing
- ▶ Turning in milling mode



# Klartext

61 + 06/2015

## Editorial

### Dear Klartext Reader,

Working on a new Klartext issue is like embarking on an exciting discovery tour. When putting together this issue, the Klartext team got a close-up look at two cutting-edge manufacturing plants—one produces design studies and prototypes for the automotive industry and the other manufactures custom components for car racing. Stories of the fascinating challenges the two companies face and why they rely on TNC controls in mastering them start on pages 4 and 8.

The section on TNC functions has more great discoveries in store for you, for example, an introduction to new control features on pages 11 and 12 of this Klartext issue. We're also presenting a classic that's always worth a closer look— Cycle 32 TOLERANCE. On page 16 you can find out how this cycle helps to optimize the accuracy and dynamic performance of machining operations.

A rewarding discovery tour was made by Bill Minello from Canada when he visited EMO in Hanover in 2013. Read on page 14 why it pays to visit trade shows and how ACC and AFC secure the mold maker's competitive edge.

Read and enjoy, with best wishes from the Klartext staff!



*Pankl Racing Systems AG manufactures engine and drivetrain components.*



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*The TNC turns designers' visions into reality at Schröter Modell- und Formenbau GmbH.*

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# Perfection in Form

Schröter Modell- und Formenbau meets highest requirements through high-tech production technology

***Situated in a rural setting southeast of Munich, Schröter Modell- und Formenbau GmbH gives shape to fascinating designs. The company creates prototypes that turn designers' visions into reality. Its perfect show cars make automotive executives' dreams come true and are a driving force behind product decisions. At trade shows they provide a glimpse of the future. To achieve their perfect forms, Schröter uses cutting-edge technology— HEIDENHAIN iTNC 530 controls move huge high-speed portal milling centers from Zimmermann. Designed to suit the needs of model builders and mold makers, the Swabian manufacturer's machine tools ensure that Schröter is best placed to meet the high and often dynamic demands of its customers.***

## Seamless control integration into the process

Schröter's models are made of a vast variety of materials, from aluminum to all kinds of plastics, and from block materials, polystyrene and foam materials to CFRPs and wood. No two models are the same. The applications include practically everything from the first design prototype to clay models optimized over and over again in the wind tunnel, and cubing models used as test equipment in series tests.

Managing director Maximilian Lörzel is dedicated to a consistent, seamless process chain from CAD design to generating the program in the CAM system and through to loading it into the control. The HEIDENHAIN control is smoothly integrated in the overall process. Large one-to-one

models are produced on Schröter's latest Zimmermann FZ37 portal milling machine with a traverse range of 8 m x 3.50 m. Milling these models can easily take up to 80 hours. To ensure seamless integration, the iTNC 530 features an Ethernet data interface that transmits even high-performance 3-D programs at lightning speed. No waiting time, no delays! Machining can start while the data is still being transferred.

"It's really quick and easy to make changes on the control," says Martin Geisler, an employee of Schröter Modellbau. The coordination of the entire process is simplified as well, because the post-processor generates the NC program in conversational format with HEIDENHAIN cycles right away. In this way, the program is very easy to optimize later on.

Organization is another aspect of the process that is optimized by managing director Maximilian Lörzel. Each employee is assigned a specific mod-







*The same employee through all production stages: In the CAD/CAM system Martin Geisler prepares the model for production, generates the NC program, and then manufactures the model on the machine.*

el and accompanies it through all stages of its production, from CAD/CAM design to workpiece blank to milling on the machine. This not only makes the job varied and interesting, but also prevents coordination problems.

**Dynamic machines for dynamic customer demands**

Schröter Modellbau has been using Zimmermann machine tools ever since the company was founded. The expanded production hall houses two brand new high-speed portal milling machines. "These machines are ideal for us. They are extremely versatile, have excellent dynamic performance and ensure a high level of availability," enthuses Maximilian Lörzel. Zimmermann adapts each machine to the customer's individual requirements, including the in-house development of milling heads. In this way the throughput, the materials and the stock removal rate can be individually defined.



*Model making on a large scale: the Zimmermann high-speed portal milling machines are customized to optimally meet the customer's requirements.*

*HEIDENHAIN iTNC 530 control: ideal functions for the manufacture of models and molds*



## **“It’s really quick and easy to make changes on the control!”**

**Martin Geisler, Schröter Modell- und Formenbau GmbH**

### **What only the control knows ...**

Working under a tight time schedule, Schröter cannot afford to have anything go wrong. Simulating the NC program is thus an important work step. Martin Geisler runs the whole program on the CAM simulator, “but my favorite is the Test Run feature right on the HEIDENHAIN control,” he points out. “It takes just a few clicks, but it’s extremely important for scheduling our work.” Because only the control knows how long the machining process will take. That’s something no CAM system can do.

This enables Martin Geisler to optimally plan the production process, which almost always takes place overnight at Schröter. He can determine, for example, when to insert a special tool that is not stored in the machine or when the end of the program will be reached.

HEIDENHAIN also provides all the necessary communication features. Interaction can be controlled through the RemoTools SDK software interface. This open interface offers comprehensive possibilities for software applications to transmit events to the machine operator, e.g. via a Windows server. A WhatsApp or text message notifies the operator when the tool needs to be changed. Thanks to the DNC interface (Option 18), the HEIDENHAIN control is already well prepared for future requirements in respect to intelligent networking.



*Indispensable for Martin Geisler during setup: the HEIDENHAIN HR 520 handwheel*

### **Experience, expertise and perfect engineering**

Reworking the 1:1 models requires a lot of skill. When producing clay models, a special clay/wax mixture is applied hot to the surface in order to optimize the body-work aerodynamics. Schröter’s task is to re-mill the optimized contour. “For this we like to use the GS Global Program Settings function of the iTNC 530 in combination with handwheel superimpositioning,” says key user Martin Geisler. The function calculates and applies a constant oversize across the entire machining operation, which eliminates the need to newly generate the NC program.

There is yet another aspect: “The material might warp, and in that case the milling cutter won’t be where it was before,” Martin Geisler explains. Cutting into the material is something he particularly wants to avoid when reworking a model. Using the

handwheel, he can make the necessary readjustments, such as the position of the milling cutter. The control will then automatically superimpose the corrections onto the programmed path.

### **High precision for series production**

When manufacturing models for component inspection during series production, a high accuracy of the surface is essential. The HEIDENHAIN iTNC 530 achieves this through its high-precision path control that smooths out an uneven point distribution, which may occur in CAM-generated NC programs.

In addition, users can use the internal Cycle 32 function to control contour deviations and to perfectly balance the ratio between speed and accuracy to suit the task at hand.





## HEIDENHAIN DNC Software Interface and RemoTools SDK

### Windows application accesses data in the TNC

Addressing current and future requirements for communication in production—also with a view to Industry 4.0—HEIDENHAIN has developed the HEIDENHAIN DNC option (Option 18). The software development kit RemoTools SDK enables Windows applications to access and, if necessary, edit data in TNC controls.

#### Applications:

- Communication with machine and production data acquisition systems (MDA/PDA)
- Connection to higher-level ERP/MES systems
- Increase in process reliability and system availability
- Communication with reporting systems that notify the operator of events during the running machining process, e.g. via smartphone

