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EDU-VET

E-Learning, Digitisation and Units for Learning at VET schools – Creating online Learning Environments in Technical Education for European metal industry

IO3: Demo Course for Moodle

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Demo Course for Moodle

Learning Unit 1: Drilling/ Reaming/ Counterboring/ Threadcutting – Basics

Welcome to the Learning Unit 1: Drilling/ Reaming/ Counterboring/ Threadcutting – Basics

The first Learning Unit serves to welcome you and to give you a first brief orientation.

This learning unit was developed within the EDU-VET project. Therefore, on this welcome page we offer a very brief orientation about the structure of this learning section. If you have further questions about the EDU-VET project or this learning unit, please do not hesitate to contact the project coordinator Prof. Dr. Marc Beutner.

We wish you much pleasure and a good learning success!

1) Overview about structure

Welcome to the Learning Unit 1: Drilling/ Reaming/ Counterboring/ Threadcutting – Basics

This learning Unit focuses the introduction to the topic “Drilling/ Reaming/ Counterboring/ Threadcutting”. Concretely, this course intends to cover the basics of machinery manufacturing processes which include the manufacturing processes of drilling, countersinking and reaming. To understand deeper issues concerning this topic e.g. cutting parameters or drilling tools, it is necessary to understand the basics of the machinery manufacturing processes.

Therefore, this course unit is structured as follows:

- Objectives and learning outcomes: The objectives and learning outcomes if this Learning Unit 1 will be presented.

- Theoretical Input and Explanation: In this section you will learn the theoretical background of machinery manufacturing processes. The focus is on the explanations of the three manufacturing processes of drilling, countersinking and reaming. Furthermore, learners should gain insights into cutting parameters and drilling tools.

- Knowledge transfer - Interactive tasks: Once you have received the theoretical input, you can test your acquired knowledge by doing interactive tasks.

We wish you much pleasure and a good learning success!

2) Objectives and learning outcomes

The objective of this course is to learn the basics of machinery manufacturing processes in order to understand the individual manufacturing processes of drilling, countersinking and reaming. Besides, the different sub processes of drilling, countersinking and reaming will be also explained. Following, you can test your knowledge by doing interactive tasks.

The learning outcomes of this Learning Unit 1 are:

- An understanding of the main aspects, processes and definition of Drilling.
- An understanding of the main aspects, processes and definition of Countersinking.

- An understanding of the main aspects, processes and definition of Reaming.
- An understanding of the relationship between the machinery manufacturing processes.
- Insights into cutting parameters.
- Insights into drilling tools.

3) Theoretical Input and Explanation

Firstly, you will get to know the different core elements of machinery manufacturing processes.

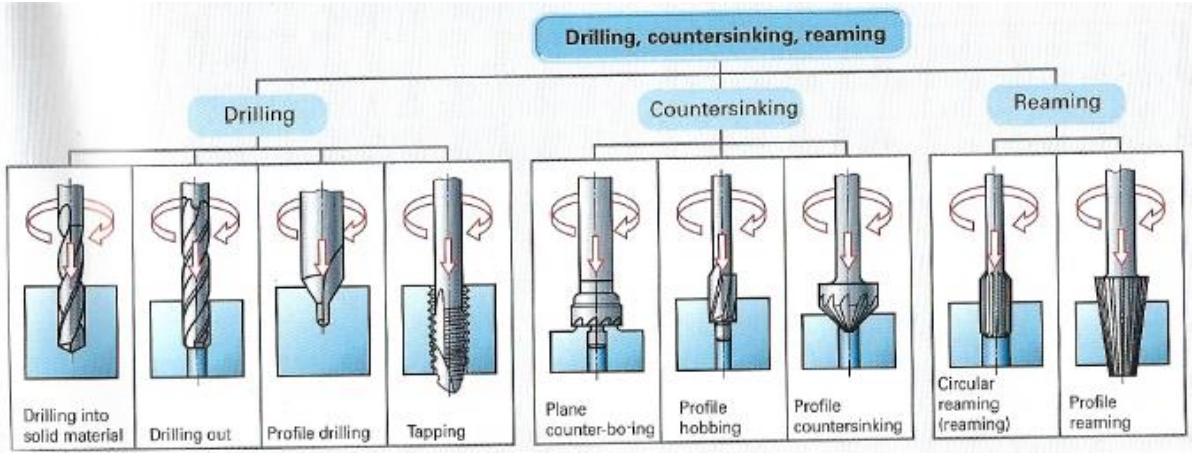

Figure 1: Drilling, countersinking, reaming manufacturing processes
Source: BARTENSCHLAGER ET AL. (2016, p. 139).

