*num*special

TOTAL SOLUTION FOR SPECIAL MACHINES

num ®

CNC HighEnd Applications

NUM Solutions and Systems
Established Worldwide

2

Outstanding solutions in machine automation have one thing in common: They are always the product of outstanding performance, exceptional technologies and a high degree of creativity!

num®
CNC HighEnd Applications

And NUM has earned its exceptional reputation in the machinery and tools industry exactly with that. We develop customized automation solutions that ensure a high degree of added value both to the machine manufacturer and the user. With our expertise that we have developed over decades, we put our motto "NUM automation solutions provide machine builders with a competitive advantage" into practice. NUM had already developed the first CNC controller in 1961, i.e. 10 years before CNC- or NC control systems found a wide acceptance among users. With the launch in 1964, NUM was one of the first CNC providers in the world. Since then, we have maintained our position as a technology leader in this segment and are eager to expand it further. Today's systems, with their flexibility and our expertise, enable us to automate the most varied machinery. Our long, successful track record supports this finding in an impressive manner. We will continue to develop the readiness and flexibility of our systems in this direction and make the necessary investments in R&D as well as in our staff.

As an international company headquartered in Switzerland, we have sales, application development and service locations all over the world (see back cover) from which we operate worldwide. Our research and development departments are located in Switzerland, Italy and France. Our main production facility is located in Italy.

It is our clearly defined vision that we keep the development and manufacture of the core products in the CNC system, including the drives and motors, under our control. This enables us to adjust the important flexibility and readiness of the systems to new market requirements even in the short-term.

The ready and flexible NUM automation systems combined with our locally available engineering expertise and the machine manufacturer as a competent partner, results in a uniquely flexible and powerful team.

Customized Projects

NUM supports you with your projects in the same way as it is ideal for your business and infrastructure. The goal of our cooperation, however, always remains the same: To find the most efficient solution for your project together with you.

Project facilitation PRODESIGN

Efficient consulting for optimal application solutions
This model is ideal for companies with their own development teams and automation specialists. As an external partner, we provide our entire know-how in the field of CNC automation and take on an advisory role.

Project cooperation CODESIGN

Merging knowledge – potentiating results
Your development team will be combined with our team of specialists. Together we will realize the automation of your machine with clearly defined responsibilities. This form of cooperation has proven to be extremely efficient in many projects.

Total solutions ALLDESIGN

Delegating responsibility – controlling result
We assume the entire project management in the sense of a general contractor and are fully responsible for the successful implementation. Starting with the development of the requirements specification, over the development and commissioning, up to support and service.

NUM Solutions and Systems
Intelligent and Creative

We have developed countless customer- and application-specific solutions for different industries and thus mapped out practical solutions for professional requirements. Based on this, our engineers have created groundbreaking total solutions for demanding applications.

All of our solutions are based on a wide range of perfectly matched proprietary products such as CNC, drive amplifiers and motors. The partnership with our customers in the evaluation, project and installation phase is further maintained by our training, support and other services even after commissioning. We attach importance to ensuring that our customers are served by our professionals with specific knowledge.
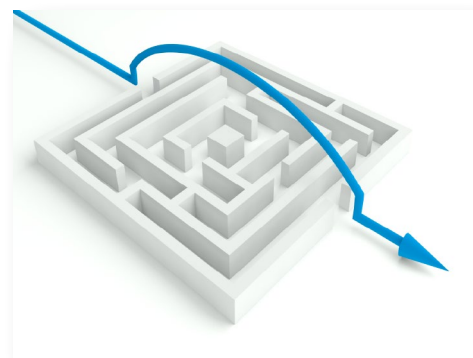
numroto