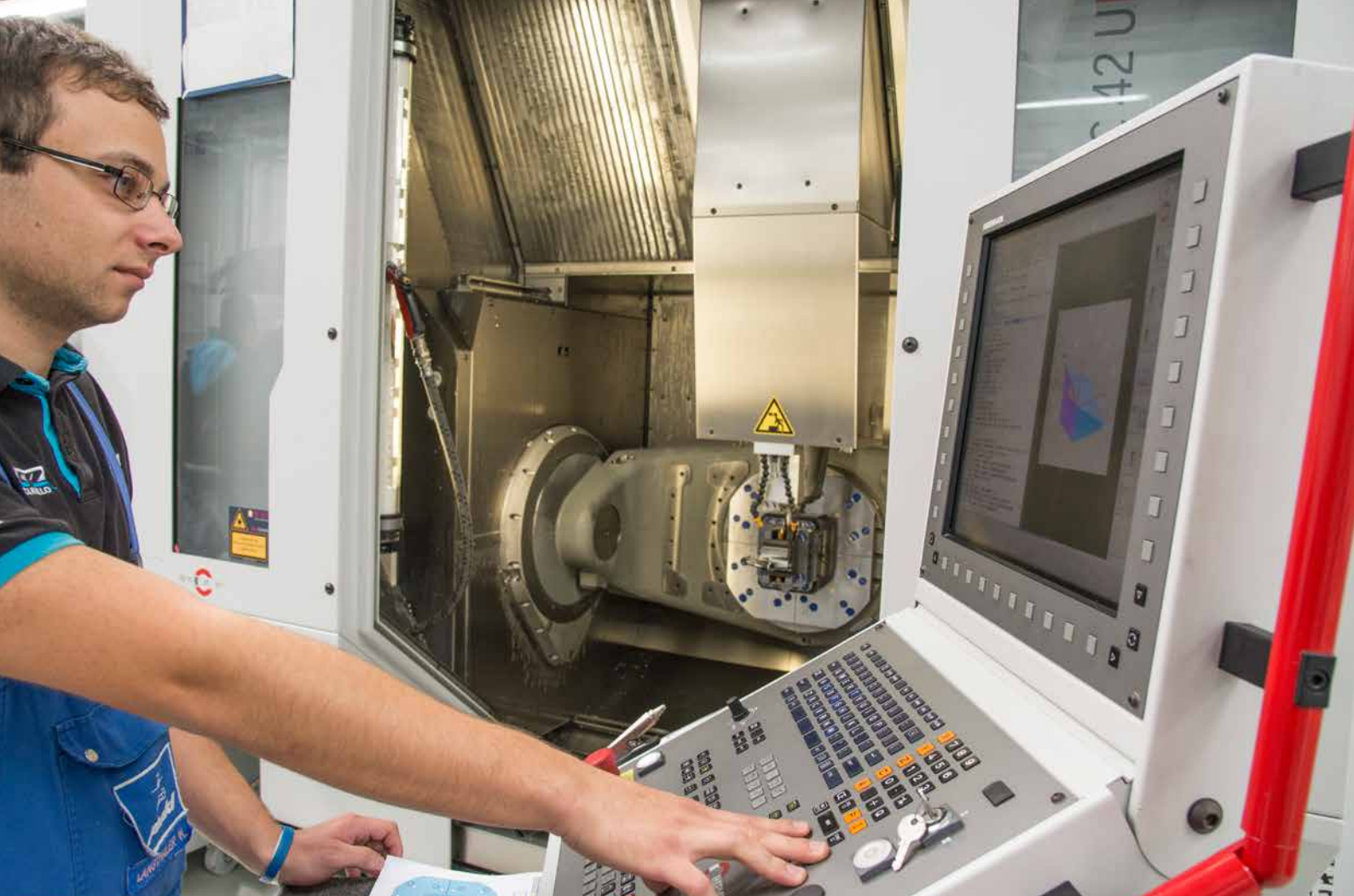
## Conclusion

“The automotive industry with its rigidly scheduled processes will continue to be our key sector in the future,” managing director Maximilian Lörzel anticipates. As an automotive supplier, he is faced with the big challenge of meeting the typical product cycles of automobiles despite a growing number of model variants. He can only provide both flexibility and speed if he can rely on the manufacturing technology. “With the combination of CAM system, Zimmermann milling machines and HEIDENHAIN controls, we are well placed to meet these challenges.” Even special requests or rush jobs from customers can be quickly accommodated. “On the technical side there’s no stopping us,” says Maximilian Lörzel with a smile.

+ [www.modellbau-schroeter.de](http://www.modellbau-schroeter.de)



*Convinced: Managing director Maximilian Lörzel (right) and employee Martin Geisler in front of the Zimmermann FZ33c 5-axis CNC portal milling machine.*



## The Quest for Speed

How control expertise unlocks greater productivity



***Pankl Racing Systems AG manufactures engine and drivetrain components that often push the limits of what is possible. Many Formula 1, DTM and NASCAR teams appreciate the products from Kapfenberg, Austria. Competition in sports also applies pressure on the performance of the parts manufacturer. The machining of the sophisticated materials used places high demands on both the employees and the machine tools. With their excellent control expertise, the machine operators at Pankl prove that difficult machining operations can be efficiently programmed on HEIDENHAIN controls. This is done on Hermle machining centers, which have the dynamic performance to cope with tough materials.***

### Machine operators give shape to car components

Working at the seventeen TNC-controlled Hermle machining centers is fun—not least because of the challenging workpieces, which can be key to the success of a racing team. In a region influenced by the vicinity of the Red Bull Ring, it is above all in-depth control expertise that gives wings to the machine operators' skills. They program many of the machining processes directly at the machine tool and turn visionary designs into real car components. For this task they are in complete control of the machine, TNC, tools and materials. Machine operator Daniel Stebegg enthuses: "It's fun to see that you can do so much more when you know more about the control's capabilities."

Some tasks can be very challenging, though. Extremely hard materials and special alloys often present surprising difficulties during machining. As time is

of the essence, they need to be resolved as quickly as possible, ideally by simple adjustment of the machining strategies, feed rates and infeeds. This is no problem with the conversational format of HEIDENHAIN controls.

With easy-to-understand dialogs, the TNC controls give operators a quick and reliable way to create machining programs even for complex contours. These are frequently needed, as Pankl manufactures many single items and small lots. Programs thus need to be constantly adjusted or newly written.

### Better results through team work

Division of labor is an important keyword for increasing the efficiency at Pankl. Everything that doesn't necessarily have to be generated by the DELCAM CAD/CAM system is programmed directly on the HEIDENHAIN control. And that's quite



a lot according to Daniel Stebegg: “5-axis machining operations, which we program with the PLANE function, are our bread and butter.” With a comparative look at machine tools that have to do without HEIDENHAIN controls, machine operator Christoph Nimmrichter adds: “Writing programs in HEIDENHAIN conversational format helps us to make sure we don’t forget any entries—because troubleshooting eats up a lot of time.”

Machine operator Franz Pillhoffer has to be particularly exact when manufacturing racing engine components. To avoid creating new programs from scratch each time, he sets great store by the easy adjustment and reuse of programs and program sections: “Labels are a very handy way to use subprograms and program section repeats.” This shortens the main program and facilitates a modular structure, enabling the operator to quickly adapt existing programs to new requirements. Christoph Nimmrichter points out another feature: “We also like the TNC’s possibility to add comments to programs. It takes a bit of time, but it makes the programs so much easier to reuse later on.” It also makes the programming clear and understandable to colleagues.

Short, simple programs are generally written at the machine: “Using the CAD/CAM system for a simple program would take longer than writing the program directly on the TNC.”

If free-form surfaces or complex contours need to be programmed, the DELCAM CAD/CAM system is ideal because of the excellent integration of the HEIDENHAIN cycles. Machine operators can make optimizations and adjust the cutting data right on the TNC—without a need to pass the program back to the CAD/CAM department for those changes.

### Competitive edge through knowledge

“We take every opportunity to learn even more about the functions of the HEIDENHAIN controls. We want to find out how to get machining tasks done even better and faster,” says Daniel Stebegg. The team tested the trochoidal milling function, for example. The TNC func-

## “Writing programs in HEIDENHAIN conversational format helps us to make sure we don’t forget any entries—because troubleshooting eats up a lot of time.”

Christoph Nimmrichter,  
machine operator at Pankl Racing Systems



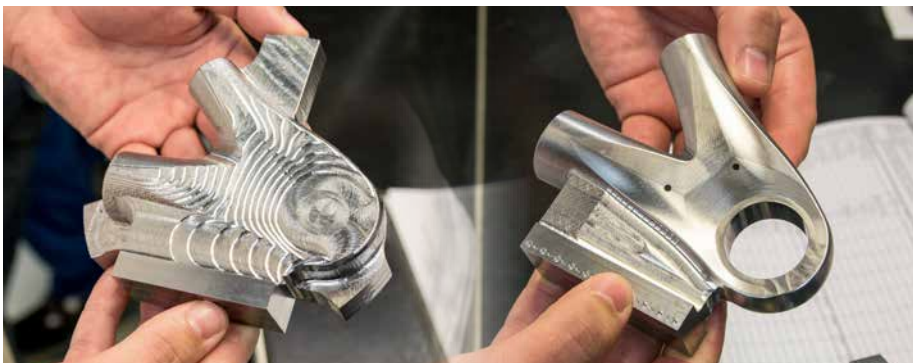
*Upright for sports car:  
Machined with high accuracy using the HEIDENHAIN iTNC 530 control.*



*A speedy bunch (from left to right):  
Franz Pillhoffer, Daniel Stebegg, Michael Langthaler, Christoph Nimmrichter*



*Impressive dynamic performance:  
Pankl Racing praises the qualities of the  
HERMLE machining centers.*



*Two steps to the perfect component:  
Joint for suspension system after roughing (left) and finishing (right).*

tion clears out slots, in particular, faster than line-by-line machining strategies. The specialists at Pankl also appreciate the ease of use of the new face milling cycle, which saves a lot of time in practice.

