D2.1. Best practice guideline monitoring and evaluating application of flipped work-based learning in CNC milling machines.

Meldal VET school

Introduction

In machining, numerical control, also called computer numerical control (CNC), is the automated control of tools by means of a computer. It is used to operate tools such as drills, lathes, mills, grinders, routers and 3D printers. CNC transforms a piece of material (metal, plastic, wood, ceramic, stone, or composite) into a specified shape, by removing material with a cutting tool. by following coded programmed instructions and without a manual operator directly controlling the machining operation.

CNC offers greatly increased productivity over non-computerized machining for repetitive production, where the machine must be manually or mechanically controlled by prefabricated pattern guides. The CNC machine provides a motorized manoeuvrable tool and often a motorized manoeuvrable platform, which are both controlled by a computer, according to specific input instructions. Instructions are delivered to a CNC machine in the form of a sequential program of machine control instructions. In modern CNC systems, the design of a mechanical part and its manufacturing program are highly automated.

In order to satisfy companies' different needs for expertise, it will be necessary to offer modules that are adapted to the operations that candidates will need to learn. Throughout this trial, emphasis has been placed on the basic knowledge required to operate a CNC milling machine. Therefore, this module includes being able to start up the machine, retrieve a programme stored in the machine and get the machine to run it. The module also covers how to measure and register tools in the machine's tool list.

Examples of modules that can be further developed include

- Building simple programmes directly on the machine.
- Building more complex programmes using different cycles.
- Generating programmes using a CAM programme, where the coding is generated from a 3D drawing.

To quality assure the work we have done through the construction of the modules, our testing and evaluation has been carried out with colleagues and students. Testing with colleagues was done both with guidance from an instructor and without a supervisor. The later only with the videos as guidance. Testing with students was only done with the instructor present. The students used the videos both before and during the test on the machine. During the test, the candidates could scroll back and forth on the films and, if necessary, re-watch sequences several times to ensure correct execution.

Afterwards, an evaluation was carried out together with the candidates.

Our experience indicate that it is important that the students watch the videos first and then do the practical training on the machine in the workshop afterwards. This means that the candidates are better prepared, as they can recognize the different steps when the training on the actual machine starts. At the same time, the films are a good support during the practical implementation. The candidate can then repeat the different sequences as many times as needed to feel confident in the procedure. The aim of the training is for the candidate to be able to complete the module independently without video support.

For safety, both for the operator and the machine, the instructor should always be nearby when the students, in pairs, start/run the machine on their own to provide guidance and possibly explain technical terms. It is an advantage that candidates work in pairs to help each other through the training. This allows one person to control the instructor video while the other operates the machine. Who does what needs to be swapped. When the candidate feels ready, the instructor assesses whether the desired competence has been achieved.

When preparing videos, you can use a video camera, GoPro camera, mobile phone or other equipment that allows you to record films. We used a mobile phone camera in our preparation. It's small, lightweight and always in your pocket. In addition, the camera has turned out very well.

When we produced these videos, one instructor reviewed the subject matter and one person filmed. The important thing is to ensure that the filming is concentrated on what is happening at any given time. Do not film anything other than what is to be filmed. This ensures that the message of what is to be learnt is as clear as possible.

The time aspect differs depending on what is to be filmed. Sometimes you can spend 10 minutes, while other times it can take up to an hour. Afterwards comes the editing of the film material to be distributed. Each finished film should be as short as possible and contain only a limited work operation. This is to make the films as specific as possible, so that it is easy for the candidate to find what he/she is looking for. It is better to make several short films than a few longer ones.

The films that have been made have been uploaded to the school's YouTube account. To make it as easy as possible for candidates to find the right film, a poster with QR codes has been created and placed by the CNC machine. The QR codes are each film's unique address. This means that candidates can easily scan the codes with their mobile phones or tablets to go straight to the right film without having to search.

The videos we've made could be applied until we change the machine, if necessary.

Competence measures
The student will be able to start up and run the selected program on a Computer Numerical Control (CNC) mill machine. Our experience indicates that students need more practice to be able to fulfil the competence objective independently. Additional repetitions are therefore

recommended. Therefore, the instructor should conduct an assessment situation to determine whether the candidate is ready to independently complete the module. This will then determine whether the candidate is ready to continue with more modules.

Experiences

The videos are good as they are and that the practical review follows the layout of the videos.

Three ways have been used to test this training:

- Self-testing without an instructor present
- Trial with an instructor present
- Trial with two learners together with an instructor present

The students use the videos as a reference service to help them move on if they have forgotten something and as an introduction to the practical training. This experience emphasizes the importance of the videos being easy to find by using QR codes.