For Reference

Visit *https://www.hoffmann-group.com/US/en/hus/*service/downloads to download the excellent *Machining Handbook* PDF, which includes descriptions of a huge range of machining tools. The section on milling tools begins on page 242.

Upcut and Synchronous Milling

Milling processes also differ according to whether the rotational direction of the tool is the same as or opposed to the feed direction. During upcut milling, the workpiece is fed toward the tool, whereas synchronous (or "downcut") milling feeds the material away from the tool during the cut.

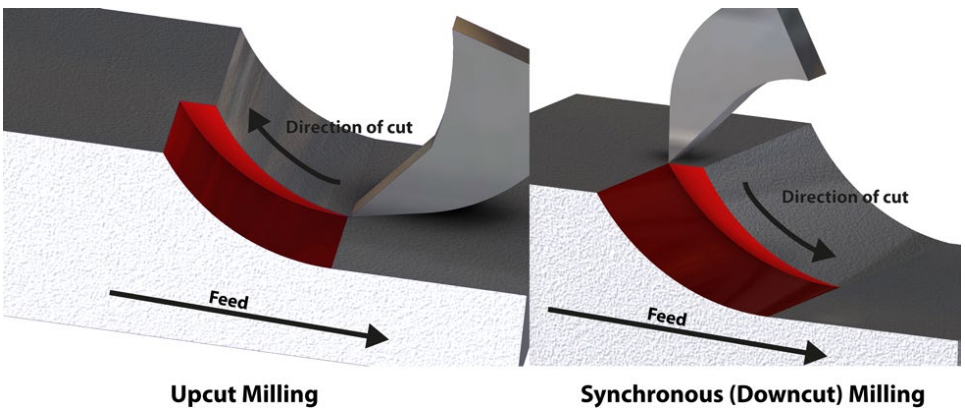

Fig. 1.13 Upcut and synchronous (downcut) milling

Upcut milling forces the workpiece toward the cutting edge, producing increased load and exerting lateral force on the cutter. These forces reach their maximum levels just before the cutting edge exits the workpiece surface. If the chip breaks at this point, the forces involved dissipate immediately, producing excessive compression of the material and an uneven cut. This quick alternation of load often causes vibrations in the tool, resulting in so-called chatter marks.

During downcut milling, the tool and workpiece move in the same direction. The force exerted by the cutter is greatest at the moment it hits the surface and decreases in the course of the cut. Lateral force is produced when the cutter enters the workpiece—i.e., the moment when the cutting edge is more or less perpendicular to the direction of feed. The cutter is under less load when it exits the cut. This reduces vibration but requires the lead screw to be virtually play-free. If this is not the case, the tool will drag the workpiece during the cut until

the play is exhausted and the tool once again enters the workpiece with a jolt. This negates the potential advantages of the downcut process.

Types of Milling Bits

Milling bits (or "cutters") are generally classed as "roughing" or "finishing." Finishing bits remove less material and provide a higher-quality finish, while roughing bits are used to quickly remove large quantities of material. These processes are equivalent to the results produced by the rough and fine files used in industrial manufacturing.

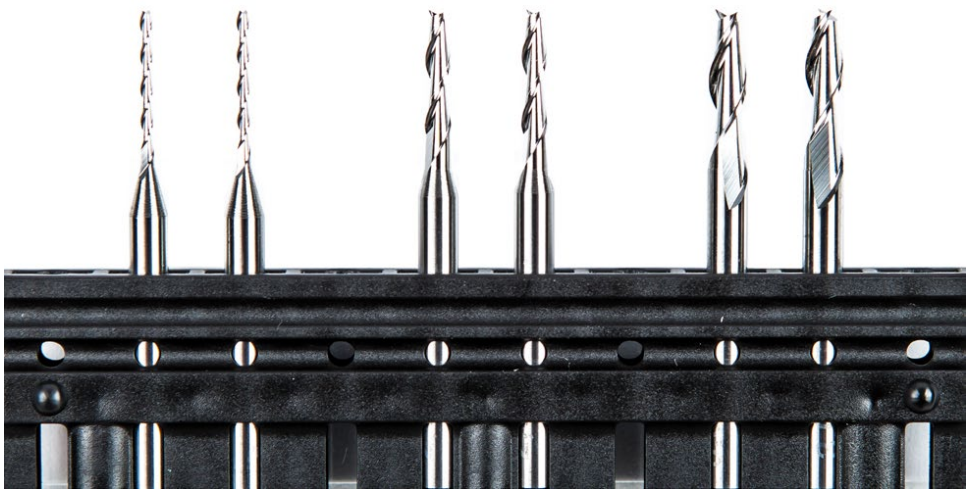

Fig. 1.14 1 mm, 2 mm, and 3 mm solid carbide fishtail bits