For those who, like the employees of Pankl Racing, have the opportunity to try out functions, it is a good idea to take advantage of the digital manual stored in the TNC. Practice-oriented training is also available, either directly from the control manufacturer or from authorized training partners. In addition to a theory section, these training courses include a hands-on section in which the participants get to solve real-world machining tasks at the machine tools.

### **High dynamic performance calls for high accuracy**

Pankl's components are designed for highest performance and top speeds. The machine operators' enthusiasm for speed has yet another reason: "The new Hermle machining centers are incredibly fast and dynamic," says Michael Langthaler. The HEIDENHAIN control helps to achieve the ideal balance between dynamic performance and accuracy, and thus allows making the most of the potential offered by these powerful machine tools.

When machining complex workpieces, it is often difficult to estimate how many tools will be needed. A single workpiece

can require the use of up to 80 tools. To avoid losing time in tool organization, the C32 and C42 machine tools from Hermle make use of the extended tool management feature of the TNC. Easy-to-read tool usage lists show the machine operators at a glance whether a tool is available or whether its tool life has expired.

Titanium and special alloys place great demands on machines and tools. In prolonged workpiece machining processes, the temperature affects the manufacturing accuracy. Working to tight geometrical tolerances is particularly important when manufacturing engine components. There, the diameters must achieve micron precision. The TNC function KinematicsOpt ensures continuous high accuracy for 5-axis machining operations. The control determines deviations on the rotary tilting table and adjusts the kinematics table accordingly. The required measuring cycle takes little time and is usually performed before starting the machining operation.

### **Exploiting the full potential is the key to success**

High-performance CAD/CAM systems are, without a doubt, indispensable for machining complex workpieces. HEIDENHAIN TNC controls enable a highly efficient use of automatically generated part programs on high-performance machine tools with excellent dynamic capabilities.

In addition, machine operators can take advantage of many powerful features of the HEIDENHAIN TNC and create part programs for relatively complex contours directly at the machine. The team at Pankl Racing uses its experience and expertise in working with challenging materials to implement excellent and efficient manufacturing solutions directly with HEIDENHAIN controls. This makes work on the machine even more valuable and is great motivation—a success for the whole team.

**+ [www.pankl.com](http://www.pankl.com)**



# New Cycles for Gear Hobbing and Interpolation Turning

New functions for the TNC 640 facilitate the programming of complex machining operations

*Cycles considerably simplify the creation of programs for complex machining operations. This can be seen from three cycles that are included in the new software version 05 for the TNC 640—Cycle 880 for gear hobbing and Cycles 291 and 292 for interpolation turning. Instead of defining many single movements, all you need to do is enter a few parameters—and the control takes care of the rest.*

## Cycle 880 GEAR HOBBING: Simplifying the manufacture of gears

Is there a really easy way to mill gears? There is. The best way to do this is to simply enter the gear parameters from the drawing into the dialog of the TNC 640. From this information

the HEIDENHAIN control generates the 5-axis path contours for gear hobbing with a profile cutter. No complex 3-D models and time-consuming programming work are required.

The new Cycle 880 facilitates the manufacture of cylindrical gears with outside or helical teeth with any angles.

The first thing you define in the cycle is the gear. Use the following parameters:

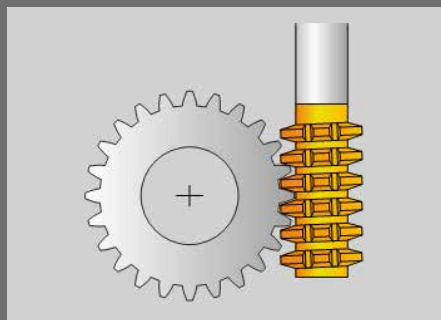
- Module
- Number of teeth
- Outside diameter
- Trough-to-tip clearance
- Angle of inclination

Then you describe the tool with the following entries:

- Tool inclination angle
- Direction of tool rotation
- Maximum cutting depth

In addition, you can select the machining strategy and the machining side.

*The new Cycle 880 makes it easy to program the complex processes required for machining gears with a gear hob.*



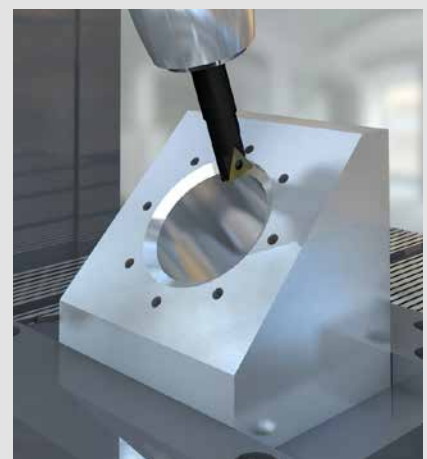
## Cycle 291 and 292: INTERPOLATION TURNING

Contours must frequently be turned in a tilted working plane. A possible use case is, for example, the face of a flange, as required for large pump bodies. With Cycles 291 and 292, the TNC performs interpolated machining. For this, the main spindle needs to be coupled to the position of the linear axes. The coupling causes the cutting edge to be oriented to or away from the center of rotation. The tool rotates about its own axis while moving on a helical path.

Cycle 291 COUPLING TURNING INTERPOLATION activates and deacti-

vates the spindle coupling. The cutting edge is oriented to the center of rotation. You program the path contours and tool movements yourself.

Cycle 292 CONTOUR TURNING INTERPOLATION is not only easier to use, but also more comprehensive. This cycle activates the spindle coupling, controls the rotation of the tool, finish-machines a previously defined contour by interpolation turning, and performs approach and departure movements. The programmed contour data in the subprogram must contain either monotonically increasing (entirely increasing or constant) or monotonically decreasing (entirely decreasing or constant) coordinates. If this is not the case, you need to use Cycle 291.



*The new INTERPOLATION TURNING cycle enables you to perform turning operations in milling mode without rechucking.*



## New Functions for Improved Process Reliability

New software features for the TNC 640 optimize the display, reliability and machine performance

***The TNC 640 is the high-end control from HEIDENHAIN for milling and mill-turning. The new software version offers you powerful new features. With the CAD viewer, for example, you can take a look at the programmed workpiece before you start machining. A new 3-D format facilitates the fully detailed, reliable data transfer from collision objects in DCM. The LAC function and Cycle 239 increase the safety and reliability of machining processes on heavy workpieces.***

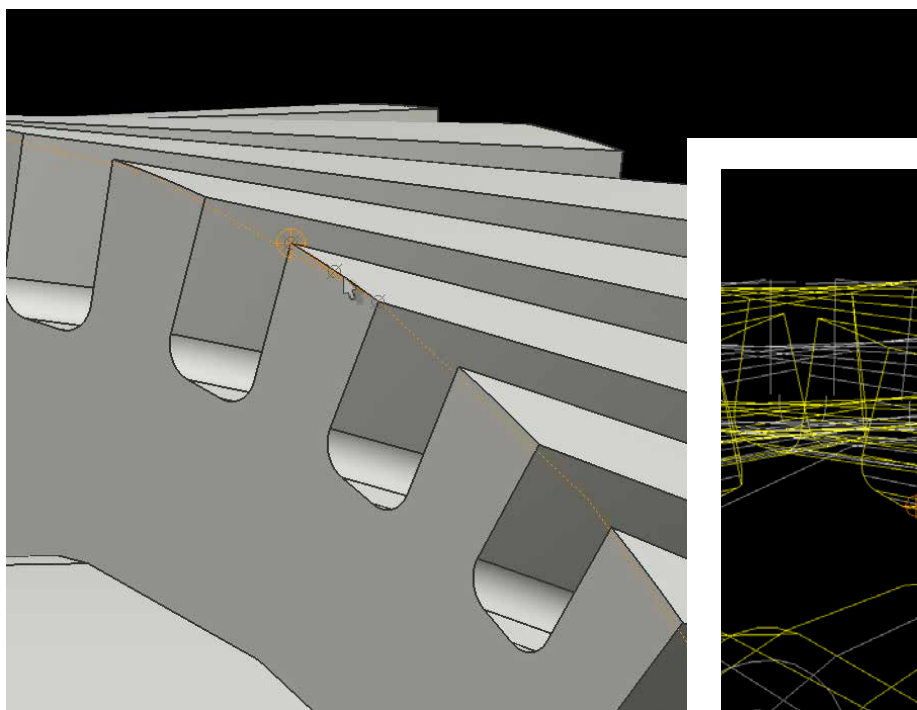
### New CAD viewer

Before you run a part program, it is always a good idea to have a look at the CAD model. Until now, the CAD preview has only been available as an option for the iTNC 530. With software version 05, the redesigned CAD viewer is now included in the TNC 640 as standard. Regardless of whether you want to access data on the local TNC hard disk or on the network, the CAD viewer opens automatically as soon as you select a file.

