



HEIDENHAIN

50 + 6/2009

Klartext

News from the World of HEIDENHAIN Controls

TNC Training

Looking over Course
Participants' Shoulders

Control

New Functions
of the iTNC 530

The TNC in Practice

How Users Overcome Challenges

+ 50th edition
with interesting user
coverage

HEIDENHAIN

Editorial

Also, check out our interactive KLARTEXT e-magazine, with even more background information, animations, and expert knowledge. Take a look at www.heidenhain.de/klartext



Dear Klartext Reader,

Time flies—and technology grows. This growth is documented in 50 issues of Klartext in 26 years. You will find some of the milestones on page 7.

Issue 1 described itself as “a newspaper for the machine tool operator.” So let’s go back to the roots with a great number of **user reports** and experiences. **Now the practical know-how of skilled machinists and specialists** is in the limelight—we’ve “looked around” in various companies to document the outstanding achievements and the hands-on application of TNC controls in the field. Be ready for a few surprises and have a look into manufacturing plants, training rooms and offices.

Of course, we’ll also introduce to you our **new control functions** and show you how to safely and simply integrate them into your operations.

So please read and enjoy, with best wishes from:

Your Klartext staff

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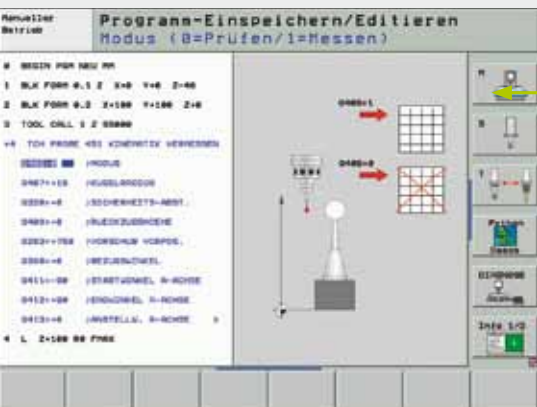
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The new NC software 340 49x-05 makes working with the iTNC 530 control even easier.

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Good Parts, Thanks to KinematicsOpt



Five-axis machining is finding ever more proponents. Metal removal rate, higher surface definition, shorter machining times and accelerated set-up times are all factors in favor of 5-axis machining. However, it can become tricky when thermal and mechanical influences change the kinematics of the machine and make time-consuming recalibration necessary. The Austrian STIWA Group shows how to master that challenge by using the KinematicsOpt software from HEIDENHAIN.

The STIWA Group—with headquarters in Upper Austrian Attnang-Puchheim—is one of the leading European companies in the area of manufacturing and assembly automation. STIWA plans, manufactures and supplies complete automation solutions including automation-friendly product design. Due to high accuracy requirements, STIWA has used machine tools with integrated linear encoders.

Efficiency with single parts and small-batch production runs

Because of the manufacturing quality required, STIWA places stringent requirements on production accuracy: $\pm 1/100$ is standard, and in tool and die making as much as $5\mu\text{m}$ accuracy is required in the manufacture of parts (tools for high-tensile sheet and plate). An entirely different requirement is associated with the batch sizes typical of STIWA: Batch sizes between 1 and 200 pieces are produced in STIWA machines and manufacturing cells. As a consequence, frequent fixing, calibration and inspection

lead to faulty parts when beginning production. All that ended, however, when they put the three Hermle C30 U, C30 UP, C20 UP machining centers into operation. The secret? These machines are equipped with the iTNC 530 and the cycle package KinematicsOpt as standard. These machines also produce parts that cannot be measured on the machine until after they have been manufactured.

A good feeling

Ever since these machines have been equipped with KinematicsOpt it has sufficed to calibrate them once per week, although the production facility is not yet optimally air-conditioned. According to Dominik Pohn there is a second significant benefit on top of the savings, "Thanks to KinematicsOpt we now know that the very first part will be according to spec. We've drastically reduced scrap!" Andreas Huber, technical manager of part manufacturing adds: "Since we've started using these cycles we can work in good conscience. The spatial angles stay stable even with weekly calibration. And when there's been a collision, KinematicsOpt shows us immediately how large the errors are." Now the machine operators can

"With KinematicsOpt I can truly depend on the machine"

Dominik Pohn
Member of the STIWA management board

simply inspect and optimized. And even if an error occurs after compensation with KinematicsOpt, now the operator can recognize immediately that the machine geometry has been affected.

Recalibration instead of new calibration

Wherever accuracy requirements are high, "intervention" is usually needed several times per day to ensure workpiece quality. The 3-D touch probes integrated in modern five-axis machine tools are normally used for workpiece alignment and measurement. The data acquired by the touch probe can be used for compensation in the NC program or the tool data. The disadvantage of that is that they only apply to one workpiece. For complex workpieces with sculptured surfaces, these measure-

Why HEIDENHAIN?

HEIDENHAIN controls and encoders have a long tradition at STIWA. As Dominik Pohn, member of the management board and responsible for the part manufacturing process of the STIWA Group reports, the NC world began a process of unification soon after the company was founded in 1972. We decided on HEIDENHAIN not only because of the convincing technical features. The simplicity in program creation, for example for thread milling or pocket milling with the integrated cycles, but also for simple deburring are among the reasons.

There were more qualified machining specialists available with HEIDENHAIN experience than there were with the know-how for other controls. Also, the trainees in the technical school in nearby Linz are required to pass their exams on HEIDENHAIN controls.

Franz Staudinger, machine setter for part manufacturing at STIWA prepares a recalibration using HEIDENHAIN KinematicsOpt.



ments can sometimes be very difficult, and in special cases it is not possible at all until the workpiece has been inspected for its dimensional accuracy. But then it is actually too late.

The new KinematicsOpt feature of the iTNC 530 adjusts the kinematic model instead of the NC program. Changes in the kinematics are measured and compensated with the aid of a high-accuracy HEIDENHAIN touch probe and the very rigid, absolutely precise HEIDENHAIN calibration ball. With this compensation information the machine can move the tool more exactly along the programmed contours.

The tilting and swiveling accuracy is particularly critical on five-axis machines. Depending on the machine and ambient condition, the measured error can be trusted for typically no more than 3 to 15 hours. Because the complete calibration of a machine tool can take as much as a full day, the method is poorly suited for correcting machine kinematic drift. →

How does recalibration work?

Recalibration is surprisingly simple to perform. KinematicsOpt works like any other touch probe cycle. First, the user has to enter the parameters in the familiar plain language of the iTNC 530 while being supported by the control's informative graphic illustrations or the straightforward information in the User's Manual. The calibration cycle takes only a few minutes. Using a precision calibration ball mounted directly on the machine table, KinematicsOpt operates together with the HEIDENHAIN touch probe system clamped in the spindle

to measure the dimensional deviations of the kinematics right where the tool meets the workpiece! If the calibration ball can stay on the machine table and the machine has an automatic tool changer, recalibrations can even be run automatically and KinematicsOpt inspects all the rotary axes one after another. The error with respect to the ball center is logged for every axis, and statistical evaluations inform the user whether the required accuracy can be maintained through recalibration or whether an entirely new calibration is necessary.

One of the typical workpieces, which can be quite difficult to machine



The solution is in recalibration, which can be conducted in a few minutes under production conditions. In the STIWA Group, recalibration is necessary only once per week—and that in spite of high accuracy requirements—an expenditure of only 15 minutes!

Accuracy without the hassle

Franz Staudinger, machine setter, is simply glad for less hassle thanks to the software. With KinematicsOpt, the Z axis stays straight. It has only one zero point instead of having to offset a datum for every side as before. It is not always easy for an operator to correctly define multi-sided operations on difficult workpiece geometries. Andreas Huber sees the risk or error. "To really understand movements in up to five axis, to always know which zero point



Left: Andreas Huber, technical manager of part manufacturing, Center: Dominik Pohn, member of the management board for "part production" in the STIWA Group, Right: Franz Staudinger, machine setter

The KinematicsOpt cycles

KinematicsOpt is implemented as a cycle package in the iTNC 530 and offers the machine operator a familiar user interface. Calibration also requires a HEIDENHAIN calibration ball. The high-accuracy HEIDENHAIN 3-D touch probe measures the center of the precision ball at various positions of the rotary axes. With the deviations measured, the kinematic model of the machine in the control is ascertained and automatically adjusted. To keep the measurement and recalibration practical and efficient in a production environment, the goal of this method is not the determination of a complete error model, but rather the quick identification of the relevant part of the kinematic model. This prevents the machining error from exceeding a certain limit in spite of changes in the environment.

