VARGUS

Thread Milling Handbook

VARDEX

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Introduction

The most ingenious invention of the last millenium was actually the screw.
The industrial production of the screw only began in the 1850's. It was invented by Vitold Reabchinsky.

In the distant past, the tools were activated by muscle power and were very similar to today's tools. The ancient hammers looked like their modern counterparts and so did the drills, planes, saws and files. The nails already served mankind in ancient times, mainly by joining parts together (mostly from wood). For that reason, man needed the hammer.

The screw, however, is a relatively modern invention. The principle of the screw had already been invented in the third century B.C. by Archimedes and screw-shaped fixtures were used in ancient times for water pumping or compression, for example, for squeezing olives or for torture instruments.

But screws for joining parts appeared only in the 16th century.

The early screws had a screwing head with one slot and the screwdriver only became popular with carpenters after 1800. Back then, screws were regarded as expensive luxury articles. The reason: production took place manually. Industrial production of the screw started only after 1850.

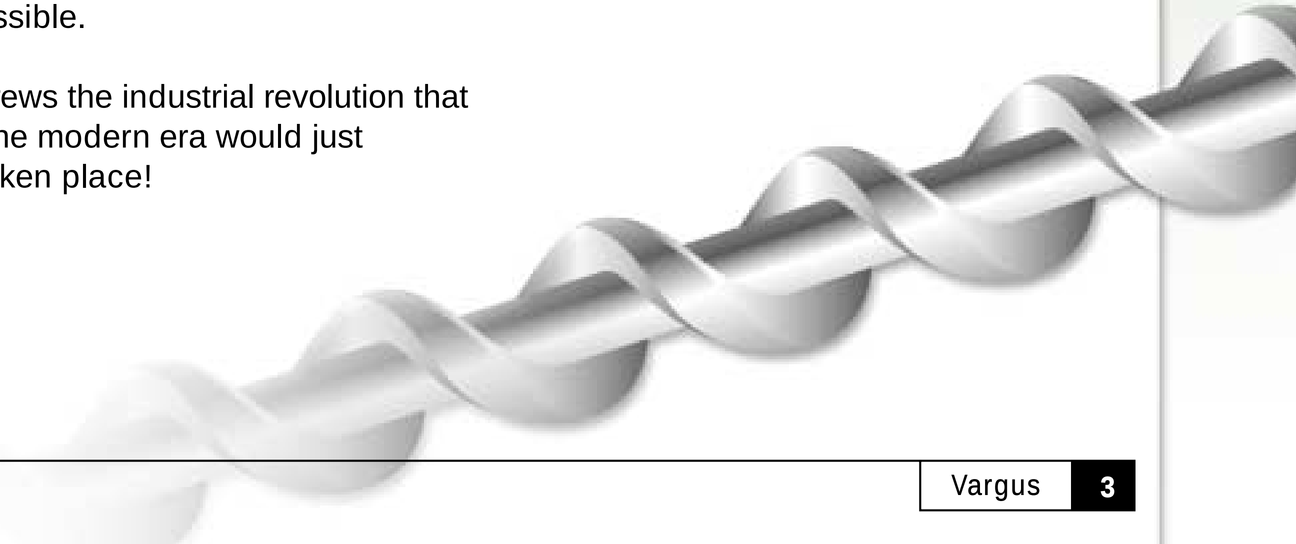
Cheap screws are actually a modern creation. Not only screws for wood serve modern civilization, but also screws designed for other materials, for example, steel that is used in modern building.

Steel screws used in the building industry obtain their strength from the friction between the screw and the nut. The screw presses the two workpieces together, and the more the screw is fastened – the more the pressure is increased.

This invention enabled the building of ships and houses, cupboards and tables, and also various domestic appliances.

The very accurate screw also enabled the building of amazingly accurate measuring instruments such as microscopes with an accuracy of up to a hundredth of a millimeter and transforming systems for telescopes that make accurate tracing of the planets possible.