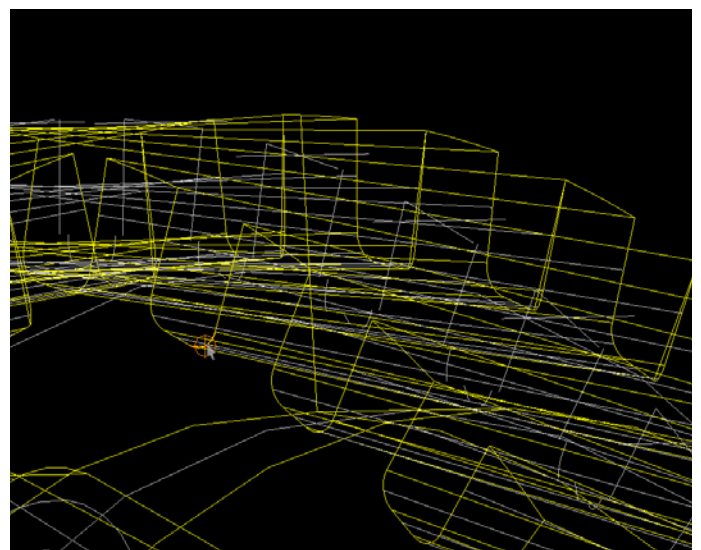
You can choose between many different perspectives and view options for displaying CAD formats like STEP, IGES and DXF. Using the mouse you can rotate, pan or zoom the view to take a closer look at details such as undercuts or small radii.

Another very useful feature is the display of information about the individual contour elements, which also includes a simple measuring function. All you need to do is set the datum at any point and then move the mouse over the model. When you pass the mouse over an element, it is highlighted in color. At the bottom of the left-hand pane in the viewer window, you can then see the type of the element and its starting and end point coordinates. The coordinates are referenced to the datum you have set.

CAD viewer: Display of coordinates



CAD viewer: Wire-model view





### New 3-D format for easy DCM setup

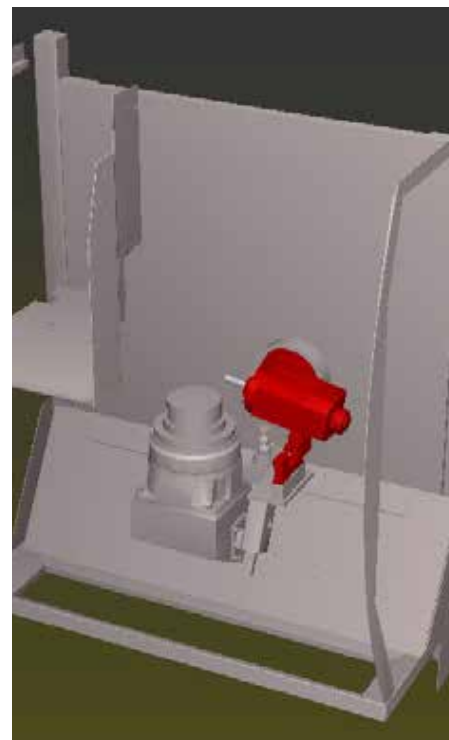
Complex and dynamic machine motions are difficult to predict by machine operators. DCM—the dynamic collision monitoring feature of the TNC—provides reliable protection against machine damage. If machine components are on a collision course, DCM stops the axis movements early on and marks the affected components in red in the graphic display. The monitoring feature is real-time capable and also effective in manual mode, e.g. during setup.

The machine tool builder sets up the DCM function and configures the potential collision objects in the machine's working space through the kinematics description. Software version 05 now provides a new 3-D format that makes it easier than ever for machine tool builders to transfer and exactly define existing 3-D data.

Users benefit from a fully detailed and realistic representation of the machine components and the machine's working space. It also enables them to make the most of the available working space.



DCM collision warning: Tool and table

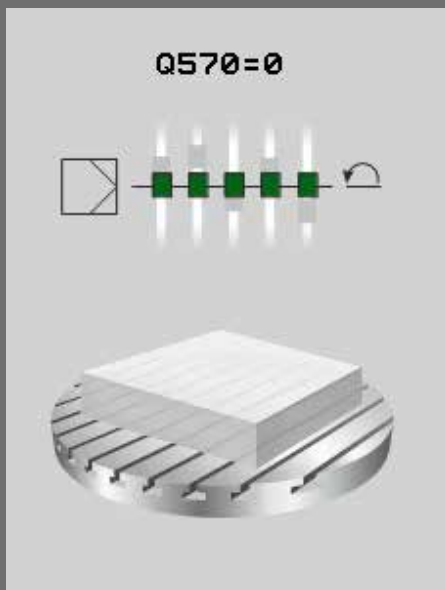


DCM collision warning: Spindle head and laser

### LAC—the simple way to manage components of varying weight

The dynamic response of a machine can vary significantly depending on the workpiece weight. A change in the load has an influence on the friction forces, acceleration, holding torque and stick-slip friction of table axes. The LAC function and Cycle 239 now provide a quick and efficient function for responding to load changes. LAC stands for Load Adaptive Control. It allows the load-dependent adaptation of control parameters and is used by the TNC 640 to ascertain the load acting on the axes. The TNC then adapts the different parameters to the new load situation.

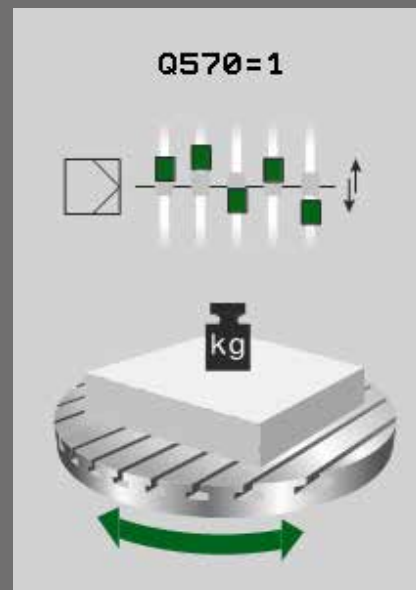
LAC and Cycle 239 thus enable you to safely machine components of varying weight.



Cycle 239 is very simple to use: Q570 is the only parameter you need to set.

#### Q570=0

- The TNC resets LAC.
- The feedforward and controller parameters ensure safe axis movements, irrespective of the load situation.
- Used during setup or on completion of the NC program.



#### Q570=1

- The TNC performs a weighing procedure to ascertain the weight of the load.
- The TNC optimally adapts the feedforward and controller parameters to the load conditions.



# Windsor Mold Group: Performance and Process Reliability with ACC and AFC

Canadian manufacturer of injection mold tooling goes for Dynamic Efficiency



**Bill Minello is Machining Manager at Windsor Mold Group in Canada. In September 2013 he boards a plane across the Atlantic to visit the EMO trade show in Hanover. What he doesn't know yet is that this trade show visit is to present the solution to a number of challenges he is faced with at the company. At EMO he discovers the TNC control functions Active Chatter Control (ACC) and Adaptive Feed Control (AFC). Here is a real-life story.**

## No trade show trick!

Bill Minello is walking around the trade show when he stops in his tracks. During a live demonstration at the stand of a major machine tool builder, the chattering noise from the machine tool has suddenly stopped while the machining operation continues. Is this chatter control just a cheap trade show trick? Or has Bill Minello just come across a solution to a number of daily issues he has to deal with in production?

He asks the machine specialists at the stand and they explain in detail how the ACC active chatter control of the HEIDENHAIN TNC control works. "It wasn't a trick! It was one of those rare moments when you hit on something really innovative. I realized at once that ACC would be perfect for our line of work!" enthuses the Canadian mold making specialist. He also recognizes the potential of the AFC adaptive feed control. Bill Minello is positive that the two new functions will perfectly complement Cycle 32 TOLERANCE (see also page 16), which Windsor Mold Group has already been using for production.