KinematicsOpt is integrated as a touch probe cycle package in the iTNC 530 and can be used identically for all machine kinematic configurations. By selecting the right cycle parameters, the measuring process can be adapted conveniently and flexibly to the respective requirements. It is also possible to choose between various positioning strategies. This makes it possible to also inspect rotary axes with Hirth couplings, such as are used particularly in the swivel heads of large machines.

applies to which side, requires a great deal of skill and demands your complete attention." There KinematicsOpt works in a surprisingly simple way: actually, the user only has to mount the calibration ball correctly and define the touch probe cycle. The iTNC handles the rest automatically.

Dominik Pohn attributes time savings of about 20 minutes per series directly to the use of KinematicsOpt. This time reduction is gained primarily in the running-in periods, because for STIWA, 200 pieces is already a "large series." Yet another factor in the unit-cost calculation is the increased productivity caused by the reduction in scrap and the subsequently higher number of good parts. And the cost of material sinks. For example, a STIWA part manufactured for injection-mold die making costs slightly more than 1000 euros—with approx. 150 euros for the material costs alone.

Conclusion

The bottom line is about 10% cost savings and the knowledge that you can depend on your machine. Pohn's conclusion is, "170,000 internal machine hours per year want to be run efficiently. HEIDENHAIN helps us here with its reliable linear encoders and TNC controls, the programming stations, and now also with KinematicsOpt." +

HEIDENHAIN iTNC 530 in the "KinematicsOpt" cycle



STIWA Group

Providers of complete automation solutions

www.stiwa.com

The Klartext in 50 Issues—a Brief Trip through Time!

HEIDENHAIN. It stands for over 100 years of company history, more than 30 years of TNC and 50 issues of the HEIDENHAIN Klartext. A glance at the first issues is like a leap through time: technical developments that are among the fundamentals today—innovative control functions that are standard today.

The first issue makes one thing clear: "The Klartext is a newspaper for the man at the machine." And, as you might guess, the first woman did not appear until issue 7 under the title "NC Technology Not Only for Men" :-).

The idea of plain language programming seems completely new, as Issue 2 gives a key-by-key presentation for the benefit of that man—or woman—at the machine. At this time the TNC 150 had just celebrated its debut by introducing parameter programming. The focal points of the issue included helical interpolation and the innovative "scaling factor" and "coordinate system rotation" cycles. (What did they teach in the basic courses back then?)

Fifty issues of Klartext document not only the development of a successful control idea. They provide insight on the state of the art technology of the time. With an example out of the realm of fantasy, Issue 7 of May '85 compares the technology of the TNC 150 with that of an old-time, mass produced radio. Its conclusion: the functions of the TNC could be realized using two million vacuum tubes—but with a current consumption of 5 megawatts and a housing with the size of a typical bunga-



The Klartext, Issues 1 (1983), 22 (1991), 31 (1996), 41 (2003) and 43 (2005) also reflect the HEIDENHAIN product line.

low. A little bit of fun beyond all practical relevance.

The issues that followed then became somewhat more business-like. They focused on innovation, for example the connection of peripheral devices such as the floppy-disk unit, a matrix printer and punched-tape reader (Issue 12, 1987).

The revelations of Issue 17 in 1989 really break new ground: TNC 407, TNC 415 and TNC 426 represent a completely new generation of controls, with a new "keyboard unit", color screen and an "operating technique that makes complex functions easily accessible through soft keys. Suddenly the TNC began to resemble the controls we know today.

Issue 31 documented a milestone of success in 1996: 100 000 TNCs in the field and the Spanish king Juan Carlos examining a TNC 426. The following issues demonstrate new technical advances: more and more HEIDENHAIN controls appear with flat-panel displays, and the modular inverters and motors complete the picture of a well-rounded product portfolio.

Then the millennium! Twenty-five years of TNC and the new iTNC 530 are the cen-

tral topics of Klartext 38 in 2001. As the flagship of HEIDENHAIN controls, the iTNC 530 features increasingly more functions, accessories and technical innovations. And the many issues of Klartext to follow did not keep them secret from the user.

Issue 50 is targeted specifically to the user, with many reports from the field in the area of schools and manufacturing. Still, the editorial staff cannot quite refrain from announcing new product features.

Klartext hopes to continue to enjoy wide circulation with many readers in the future as well—both on paper and in the live, interactive version on the Web. Thanks to you, our loyal readers! +

Perfect Milling Solutions from the Very Start

HEIDENHAIN controls are at work particularly for milling work in toolmaking and in the training center of the Hirschvogel Company. For Hirschvogel, the synergy is obvious: Even the apprentices are made familiar with HEIDENHAIN controls which, thanks to their plain language and shop-floor programming, are particularly useful in toolmaking—with its special manufacturing structure of single-part and small-batch production.



The Hirschvogel apprentices train in well equipped classrooms on the very same machines that are also used in production. Like all milling machines in the Hirschvogel plants, the CNC milling machines in the new 22,070 square feet (2,050 square meter) training center are equipped with HEIDENHAIN controls, for which the Braun Machine Tool Sales & Service GmbH in Emmerring makes an important contribution. This authorized HEIDENHAIN distributor not only takes care of the smooth operation of the HEIDENHAIN controls and measuring equipment. On existing machines it also performs retrofitting to the preferred controls and provides process-specific solutions in the context of the Hirschvogel production and R&D efforts.

The training center, which takes on milling tasks for toolmaking as part of the training, utilizes milling machines from the Mikron and DMG companies, but also the models Maho 400 E, Maho 500 C and Maho 600 E/C. With and without a rotary table, these 3 and 4 axis machines were delivered with Phillips 432 controls and were totally different from the machines used in production: there for eight years only HEIDENHAIN

controls have been in operation, from the TNC 426 through the TNC 430, all the way to the iTNC 530.

Retrofitting to HEIDENHAIN controls

To avoid time-consuming re-education on different makes of controls, to have more time for educational content, and also to be able to train the apprentices for immediate employment on the production machines, Hirschvogel went to the machine tool builder with the question of retrofitting but were not happy with their answers.

Through HEIDENHAIN, the company in Denklingen contacted an “old acquaintance” in early 2007: The Braun Machine Tool Sales & Service GmbH was already active as a service partner for HEIDENHAIN linear scales on milling machines and lathes. The new mission: to show the way to retrofit the existing milling machines to HEIDENHAIN controls.

Apprentices can do more than you may think

At the same time, Hirschvogel wanted to use this project as part of the training program and have the apprentices do the

retrofitting. The Hirschvogel apprentices learned about machine technology first-hand. Future mechatronic and electronic technicians realized the retrofitting according to the project plan from Braun. It documented who was to do what. Today, the young men and women who did the retrofitting know every bolt and terminal, the circuit diagram and the software. Johann Reisacher, responsible for training, was skeptical at first, but now he admits: the machines run as well as ever, and the HEIDENHAIN iTNC 530 was integrated relatively smoothly. The combination of analog and digital drives and different numbers of axes needed no special solutions.

The modular HEIDENHAIN strategy—according to Michael Dahme, Manager of Process Development and Organization—proved to be exceedingly practical. He confesses now, “I had my doubts about attempting this type of intervention on machines that were already running satisfactorily. What if they hadn't managed to finish the project in the necessary time and we lost the production capacity for toolmaking? A project like that requires trust in the partners involved.” After his conversation with Braun he knew that it would work—and he would be proven right. Even though not all machines are fin-



A look into the new Hirschvogel training workshop

Hirschvogel Automotive Group

The Hirschvogel Automotive Group with headquarters in Denklingen, Germany, is an R&D partner for the automotive industry, and a specialist in solid-blank forming. Hirschvogel develops and supplies components for cars and light commercial vehicles. This includes load-optimized wheel hubs, weight-saving hollow shafts, etc., particularly for high-end vehicles. The know-how and competence of more than 2,700 employees and the use of state-of-the-art technology make Hirschvogel a partner to numerous vehicle manufacturers and their vendors.

Christian Maisson, apprentice on a Maho 400E milling machine that he personally retrofitted to its HEIDENHAIN control

ished yet, the Braun company proved to be a reliable partner. The Hirschvogel people summed it up as follows: the employees know what they're talking about, the continuity of the oversight personnel, the competence in customer service, even the scheduling were and are OK. Another positive comment was that, with Braun, even spontaneous solutions without long preparation could be realized.

Steffen Kunze, the person responsible at the Braun company, confirms that his company is frequently entrusted with special tasks ranging from workpiece infeed to workpiece inspection.