Without screws the industrial revolution that rushed in the modern era would just not have taken place!

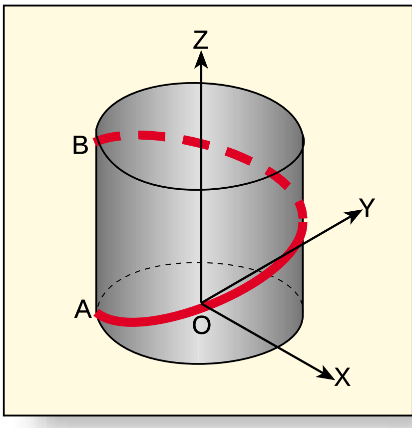


About Thread Milling (general)

Thread Milling is a method for producing a thread by a milling operation.

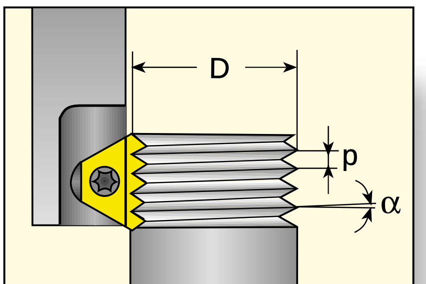
The most common way to produce a thread is still by tapping and turning but today we see more and more milling and this is because CNC milling machines with three simultaneous axes are very popular. These can now be found in every small workshop.

To perform a Thread Milling operation, a helical interpolation movement is required. Helical interpolation is a CNC function producing tool movement along a helical path. This helical motion combines circular movement in one plane (x,y coordinate) with a simultaneous linear motion in a plane perpendicular to the first (z coordinate).



Vargus Thread Milling system

Vargus thread milling tools are based on indexable multitooth inserts. The cutter rotates around itself at high speed and at the same time moves along the helical path. All the teeth are machined simultaneously so every tooth creates one pitch. At the end of the operation all pitches are combined into one complete thread and that by one pass only. This result is achieved with Vardex high accuracy inserts and use of a CNC milling machine.

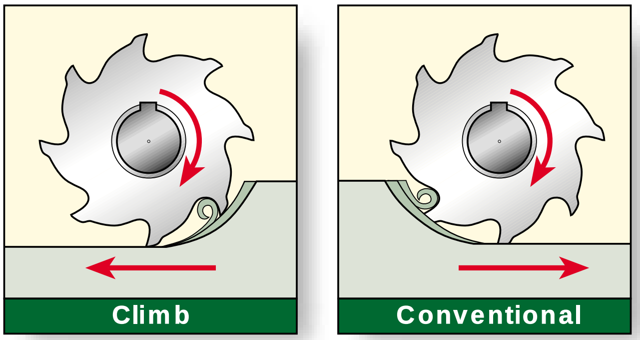


α: helix angle
D: external diameter
p: pitch

Advantages of the system and field of application

- Enables machining of large work pieces which cannot be easily mounted on a lathe
- Non-rotatable and non-symmetrical parts easily machined
- Complete operation in one clamping
- Threading of large diameters requires less power than threading by taps
- No upper limits to bore diameter
- Chips are short
- Blind holes without a thread relief groove can be machined
- Thread relief groove unnecessary
- One holder used for both internal and external threads
- One tool used for both right hand and left hand thread
- Tooling inventory can be reduced to a minimum as small range of tooling covers a wide range of thread profiles
- Interchangeable inserts
- Suitable for machining of hard materials
- Threads have a high surface finish
- Allows for correction of tool diameter and length
- Interrupted cuts easily machined
- One tool for a wide range of materials
- A better thread quality in soft materials where taps normally tear the material
- Short machining time due to high cutting speed and rapid feed rates
- Small cutting forces allow machining of parts with thin walls

Climb and conventional



There are two methods for the milling operation - climb milling and conventional milling.