## First tests passed with flying colors

Bill Minello is intrigued by the demonstration at the trade show, but wants further proof of the effect of ACC. Machining tests are performed at the machine tool builder, exclusively for Windsor Mold Group. The tests amaze the Canadians even more. As a result, the first machine at Windsor Mold Group is equipped with ACC by the machine tool builder. Again everything runs smoothly right from the start. The mold making specialists carry out their own tests to gather further proof of ACC's capabilities.



Bill Minello (third from left) and his employees Jerry, Ed and Karen: Windsor Mold Group sets great store by a highly qualified staff and offers challenging career opportunities with flexible working hours.



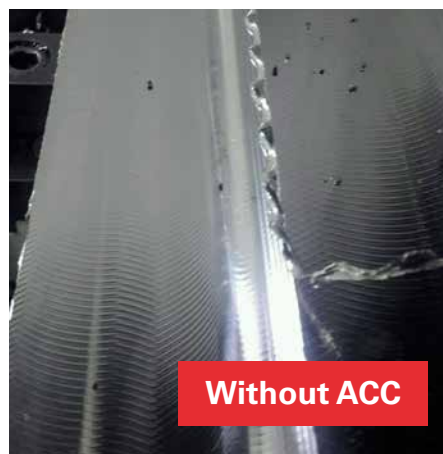
**“With ACC the material removal rate has increased by more than 60 %.”**

**Bill Minello, Manager, Windsor Mold Group, Canada**

In a machining test, they first choose an infeed of 4 mm under a high spindle load and without ACC. This produces a clearly audible chattering sound. After slightly increasing the infeed to 4.5 mm, they are forced to abort the test after just a few seconds to prevent damage to the machine. With ACC activated, the infeed is gradually increased to 7 mm before a slight chattering sound can be heard: “There are no visible marks in the surface after roughing. This shows us just how effectively ACC can reduce chattering,” reports Bill Minello. The initially installed on/off switch for active chatter control is soon removed: “If ACC can detect and eliminate chatter whatever the machining situation, why switch it off?” Bill Minello asks. ACC has been active ever since.

### A leap forward

Windsor Mold Group is headquartered in Windsor, Ontario, Canada, a city located just across the border from the famous Motor City of Detroit in the United States. Needless to say that the majority of the mold maker’s customers are American automobile manufacturers. The customers demand ever more complex molds in ever smaller lot sizes. The wish list includes everything from compact to large molds, from molds for exterior lighting components to molds for the vehicle interior, from molds for concealed parts to molds for parts with visible surfaces. Another factor is the high cost-pressure from competitors.



*Result of the machining test with an infeed of 4 mm without ACC.*



*Result of the machining test with an infeed of 7 mm with ACC.*

With these TNC functions, Windsor Mold Group responds to these requirements by presenting innovative technical solutions. The company currently uses ten machine tools with iTNC 530 controls. The efficiency-raising aspects of ACC for chatter control and AFC for spindle performance optimization ensure a significant increase in material removal rates. In addition, their monitoring functionality increases the process reliability. The TNC functions also reduce strain on the tool and the machine by limiting the mechanical load. Cycle 32 TOLERANCE makes it possible to achieve perfect surfaces and a high accuracy of fit

for two-piece injection molds. “We appreciate the accuracy and reliability of HEIDENHAIN controls,” confirms Bill Minello. “That’s why we have ordered more machines, equipped with the new TNC 640 and ACC of course!”

+ [www.windsormoldgroup.com](http://www.windsormoldgroup.com)



# A Perfect Combination of Accuracy and Dynamics

Cycle 32 TOLERANCE for optimizing TNC path control

**CNC machines are usually supplied with a “universal” configuration designed to suit a vast range of applications. If they have a TNC control, this universal configuration allows achieving good to excellent machining results. Cycle 32 TOLERANCE provides the possibility to further customize the machine to the task in hand. This is particularly useful, for example, when machining free-form surfaces with relatively long machining times. The cycle enables operators to achieve the ideal mix of accuracy and dynamic performance.**

Each step in machining a workpiece would actually require a dedicated machine setup. For example, the setup for a finishing operation would be focused on a high contour accuracy and excellent contour smoothing. In a roughing operation, however, this setup would fail to take full advantage of the feed rate potential. The same applies the other way round. To achieve the best possible combination of accuracy and dynamics for all machining operations, operators need a way to fine-tune the predefined machine configuration—and thus also the TNC’s path control. The TNC controls offer this possibility with **Cycle 32 TOLERANCE**, which is available as standard.

## The wider the path, the faster the corner speed

The path deviation  $T$  is usually set by the machine tool builder. It defines a default value for the maximum permissible contour deviation. **Cycle 32 TOLERANCE** enables operators to individually adapt the path deviation  $T$  to the specific ma-

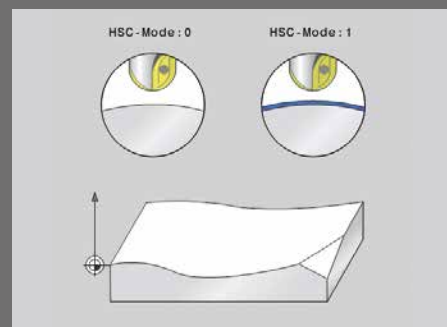
chining operation by specifying the path width that is available to the control. In this way, operators can directly influence the maximum achievable machining feed rate—and thus the machining time. This is particularly useful for contour elements involving many direction changes, such as typical free-form surfaces.

An example from car racing illustrates the principle: The wider the track is, the faster the race car can go around a turn. The driver chooses the racing line that allows the highest speed through the turn. On a narrow track, in contrast, the driver has no choice of line and is forced to slow down.

Roughing operations, in particular, frequently support wider paths, and thus higher tolerances for the path deviation  $T$ . In this way the operator can also increase the maximum possible machining feed rate in narrow places. For finishing, the operator needs to reduce the tolerance value again or reset it to the value defined by the machine tool builder. This is done by programming **Cycle 32 TOLERANCE** once again with a low value or without a value.

## “Lane Assist” included

**Cycle 32 TOLERANCE** additionally provides the parameter HSC MODE 0 or 1, which allows adjusting the path control settings. To stick with the car racing example: The HSC MODE parameter corresponds to a lane assist system in the race car. Level 0 permits only a slight deviation from the optimum line; the system intervenes at an early stage, even if this will lead to a loss of time. Level 1 allows a faster overall speed. It tolerates deviations from the optimum line as long as the defined tolerance  $T$  is not exceeded, i.e. as long as the wheels of the race car stay on the track.





Applied to the machine tool this means: If HSC MODE is set 0, the focus is on contour accuracy. During finishing, the defined path deviation  $T$  is not always used to the fullest by the TNC control in order to increase the contour accuracy. HSC MODE 1 places the focus on reducing the machining time. During roughing, this setting ensures that the path deviation  $T$  is used to best effect. It enables the machine to reach and maintain a higher machining feed rate in corners or narrow turns with sharp direction changes. This not only saves machining time. A constant machining feed rate also helps to extend the tool life.

### Guide values facilitate programming

To determine the path tolerance  $T$  in **Cycle 32 TOLERANCE**, machine operators can use the following values as a general guide:

- For finishing,  $T$  should be at least 110 % to 300 % of the chord error used in the CAM system. The CAM chord error is usually defined in a range between  $1\ \mu\text{m}$  and  $4\ \mu\text{m}$ . Using these settings, the TNC will reproduce the contour to be machined as accurately and true to detail as possible. Depending on the focus of the finishing operation, the tolerance values will range between  $5\ \mu\text{m}$  for increased contour accuracy and  $20\ \mu\text{m}$  for increased contour smoothing. For high-precision machining operations, tolerances far below  $5\ \mu\text{m}$  are not uncommon.
- For roughing, operators should use higher values. The values depend on the desired oversize that is to be left on the contour. Typical val-

ues for roughing are a chord error between  $4\ \mu\text{m}$  and  $30\ \mu\text{m}$  in the CAM system and a path tolerance  $T$  between  $0.05\ \text{mm}$  and  $0.3\ \text{mm}$ .

Depending on whether a roughing or a finishing program is created in the CAM system, a position resolution to four decimal places is recommended, for example  $L\ X-12.0215\ Y+12.8951\ Z+12.1258$ . This helps to avoid a falsification of the contour due to rounding errors in combination with a low position resolution.