NUMROTO – successful trendsetter in high-precision tool grinding for many years

numspecial

NUMspecial – creative and practical solutions for your specific applications

numcut

NUMcut – a complete solution for advanced cutting machines

numgear

NUMgear – intelligent total solutions for new machines or as a retrofit in the field of gear machining

numtransfer

NUMtransfer – economical and flexible for all lot sizes for transfer, rotary transfer and multi-spindle machines

numhsc

NUMhsc – excellent quality at the highest speeds on machines with 5 or more axes

numgrind

NUMgrind – grinding and dressing cycles, with intuitive shop floor entry screens and 3D visual validation

nummill

NUMmill – flexible solution with a graphical interface for extensive milling cycles, including full 3D simulation

numwood

NUMwood – long tradition with powerful complete solutions in woodworking

numretrofit

NUMretrofit – rational extension of the service life of your machine by years

Flexium⁺ and Flexibility

As a world-class CNC system, Flexium⁺ offers built-in features to cover any demand of the industry from eye surgery needles to rocket boosters; from the tiniest watch mechanism to the biggest ship propulsion gears; from economical standalone machines to the largest supervised machining centers and much more. In line with this pledge of "providing you – our customers – automation solutions to develop your competitive advantage" NUM has packed the Flexium⁺ range with technology to tailor CNCs and drives in order to get the most out of your machines. Let's see some of them.

Custom G codes

Flexium⁺ offers standard G functions for different types of application. A unique G code with some parameters can execute complex moves once or after each positioning. Such G codes embedded in the CNC firmware are written in ISO code completed with some additional functions. The respective macro can be exported from the firmware and, despite being quite complete, modified according to a specific need (particular tooling, special feed rate/spindle speed or whatever). Obviously, complete new functions can be developed too. Implementing is as easy as 1-2-3. A lot of applications can be imagined: a particular pocket cycle, starting axis movements with some delay (time or distance), non conventional interpolation, variable feed rate, etc... the sky is the limit.

Some advanced programming functions

As complement of symbolic or structured programming, the Flexium⁺ range offers several uncommon functions as BUILD, R.OFF, CUT etc. Together with the custom G codes these powerful functions further push the possibility of satisfying to particular application requests.

- BUILD: Reads a part program and creates a related table of data. It becomes easy to make some calculation in this table which can be later used for movements. A simple application could be used to execute a trajectory in reverse, but many more possibilities exist.
- R.OFF: Calculates an offset trajectory; in addition to BUILD it opens the field of possibilities in tool compensation.
- CUT: Used for the roughing cycles. This function eliminates the parts of grooves which cannot be machined with selected tool to later execute them with a different tool.
- G76+: Creates binary files. These files can be used by dynamic operators. It then becomes then quite easy to create a sequence of moves synchronous or not – using the dynamic operators described on the next page.

Integration of a special electronic gear box (special axis / spindle synchronization) in the CNC system allowed to increase the speed of the honing wheel by more than 2.5.

Flexium⁺ and Flexibility

Dynamic operators

The 'Dynamic Operators' function is one of Flexium⁺'s most powerful features even if the concept is very simple. Basically a dynamic operators' application is a set of read, calculate and write operations executed at the same pace as the fastest task of the Flexium⁺ NCK. These operations can be described in a simple ISO syntax, or, for the more demanding cases, the C language. The number of applications using this feature is unknown but not a week goes by without a new opportunity presenting itself. Some of the most frequent applications for Dynamic Operators include Coordinate Transformation, Gap Control on cutting machines, Flow Control, Non Linear Interpolation between axes (table defined coordinates), all kind of compensation, access on I/Os in the CNC realtime, etc.

Comprehensive integrated PLC

Flexium⁺ contains an integrated PLC which offers a comprehensive functional range. All five programming languages for application programming defined in the IEC 61131-3 are available:

- **IL** (instruction list) is an assembler like programming language.
- **ST** (structured text) is similar to programming in Pascal or C.
- **LD** (ladder diagram) enables the programmer to virtually combine relay contacts and coils.
- **FBD** (function block diagram) enables the user to rapidly program both Boolean and analogue expressions.
- **SFC** (sequential function chart) is convenient for programming sequential processes and flows.

An additional graphical editor (not defined in the IEC standard) is also available:

- **CFC** (Continuous Function Chart) is a sort of freehand FBD editor.