For many years it was common practice to mill against the direction of the feed due to the absence of backlash eliminating devices and the use of high speed steel cutters. This method is called conventional milling.

In conventional milling, friction and rubbing occur as the insert enters into the cut, resulting in chip welding and heat dissipation into the insert and workpiece.

Climb milling, the second method, is now generally recommended. The insert enters the workpiece material with some chip load and proceeds to produce a chip that thins as it progresses towards the finish. This reduces the heat by dissipating it into the chip.

Based on the above, Vargus recommends using the climb operation which will give you:
- reduced load from the cutting corner
- better tool life
- better surface finish

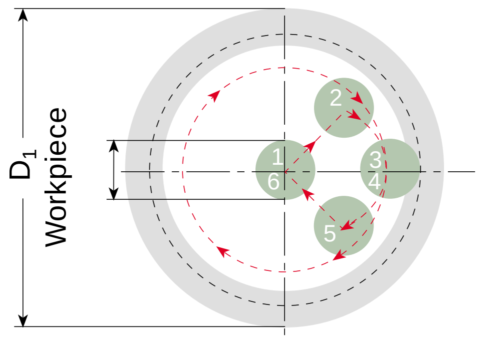
Infeed method

How does the thread milling cutter enter and exit the workpiece?

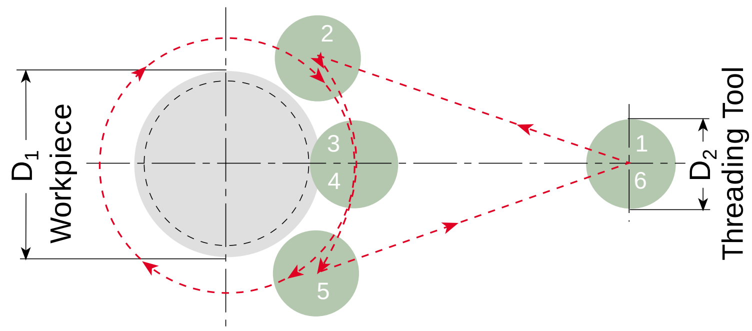
Tangential arc approach - The best method ! ! !

With this method, the tool enters and exits the workpiece smoothly. No marks are left on the workpiece and there is no vibration, even with harder materials.
Although it requires slightly more complex programming than the radial approach (see below), this is the method recommended for machining the highest quality threads.

Internal Thread



External Thread



1-2: rapid approach
2-3: tool entry along tangential arc, with simultaneous feed along z-axis
3-4: helical movement during one full orbit (360^0)
4-5: tool exit along tangential arc, with continuing feed along z-axis
5-6: rapid return

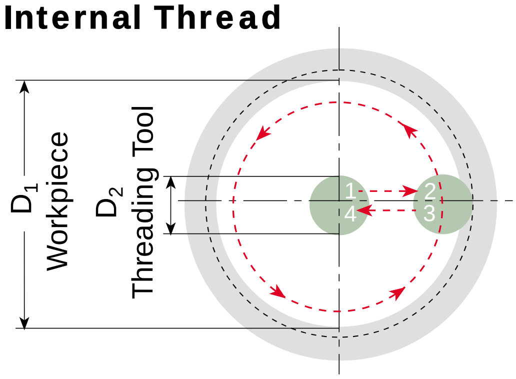
Radial approach

This is the simplest method. There are two characteristics worth noting about the radial approach:

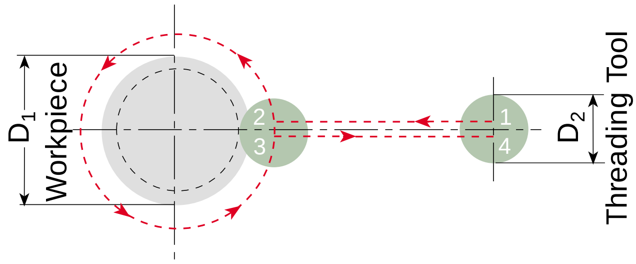
- a small vertical mark may be left at the entry (and exit) point. This is of no significance to the thread itself.
- when using this method with very hard materials, the tool may have a tendency to vibrate as it approaches the full cutting depth.