→



Uniform control facilities ensure high productivity and at the same time fewer operating errors.

Manuel Mayer, apprentice, at one of the E-learning stations

The reason is the cost saved in batch production—and perhaps the good reputation that this HEIDENHAIN agency has earned.

Tool manufacture at Hirschvogel

Tool manufacturing at Hirschvogel consists mainly of single part production. However, as a cost center managed by Dr.-Ing. Christian Hinsel, small batches are also manufactured. The tool manufacturing department is responsible for regular corrective tool maintenance, but also for the rapid manufacture of replacement parts for large fabrication systems that could be procured—if at all—only after month-long lead times. This department has become the supplier for the internal maintenance and repair, and therefore enables Hirschvogel to react quickly to challenges, such as quickly manufacturing a large gearwheel from a sample.

A world of controls for all milling machines

This manufacturing structure is also the reason why Hirschvogel preferred the workshop-oriented HEIDENHAIN controls especially for their milling jobs. The fast block processing time counted as another plus. The high demands for programmability, but also the goal of realizing the highest possible productivity with the lowest possible risk of operating errors was the decisive factor for the consistent control landscape. They wanted to avoid having to rewrite part programs or retrain the machine operators.

Central programming and shop-floor programming complement each other. The apprentices learn G-code programming as well as HEIDENHAIN plain language programming. The HEIDENHAIN control simulation on the PC serves as a welcome



tool for basic and advanced training. All programs individually created at the machine are saved because, —in the words of Dr. Hinsel, toolmaking manager—“you can never know whether this application might not come again.” The HEIDENHAIN controls offer an important feature with its remote function, which make it safer to work with old programs that might cause errors in the program run. The controls capabilities for telecommunication are also important for Hirschvogel. The data are transmitted from their plant in Denklingen to Hirschvogel Automotive Group’s international locations. Digital downloading of programs is part of their day-to-day operations. And one other advantage of the German hardware and software: the Japanese programs are not as well developed in their networking capabilities.

The training at Hirschvogel

At present, Hirschvogel Umformtechnik GmbH is educating 123 young people in 11 occupations. The apprentices are provided with the opportunity to advance seamlessly from their apprenticeship to the practice of their occupation. “The technical competence of the employees on the basis of the dual training is one of the foundations of our enterprise; this is the primary advantage of our location over countries like China or even the USA, and in spite of the globalization process, for us it’s the main reason for the loyalty of this company to its location,” says Michael Dahme, Manager of Process Development and Organization.



From left to right: Franz-Xaver Unsin (master craftsman for milling and toolmaking), Johann Reisacher (training manager), Dr.-Ing. Christian Hinsel (manager, toolmaking), Michael Dahme (managing director, process development/organization), Jürgen Gistl (trainer), all with Hirschvogel Umformtechnik GmbH, 86920 Denklingen, Germany

On their wish list: Higher process security, reduction of measuring and polishing time

When asked, what Hirschvogel would like to see from HEIDENHAIN in the future, the answer is very clear: "We want greater process security, especially for single-part machining. We want to eliminate programming errors, and considering today's ever faster acceleration values, we don't want to risk any collisions with the machine or have to swallow the destruction of expensive workpieces. In this respect we see interesting ideas at HEIDENHAIN. We want to see less use of the measuring machines by implementing process-integrated measurement, sort of as a second-

ary benefit. In the future we want to set higher standards for surface definition. Ra 0.1 μm and better are requirements that also apply to the control together with the attainable contour accuracy and the capability of influencing contouring paths.

Our goal is to be able to do without the 'normal' polishing as an additional step. Beyond that, increased automation, for example with pallet changers, is an important topic for us—an aspect for which HEIDENHAIN's solutions are not bad," says Michael Dahme. +

Hirschvogel Automotive Group
R&D partner for the
automotive industry and
manufacturing specialist in
solid-blank forming.

www.hirschvogel.com

The training is accompanied by comprehensive offerings in continuing education for the approx. 2,100 employees in Denklingen and at the Schongau location. The employees are offered a continuing education program with 400 (!) courses. Together with two other companies in the area, Hirschvogel offers parallel to their mechatronics training a university-level education in economics and technology with a bachelor degree from the University of Applied Management in Erding.



Left to right: Steffen Kunze (sales engineer, Braun), Michael Dahme, apprentice, Johann Reisacher

New Functions of the iTNC 530!

The new NC software 34049x-05 for the iTNC 530 includes a series of new functions. These functions make it even easier to work with the control, and they also make operation of the machine safer. Here they are at a glance!

News from the Dynamic Collision Monitoring option (DCM)

Tool-carrier kinematics management:
The assignment of the tool-carrier kinematics in the tool table was simplified considerably.

Benefit: Select an available tool carrier from a list. When a tool is called, the iTNC automatically monitors the tool carrier to which you have assigned the respective tool.

DCM in the Test Run operating mode:

Use the Test Run mode to check for collisions before actually machining a part

Benefit: This enables you to avoid machine downtimes and increase machine availability, especially during unattended operation.

Fixture monitoring:

The collision monitoring function of the iTNC 530 now also includes the chucking equipment.

Benefit: This enables you to detect collisions between the tool and fixtures before they have a chance to happen.

News from the KinematicsOpt option

Automatic measurement of rotary axes:

Reduce the number of measuring points per angular increment from four to three. You don't even need to set the datum in the ball center anymore.

Benefit: An accelerated measuring process in touch probe cycles for automatic measurement of rotary axes.

There are also more comprehensive log files available.

Benefit: The transparency of the calibration process is increased significantly.

New cycle: 452 PRESET COMPENSATION

Benefit: Working with tool changer heads has become easier because the workpiece datum (preset) applies for all heads. Now the machine operator can measure a new or exchanged milling head himself without having to call a service technician.

In addition, a great deal of time—especially in series production—can be won by compensating for the drift in the principal axes during machining without having to calibrate the entire kinematics.

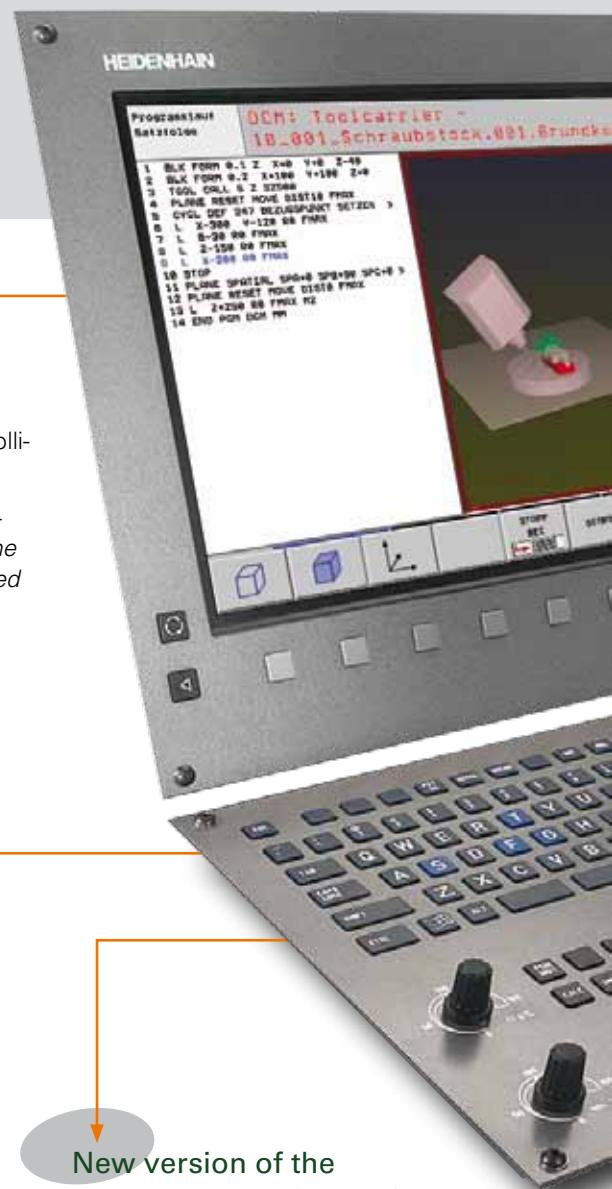
New version of the DXF converters (option)

You can use the DXF converter to open CAD data directly on the iTNC 530 in order to extract contours.

New: Polyline

In addition to the LINE, CIRCLE and ARC elements, the new version now supports the POLYLINE element.