Execution of the PLC code is very fast because it is compiled in machine code. Debugging functionality is extensive and contains variable monitoring/writing/forcing by setting breakpoints/performing single steps or recording variable values online on the controller in a ring buffer (sampling trace). Libraries for different tasks are available and simplify the life of developers. Because of this comprehensive PLC functional range, there is virtually no limit to the automation of machines.

Extended NCK Access

The normal realtime Ethernet bus between NCK and PLC allows for rapid and numerous exchange of data; however not everything is transmitted as this would increase the flow of data for a usage not always required. This is what Extended NCK access (ENA for short) is for. ENA is a PLC library permitting to read and write data as well as part program with an easy syntax. The most frequently used functions are:

- Axes information: Positions, offsets, distance to go, overtravel, lag etc.
- Tools data
- NCK parameters
- Drive parameters
- Machine control
- Drive control
- Part Program Memory management: list of program, size, creation, deletion, modification...

By integrating special compensations and a corresponding mechanics, this machine is able to cut parts in the range of ±0.01 mm by means of a water jet.

Based on the real-time possibilities of the control system, the functionality has been enhanced for this machine. This significantly increases productivity.

Flexium+ and Flexibility

Visualizations

Using Flexium tools, it is possible to easily create graphic pages that will display user information for guiding the machine user. To create a page just pick a graphic object from the wide range possible, position it with the mouse on your design, define its properties (colors, size, animation, position, rotation, ...) and if necessary the reactions according to an event (get focus, click, ...). In few minutes a sophisticated page will appear in front of you. Once the pages are created several possibilities are offered to make the best use of them:

- PLC visualization: The pages are embedded in the main window of the Flexium+ HMI.
- Target visualization: The pages created are independent from the Flexium+ HMI.
- Web visualization: the pages can be displayed on any system that is connected to the PLC, using a simple browser.
- HMI Classic: Similar to target visualization but the PLC program of the visualization runs on another system than the other PLC programs.

HMI personalization with HTML and FXServer

Flexium+ HMI is written in HTML / JavaScript and communicates with the Flexium+ NCK through FXServer in order to read and write data. An advantage of this structure is that the HMI code follows the Internet standards. It is always available and can be edited with a simple text editor or with one of many available HTML editors. No specific development suite has to be provided and managed. Some selected places are foreseen for added code which will remain compatible with all future evolutions of the HMI.

DEMX (Drive Embedded Macros)

NUMDrive X HP also has a unique functionality: DEMX (Drive Embedded Macro). It allows the user to create their own realtime macro to interact with all physical and virtual drive resources even manipulating the regulation algorithms. The user can design and implement filters, observers, defines test points, pilot outputs with self-made rules, etc.
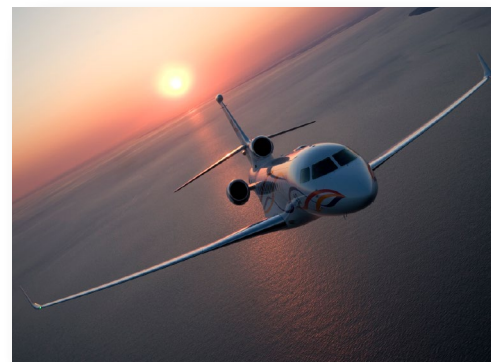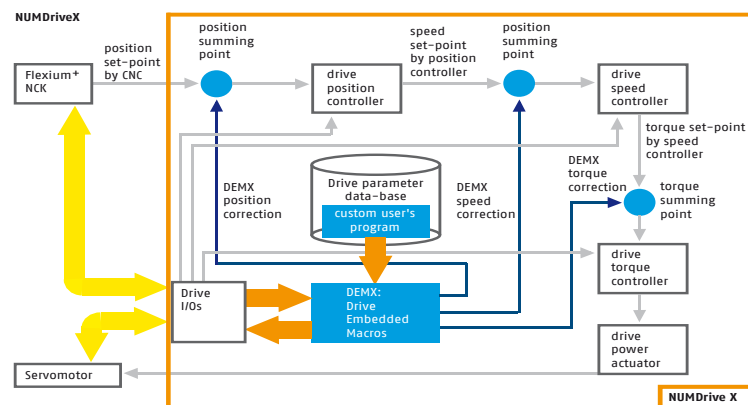
The design of the wings of Falcon airplanes needs a special press. It presses the wing in the designed form with up to 200 tons. For this special press with 18 electrical axes, process-relevant real-time programs and an adapted HMI have been integrated into the control system.