Note: Radial feed during entry to the full profile depth should only be 1/3 of the subsequent circular feed!...

Internal Thread



External Thread



1-2: radial entry
2-3: helical movement during one full orbit (360^0)
3-4: radial exit

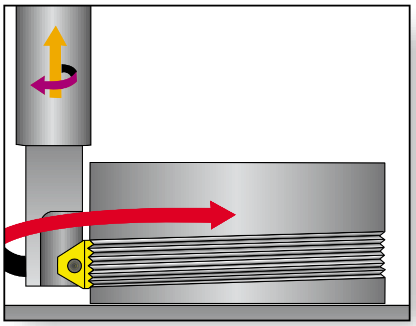
External/Internal RH. LH.

Vardex TM tools can produce external and internal,
RH or LH threads depending only on the tool path which is programmed.
The following drgs. will clarify it very easily.

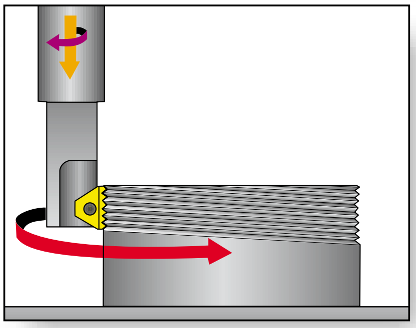
For conical applications such as NPT or BSPT, left hand tools can be used.
In such a case the tool must be moved in the opposite direction.

Thread Milling methods

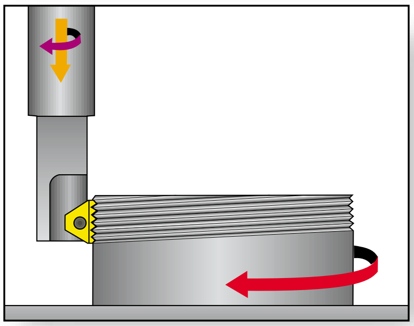
External



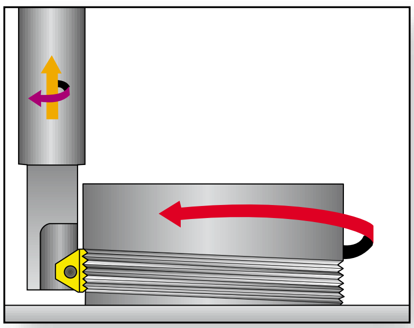
Right Hand Thread - Conventional Milling



