HIGH SPEED MACHINING

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Machining with high speeds (HSM) is one of the modern technologies, which in comparison with conventional cutting enables to increase efficiency, accuracy and quality of work pieces and at the same time to decrease costs and machining time.

Even though High Speed Machining is known for a long time (first tries were made in early twenties of the past century) there are still a lot of questions and less or more complicated definitions of HSM.
The first definition of HSM was proposed by Carl Salomon in 1931. He has assumed that at a certain cutting speed which is 5 –10 times higher then in conventional machining.
Definition

- High cutting speed machining
- High rotational speed machining
- High feed machining
- High speed and feed machining
- High productive machining

Finally,

“HSM is a powerful machining method that combines high feed rates with high spindle speeds, specific tools and specific tool motion.”
Fig. 1 High-speed cutting ranges in machining of various materials [3]
High Speed Machining

- **What is it?**
  - Very high tool rpm, small depths of cut and high feed rates
  - Mostly used in milling hard mold and die steels (hence the term “hard milling”)

![Image of a part being machined]
High Speed Machining

- **Value**
  - Maximizes overall productivity – fewer process steps, faster machining
  - Machining Mold and Dies made of very hard materials, deep cavities and fine details typically require time consuming EDM processes.
  - HSM produces high quality finish on milling machine – reduces need for EDM electrodes and hand finishing

- **Challenges**
  - How to drive HSM machines to capacity without breaking tools
  - Tool makers cutting data ranges are highly optimistic
HSM - Truth and Myths

“You do not need NURBS anymore.”

“The controller runs better with more data.”

“When the machine choking and jerks, reduce the number of points by lowering the tolerance.”

“Increase the amount of stock being cut if the finish is dull.”

“Tool must be constantly engaged with blank.”

“The tool path must be tangential everywhere.”

“Always use ball end mill.”

“Never cut with the bottom of the ball end mill.”
Demands On The Machine

- Spindle speed range \( \leq 40000 \text{ rpm} \)
- Spindle power >22 KW
- Programmable feed rate 40-60 m/min
- Rapid travels <90 m/min
- High thermal stability and rigidity in spindle
- Coolant through spindle
- Advanced look ahead function in the CNC
<table>
<thead>
<tr>
<th>Conventional</th>
<th>HSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>The contact time between tool and work is large</td>
<td>Contact time is short</td>
</tr>
<tr>
<td>Less accurate work piece</td>
<td>More accurate work piece</td>
</tr>
<tr>
<td>Cutting force is large</td>
<td>Cutting force is low</td>
</tr>
<tr>
<td>Low surface finish</td>
<td>High surface finish</td>
</tr>
<tr>
<td>Material removal rate is low</td>
<td>Material removal rate is high</td>
</tr>
<tr>
<td>Cutting fluid is required</td>
<td>Cutting fluid is not required</td>
</tr>
<tr>
<td>Material removal rate high</td>
<td>Material removal rate is low</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Dimensional tolerance 0.02 mm</td>
<td>Dim tolerance 0.1 - 0.2 mm</td>
</tr>
<tr>
<td>There is no need of making cutting tool according to the contour to be machined</td>
<td>Cutting tool has to be made according to the contour to be machined</td>
</tr>
</tbody>
</table>
Advantages

- High material removal rate
- High surface finish
- Increased productivity
- Possibility of machining of very thin walls
- Reduction in lead times
- Low cutting force
- Cutting tool and work piece temperature are kept low
- Connection time between the cutting edge and work piece is short
- It eliminates the need of coolant
- Reduction of production process
Disadvantages

- High speed machines are more expensive as than manually operated machines.
- Tools used for high speed machines are quite costly.
- A part of machine which includes machine and tooling are expensive and requires extensive justifications.
- Repairing is expensive too.
- High speed machines do not eliminate all the error.
- Internal shapes cannot be machined in High speed machining.
- Size limitations depend on the size of machine.
Applications

- Industry which deals with the machining of Al to produce automotive components, small computer parts or medical devices.

- Used to machine such parts as die casting dies, forging dies, injection moulds and blow moulds, milling of electrodes in graphite and copper, modeling and prototyping of dies and moulds.

- Die mould industry which requires dealing with finishing of hard materials.
Case Study-HSM on Connecting Rod Die

- Improved In-process work-piece performance
- Automatic cut levels in cavity milling
- New Z-level Plus path to contour floors while roughing
- Trochoidal cutting to avoid over-embedding tool
- Holder checking for multiple tools

<table>
<thead>
<tr>
<th>Measurement</th>
<th>NX2</th>
<th>NX3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations required</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Rest mill path</td>
<td>4:30</td>
<td>1:30</td>
</tr>
<tr>
<td>generation time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Programming</td>
<td>6 hr</td>
<td>2 hr</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

- HSM is not simply high cutting speed. It should be regarded as a process where the operations are performed with very specific methods and precision equipment.
- HSM is performed in finishing in hardened steel with high speeds and high feeds often with 4-6 times conventional cutting speeds.
- HSM is high productive machining in small sized components in roughing to finishing and in finishing to super finishing in components of all sizes.
- Improvement of quality and optimization of cost.
WEBSITE REFERENCE

• UGS PLM Software
  http://www.plm.automation.siemens.com
• Vibrafree.com
  http://www.vibrafree.com/UHSHM/UHSHM.htm

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Thank you