CNC Milling

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Section two
International Benchmarking

What is the TVET Model in place that helps raise standards amongst students?

Germany & Austria

The education system in Germany operates on the principle of "dual," which refers to the two complementary components of training: theoretical education in vocational schools and practical training in companies. This combination allows students to gain both theoretical knowledge and hands-on experience, making them well-equipped for the demands of the job market.

At the core of the dual education system is the close cooperation between vocational schools and businesses. Companies actively participate in the training process. This collaboration ensures that the education provided aligns with the needs of the industry, fostering a strong connection between education and employment.

Companies take more responsibility for the education and training of the apprentices. The dual system is never used as a way of providing cheap labour. Most companies will have an in-house training school and all apprentices will have a mentor.

How does this country work with Industry to develop their TVET systems?

Qualifications are developed by the associated chamber of commerce, working in partnership with industry, so therefore, nationally standardised.

Employers are at the heart of the dual system - they take an active role in training the learners.

The downside is that not all learners will be guaranteed employment at the company at the end of the training period.

In terms of training and developing WorldSkills Competitors – what do these countries do differently?

In these countries, the WorldSkills competitors are seen as elite athletes. They have an extensive training network around them, including multiple specialist and technical trainers. They make good use of previous WorldSkills competitors, with these often training the new competitors.

Germany and Austria always have good access to the latest technology, and in some instances, the companies that employ the competitors have equipped their training schools with the same machines which are used in WorldSkills competitions.

Both Countries train regularly with other countries nearby such as Liechtenstein and Switzerland, exchanging ideas and educational input.

Insights observed where countries have showcased excellence within this skill

UAE	Austria
On difficult modules when the allotted time for programming is short, UAE adapt their sequence of work to ensure that they can output and run enough CNC code to ensure the machine is always running and cutting metal. They continue to use the CAD/CAM software to complete the programs while the machine is cutting the part. They have a real depth of understanding of task timings that make this process the most efficient.	In the drawing and modelling stages, Austria carries out extra work to ensure the finished product has no sharp edges and all edges are broken to the same size and style. They add small, modelled chamfers on all vertical wall edges to create break edges that match the size and shape of the horizontal edges which are formed with a chamfer cutter. This improves the look and feel of the finished product.

What do international Standards of Excellence look like in CNC Milling?

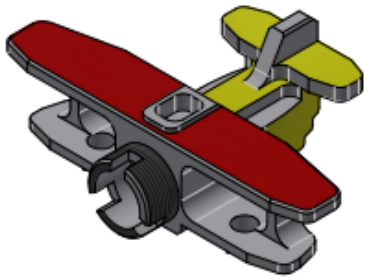
Being able to produce CNC part programs for multiple complex parts in a short time frame with tight tolerances.

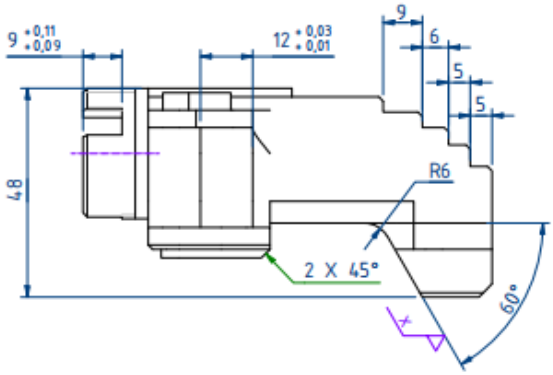
Competitors must be able to master a CAD/CAM system to produce and/or edit 3D models before they use the geometry created to produce toolpath strategies and the resulting CNC programs.

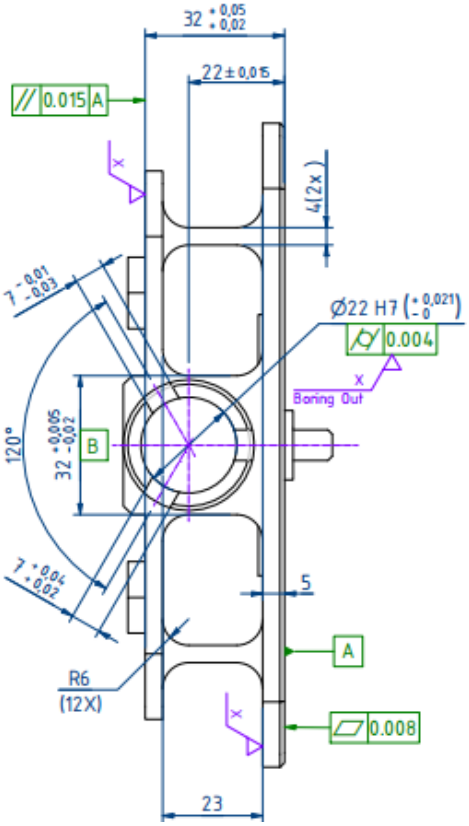
The competitors must also be able to set the CNC machine quickly and efficiently with the greatest accuracy and create the physical component in the time limit as well as to the dimensional requirements, down to as small as +/-0.01mm.