Shoe modelling is a vital part of shoe production. In order to produce these shoe models efficiently, a special milling machine is necessary. Additional real-time functions and macros were integrated into the control system. This significantly increases the production output of the machine.

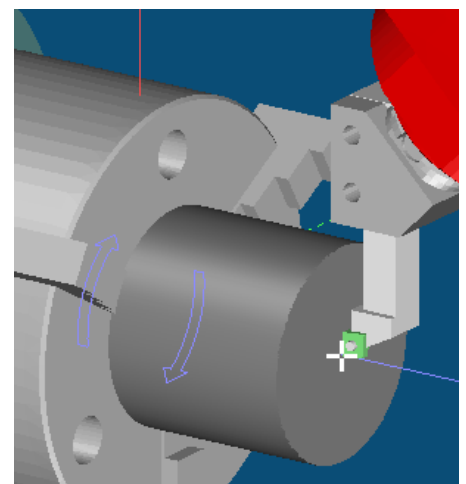# Flexium⁺ and Flexibility

Simulation of your Machine in Flexium 3D

Flexium⁺ offers a 3D simulation tool called Flexium 3D. During the part program simulation the path of the TCP (tool center point) is visualized, the material removal on the work piece is simulated and a collision check is made between machine components, part and tools. The simulation can be exectued offline or online. With the Kinematic-Editor, which is part of Flexium 3D, an accurate model of the real existing machine can be made independent of the kinematic type. In the Kinematic-Editor all physical axes are integrated in the parent-child construction tree regarding the kinematic chain of the machine.
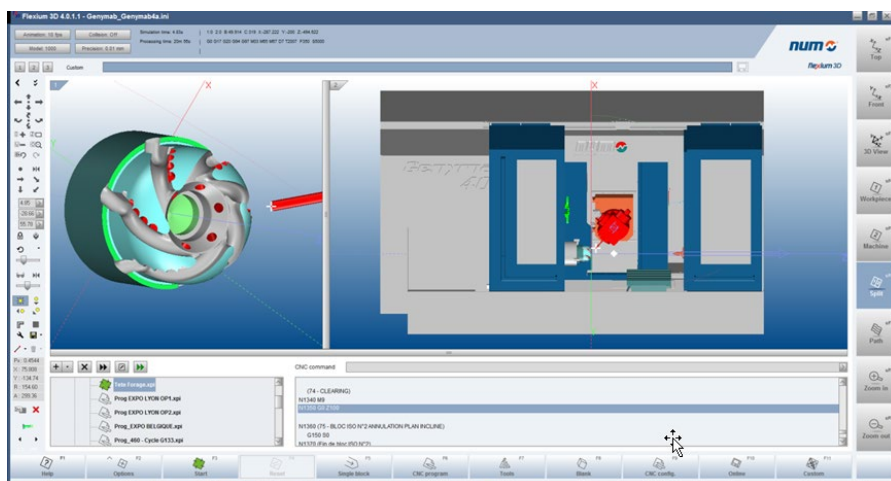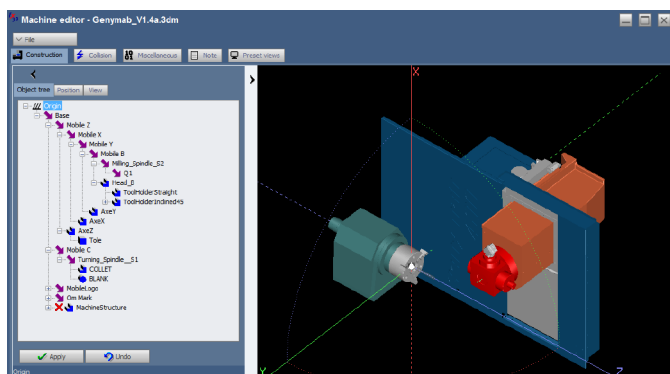
Protection of Applications