### Cycle 32 TOLERANCE also takes rotary axes into account

For optimizing simultaneous 4-axis or 5-axis machining programs, Cycle 32 TOLERANCE additionally offers the possibility to set the tolerance for rotary axes  $TA$  to suit the type of machining operation. In simultaneous 5-axis machining operations, the maximum feed rate at the tool center point (TCP) is often not limited by the linear axes, but by the rotary axes. In these cases, the TNC control adapts the maximum machining feed rate to the slowest rotary axis.

The tolerance for rotary axes  $TA$  gives the TNC a value for smoothing the motion of the limiting rotary axes. In this way, the control can make the path contours more homogeneous. At the same time, the permitted smoothing results in more even paths, which can help to reduce the machining time. The influence of the limiting rotary axes on the maximum feed rate at the TCP is reduced.

A key benefit of the TNC control is that the contour—and thus the path at the TCP—will not deviate from the nominal path despite the additional tolerance for rotary axes  $TA$ . The TNC takes the TCP de-

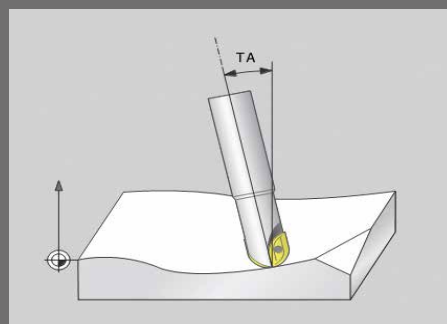
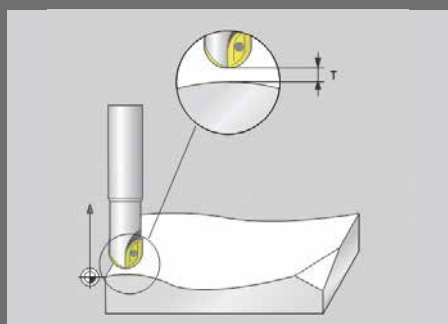
viation resulting from the smoothing of the rotary axes into account and compensates it in compliance with the defined path tolerance  $T$ .

When defining the rotary axis orientation, the resolution for rotary axes in NC programs should be specified to four decimal places, for example  $L\ X-12.0215\ Y+12.8951\ A+12.1258\ B+32.8945$ . When using vector programs, the output of the orientation vector should be specified to seven decimal places, for example:  $LN\ X-12.0215\ Y+12.8951\ TX-0.0455636\ TY+0.2118529\ TZ+0.9762388$ . Too low an output resolution can negatively affect the machining results.

### In complete control of dynamics and tolerances

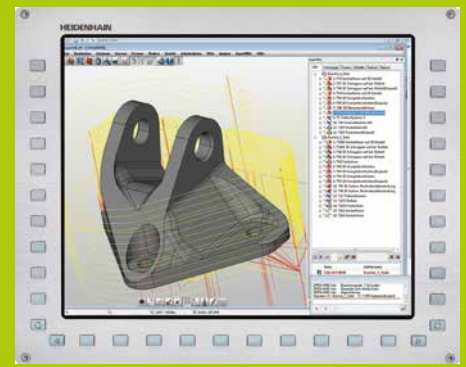
Thanks to the special path control of the TNC, very dynamic machine motion can be achieved. At the same time the control ensures that the defined tolerance values are observed. Regardless of the machining mode, the machine will always comply with the defined path tolerance  $T$ .

On straight contour sections or large-diameter arcs, the TNC does not use the path tolerance  $T$  to the fullest. In these cases, this is not necessary anyway in order to reach the maximum machining feed rate. The control simply moves along the center of the contour path defined by the NC program. In addition, the path tolerance  $T$  does not affect positioning movements with exact stop, e.g. when approaching drilling positions.



# In a Central Position for Digital Order Handling

The TNC 640 in your process chain



***Economic manufacturing demands an efficiently working process chain. It is key to ensuring seamless communication and knowledge transfer between everyone and everything involved in the process. The control plays a pivotal role, as it is located at a central position within the process chain. The TNC 640 is an ideal solution to perform this task.***

Every company is different, of course, and has its own philosophy of organizing workflows. The framework conditions also vary widely depending on the company size, manufacturing depth, lot size, and range of machinery. The basic links and steps of a process chain, however, can be compared. It has to seamlessly connect the design, programming, simulation, production planning and production stages. For digital order handling, communication and data transfer have to be possible in all directions. After all, the goal of all these measures and investments is to increase efficiency in the workshop.

## The control as the nerve center

The control takes a central position in the process chain. It is the last data processing link in digital order handling before the machine transforms digital bits and bytes into mechanical motion, swarf and the desired workpiece. During production at the machine, a wide variety of additional data and

information are generated that are needed elsewhere along the process chain. This includes information on changes made to the part program on the control as well as data for quality assurance. All these details need to be continuously updated and made available to all working steps involved in the manufacturing process.

To transfer this digital knowledge quickly and without loss, the universal availability of electronic production documents is indispensable. For this, it is essential to ensure easy, direct access to the order data, including technical drawings, CAD data, NC programs, tool data, work instructions, tooling lists, inventory data, etc. Digital order data such as photos or test reports that are generated during the manufacturing process also have to be passed on directly.

## The TNC 640 fulfills all requirements

To ensure that a control is able to fulfill the important functions within digital order handling in any company, it has to be adaptable to the existing process chain. As processes are subject to changes, the control also has to be open to modification and further development.

With its future-oriented software platform, the TNC 640 is well-placed to meet

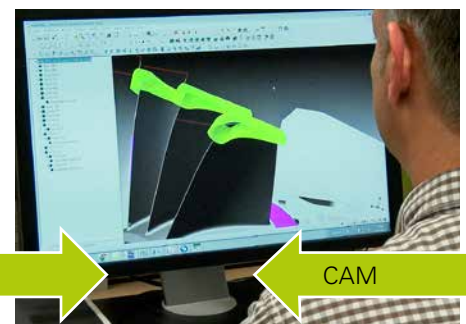
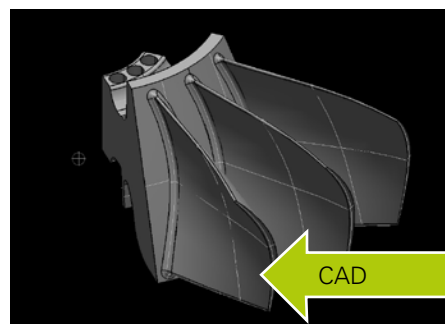
all these requirements. It offers machine operators a high level of support in performing a wide variety of tasks. This ensures short response times. To integrate the TNC 640 into the process chain and access the desired data on the control's user interface, HEIDENHAIN provides two different solutions.

## Standard functions of great practical value

Even the standard features of the TNC 640 provide access to the manufacturing process data right at the control through a CAD viewer, a PDF viewer and the Mozilla Firefox web browser. Viewing with the browser requires no separate program installation. The operation of web-based documentation software or ERP systems is just as possible here as access to the e-mail inbox.

The practical benefits of the standard features are obvious; for example, if data to be supplied by the client is missing. Say there is a rush job and the client e-mails the necessary data as a DXF file. With the TNC 640, the machine operator can go straight to the e-mail inbox and save the received DXF file. The operator can then open this file on the TNC 640, load the required data and start the manufacturing process—with no roundabout ways and no need for assistance from colleagues.

*Seamless from idea to workpiece without data loss: a modern process chain with integrated TNC 640*





### Access to a Windows PC: Option 133 REMOTE DESKTOP MANAGER

Option 133 REMOTE DESKTOP MANAGER provides an expanded solution for integrating the TNC 640 into the process chain. The push of a button on the control keyboard is all it takes to switch between the control screen and the screen of a Windows PC. It can be a computer in the local network or an industrial PC (IPC), such as the HEIDENHAIN IPC 6641, in the machine's electrical cabinet. The key combination for switching the screens is user-selectable and can be defined in the settings of the TNC 640.

From the control, machine operators can directly access all data processing systems in the process chain. All the usual applications, e.g. for managing, documenting and visualization, can be simply operated and used right on the TNC 640. CPU-intensive CAD/CAM tasks do not affect CNC machining and machine performance.