Benefit: Polylines are used in CAD drawings when the desired contour cannot be created with just circles or lines.



Continuing development, improvement and simpler features—to make the user's work simpler and more effective.

+ New NC software 340 49x-05!



New and improved cycles

New Cycle241 for single-fluted drills: Specifically for deep-hole drilling. Machining speed and feed rate are not switched on until the tool is in the pilot hole.

New calibration cycle 484 for automatic tool measurement:

This new cycle supports the wireless cordless TT 449 tool touch probe from HEIDENHAIN for automatic tool calibration.

New Programming Functions

Q-parameter programming:

In addition to the globally effective Q parameters, there are now 500 QL parameters that are only effective locally (i.e. within a part program). There are also 500 QR parameters (R = nonvolatile) that remain active, even after a power interruption, until they are reset.

The benefit: This prevents conflicts when programs are nested.

Distance to go in the tilted system:

The new DG 3-D additional position display mode displays the distance-to-go

Measuring cycles

412, 413, 421 and 422 for circle probing: A new parameter enables you to define the type of positioning (line or arc) between the measuring points to clearance height.

Measuring cycles for datum setting:

The measuring cycles 408 to 419 for datum setting now also automatically write to line 0 of the preset table when the display is set.

Benefit: The datum set in this manner stays in the control memory and can be restored even after another preset has been activated.

in a tilted coordinate system when the working plane is tilted.

Benefit: This makes it easy for you to see the distance that remains to be traversed by the tool in the tilted coordinate system.

Separate table for pallet presets:

A preset table for managing pallet datums is now available in addition to the preset table for managing workpiece datums.

Benefit: This makes it possible to manage the pallet datums independently of the workpiece datums.+

Selection of machining positions:

Use the mouse to mark area and the TNC shows you all its hole diameters. Then select and filter the desired diameters.

Benefit: Narrow your selection of machining positions much more quickly.

The TNC even conducts finds the shortest distances and moves through the machining positions on the most efficient path.

More information in the interactive Klartext e-magazine

www.heidenhain.de/klartext

Simultaneous 5-Axis Milling for Top Architects

Large construction projects require unusual solutions. This also applies to the tools to be used. This is why the Holzbau Amann GmbH timber construction company in Weilheim-Bannholz, in the middle of the Black Forest, is using a 5-axis CNC machining center. Their job: Precise machining of more than 35-m long support beams for remarkable construction projects whose wooden structures were developed, produced and mounted by the Black Forest company. 1,700 load-bearing parts from 2 to 16 meters length are listed in the bill of materials for the new Centre Pompidou in Metz, France. A HEIDENHAIN iTNC 530 is making an important contribution to the realization of this construction project: with the processing speed of the machine's original control, built in 1993, it would not have been possible to tackle a job of this size. It was the advice and ideas of the HEIDENHAIN distributor Haas Werkzeugmaschinen GmbH in Villingen-Schwenningen and the HEIDENHAIN Engineering Team from Traunreut arranged for the productivity that makes this challenging construction project possible.

When the Black Forest timber construction company won the contract, Peter Amann knew, and tests confirmed, that the performance of the milling machine to be used for the project was not adequate for the task. The world's first CNC-controlled cross-cutting and trenching ma-

chine built in 1993 was able to saw, mill, plane, flute, rabbet, drill and groove all workpiece sides on all sides of the workpiece and to completely machine components for such supporting elements in one work cycle. The workpieces are clamped on a car running on tracks and remain there in the same setup from the first to the last machining step. That guarantees high-precision machining even on rough sawn wood. CNC technology and a tool magazine with 15 pockets add up to high flexibility and make it possible to machine complex workpieces. The problem: the Lignamatic of the Swiss manufacturer Krüsi in its original condition, that is with the original control, would have been able to produce only one car per day, and many geometries would take up to two days.

Well advised by metal workers

The Holzbau Amann company would never have won the order for the supporting frame of the Centre Pompidou if they had offered a production phase lasting years. So what's to be done? The production had to be faster, and Peter Amann knew together with the Project Manager Tobias Döbele that it wasn't the mechanics of the machine that were limiting productivity—it was the control. The construction entrepreneur looked for help and researched the Internet. A visit to the HEIDENHAIN home page motivated him to ask col-

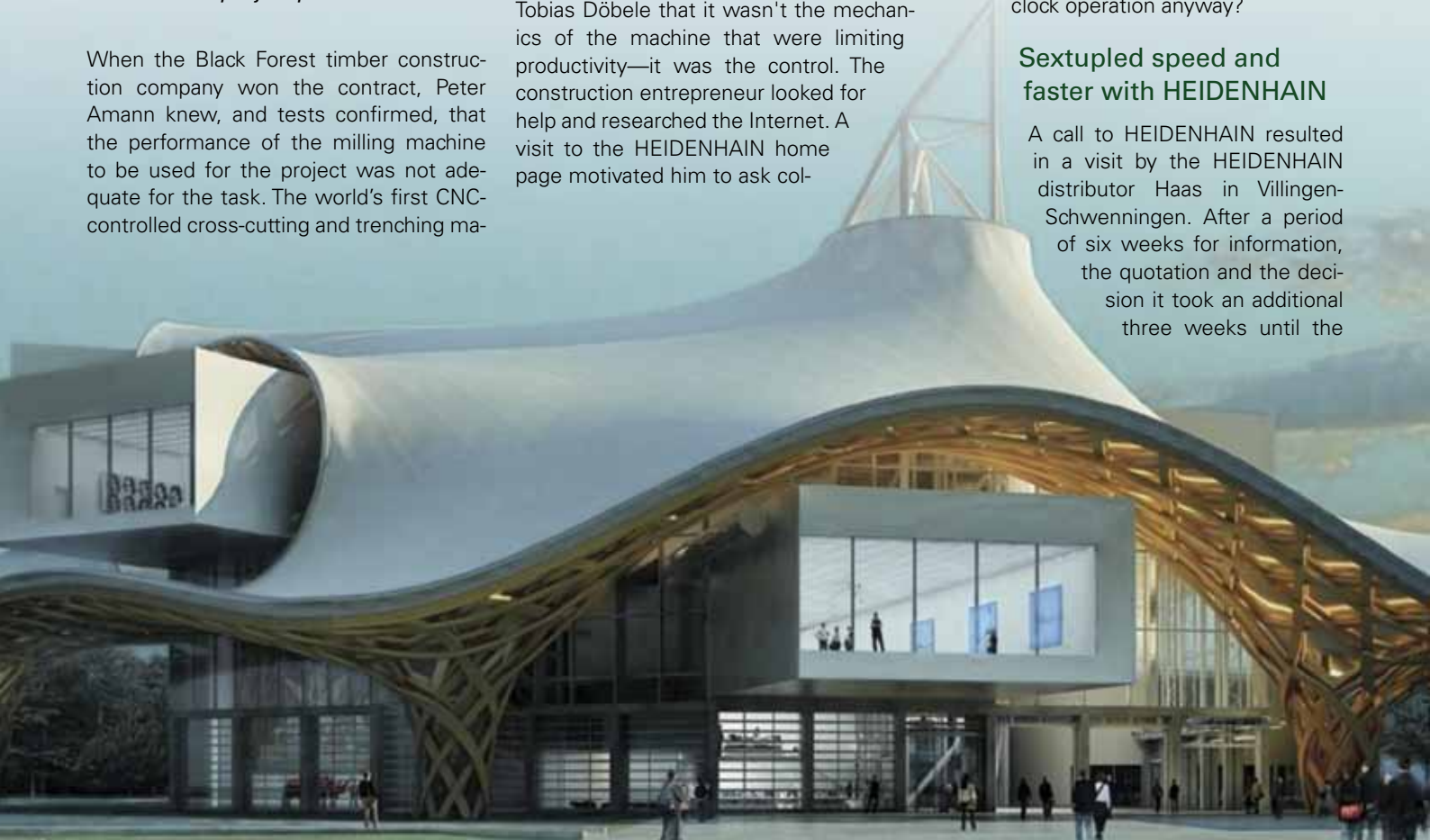
leagues in metal-working companies why they use which machine-tool controls. Peter Amann was repeatedly told, "For simultaneous milling use HEIDENHAIN controls. Other controls have trouble staying accurate with 5 axes."

He quickly learned that the computing power and accuracy required by this construction project called for a HEIDENHAIN control. Accuracy of 1/10 mm with reference to a workpiece length of more than 35 m was a prerequisite. Also, an exact and individually programmed master-slave mode was required. Each of the axes was to be defined as a master that the other axes follow.

