Anomalies in the use of hobs and solutions

Errors generated on the workpiece, excessive hob wear or the breakage of teeth are things which in theory should not occur but which in reality are common place on the shop floor.
Identifying the cause of excessive wear or of breakage is not easy and these problems often remain unresolved unless a great deal of time and resources are spent on an in depth manufacturing analysis of the tool and the machine.
Generally it is easier to find the cause of unusual errors on the hobbed workpiece.
In this article the anomalies that may arise during hobbing are summarised and possible causes and remedies are given.
The causes of error on a gear or on a hob which performs poorly may be due to:

- *Hob design;*
- *Hob manufacture;*
- *Maintenance of the hob;*
- *How the hob is used.*

Each of these points has already been examined in depth in the previous chapters and therefore it is sufficient to simply list the problems that might arise so as to identify what kind of in depth analysis is required.
Also, only the possible causes of error or poor performance are listed. Those which are due to the actual hobbing process itself, and which are therefore perfectly foreseeable, have not been included.
An example of a foreseeable error is the lead errors that are generated by the hob feed (groove marks) or profile errors generated by the enveloping of the teeth.

Problems with the hob

a)- Excessive wear on the whole hob.

This may be caused by the following:

- Hardness level of the hob is lower than what it should be.
- Hardness level of the workpiece is higher than what it should be.
- Cutting speed and feed speed inappropriate for the material of the hob and the material of the gear.
- An excessive number of workpieces has been cut.
- Resharpening has not been carried out properly i.e. with too many passes or with an unsuitable grinding wheel i.e. the teeth have undergone excessive heating which has modified the structure of the steel.
- Masked chipping: in this case the hardness level of the hob is probably too high.
- If the hob is TiN coated, it may be that the coating layer has not properly adhered to the tool. In this case, apart from the actual wear, the TiN film will also peel off.
- Problems with the coolant. Check that the oil flow reaches the work area correctly and that it is not interrupted. Also it is necessary to check that the oil has not lost its original properties or deteriorated.

b)- Excessive wear on a row of teeth in a longitudinal direction.

In general this anomaly is found on new hobs although it is rare and it is caused by faulty manufacturing and more precisely:

- Hardness level lower than normal on one or two rows of teeth
- The hob is completely off centre; in this case, however, there would be a very excessive indexing error on the workpiece produced.

- The cause may be attributed to the TiN coating which might not have adhered properly to a row of teeth (the hob may not have been cleaned properly during the TiN coating phase). This hypothesis is, however, very unlikely since hobs are washed with automatic equipment and they are rotated inside the coating oven so that the whole hob is coated uniformly.

c)- Excessive wear on a row of teeth in a circumferencial direction.

This type of wear is often to be found and it may be caused by:

- A workpiece which is much harder than normal or which has some kind of inclusion.
- Hob axial shifting at the end of each hobbed workpiece has not occurred.
- The hob has come into contact with some hardened part of equipment during set up.
- Sometimes wear may be particularly evident on one of the hob teeth and then it gradually decreases along the whole circumference of the thread. This is typical of incorrect shifting.

d)- Excessive wear on one tooth flank.

- This particular type of wear is frequently found on hobs with protuberance. If this type of hob is used to cut gears with a small number of teeth, there will be more wear in the area of protuberance where the hob comes into contact with the workpiece.
- This type of wear is more likely to occur on hobs which have a large helix angle with axial gashes (not helicoidal).
- It may also depend on whether the hob has been correctly positioned on the machine. In fact, if the inclination angle of the hob axis is not exact, there will be a reduction in the relief angle on one flank which in serious cases may even lead to the hob tooth flank rubbing against the workpiece.