All the functions mentioned previously allow the functionality of the control to be increased. They contain know-how and should be protected. Protected against reading and/or manipulation of source code but also protected against unauthorized execution. To fulfil these needs Flexium⁺ offers different possibilities.

Source code protections of NC programs is accomplished by storing them in encrypted form in macro zone 2, with password protection. Source code of PLC programs can be protected by means of a password set inside Flexium Tools or by means of a security key. Sometimes the use of PLC modules and libraries must be paid for. This can be organized by means of a runtime key. To prevent the use of some NC programs, a protection can be integrated into the program itself.
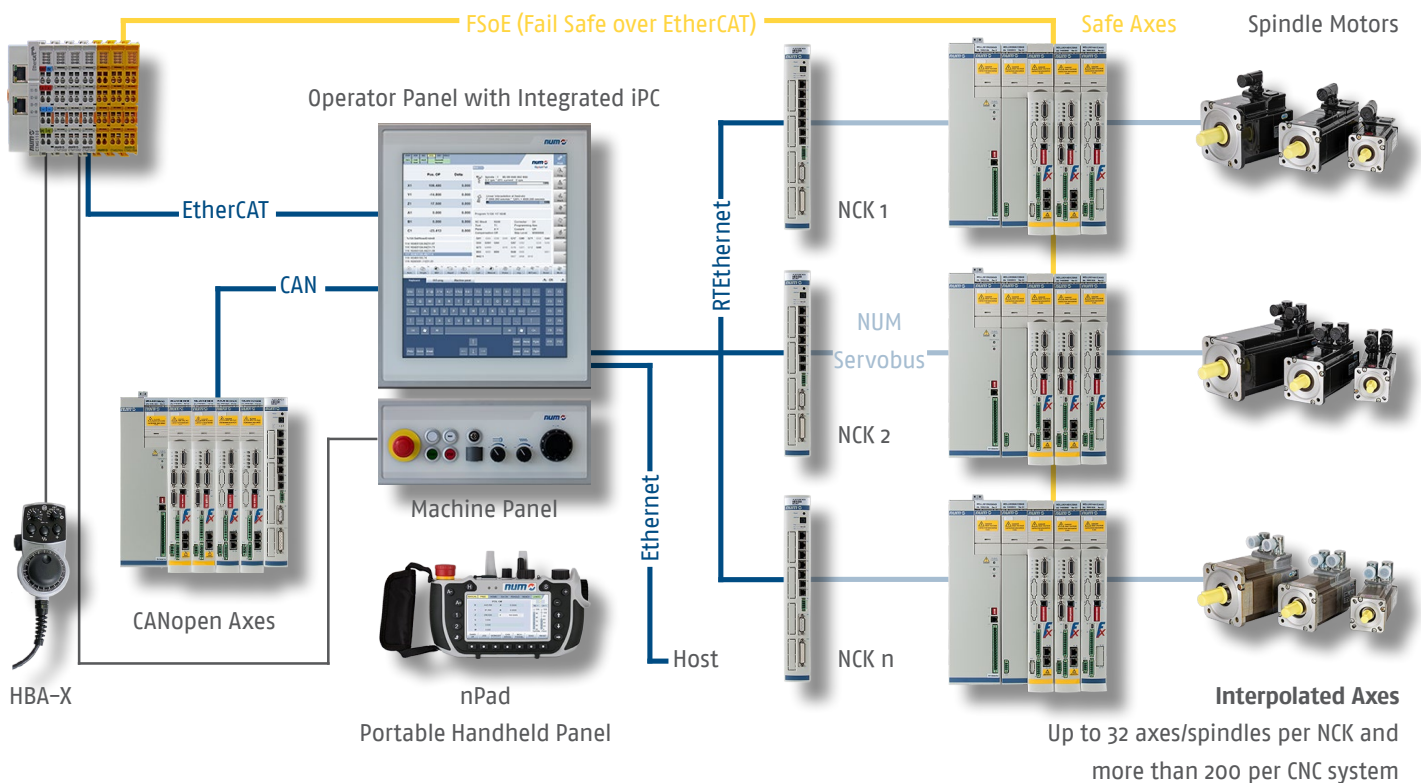
Flexium+ CNC–System
Flexibility, Productivity and Safety