A solution with a PC control offered as an alternative seemed to Peter Amann to be neither adequate nor reliable in operation. This PC solution was supposed to incorporate comprehensive machine refitting including completely new drives and a new spindle that was to be designed for up to 30,000 rpm. If wood is machined at about 3000 rpm with such a fast spindle, will it be able to provide enough torque? And would a PC be able to withstand the round-the-clock operation anyway?

Sextupled speed and faster with HEIDENHAIN

A call to HEIDENHAIN resulted in a visit by the HEIDENHAIN distributor Haas in Villingen-Schwenningen. After a period of six weeks for information, the quotation and the decision it took an additional three weeks until the



A Roof like a Chinese Hat

This building with the spectacular roof design, innovative construction technology and generous dimensions of 8,000 square meters (over 86,000 sq. ft.) houses three exhibition galleries immediately under the roof. Because the arts center in Metz will present valuable collections, it must offer the appropriate security. The roof design, which reminds one of a traditional Chinese hat, employs a completely new technology and extends over the entire building with a reach of over 40 meters (130 feet). Hexagonal modules from special triple-layer plywood are put together like swaths of cloth and coated with a waterproof membrane of fiberglass and Teflon.

Webcam of the construction site in Metz:
www.centrepompidou-metz.fr/site/de/nav/webcam-chantier

machining center could resume operation—but with its speed of operation increased by far more than a factor of six. For Oliver Haas this project was a two-fold first: this was the first time that he and his employees had to modernize a wood-working machine, and he had never had to reequip such a large machine. But the whole time he knew: “Everything asked for by the Holzbau Amann company is within the HEIDENHAIN control’s capabilities.” Today the modernized machine can handle 6 to 8 cars per day. Thanks to this productivity jump, in the example of this Centre Pompidou contract, the required approx. 1,700 girders that would have taken 1700 to 2000 working days can now

be produced in 232 to 285 days. In this time the machine will mill 850 metric tons of raw beams to produce 500 tons of machined loadbearing framework. Holzbau Amann will even accomplish this milling task in less than 150 working days. This is no mathematical error: a second HEIDENHAIN control will soon start operation on a practically identical machine. Peter Amann was able to convince a colleague of the solution he found and work out a comparable retrofit, again with Haas as subcontractor. Using the CAD data from the Holzbau Amann company, the woodworkers will machine some of the girders and contribute to the required short production time. →

A look into the production halls



Peter Amann (left) of Holzbau Amann GmbH; Oliver Haas (right) of the Haas Werkzeugmaschinen GmbH machine tool company



The solution: the iTNC 530, absolute rotary encoders, an optimized electrical cabinet and intelligent machine-control interfacing.

In order to fulfill the requirements listed and ensure the desired machining speed, Haas integrated the HEIDENHAIN iTNC 530, installed the HEIDENHAIN rotary encoders of the model ROQ 425 with integrated bearing for separate shaft couplings, optimized the electrical cabinet and provided for new cabling. Within a single service day, HEIDENHAIN service engineers and technicians interfaced all the parameters of the control to the far lower shaft speeds required in woodworking. This ensured that the A and B axes are also reliable in operation.

You have to be able to trust the control. Recalibration is not possible!

Not a single beam matches another; each component is numbered. The large number of required measuring points and the size of the components make it economically impossible to inspect the accuracy of the machined girders. The last girders were manufactured in mid-May. This was followed by the logistical heavy labor of hauling the product over the narrow streets of the Black Forest to Lorraine. In the city of Metz, work then started on the "construction puzzle." According to Peter Amann, "Up to now the assembly has proceeded with components of the de-

Milling operation on a girder for the Centre Pompidou

Machined and numbered girders ready for assembly

gree dimensional accuracy that is simply indispensable in projects of this kind."

When asked why Holzbau Amann didn't simply invest in a faster machine "off-the-shelf," the entrepreneur quite simply answers "a comparable new machine would have cost about 800,000 euros and required lead time before delivery. The retrofit was decidedly more economical and much faster." The Lignamatic with iTNC 530 control, up to now the only one the world over, has been running problem-free in three-shift operation, week for week, from 10:00 p.m. Sunday to 10:00 p.m. Saturday since March 2007—proving that the HEIDENHAIN control is well-suited even for complex, large-scale woodworking tasks. But soon this distinction will disappear: another modernized Lignamatic from Haas will go into operation to ensure that the production deadline is met. Because the Centre Pompidou, a 45-million euro construction project, is planned to open in 2009.

The architects Shigeru Ban and Jean de Gastines have said about the first outpost of the Parisian Centre national d'art et de culture Georges Pompidou, generally known as the Centre Pompidou: "We wanted to realize an architecture that expresses the opening, the interaction of cultures and the well-being of man in an immediate and perceptible relation to the environment."+



Astonishing constructions of wood

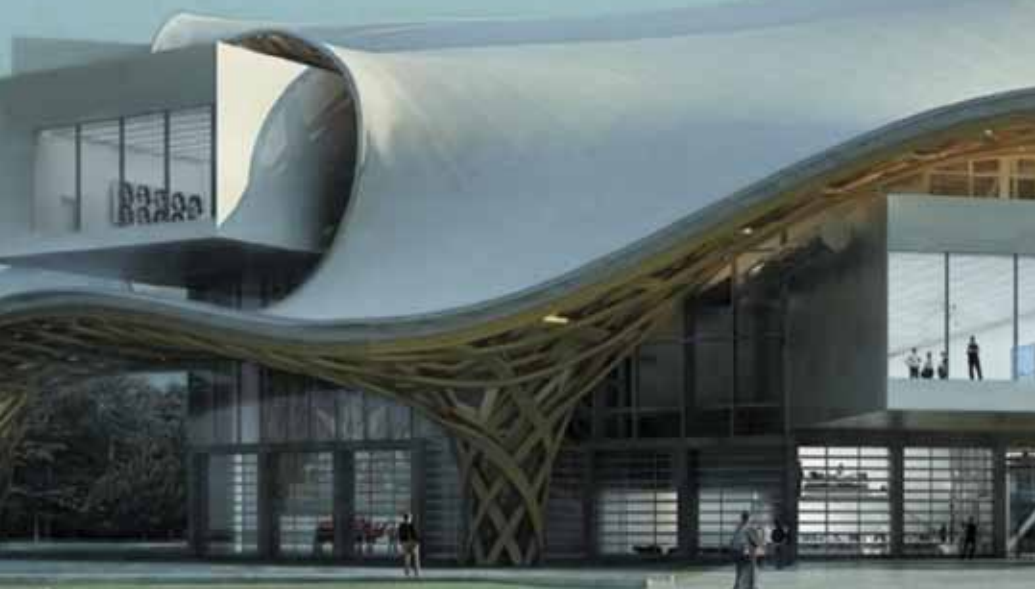
Founded in the town of Bannholz in Germany's Black Forest in 1932, Amann and his over 50 employees now provide components for wooden buildings. They supply them worldwide and often with world-class architects. The range of building types comprises trade-show halls, ice-skating halls and indoor swimming pools as well as industrial buildings, schools, churches, office buildings or residential homes like that of the star architect Norman Foster. Even massive wooden bridges spanning up to 70 meters (230 ft) come from Bannholz-Weilheim.

*Holzbau Amann GmbH
D-79809 Weilheim-Bannholz,
Germany
www.holzbau-amann.de*

Partner for superior manufacturing machines

Besides his high-end machine tools, Oliver Haas, CEO of the homonymous machine tool manufacturing company Haas Werkzeugmaschinen GmbH, offers his customers qualified service and competent advice on every aspect of machine tools. This includes the inspection and repair of HEIDENHAIN encoders.

*Haas Werkzeugmaschinen GmbH
D-78052 VS-Villingen, Germany
www.haas-wzm.de*



Silence reigns in the room. All you can hear is the clicking of the TNC keyboards. You can hear a soft moan. Later someone else whispers with his neighbor. The course participants concentrate on an exercise that their instructor Harald Stuttrucker has just given him. They've been asked to create a plain-language program using cycles to mill a hole pattern with 8 holes and 3 circular studs into a block. One calls out, "I've got it!" Another asks, "How did you solve it?"