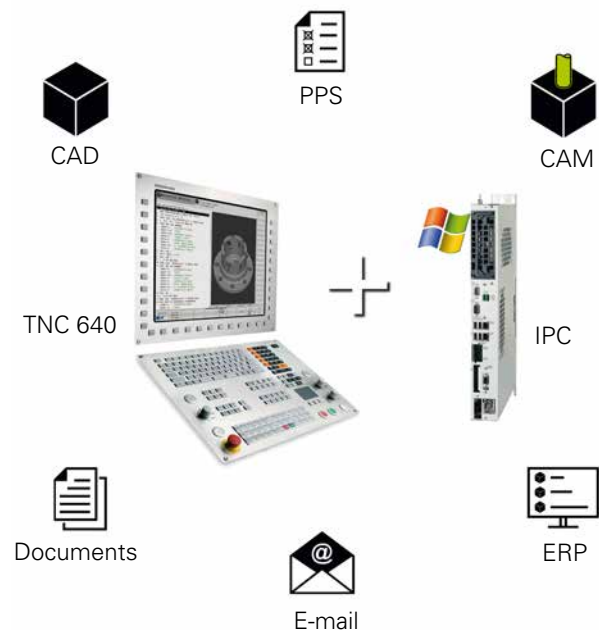
#### How easy and effective this solution is can be seen from the following two examples:

A common issue in production is delays caused by incomplete dimension data in drawings. Instead of doing the legwork or putting a lot of time into research, the machine operator simply loads the CAD model on the TNC 640. The required dimension data and information can thus be quickly provided to the machine, even if the colleagues from design are currently not available.

In the second example, a component for a time-critical job was programmed in the CAM system. The machine operator in the workshop notices that the tool to be used for machining permits a higher infeed. He wants to change the part program to take advantage of this fact and improve manufacturing efficiency. The

operator starts the CAM application directly from the TNC 640, increases the infeed, and generates a new NC program. Then he loads the new NC program and continues machining. In the CAM system, the new infeed values are stored centrally and are visible to everyone involved in the process.

*No influence on CNC machining and machine performance: the combination of TNC 640 and industrial PC, such as the HEIDENHAIN IPC 6641*



#### The TNC 640 in your process chain: Benefits of integration

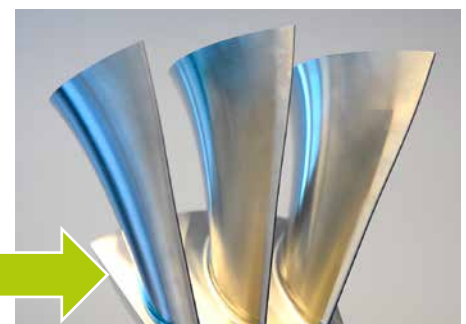
- **Access Windows-based applications directly from the TNC 640:**  
Operate CAD/CAM systems or manage job orders
- **Enhance competitiveness through an optimized information flow:**  
Close information gaps and save valuable time and resources
- **Use PC functions on the machine:**  
Gain remote access without affecting machine performance
- **Increase efficiency in manufacturing:**  
Implement seamless data exchange and optimally coordinate processes
- **Take advantage of standard features:**  
Improve processes in the workshop without a need for additional options



TNC



Machine



# Investment-Safe Repairs

HEIDENHAIN provides a 12-month warranty on complete devices

Warranty conditions are simple, concise and highly customer-friendly when the HEIDENHAIN service department repairs devices—12 months warranty not just on the parts repaired, but on the complete device. The HEIDENHAIN service department gives customers a 100% assurance that their investment is safe for the next year following repairs to controls, position encoders, subsequent electronics or any other HEIDENHAIN products. Whether a repair makes sense at all because other parts in the device might require repair in the foreseeable future is a situation that HEIDENHAIN customers do not face, and repair costs are transparent and planned sustainably for the long-term.

Service work always includes updating to the latest state of technology as well

as comprehensive functional testing of all assemblies in the device. This uncompromising orientation to quality enables HEIDENHAIN to provide its above-average warranty levels. This in turn reflects the company's trust in the quality and reliability of its own products as well as the service work performed.

If these services are carried out directly by HEIDENHAIN, customers benefit from repairs making the most of HEIDENHAIN's specialized production and measuring equipment. Intensive training for service employees ensures deep product expertise, and detailed documentation of service cases aids both rapid error diagnosis as well as consistent product improvement.



*Satisfied customers thanks to investment safety—HEIDENHAIN provides a 12-month functional warranty not just on the parts repaired, but on the complete device.*

**+ For more information see:  
[service.heidenhain.de](http://service.heidenhain.de)**

# Machine Upgrading

New HEIDENHAIN controls replace the TNC 150, TNC 151 and TNC 155



*Sustainable machine upgrading for more efficient and precise production: replacing the TNC 150, TNC 151 and TNC 155 classics with modern HEIDENHAIN controls*

They're genuine classics among numeric contouring controls: HEIDENHAIN controls of the TNC 150 series consisting of the TNC 150, TNC 151 and TNC 155 controls have been reliably providing their services on milling machines across the world for more than 30 years. HEIDENHAIN has ensured the complete supply of spare parts and replacement devices throughout this period, but technical progress has now become apparent with parts supply for TNC 150 controls—parts required for repairs can now no longer be produced. This production has partly ceased to be economic, but is also technically no longer feasible. Developments are particularly striking in the electronics sector, meaning that assemblies and their associated technology, sometimes over 30 years old, are simply no longer available.

Despite this, TNC 150, TNC 151 and TNC 155 users can of course still rely on HEIDENHAIN, even after 30 years, to provide solutions when servicing is need-

ed—machines equipped with the control classics can be upgraded to the latest controls. Such modernizations are particularly advantageous with machines having large traverse ranges and mechanically robust constructions, and customers specify the latest control model for upgrading purposes according to their machine and desired extent of modernization. The TNC 128 or TNC 320 are available for simple 3-axis machines, whereas upgrading to the state-of-the-art TNC 640 control is recommended for machines that are more complex.

The result is a sustainable modernization of machines and production processes, achieving production with greater precision and efficiency. The new HEIDENHAIN controls feature modern hardware with faster processors, significantly larger memories for NC programs and modern, rapid graphic simulation. NC programs are imported via USB stick as standard, and connecting to the company network via Ethernet is just as possible. 2-D drawings



can be loaded directly on the control with the DXF import option, and contours or positions for boring and drilling operations are simply clicked on, thereby saving time and avoiding errors during the importing process.

Also decisive for many customers is the full upward compatibility of TNC controls—thanks to this, operators can largely continue to use the old NC programs on a control from the TNC 150 series on modern controls. Users rapidly familiarize

themselves with the new control thanks to the intelligent operating concept, and only new cycles need to be learned, if they are used.

A special bonus during the 2015 start phase: all upgrading customers who send their TNC 150, TNC 151 or TNC 155 controls back to HEIDENHAIN receive a voucher for an NC programming training at the HEIDENHAIN headquarters in Traunreut or a local service agency. Participants rapidly get to know the new control

functions and options, enabling them to put these to good use for everyday production processes. Work on the upgraded machines becomes more efficient and more productive.

+ For more information see: [service.heidenhain.de](http://service.heidenhain.de)

## Signs of Life from the Comet

Rosetta space mission

***Our Sun and the astronomical objects orbiting it formed from a cloud of dust and gas 4.6 billion years ago. They all have been constantly changing ever since, whereas comets from the outer solar system have remained almost unchanged. They are relics from the beginning of our solar system and thus important witnesses to the formation of the Earth—and possibly even of life on this planet. That's what makes the Rosetta comet mission so important and exciting.***

Eleven years ago, in March 2004, the Rosetta space probe was launched to make detailed studies of comet 67P/Churyamov-Gerasimenko. In August 2014, it went into orbit around the comet, having covered a total distance of 6.4 billion kilometers. In November 2014, the Philae lander was dispatched from the Rosetta space probe and landed on the surface of the comet.

Rosetta and Philae will travel with the comet until it reaches the point nearest the Sun in August 2015. During this time, the space probe will continue orbiting the comet while Philae will remain on the surface. The measuring instruments on board the two modules will closely monitor the comet as the initially cold and inactive lump of dust and ice awakens under the heat of the Sun.

Scientists are hoping, in particular, that the gathered data will shed light on the comet's composition. They are convinced that part of the Earth's water originates from asteroid and comet impacts. It is also likely that many organic molecules, such as amino acids, reached the Earth in the same way. These molecules are considered to be the building blocks of life.

### Measurement technology from HEIDENHAIN ensures reliable communication

During the long journey, all communication as well as the control of the Rosetta space probe and the Philae lander are made possible by a high-precision antenna on the Earth. It is located in Western Australia and has a clear height of around 40 m. To

be able to transmit and receive signals to/from the modules over a distance of more than 500 million kilometers, the antenna has to be aimed with pinpoint accuracy despite its weight of 45 metric tons.