e)- Breakage of one or more non-consecutive teeth

- In general this type of breakage is a result of cracks caused by bad resharpening. In fact if too much stock is removed per each pass during resharpening or if the grinding wheel is unsuitable for the job, the teeth may endure excessive heating which causes internal stress and may result in cracking. In general breakage of this kind is easy to identify since it often occurs during the resharpening operation itself and also because it occurs on non-consecutive teeth. The tooth usually breaks off cleanly without leaving any remaining material at the breakage point unlike with other types of tooth breakage. This type of breakage does not usually occur until the hob has worked for about 60 - 70 % of its life.

f)- Breakage of many consecutive teeth

This type of wear may have many causes:

- The hob has come to the end of its life i.e. the tooth section is so worn that it cannot bear the cutting force.
- Accidents in the machine such as: feed without the hob rotational motion and start of rotation when the hob has already partially penetrated the workpiece; breakage of the spindle or of the workpiece clamps or bad workpiece clamping due to insufficient pressure; the workpiece has an increased outside diameter.
- A workpiece with a much higher hardness level than foreseen has been cut.
- Collision with other equipment during set up
- If a tooth breaks off because of cracking, it may cause a chain reaction and the consecutive teeth may break off since the broken teeth are pushed against the surface of the gear to be cut by the efficient teeth. In this case it is almost always possible to identify the tooth that broke off first because of the cracks.

➢ Blockage of chips in the grooves. In general it is possible to identify grooves which have been blocked by chips even on a broken hob. (see fig. No.1)

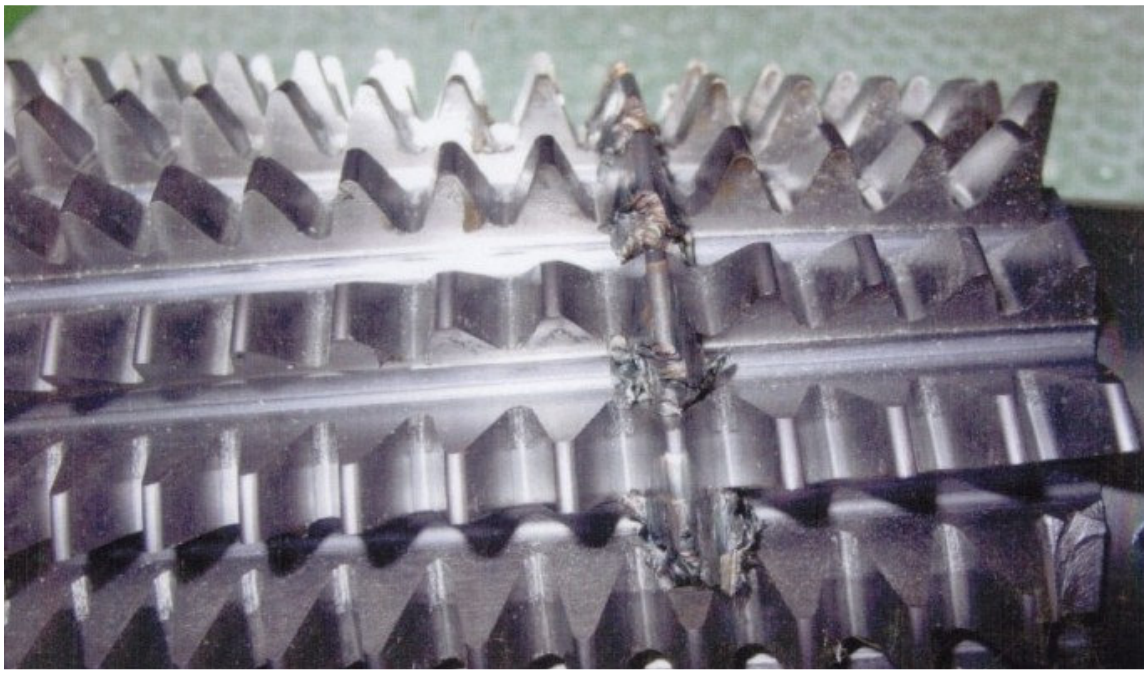

Figure No.1

g)- *Complete breakage of the ho*b.
The figure No. 2 shown a carbide hob broken because different thermal coefficient between hob and clamping device.