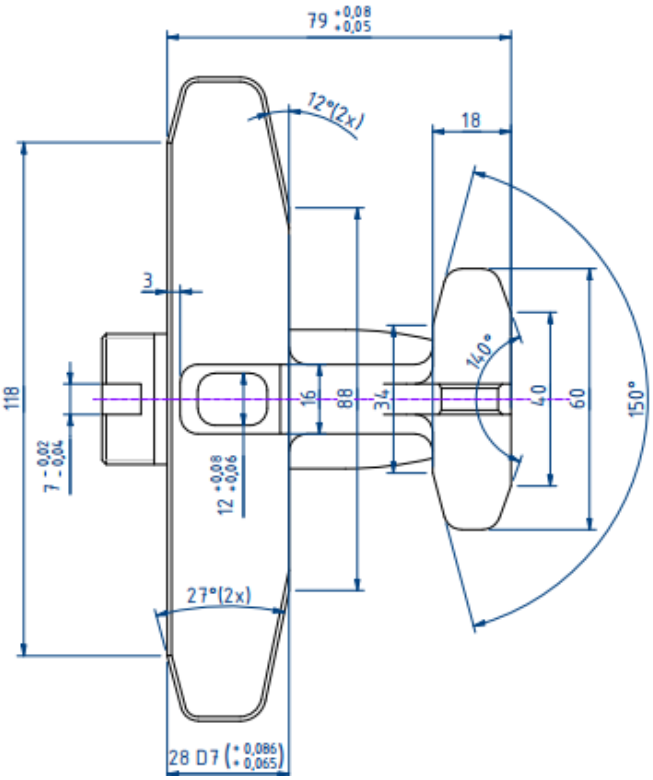
For example, the following project was modelled and programmed in 2 hours 45 minutes and machined, including setting the machine and tools within 4 hours.
Total task time: 6 hours 45 minutes.

(Only partial drawing views are shown)









Current key trends, practices and techniques in CNC Milling

Trochoidal milling techniques are used as a standard roughing strategy - allowing increased material removal rates and improved tool life.

More use of technology for improved accuracy is required, such as laser tool measurements and digital tool presetting devices as well as optical and radio spindle probes.

What are the key attributes both technically and mentally that a high performing CNC Competitor requires to reach excellence in this skill?

A CNC Competitor requires the following skills:

National:

- Read engineering drawings
- Understand tolerances
- Program CNC toolpaths from solid models and wireframe geometry
- Produce CNC programs
- Set a machine vice
- Set tool information on the machine
- Calculate speeds and feeds
- Run CNC programs safely
- Accurately measure and adjust tool information
- Compete under time pressure

International:

All of the above plus:

- Produce solid models using CAD/CAM software, from given engineering drawings.
- Create and adapt Solid, surface and wireframe geometry in CAD/CAM
- Adjust and optimise CNC programs.
- Able to use multiple methods to set Workpiece datums
- Able to set tool length offsets using manual and automated methods, including using external preset machines
- Interpret inspection data and adjust workpiece datums accordingly to ensure accuracy
- Adjust tool wear offset data to improve accuracy
- Optimise the machining strategy to reduce vibration and improve accuracy
- Set and run parts with multiple sides machined
- Check and calibrate machine spindle and tool probes to ensure accuracy.
- Build tool assemblies to ensure a high degree of accuracy.
- Use multiple methods of hand measurement to an accuracy of 0.01mm

Mindset requirements:

National:

- Visualise a manufacturing solution to the given test project
- Work organisation and time management
- Working under pressure

International:

All of the above plus:

- Resilence
- Ability to use reflection to learn from failure
- Commitment to the process
- Organise self-guided learning
- Curiosity - willing to research and develop new ways of working