The instructor looks over a student's shoulder, gives him a tip and lets him continue working. "The participants are supposed to find the solutions on their own. The best way to learn is to make your own mistakes," says Harald Stuttrucker, one of the course instructors while explaining the HEIDENHAIN training technique. The course is designed to alternate between lecture and task phases, whereby the task phases, in which the participants complete tasks on their own, are significantly longer. This technique also requires that all participants finish the examples completely. "We continue only when the last person is finished. The faster people are given additional tasks," Stuttrucker explains. The goal of the course is to leave no one out. All participants have to understand the course contents and be able to apply them later in their companies. The instructors expressly encourage the participants to help each other.

The iTNC 530 helps them to solve the problem. It always shows the participants the status of their program by starting a graphic simulation with the program sequence. In this way the participants can review their program at any time and see how the tool cuts through the workpiece.

Now everyone has finished the program and the course participants feel satisfied and look at the instructor, who goes through the solution again step by step. He works with two beamers in order to show the task and the solution separately. For HEIDENHAIN, modern training equipment is a matter of course, because a good learning atmosphere helps guarantee success. The bright and well equipped training rooms at the Traunreut location comprise 10 programming stations each including the TNC keyboard unit. There is also a demonstration machine completely equipped with a rotary table, swivel head and, naturally, HEIDENHAIN encoders, as

"Ah, so that's how it's done! Experiences in a TNC Basic Course

in Traunreut ...



well as a 5-axis machine on the ground floor. This enables the instructor to demonstrate to the participant all possible machining situations very realistically.

At 10:00 o'clock there's a short break. The participants visit the school's centrally located café. The breaks offer them the opportunity to become acquainted with each other and exchange information. This is also the reason why a supper is organized one evening of the training week. A friendly atmosphere soon sets in and there's plenty to talk about. Where are you from? What do you manufacture? The course participants come to Traunreut from a wide array of regions and for a variety of reasons. One participant's company is setting up a new machine equipped with a HEIDENHAIN iTNC 530 control; another has just finished his apprenticeship and is being sent off for additional training before beginning his future tasks with his new employer, a toolmaking company.

Now it's back to work. A full training folder with 12 chapters is waiting to be worked through. Harald Stuttrucker passes out the next exercise sheet. The exercise and solution sheets are yellow, the explanatory sheets white. The participants receive a package to take home including a training folder, a manual and a USB stick with their programs so that they can use the mate-

rial for reference when at work at their companies. Most participants will apply what they learn immediately back on the job and are motivated to quickly increase their proficiency. They can nevertheless continue—with the aid of the NC database on the Internet or the Helpline – to count on support from HEIDENHAIN.

One participant said, "It's getting a little better every day. Yesterday it seemed more complicated," before a concentrated silence settled on the group. All you can hear is the clicking of the TNC keyboards ...

Instructor Stuttrucker helps a course participant



... and on Site at Volkswagen in Brunswick.

Place of action: the so-called “former control center” in Hall 7 of the Volkswagen component and tool manufacture operation in Brunswick. From here—just a few meters below the hall ceiling—you can enjoy a panorama over a plant that could make the heart of any mechanical engineer or technician beat faster. In several aisles stretching hundreds of meters, machine tools and machining centers of all types and sizes stand next to each other. This is where prototypes and tools—usually very complex ones—are manufactured for production in the various Volkswagen factories.

But none of those present allows himself to be distracted by the impressive view. Everyone is closely following the statements of the HEIDENHAIN instructor



Training room at Volkswagen with “panorama”



Lothar Böhm, who is teaching a 5-day on-site course on the fundamentals of TNC programming at programming stations and at the machine.

During the practical programming exercises that are interspersed throughout the course, Lothar Böhm moves among the participants and helps. He's available wherever a participant comes to a dead end, has an additional question or wants to explain an idea. In time an optimistic and friendly atmosphere develops—the course is in its third day—among the participants and the instructor. Everyone uses the familiar

form of address and accepts ideas and corrections in a constructive way. There's a mood that reflects a desire to learn and enhances learning progress.

Although the course does not take place in a HEIDENHAIN training room, all participants have laptops with programming stations installed and TNC keyboard connected. Before the course began, the training equipment was delivered, set up and the programming software was installed. After all, on-site courses have to fulfill the same high quality requirements for the instructor and equipment for which the HEIDENHAIN name stands.

Learning at the machine in the Volkswagen component and toolmaking department in Brunswick

Need for training arises from transition to HEIDENHAIN control

The eight course participants are among the first at the Volkswagen toolmaking plant in Brunswick to be trained for writing programs on HEIDENHAIN controls. The reason is, after an extensive evaluation of various control alternatives the component and tool making department decided to implement HEIDENHAIN controls. In all probability, all new machines in the future will be equipped with TNCs from Traunreut. This entails a training requirement for 50 to eventually 100 Volkswagen employees from the production planning and manufacturing departments.

One of these first participants is Jürgen Peter, who agreed to a personal interview with us during the break. He calls the TNC "quite a good control." He explained, "With the other controls it was always a bit awkward to position to where you needed to go. Now that's much easier." Jürgen Peter should know: he's been at Volkswagen since 1974 and has been responsible since the early 90's for CNC programming, so he has very close knowledge of several controls from other manufacturers. In answer to the question whether he has any proposals for improving the training he answered, "Let me think ... at present no, but it's only the third day." On appraisal that he shares with other interview



Practical training at the machine

partners. Norbert Loske, who after a few words replied, "That's a good question," continued to say, "Actually I don't see it could be done any better." Norbert Loske also has his experience: since 1982, he's been working at Volkswagen with CNC controls and today he's in the production planning effort. He explains what he expects from HEIDENHAIN controls: "With these well documented functions we'll simply get faster."

At the end of the day, when the other participants are on their way home, Lothar Böhm and Norbert Loske get deeply involved in a discussion of advanced problems in TNC programming, which confirms a statement made by almost every one of the interviewed participants: The way in which Lothar Böhm responds to individual needs and desires of the participants greatly contributes to the success of the training. +

Instructor Böhm and training participants



You can hear the complete interview in the interactive Klartext e-magazine under www.heidenhain.de/klartext.

You will find the training program at www.heidenhain.de/training

{ CNC Technology = Theory x Practice }

The Formula for Joy in Learning

*) "Theory x Praxis" is the mission statement of CNC Technik Kolm. The equation stands for the particularly close relationship between the imparting of theoretical knowledge and its practical application at the control. Realistic training can be applied quickly and perfected in its daily use—and it offers more than just the sum of the imparted facts.

We all learn in order to do. A simple as that sounds—it is not at all simple for the providers of CNC training. It puts them to a hard test! All too often, the conditions in the training room deviate from those in the workshop. To break away from this rule, the CNC Technik Kolm company has made it their motto to strive for the closest possible connection between theory and practice.

Lake Attersee in the foothills of the Austrian Alps is a magnet for tourists. For trainees who place high value on experiences and especially practice-oriented training, the CNC Technik Kolm company is just one more attraction in a lovely region.

The Klartext staff was on site in Schörfling in order to ask about the conception of their NC training. Here we met the trainer team: Mr. Johann Kolm, the owner, Paul Kretz and Bernhard Degelsegger—three experienced NC trainers with a passion for imparting practical knowledge.

Just after we arrived at the new company headquarters, airplane models, components of a vehicle model, and small steam engines caught our eyes. Of course we immediately thought about their relationship with NC training.

Motivated model construction for motivated training

And in fact, everyone in the team has his own specialty in model construction. Mr. Kolm—who is responsible for the development and manufacture of airplane motors—explains that relationship and its benefits for NC courses:

"Model construction has the advantage that you can realize a project from the very first ideas all the way to the finished product. Also, most of the workpieces are built to a scale of 1:1, so they're too large and too expensive for training classes. At the same time, the accuracy requirements are very high, the tolerances often tighter, and it's also more difficult to set up the small workpieces. The manufactured components serve not only as examples—they're also supposed to work."

That sounds like a very attractive challenge—for the trainers. To what degree do the course participants profit from these practical experiences? Does model building flow directly into the course content?

Model building provides the course participants with the challenge of deciding themselves how to solve tasks. As Mr. Kolm says, "The goal is to develop one's comprehensive ability to solve problems." There is a lot more involved than just drilling holes or milling pockets in a plane.

Beginning from a production drawing, the student has to create a program, define the setup, find suitable tools, plan machining strategies, and finally to measure the workpiece on the machine table. It includes the entire process sequence."

This process sequence calls for both the HEIDENHAIN programming stations and the iTNC 530. The trainers at CNC Technik Kolm are convinced that the easy learnability of HEIDENHAIN controls result in a particularly high degree of acceptance among the trainees. Empirical values show that beginners can often program simple parts at the programming stations after only three hours. Some manage the transition from G-codes to the HEIDENHAIN plain language programming after only a single day of training.