Drilling:

The first core process of machinery manufacturing is the Drilling.

“Turning is a machining process in which the cutting movement is performed by the workpiece and the auxiliary movement (feed and infeed) by the tool. Feed and infeed are generated on most lathes by longitudinal and cross slides. The tool used for turning, the turning tool, has only one main cutting edge. Simple turned parts obtain their shape by a feed movement in the direction of the axis of rotation or perpendicular to it. The associated processes are named according to the direction of the feed movement that takes place during machining (longitudinal or facing). The contour of the finished part is created by several steps. The infeed takes place before each step outside the workpiece” (FACHWISSEN TECHNIK 2020, n.p.).

The drilling process consists of the following core elements

- Drilling into solid material
- Drilling Out
- Profile Drilling
- Tapping

(cf. BARTENSCHLAGER ET AL. 2016, p. 139).

Countersinking:

Another basic process of machinery manufacturing is the Countersinking.

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"Countersinking is used to produce profiled or conical surfaces perpendicular to the axis of rotation. As well as drilling, it is based on rough machining. The countersink - a multi-blade tool - produces shaped partial surfaces. In contrast to drilling, however, it does not work into the solid, but into already existing holes. The tool is better guided by several cutting edges, on which the cutting and feed forces are distributed. The cutting speed must be lower, the feed rate can be selected higher than for drilling" (FACHWISSEN TECHNIK 2020, n.p.).

The countersinking process consists of the following core elements:

- Plane counter-boring
- Profile hopping
- Profile Countersinking

(cf. BARTENSCHLAGER ET AL. 2016, p. 139).

Reaming:

The third key component machinery manufacturing is reaming.

"Reaming is a reaming process with low chip thickness to produce precisely fitting bores with high surface quality. The cutting work is mainly performed by the first cut of the reamer. The circular grinding chamfers smooth the bore surfaces and are of great importance for the surface quality, dimensional and shape accuracy. The reaming allowance depends on the bore diameter and the type of reamer, e.g. straight or twist fluted reamer 0.1 mm to 0.5 mm, skiving reamer up to 0.8 mm. The cutting speed is considerably lower than when drilling. The feed rate depends on the material, the bore diameter and the required surface quality" (FACHWISSEN TECHNIK 2020, n.p).

According to countersinking process the following core elements can be listed:

- Circular reaming (reaming)
- Profile reaming

(cf. BARTENSCHLAGER ET AL. 2016, p. 139).

Cutting parameters:

In the last sections, you learned the basics of the different procedures of manufacturing processes. Furthermore, this following section will have a closer look into the very extensive drilling process. Therefore, the cutting parameters will be focus.

"During Drilling, the tool primarily carries out a circular cutting movement while the feed movement takes place in a straight line along the rotational axis. The toll cutters penetrate the material due to the feed force. The circular cutting movement creates the cutting force" (BARTENSCHLAGER ET AL. 2016, p. 139). The following figure also illustrates forces and movements during the drilling process:

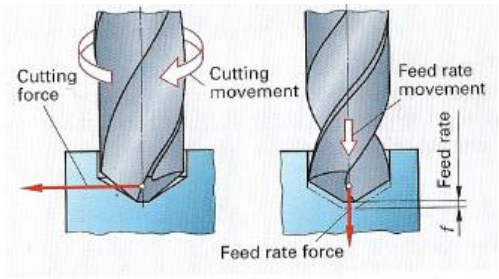


Figure 2: Forces and movements during drilling
Source: BARTENSCHLAGER ET AL. (2016, p. 139).

For calculating the forces and movements during drilling, you have to use the cutting speed rate, which depends on the one hand on the drill type or drill process and on the other hand on the material and the required work quality.

"The speed n can be read off from speed diagrams or calculated from the cutting speed Vc and the drill diameter d" (BARTENSCHLAGER ET AL. 2016, p. 139). The speed rate can be calculating with the followed formula:

Speed: $n = \frac{Vc}{\pi * d}$

In addition, you have to calculate the feed rate f.