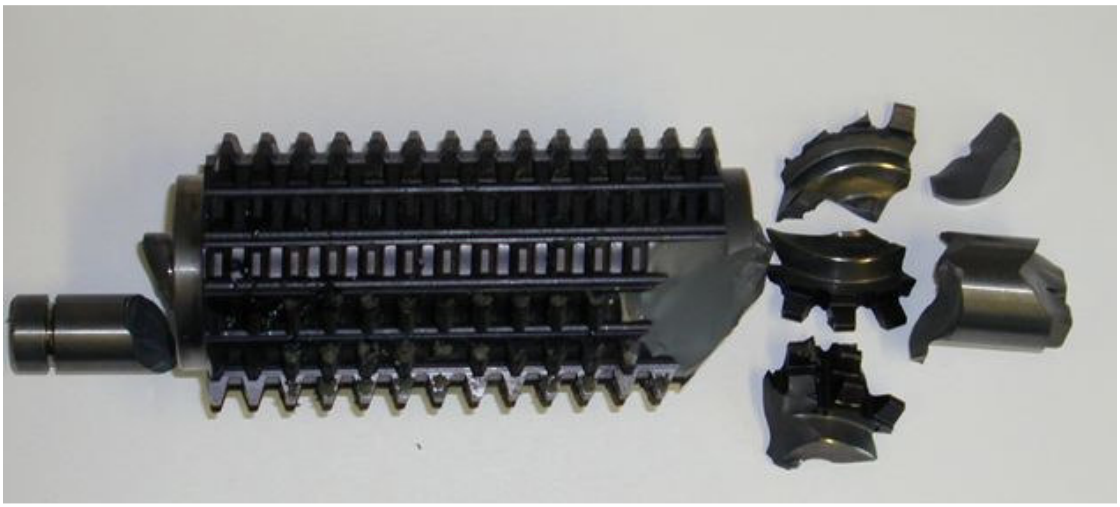

Figure No.2

Problems with the gear
a)- Very bad profile error
➢ Bad indexing of the gashes. It is necessary to check this parameter carefully after resharpening.

- Excessive hob run out during machining. It may be caused by hob run out (manufacturing error or bad resharpening) or more frequently, by bad mounting of the hob on the machine.
- Incorrect thread angle. This is a very rare error.
- Axial backlash of the hob spindle.

b)- Pressure angle error

- Resharpening error on the back relief angle (cutting angle). It is necessary to check that the grinding wheel is positioned correctly on the axis when relieving at 0°. If the rake angle is different from zero, it is necessary to measure the amount by which the wheel is off centre.
- Error in the hob pressure angle. This is a manufacturing error which occurs very rarely.
- Error in mounting the gear. The run out of the workpiece and the perpendicularity of the faces to the bore must be checked.
- It may also be that the error is not true but depends on an incorrect reading of the inspection equipment or on bad mounting of the workpiece on this equipment.

c)- Erred tooth chamfers

- As in the previous case, the back relief angle may be erred. Check the resharpening angle.
- Error on the tooth thickness of the gear. If the thickness is too low, the chamfer is too big and vice versa. This is a very frequent error.
- Gear has an outside diameter which is out of tolerance.
- Hob mounted with an incorrect inclination angle. Check the helix angle of the gear and that of the hob.
- The start of semitopping on the hob is wrong. This may occur when cutting a gear which has a different number of teeth to those for which the hob was designed.

d)- Tooth surface in a bad state

- Excessive hob wear. It is necessary to replace the hob.
- Cutting oil inadequate. Check that the flow is sufficient enough and that the oil has not deteriorated. Use oil with anti-adhesion and Extreme Pressure additives.
- The material to be cut has different characteristics to those at the beginning of manufacturing