ATNC for model construction?

The question remains as to how well the tasks of model building harmonize with the HEIDENHAIN controls. Mr. Kolm considers them optimally compatible: "As we've shown, the bar hangs very high with our projects. And there we plainly profit from the simple programming. Particularly in the area of multi-sided machining, we love the PLANE functions. We can't imagine doing without the measuring cycles, both for aligning the workpieces and inspecting them. Also, we program our own projects at the programming station and

only about 10% using CAD/CAM. Thanks to this shop-floor type of programming we know lots of tricks for dealing with the machine and the control—and this knowledge enhances the practical benefit of the course.

Course schedule

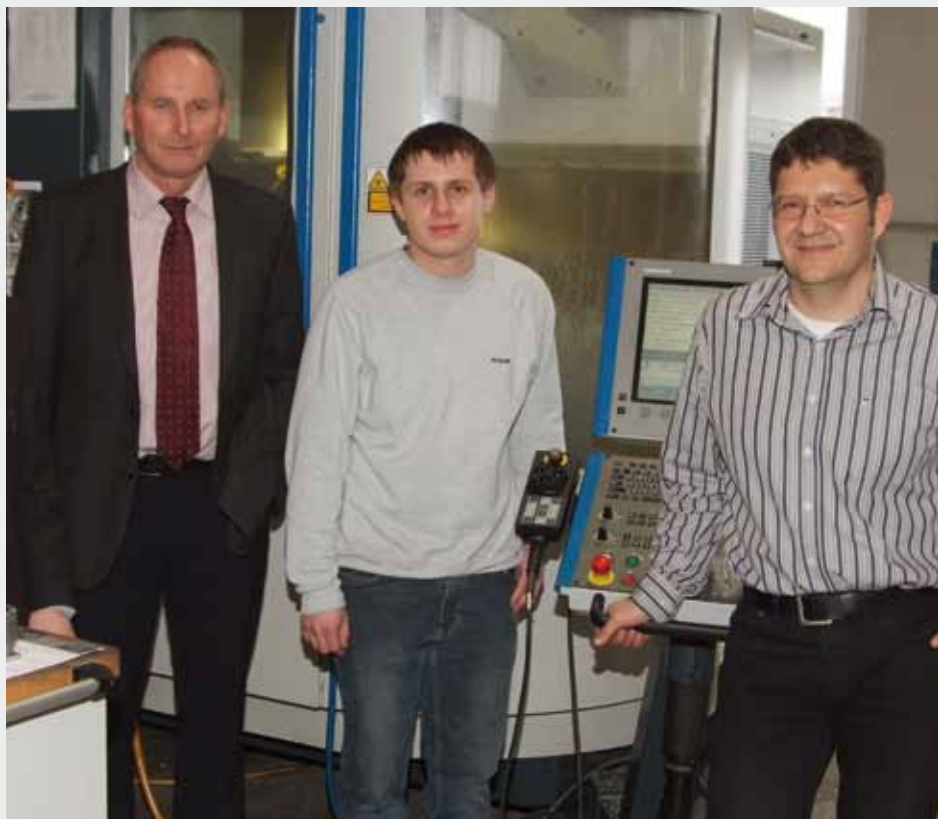
Of course, even CNC Technik Kolm cannot do without theory, and the participants learn theory in a modern training environment with HEIDENHAIN programming stations. Every theoretical section is followed by the workshop practice, which means “prepare, set up, machine.” They work in small group so that everyone gets his chance at the 5-axis machine. This sequence repeats itself throughout the entire course. And in fact, practically all of them can take the part he manufactures home. And you can hardly find more practicality than that!

Projects with a fun factor

Mr. Kretz is involved in an unusual project. From 1959 to 1974, the Austrian company Steyr-Daimler-Puch built the “Haflinger,” an all-terrain vehicle used for military purposes, but in many countries also for nonmilitary use in a wide variety of versions. The vehicle is considered extremely capable off the road. It features two separate differential locks and an independent wheel suspension with independently suspended half-shafts (swing axles). This



From left to right:
Hannes Wechselberger
(training director HEIDENHAIN),
Bernhard Degelsegger,
Johann Kolm, owner



gives the vehicle great ground clearance in spite of its small wheel size to enable it to climb the most difficult mountainsides. Kolm is building a true-to-the-original model that will go onto the market as a valuable replica. In addition, the company used manufacturing technologies that, at least in model construction, are unusual. These include castings produced in steel molds and machining on 5-axis machine tool with HEIDENHAIN control.

Mr. Deggelsegger's steam engines are already in operation. The steam-driven fire engines and difficult machines also have to meet very high quality requirements. At any rate, they are a feast for the eyes and help to loosen up the atmosphere in the course.

Paul Kretz with a genuine Haflinger and a model of the chassis

“The ease of learning is one of the HEIDENHAIN controls’ advantages”

Johann Kolm,
owner of CNC Technik Kolm

Conclusion

Understandable theory, true-to-practice simulations and shop-floor experiences result in a fast learning experience and create a close relationship to the real work. Model construction, with its comprehensive challenges, makes an essential contribution to the joy of learning. +

The HEIDENHAIN training partner CNC Technik Kolm in Schörfling, Austria, offers CNC basic courses, advanced courses and individual courses.

www.cnctechnik.net

Do you know this function?

iTNC 530: Special Functions—Clearly Explained

Function: 3-D Tool Radius Compensation

Today, 2.5-D machining without tool radius compensation would be unthinkable. Tool radius compensation lets machine tool operators allow the control to calculate the appropriate tool path for machining contours using tools of differing dimensions. Radius compensation (RR/RL) makes it very simple to adjustment fits, for example due to tool wear, with the aid of the delta input (DL/DR) in the tool table. Of course you can also use this function to realize a roughing allowance, whereby the delta values DL/DR should be entered in the program itself, and therefore in the TOOL CALL block.

3-D tool adjustment is “under control”

During 3-D machining, radius compensation over RR/RL is insufficient because, a ball-nose cutter, for example, almost continuously changes its tool-workpiece contact point when machining sculptured surfaces. In this case, a simple compensation toward the left or right of the contour path (RR/RL) would lead to an undesired result.

For adapting the tool dimensions when machining sculptured surfaces, the iTNC offers the so-called “3-D tool radius compensation.”

Since most NC programs for 3-D machining are created on an off-line CAM system and the calculated contour paths have already been adapted to the selected tool before the program is complete, any readaptation due to tool wear, special contour accuracy or the use of tools with other dimensions than those calculated in the CAM system usually require recalculation in the CAM system to output a new NC program. However, you can also simply adapt the program right at the control itself with the aid of 3-D tool compensation.

Independence from the CAM system

In particular for very cost-intensive and exact parts, the user can enter a small oversize to approach in steps and then arrive at the desired result. And it's no longer necessary to start a time-consuming recalculation and completion of the part program, be it due to a new tool with dif-

ferent dimensions or the same tool after wear. Add to that the possibility during shift operation that the CAM programmer is not always available.

During repair work on sculptured surfaces (stamping die molds), this makes it possible to rough and finish with the same program data. Especially when NC programming is moved from another location to the shop floor, the 3-D adaptation at the control can save a great deal of time.

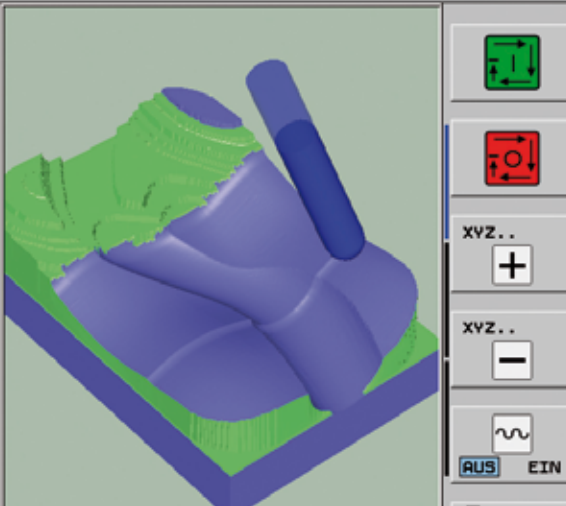
The use of the 3-D radius compensation is not limited to ball-nose cutters. It can also be used for end mills or toroid cutters.

