



**numjobs**

## Internship opportunity at NUM

### About us

Outstanding achievements in the engineering industry have something in common: they always result from superior performance, exceptional technology and a high degree of creativity. In that way NUM has built up an outstanding reputation in the tool and machinery industry. We develop complex, customized CNC automation solutions that guarantee the machine manufacturers as well as users with a high degree of added value.

NUM's successes are achieved essentially through the know-how and personal commitment of our employees.

And we now offer you the opportunity to actively contribute to this success working alongside the R&D Sw team at the NUM office in Cuggiono (MI).

We are proposing the following six months internship:

### Internship Projects

#### Study and development of a dynamic anti-collision algorithm

**Project Overview:** The goal of this project is to research and develop a dynamic anti-collision algorithm tailored for machine tools and robotic arms. The internship will follow roughly the following structure, where the progression through the subsequent phases will depend on the candidate's technical proficiency and the achievement of project milestones:

- **State-of-the-Art Analysis:** Study of modern approaches to dynamic anti-collision, focusing on computationally efficient representations of geometrical objects and transformations (e.g., Dual-quaternions, Projective Geometric Algebra – PGA, etc...).
- **Prototyping:** Implementation of one or more anti-collision algorithms within a suitable testing environment (MATLAB, python, Mathematica,...).
- **Performance Benchmarking:** (If multiple algorithms are implemented) Comparative analysis based on key performance indicators such as computational efficiency, memory footprint, and scalability, identifying potential issues.
- **Firmware Integration:** Implementation of the selected algorithm into the NUM CNC firmware, under the guidance of a senior developer.
- **Experimental Validation:** Functional testing and performance verification directly on a machine tool.

### Internship Projects

**Project Overview:** This project focuses on the research and development of offline optimization algorithms designed to smooth CNC toolpaths. The primary objective is to maximize manufacturing throughput and enhance surface finish quality by converting discrete paths into high-order continuous trajectories. The internship will follow a progressive structure, where the depth of the later stages will depend on the candidate's analytical proficiency and the achievement of project milestones:

- **State-of-the-Art Analysis:** Study of mathematical models for path smoothing, focusing on interpolation and approximation techniques using B-Splines, NURBS, etc...
- **Kinematic Optimization:** Investigation of methods to ensure continuity  $C^2$  or more while respecting strict geometric tolerances and kinematic constraints of the machine tool (speed, acceleration and jerk).
- **Prototyping and Simulation:** Implementation of the most promising algorithms in a suitable testing environment (MATLAB, python, Mathematica,...) evaluating their behavior in terms of curvature continuity and feedrate stability.
- **Comparative Analysis:** Performance benchmarking of different methods based on computational complexity, algorithmic robustness, and the resulting impact on machining dynamics.
- **Implementation and Validation:** (Upon successful prototyping) Integration of the selected algorithm into the NUM CNC software environment and final experimental validation through real-world machine tool testing



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## Study and development of an AI agent for CNC machine Tuning

**Project Overview:** This project focuses on leveraging Artificial Intelligence (AI) to automate and optimize complex industrial operations, with a specific focus on the autonomous tuning of axis PID controllers in CNC machines. The primary objective is to replace manual on-field calibration with intelligent algorithms. The internship will roughly follow the next steps, but the achievement of these points relies on the candidate's determination and proficiency:

- **State-of-the-Art Analysis:** Study of modern Artificial Intelligence and Machine Learning techniques applied to control systems, focusing on Reinforcement Learning (RL) algorithms (e.g., Deep Deterministic Policy Gradient, Soft Actor-Critic) or evolutionary algorithms suitable for automated parameter optimization.
- **Prototyping and Simulation:** Implementation of the AI agent within a simulated environment that models the CNC axis dynamics (using MATLAB/Simulink, PyTorch/TensorFlow, etc.), training the model to find optimal PID gains.
- **Performance Benchmarking:** Comparative analysis of the AI-driven tuning against classical tuning methods (e.g., Ziegler-Nichols, frequency response analysis) based on key control metrics such as tracking error, settling time, overshoot, and algorithmic robustness.
- **Software Integration:** Implementation of the trained AI algorithm into the NUM software tools, under the guidance of a senior developer, establishing a reliable communication pipeline with the machine's control loops.
- **Experimental Validation:** Functional testing and real-world verification directly on a physical machine tool, assessing the agent's ability to autonomously tune the axes under actual mechanical loads, friction, and resonances.

### What we are looking for

We are looking for a flexible and highly motivated person with a strong mathematical and geometrical background. You will be integrated in an international development team spread in 3 different countries: Switzerland, France and Italy. You will report to the embedded software development manager.

### Your background

- University courses in Engineering, Mathematics or Physics
- Knowledge of English language
- Ability to collaborate with senior engineers
- Experience in Drive and/or CNC development would be a plus
- Knowledge of programming languages such as: C, C++ would be a plus

### Your personality

- Strong solution oriented and conceptual thinking skills
- Team player with good communication skills
- Independent working attitude
- Pragmatic and solution-oriented working methodology

### What we offer

- An international, dynamic, growing company with whole value chain from R&D to sales and manufacturing
- Pleasant working atmosphere with flexible working hours

Contact:

**Maria Giovanna Berra**  
Human Resources  
Tel +39 02 97 969 213  
maria-giovanna.berra@num.com

**NUM S.p.A.**  
Via F. Somma 62  
IT-20012 Cuggiono (MI)  
www.num.com