"The feed rate f in mm per rotation primarily depends on the material, the cutting material and the diameter of the drill, on the drill process and the drilling depth (see Table 1). It influences the chip formation and the power requirement. The feed speed vf in mm/min is calculated from the rotational speed n and the feed rate f" (BARTENSCHLAGER ET AL. 2016, p. 139):

Feed speed: $vf = n * f$

In summary, you have to consider:

"The rotation speed results from the selected cutting speed and the drill diameter, and the feed speed results from the rotational speed and the feed rate" (BARTENSCHLAGER ET AL. 2016, p. 140).

Drilling Tools:

In addition, in this learning section you will learn more about other drilling processes and drilling tools which include profile drilling, system tools and boring. Its basics and fundamentals will be presented step by step.

Profile Drilling:

"Centre drills produce locating holes for milling and grinding between points. NC spot drills are used for precisely-positioned spot drilling into full bodies and for centring on NC machines. They are manufactured with a point angle of 90° or 120°, and can simultaneously produce the countersink for subsequent screw thread tapping at the same time as the centring" (BARTENSCHLAGER ET AL. 2016, p. 144).

Figures 3 and 4 show you the centring drill hole with centring drill as well as a NC spot drill.

Figure 3: Centring drill hole with centring drill
Source: BARTENSCHLAGER ET AL. (2016, p. 144).

Figure 4: NC spot drill
Source: BARTENSCHLAGER ET AL. (2016, p. 144).

System Tools:

System tools are also a key component of other drilling processes and drilling tools. With reference to BARTENSCHLAGER ET AL., it is declared as follows:

"Modern system tools can be used to produce high-precision drill holes and profile drill holes, for example in pump housings, using solely one tool. Multi-step drill bits or system drills are available comprising a carrier, adjustable guide rails and a cutting part with adjustable and replaceable cutters. It is often possible to do without post-processing such as reaming and countersinking. System tools are often used in drill bit systems. The base carriers forms the interface between the drilling tool and the drilling machine. No spinning and no longitudinal displacement in the clamping equipment must occur so that the torque and feed force are transferred without problem. Concentricity errors and lack of stiffness are frequent causes of drilling problems" (BARTENSCHLAGER ET AL. 2016, p. 144).

Additionally, please have a closer look into the two figures, which present the multi-step drilling machine and the drilling tool system:

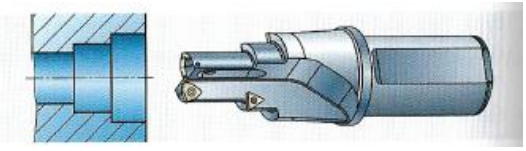


Figure 5: Multi-step drilling machine
Source: BARTENSCHLAGER ET AL. (2016, p. 144).

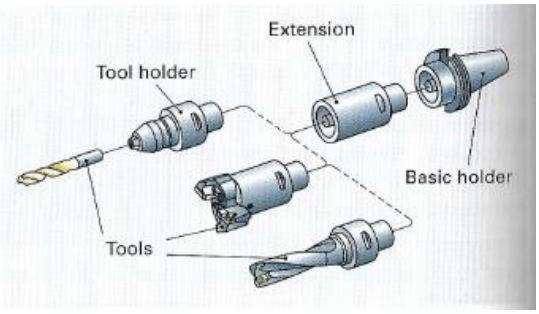


Figure 6: Drilling tool system
Source: BARTENSCHLAGER ET AL. (2016, p. 144).

Boring:

The last procedure of other drilling processes and drilling tools is the boring.

Boring can be defined as “drilling to increase the size of pre-drilled, pre-cast or pre-punched holes, or is used to connect two offset drill holes” (BARTENSCHLAGER ET AL. 2016, p. 144).

On the one hand, the boring tools include rebore drills which “are tools with 1 to 4 blades. The chamfer diameter of drill tip is such that the prepared hole diameter must be at least 70 % of the boring diameter. The cut speed and feed rate is selected as for drilling with HSS drills” (BARTENSCHLAGER ET AL. 2016, p. 144).

On the other hand there are boring/ cutting out tools with CC inserts. These tools “are used for boring larger diameters. Fine-boring heads enable adjustment of the drill hole diameter in the µm range using a Vernier scale” (BARTENSCHLAGER ET AL. 2016, p. 144)

Let´s have a closer look into the figures 7, 8 and 9.

Figure 7: Rebore drill (spiral countersink)
Source: BARTENSCHLAGER ET AL. (2016, p. 144).