Because of the increasing complexity of many workpieces, the 3-D tool radius function has significant potential. It enables the user to react directly and therefore promptly to changing cutting conditions. It is quite possible that this type of 3-D tool radius compensation will soon become as indispensably a part of daily operations as the radius compensation in 2-D machining. +

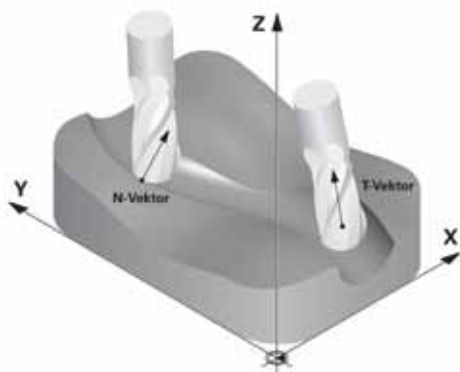
Manueller Betrieb

Programm-Test

13086 LN	X+42.664	Y+30.307	Z-7.17>
13087 LN	X+42.664	Y+30.431	Z-7.02>
13088 LN	X+42.664	Y+30.718	Z-6.76>
13089 LN	X+42.666	Y+31.033	Z-6.54>
13100 LN	X+42.666	Y+33.378	Z-5.15>
13101 LN	X+42.666	Y+34.064	Z-4.39>
13102 LN	X+42.666	Y+35.887	Z-3.98>
13103 LN	X+42.666	Y+36.35	Z-3.795>
13104 LN	X+42.666	Y+36.500	Z-3.722
NX-0.2063 NY-0.2058 NZ+0.9355			
TX-0.1548 TY-0.2087 TZ+0.9448			
13105 LN	X+42.666	Y+36.026	Z-3.65>
13106 LN	X+42.666	Y+37.066	Z-3.58>
13107 LN	X+42.666	Y+37.307	Z-3.53>
13108 LN	X+42.666	Y+37.429	Z-3.50>
13109 LN	X+42.666	Y+37.551	Z-3.48>
13110 LN	X+42.666	Y+37.674	Z-3.46>
13111 LN	X+42.666	Y+37.797	Z-3.44>
13112 LN	X+42.666	Y+37.88	Z-3.431>
13113 LN	X+42.666	Y+37.962	Z-3.42>
13114 LN	X+42.666	Y+38.045	Z-3.40>
13115 LN	X+42.666	Y+38.128	Z-3.40>
13116 LN	X+42.666	Y+38.211	Z-3.39>
13117 LN	X+42.666	Y+38.294	Z-3.38>
13118 LN	X+42.666	Y+38.378	Z-3.38>
13119 LN	X+42.666	Y+38.462	Z-3.37>
13120 LN	X+42.666	Y+38.547	Z-3.37>
13121 LN	X+42.666	Y+38.631	Z-3.36>



Example of a program for 5-axis simultaneous machining with 3-D radius compensation. Between the two finishing cuts, a 3-D contour oversize was realized by entering DR2=0.5 in the TOOL CALL command.



Surface normal vector (N vector):
Information for the 3-D compensation direction via DR2 and
Tilt vector (T vector):
Information for the tool orientation

Here is an example:

The tool radius is compensated in 3-D on a ball-nose cutter through DL for the tool length or DR2 for the ball radius. If, for example, a 3-D contour oversize of 0.2 mm is required, then DR2=0.2 is entered in the TOOLCALL block.

This prompts the question of where the control gets its information for the direction of compensation. Besides the X, Y and Z coordinates of the line end point, this information can be provided by a (surface normal) N vector in the LN block of the control.

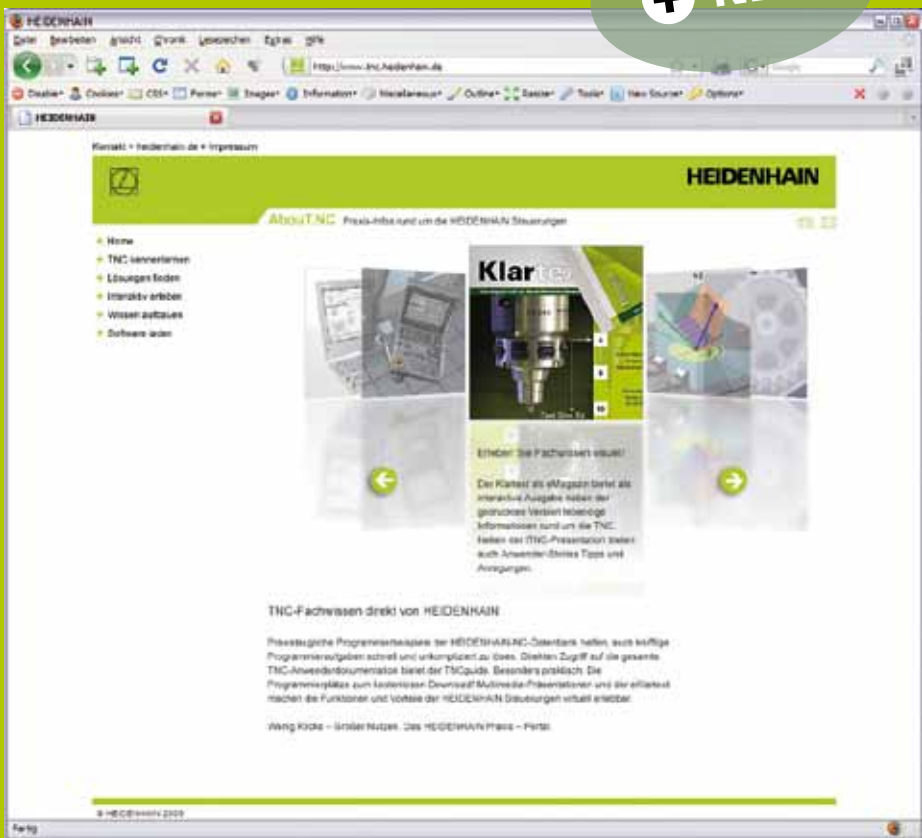
For machining with an inclined tool, the additional information for the tool orientation (tilt) is contained in the T vector, and the direction for the 3-D tool radius compensation is transferred in the N vector. Both of these vectors are provided by many CAM systems and can be transferred to the NC program after the postprocessor is configured.

NC program:

```
LNx+31.737 Y+21.954 Z+33.165
NX+0.2637581 NY+0.0078922 NZ-0.8764339
TX+0.0078922 TY-0.8764339 TZ+0.2590319 F1
```

The **surface normal vector** is described with the components NX, NY, NZ and the **tilt vector** with the components TX, TY and TZ.

The 3-D tool radius compensation is therefore also possible in 5 axis simultaneous machining.



New TNC practice site on the Web!

Type the search word "TNC" into a search engine and you'll get to choose from about 7 million hits. You'll find it faster to visit the new address **www.tnc.heidenhain.de**: Here users can find concentrated TNC knowledge at first hand. It features ideas for practical solutions, software, programming examples, manuals, interactive presentations and lots of information all about HEIDENHAIN controls. Briefly stated: practical aid for your work with a TNC control.

The new Web special is divided into five categories:

Get to know the TNC shows comprehensive information on the equipment and functions of the current-model TNC controls. It also provides information on current topics and advice from users for users.

Find solutions provides you with programming examples for frequent but not very simple jobs. A well filled database is available for everyone who logs in.

Interactively experience imparts practical knowledge with plenty of animation and interaction: the topics range from the very basics over multi-sided machining all the way to the application of touch probes.

Build knowledge informs you about courses at HEIDENHAIN, with curriculum and booking opportunities.

Load software stocks TNC downloads for your PC.

A TNC webmaster staff constantly feeds the site with current information on topics like applications and controls. And the available programming examples are growing continuously.

Effective immediately: Go first to the new praxis site to find compelling solutions or thought-provoking knowledge in an entertaining setting.

Take a look at:
www.tnc.heidenhain.de



Warning!
**Machine tools without
linear encoders
may be inaccurate.**



HEIDENHAIN
shows the way to precision.

Machine tools without linear encoders use the pitch of the ball screw as the measuring standard. But at the same time, the ball screw transfers enormous forces at high traverse speeds and deforms due to thermal changes. Result: the position values become inaccurate. Machine tools with linear encoders are statically, dynamically and thermally more precise—advantages that we symbolize with a sign. Most linear encoders installed on machine tools have it: our sign of precision. For more information, visit:
www.heidenhain-setzt-ein-zeichen.de

- + angle encoders
- + **linear encoders**
- + contouring controls
- + position displays
- + length gauges
- + rotary encoders