Flexium+
Extreme Scalability

flexium+
CNC System

NUM EtherCAT Terminals
NUMSafe PLC & Safe Terminals

FSoE (Fail Safe over EtherCAT)

Safe Axes

Axis Motors /
Spindle Motors

Operator Panel with Integrated iPC

EtherCAT

RTEthernet

NCK 1

CAN

NUM
Servobus

NCK 2

Machine Panel

Ethernet

CANopen Axes

Host

NCK n

HBA-X

nPad
Portable Handheld Panel

Interpolated Axes
Up to 32 axes/spindles per NCK and
more than 200 per CNC system

The control system is characterized by an extremely high scala-bility. It allows the perfect adaptation to the respective applica-tion solution. Thus, in a simple way, systems from 1 to over 200 CNC axes can be realized. The Flexium+ system has a secure PLC in addition to the normal PLC, which communicates via FSoE (Fail Safe over EtherCAT) with the secure inputs and outputs as well as with the NUMDrive X drive control systems. The system covers all necessary safety functions in a simple manner. The program-ming of the safety logic is carried out with the same software tool as the rest of the PLC. This same tool is also used for the en-tire system parameterization and commissioning of the machine.

The NUMDrive X drive solution is the result of more than 20 ye-ars of experience in the development of fully digital drive sys-tems. It is available in different versions with different perfor-mance data. The wide range of drive amplifiers is available in single and dual axis versions and also in different performance levels (processing power). This allows a technical and financi-ally optimum adaptation to every application. These modules are designed for rated currents of a few up to 200 amps. Ano-ther strength of the drive amplifier is its compactness and high energy efficiency.

NUM Motors
Perfect for all Applications

Excellent volume/performance ratio and great dynamics, so that our motors can satisfy almost all applications.

NUM has more than 50 years of experience developing servo and spindle motors. We pioneered the development and production of AC brushless servo motors, as well as synchronous spindle motors with flux weakening.

The comprehensive **servo-motor** series of NUM offer an excellent volume/output ratio, as well as first-class dynamic properties optimized for the machine tool industry. They, with perfect concentric run-out, satsify even at very low speeds. The so-called "single cable" motors offer the advantage that the complete measuring system cable is eliminated. This simplifies the wiring of the machine significantly and thus saves money.

The **asynchronous motors** of the AMS series offer excellent quiet running at low speed, quick and accurate positioning and are ideally suited as a C-axis and for spindle indexing.

The TMX series **torque motors** have an extremely low cogging torque as well as a very high S1 torque density. They are ideal for applications that require very smooth and precise motion, especially at low speeds. Typical applications are direct drive rotary tables or workhead axes of machine tools. The TMX motors are complemented by an extensive range of torque motors from our partner company Schaeffler Industrial Drives (IDAM), who's customers include many well-known European machine builders.

