WAYS TO OPTIMIZE CYCLE TIME

In a series of articles, Tornos expert Marco Dolci offers detailed information on the basics of bar turning and suggests ways to optimise the cycle times on machines working with ISO-code programs.

The cycle time is the time the machine needs to produce one workpiece; it is thus a most important factor in the manufacturing world where production prices have always been under cost pressure. The faster a machine can machine parts, the more workpieces can be produced within a specific time and the higher the profit will be for the company.

Every second counts

Let’s imagine a workpiece series that must be manufactured in large-scale production for a period of one year by means of a machinery fleet consisting of 10 machines. These machines are producing 24/7, the cycle time for one workpiece is 65 seconds and the price amounts to 1 per workpiece. The maximum workshop capacity is 4,851,692 workpieces per year, which corresponds to a turnover of 4,851,692 per year. With a cycle time optimisation of just 2 seconds, the maximum production capacity and with it the turnover will rise to 5,005,714 workpieces per year or 5,005,714 per year, respectively. The 2 seconds that have been saved for each workpiece entail an additional profit of 154,022.

WORK SEQUENCE FOR THE MANUFACTURING OF A WORKPIECE

Each stage of workpiece manufacturing is equally important to reach the optimum cycle time. The definition of the operation schedule also incorporates the tool list, workpiece programming, set-up, program set-up on the machine (production of the correct workpiece) and optimisation of the cycle time by adapting the program.

OR DO YOU WANT TO DISPLAY THE CYCLE TIME?

On ISO-type Tornos machines of the latest generation, the cycle time can be displayed via the T-Mi interface (CNC screen). Simply go to the “HOME” or “PROD” page of T-Mi.
Tricks and tips

You are advised never to rely on the first cycle time only. To get a representative time, you should always wait for the second program run. It should be noted that there might be slight fluctuations between the cycles due to real-time keeping. The TISIS programming software allows the assessment of the cycle time.

Definition of the operation schedule

To achieve an optimum cycle time, operations should be performed simultaneously to a maximum degree. The intelligent establishment of the operation schedule is thus required to make sure all machine channels are utilised in the best manner. On a simple two-channel machine, it may make sense to realise the turning operations in back machining mode to ensure the best equilibrium of the machining times between the two channels.

It may be interesting to know that certain tool manufacturers offer solutions with a tool holder that is able to perform facing operations. This means that more turning operations can be performed in back machining mode, which is a clear advantage.

In the example below, we have shifted the process “Tournage 5” to the back machining operation list and could therefore save four precious seconds of the cycle time.

TOOL SELECTION

To achieve the optimum cycle time, it is important to cut down the machining times (the time the tools are effectively cutting material) as far as possible. To do so, the tools most suitable for the workpiece to be machined should be selected. When selecting tools, the tool characteristics, the coating, the rigidity of the tool holders, the number of teeth (in case of end mills) and the possibility to provide through-tool coolant supply should be taken into consideration.

Working with high-quality tooling is an important investment. If tools allow higher cutting feed rates or higher stock removal rates during roughing, the cycle times will lower the net costs for the workpieces.
**MOUNTING THE TOOLS**

The mounting of the tools is of fundamental significance for the cycle time. The following aspects should always be taken into consideration: tool geometry, cutting direction of the tools, tool scheduling (based on the process) and approximation of the tools. Now, let’s look at these aspects in detail.

**Tool geometry**

It is important to try to provide all tools of one system with the same geometry (X and Z). In this way, axis movements during tool indexing can be kept as small as possible.

**Cutting direction of the tools**

The tools (tool holders) should always have the same cutting direction. In this way, any changes of rotational direction of the cutting spindle are avoided that would otherwise be at the expense of the cycle time.

Interestingly enough, the counter-spindle always turns counterclockwise [M404] when the workpiece is clamped. This is due to the cutting direction of the cutters. And very often, we use the counter-spindle for back machining using drill bits. That means that the counter-spindle must always change its direction of rotation [M403] which may affect the cycle time. To avoid such direction reversal, it might be interesting to use left-hand drill bits.

**SELECTION OF THE MACHINING PROCESS**

It is always an interesting question whether the selected machining process is the best process in terms of cycle time. For cutting screw threads, it might make sense to consider the machining processes such as thread chasing (several passes) or thread whirling or rolling (one pass). If several faces are to be machined on the workpiece, polygon cutting might be faster than cross milling.
Tricks and tips

Tool scheduling
It is most important that the tools are arranged in the order in which they are used for machining. That means the tool that is used first must be arranged next to the second one, the tool that is used as the second one must be arranged next to the third tool and so on. In this way, unnecessary back and forth movement of the tooling system is avoided during tool indexing.

Approximation of the tools
It is most important to try to arrange the tools as close as possible to each other before they are used. This as well is intended to minimise any axis movements during tool indexing.

It should also be noted that certain tool manufacturers offer tool carriers that enable the maximum proximity between the tools. In some instances the number of tools that can be used on the machine can also be increased. This kind of tooling system delivers the additional advantage of shorter tool indexing times.
Workpiece pickup by the guide bush
Where suitable for the workpiece, Tornos offers solutions for directly picking up the workpiece with the guide bush. This avoids any part pickup by the counter-spindle and thus saves a lot of time.

Working without guide bush
Many Tornos machines can be operated without the guide bush. One of the advantages of operation without the guide bush is that the remnant length is kept short. With shorter remnant lengths, considerable material savings are possible and in addition, less bars are required for feeding. We are thus able to save time. This may be interesting for large-scale production. In the working mode without guide bush, Tornos recommends not to machine workpieces to a length that is three times larger than their diameter.

The bar material
Even the bar material used may have impact on the cycle time. Its straightness is very important and as long as a bar is perfectly straight, the productivity can be increased thanks to the fact that the longer the bar, the less often a new bar must be fed. Profilled bar material can be used as well to achieve cycle time optimisation. With a hexagon bar, time-consuming machining processes may be avoided. Nowadays, it is rather easy to find profiled bar material as well as collets and guide bushes for special bar profiles. The machining of tubes may be interesting as well. This is because hole drilling processes can be avoided and the amount of cutting can be reduced because the tube does not need to be cut down to the center of the material.

High-pressure pump
Tornos offers various high-pressure (HP) pump solutions. As far as the cycle times are concerned, these HP pumps are interesting for two reasons: they permit better chip discharge and better heat dissipation. This often brings about a slight increase of the cutting feed rates. Thanks to the better chip discharge, machine stops for manual chip removal are avoided.

Part machining the other way round
Did you ever think about machining a workpiece in the reverse direction? Or to be more precise, did you ever think about back machining the part of the workpiece that is normally machined by front machining and vice-versa? Such considerations are often interesting. Sometimes, you can even gain time. It may also be interesting to know that certain tool manufacturers offer solutions with tool holders that are able to perform facing operations. This means that more turning operations can be performed in back machining mode and this is a clear advantage.

Optional machine warm-up function
Tornos offers an optional machine warm-up function for highly precise workpieces. With this function, the machine can automatically be started at a pre-determined date and time without material having been loaded. Idle times for reaching the correct operation temperature are thus avoided.

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<td>Without preheating</td>
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In the next edition of the decomagazine, Marco Dolci will present possibilities to optimise the machining process by suitable tool indexing, approach and retraction and by simultaneous machining. Later, he will explain more programming tricks that allow time savings.