A deviation of the antenna position from the nominal value is only permitted in a very low range down to an angle of 0.006 degrees (21 arcseconds). This accuracy has to be reliably provided by the positioning system even under harsh conditions, such as wind speeds between 45 and 60 km/h acting on the antenna. This key positioning task is fulfilled by a servo system in which HEIDENHAIN angle encoders are responsible for high-precision position detection. They have been working without any problems ever since the beginning of the mission and have contributed significantly to the success of all maneuvers performed so far.



Angle encoders from HEIDENHAIN ensure a highly precise orientation of the antenna used for sending signals to and receiving signals from the space probe.

# Training Network: Short Paths to Technical Training

Long-range knowledge transfer

**The HEIDENHAIN Training Network is a worldwide network consisting of HEIDENHAIN subsidiaries and distributors on the one hand and authorized training partners on the other. The goal is to make technical training of high quality available at all locations, both in Germany and worldwide.**

## Worldwide competent training program

In its Training Center in Traunreut, Germany, HEIDENHAIN offers a comprehensive program of courses intended both for the TNC user as well as for specialists in service and interfacing. The course contents, the equipment and the training documentation meet the demands for high quality instruction.

HEIDENHAIN is present in all industrial countries with its own subsidiaries or through distributors in a worldwide network of courses for NC programming, servicing and control-machine interfacing. The requirements regarding the content and quality of knowledge transfer are oriented on the courses in the Training Center in Traunreut.

## Directly from HEIDENHAIN: knowledge transfer for service and interfacing

Courses for the interfacing of controls and encoders to machines as well as on service topics set very high demands on product-specific technological knowledge. And no one is more competent than HEIDENHAIN itself in such matters. This is why such courses in Germany are offered exclusively in the Training Center in Traunreut. Everywhere else in the world, the HEIDENHAIN network of subsidiaries assumes this demanding task.

Specialists for the interfacing of controls or for retrofitting, service and repair enterprises profit from a comprehensive program of courses.



Service courses take place all over the world at HEIDENHAIN subsidiaries.



### TNC knowledge for high demands

For many years, the training network has been continuously expanded in order to optimize access to courses by establishing numerous providers at all locations. The TNC users in particular in Germany and its neighboring countries profit from an increasingly dense network of authorized training partners. These external training facilities impart practical TNC knowledge for TNC users in programming courses. These are independent companies and educational institutions that are optimally prepared by HEIDENHAIN through a special program in Traunreut and are kept continually up to date on the latest information regarding new developments.

The quality of knowledge transfer from the authorized training partners is comparable with the requirements of the training program offered in the Training Center in Traunreut. Besides the well-equipped training rooms with original HEIDENHAIN

TNC programming stations, course participants can also expect access to CNC milling machines with HEIDENHAIN controls. The knowledge is conveyed in individual units using easily understandable and user-friendly practical exercises. And naturally the course contents are coordinated with the contents in Traunreut.

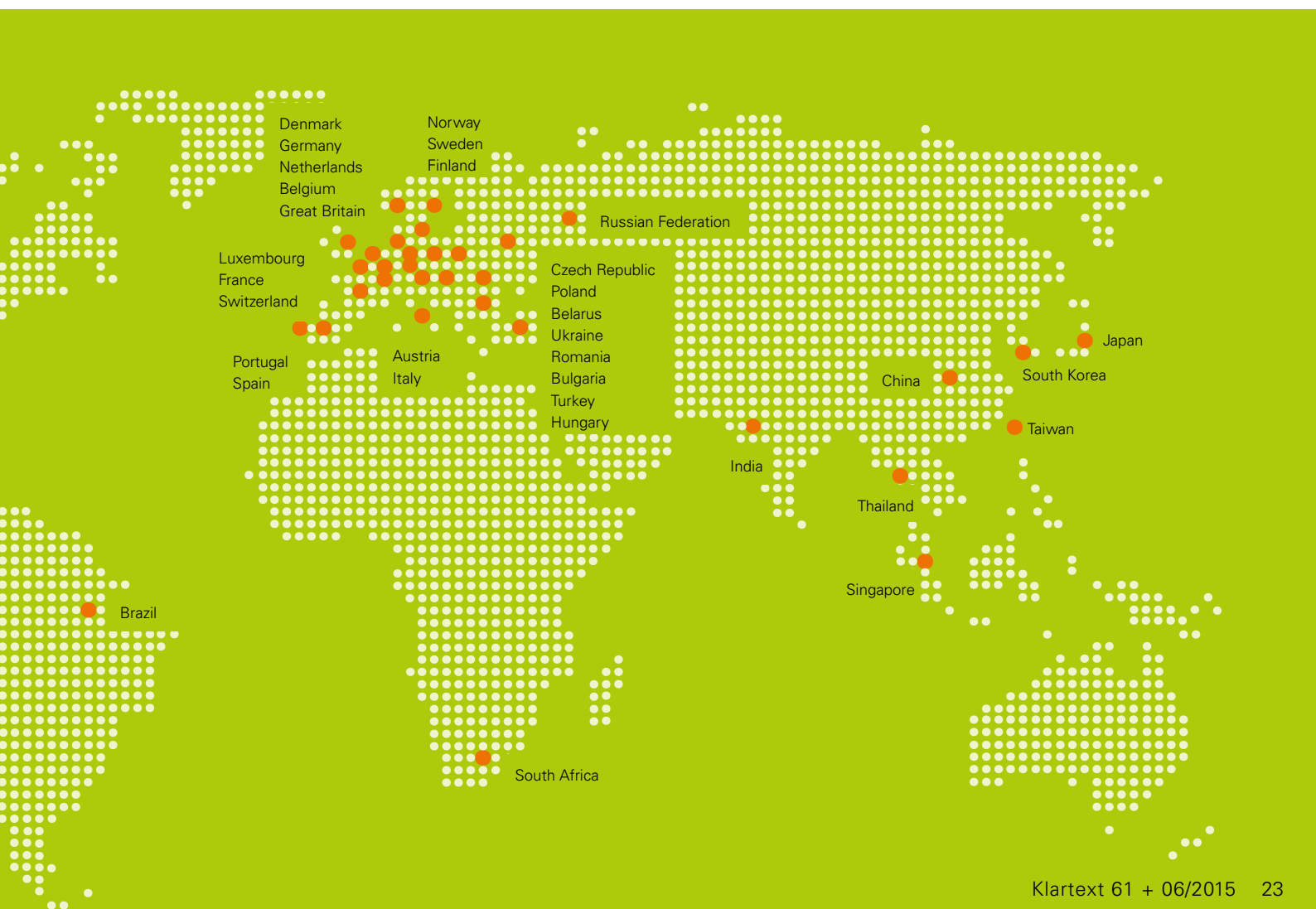
The course curricula of the authorized training partners covers a large range, beginning with the basic seminars for NC programming to HEIDENHAIN basic courses for operating principles and fundamental functions of the controls, all the way to special topics such as machining in a tilted plane or tool and workpiece calibration. Beyond this, on-site special courses are also offered that are tailored to the customer's specific requirements. All in all, a well-rounded package with the clear goal of optimally training TNC users to be able to work with their TNCs effectively and therefore economically.

### Finding courses easily

Many partners in the HEIDENHAIN Training Network offer additional courses that are specifically adapted to the requirements of an enterprise. This makes it possible to use the respective machine to its full potential. The course duration is also definable: from one-day seminars to a full-week course.

The different training partners have various topic areas in their curricula. You can find the right course for you by using the interactive course search function:

+ [http://training.heidenhain.de/de\\_EN/worldwide-search-for-courses/](http://training.heidenhain.de/de_EN/worldwide-search-for-courses/)





# HEIDENHAIN



## + All-Around Protected Touch Probe

The TS 460 touch probe from HEIDENHAIN helps you in workpiece setup and measurement in the machine tool's working space. One innovation is the mechanical collision protection between the touch probe and taper shank: in the event of a light collision of the TS with the workpiece, the adapter allows the touch probe to yield. At the same time, the control stops the probing process. Neither the probe nor the machine suffers damage. At the same time, the collision protection adapter also functions as a thermal decoupler, protecting the touch probe from excessive heating through the spindle during very long or intensive probing processes.

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Angle Encoders + Linear Encoders + Contouring Controls + Position Displays + Length Gauges + Rotary Encoders