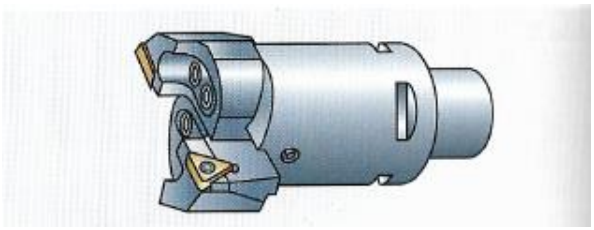


Figure 8: Dual-cutter boring tool
Source: BARTENSCHLAGER ET AL. (2016, p. 144).

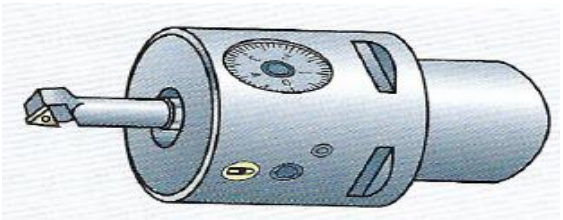
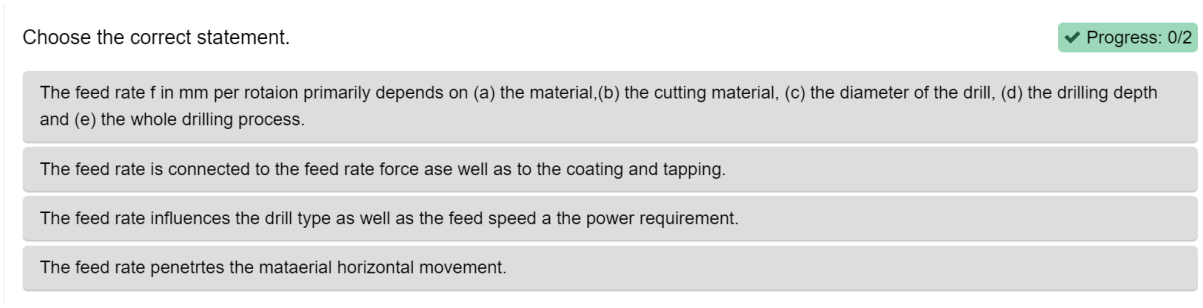


Figure 9: Incision fine-boring head
Source: BARTENSCHLAGER ET AL. (2016, p. 144).

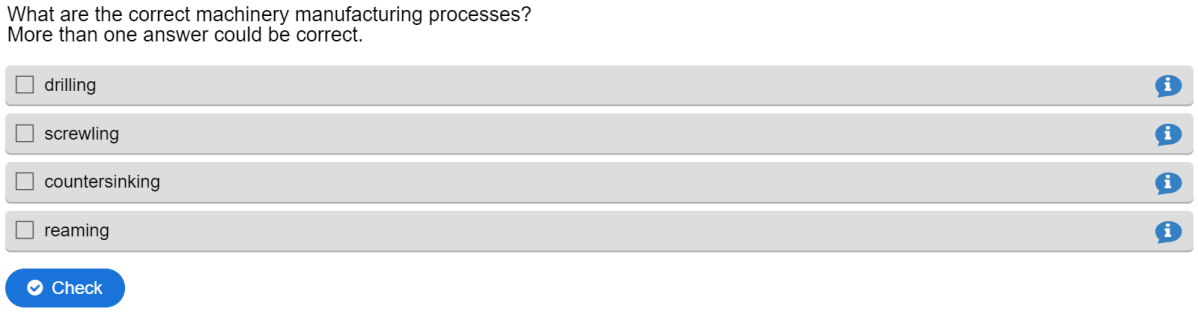
4) Knowledge transfer - Interactive tasks

After the theoretical input, now you can test your learned knowledge by doing following interactive tasks.

Task 1) Please choose the right statement:



Task 2) What are the correct machinery manufacturing processes? More than one answer could be correct.



Task 3) Here, you can deepen your knowledge. Unfold the tabs so that you can have a closer look at the summarised definitions.

Please have closer look into the learning platform. There you will find more interactive tasks.

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Literature:

BARTENSCHLAGER, J. / DILLINGER, J. / ESCHERICH, W. / GÜNTER, W. / IGNATOWITZ, E. / OESTERLE, S. / REIßLER, L. / STEPHAN, A. / VETTER, R. 7 WIENEKE, F. (2016): Metal Engineering Textbook. Haan-Griuten: Verlag Europa.

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