Key data of the motor series:
- Servo-motors from 0.318 to 160 Nm (IP65, IP67)
- Rated speeds of the servo-motors up to 8000 rpm
- Spindle motors up to 55 kW
- Special kit motors
- Liquid-cooled spindle motors
- Liquid-cooled servo motors
- Asynchronous and synchronous motor spindles (motor spindle)
- "Single cable" motors
- Custom motors
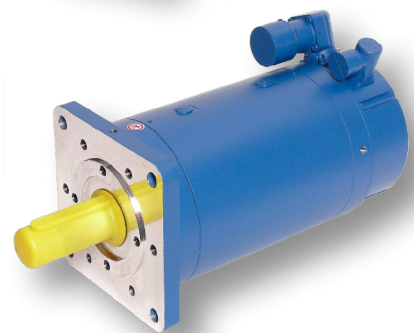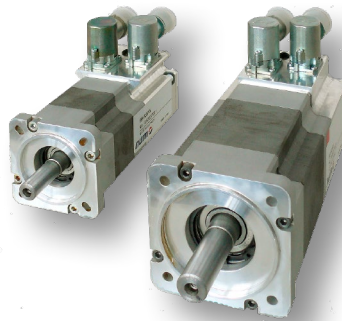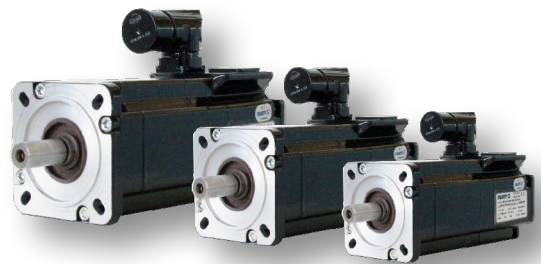
SCHAEFFLER

NUM Services
Worldwide at your Service

The decision for NUM is also the decision for a customer service that will support you long after the initial investment as on the first day – even after 20 years and on-site. Our specialists can ensure an extended life for your good (but old) machinery with NUM retrofits.

Worldwide support by experts

For professional analysis and trainings, a perfect infrastructure is available to our experts in all centers of excellence. So that we can assist you quickly and efficiently around the world, we also rely on the advantages of the most modern communication technologies, e.g. for remote maintenance via Internet. Of course, we will be happy to offer advice on site in your company.
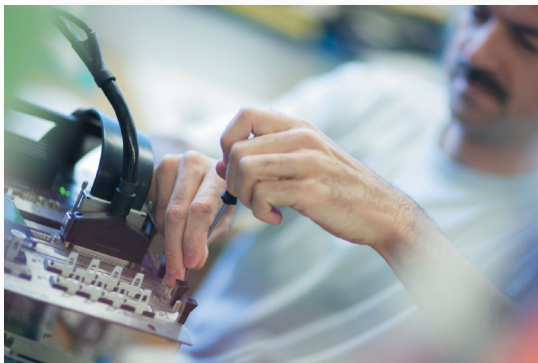
Comprehensive training offer

We orient our training to your indivual needs – whether its operator training, maintenance, repair and service training, PLC programming, or adjustment of servo drives.

NUM provides a training offer matched to the customer needs:
- CNC operation
- CNC programming
- PLC programming
- Commissioning and servicing
- Preparation of custom surfaces
- Customized customer training

Technically always up to date

Our team of specialists will actively inform you on the latest hardware– and software developments and provide you with useful technical information.

Repair– and spare parts service

If an error unexpectedly occurs in your CNC system in spite of proper maintenance, you can trust that this will be fixed by dedicated service employees of our global network.

Customer service

For you and your markets, we have a worldwide service organization. The International customer service provides telephone consultation, deployment on site, even for many years old installations. With a retrofit from NUM, the operating time of an excellent machine can be extended by many years.

Our customer service is available and responsive to help even with cutting edge products and custom developments. We carry local inventory and have your materials and components in stock ready to meet your requirements for quality and delivery times.

Complete CNC Solutions Worldwide

num ®
CNC HighEnd Applications

Finland
Sweden
Great Britain
Germany
Austria
France
Switzerland (Headquarters)
Spain
USA
Italy
Turkey
Russia
Mexico
China
Taiwan
India
Thailand
Brazil
South Africa
Australia

- NTC (NUM Technology Center)
- NUM Agent
- NUM Contact

NUM systems and solutions are used worldwide.

Our global network of sales and service locations guarantees professional service from the beginning of a project to its execution and for the complete life cycle of the machine.

NUM has service centers around the world. Visit our website for the current list of locations.

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