Left Hand Thread - Conventional Milling

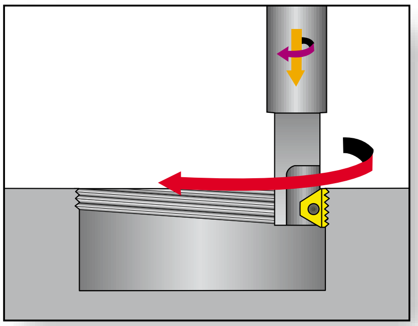


Right Hand Thread - Climb Milling

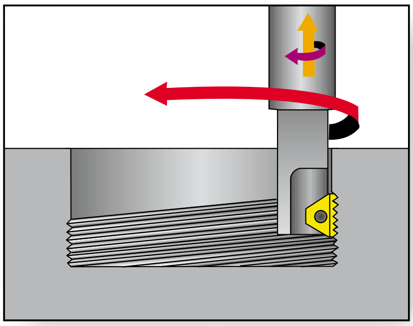


Left Hand Thread - Climb Milling

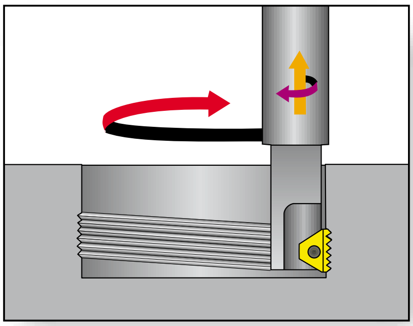
Internal



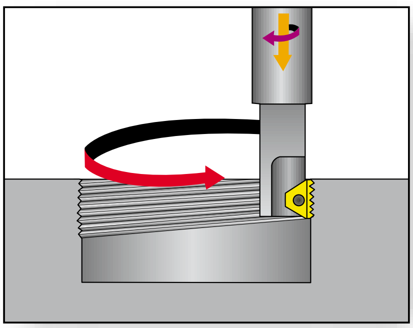
Right Hand Thread - Conventional Milling



Left Hand Thread - Conventional Milling



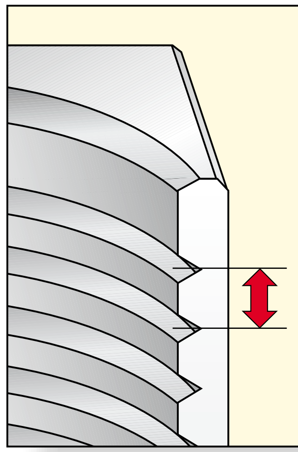
Right Hand Thread - Climb Milling



Left Hand Thread - Climb Milling

Coarse pitch threads

Internal



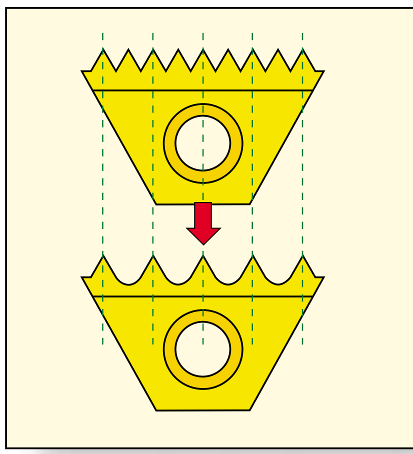
Coarse pitch threads are a combination of small thread dia. and relatively large pitches. The thread milling operation is based on three-axes simultaneous movement so the profile shape on the workpiece is not a copy of the insert profile. In other words the profile is generated and not copied which is contrary to the thread turning operation.
This fact causes a profile distortion, especially when machining coarse pitch internal threads.
The profile distortion depends on four main parameters:

- Thread dia.
- Tool cut. dia.
- Thread pitch
- Profile angle

For internal threads, as a general rule, when the ratio between cutting tool dia. (D_2) and the thread dia. (minor dia.) is below 70% the profile distortion is neglected.
Above this ratio, however, the standard inserts will not give the correct profile.
We in Vargus have developed tools which correct the profile distortion and by that give a solution for the coarse pitch threads.
The inserts are identified in the catalogue by the no. 028/... and the toolholders by the number 124/... In our new catalog, tables can be found which indicate exactly which tools to use for every standard thread.
E.g.: For M24x3.0 (coarse pitch thread) the right toolholder is TMC 25-4 124/002 + insert 4I3.0ISOTM 028/007.
But for M42x3.0 (non-coarse pitch thread) the right tool is TMC 25-5 holder + 5I3.0ISOTM2 insert.

External

In general, for external thread (such as ISO, UN, W) the profile distortion is neglected.
For small profile angle such as ACME (29 deg.) and TRAPEZ (30 deg.) every case should be examined separately.



Fine pitch threads

Fine pitch threads are threads with small pitches.
It is dificult to produce multitooth inserts for small pitches because of the small radius between the teeth.
Vargus developed inserts where every second tooth was dropped to enlarge the radius between the teeth.

Important!

- All the fine pitch inserts are partial profile type (as a result of the enlarged radius).
- Two orbits are required to complete the thread because we dropped every second tooth.

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