



Machining Master Class

Horn triumphs over exotic alloys for PWA

Substitution of a machining process using a Horn Type 382 grooving/slotting cutter with Type 314 grooving inserts has reduced machining time on certain components from around 100 hours to 44 hours at PWA International Ltd., Rathcoole, near Dublin. The cutter is used to machine internal slots at the third and fourth stage positions on low pressure turbine casing repair sections manufactured in Inconel 901, Inconel 718 or Waspalloy. On a prior operation within the same cell, which is carried out on a vertical boring machine, application of Horn 312 type grooving inserts has improved cycle times, on reprofiling of re-metalled features, by about 50 per cent. This has been achieved through improved wear resistance of the Horn inserts, allowing sustained use of much higher speeds than the previous tooling regime.

PWA International is a leading specialist in the field of reconditioning major jet engine components produced by parent company Pratt & Whitney for use on civil airliners. Low pressure turbine casings vary in size up to around 70 inches maximum diameter and are not unlike a large metal bowl in shape. These are constructed by welding a number of rings together. On the inner surface there are a large number of annular ribs; these stiffen the main structure but their primary purpose, once they are machined with slots and holes, is to provide the means of locating internal engine components such as nozzle and stator vanes.

Hugh Kavanagh, PWA product support engineer explains. "In service the inside of the engine is subject to high temperatures and the passage of corrosive gases while the cycle of expansion and contraction when the engine is running and idle causes fatigue. Over time this causes deterioration of the internal features and all engine manufacturers specify periodic service intervals when major overhaul becomes necessary."



A wide range of repair procedures are available to PWA, in accordance with the manufacturer's manual for the engine. In some cases a patch repair can be welded on. In many cases a complete ring section is cut out and an entire new section is welded in using electron beam welding. Another procedure is to rebuild worn sections by plasma spray application of new metal. In all cases the repaired area is stress relieved to bring the assembly to a consistent metallurgical condition. The case is then re-machined before being returned to the engine rebuilder for assembly.

Mr Kavanagh noted. "Tooling development is an important aspect of our activities as it allows us to maximise the performance of our machine tools."

The machining process is complicated by the fact that the materials being machined are at the exotic end of the range while the components, though large, are also fairly delicate. On the slotting operation, which is carried out on a rotary indexing table on a large horizontal boring machine, dozens of slots up to one inch deep are machined in the ribs.

"We used to machine these using an alternative make of cutter," said Mr Kavanagh. "It was OK from the standpoint of accuracy the operation took a very long time - typically 100 hours. Around 95 per cent of casings that we handle need this operation so it was identifiable as a major bottleneck in the reconditioning process."



The solution was provided by Horn UK, who were brought in by Dublin-based Flatley Engineering, distributors for Horn tooling in Ireland. Horn worked with PWA to optimise feeds and speeds for the process. It uses a Type 382 disc-type groove milling cutter of 160 mm diameter having a double row of eight inserts to give 15.5 mm overall width with 16 cutting edges.

These are provided by Horn 314 grooving inserts, each of which has three indexable cutting edges. The diameter of the tool allows relatively high machining speeds to be achieved, while the Horn insert/toolholder combination allows much higher feeds and speeds to be sustained, for much higher rates of stock removal.

"The Horn tooling has made a major impact on the slotting milling operation and the applicable costs," Mr Kavanagh reports. "Our capacity to complete slot machining has effectively been doubled by a relatively straightforward alteration to the machining route. Throughput of these components is now much quicker as the bottleneck has been unplugged. Indeed the success of this exercise led us to examine where else we could achieve savings using Horn tooling."



The next candidate application turned out to be a close tolerance vertical boring operation within the same cell as the slotting application. The principal activity on the vertical machines is re-machining of internal lips and grooves following welding repair to build up wear areas. This is close tolerance work with lip thickness, groove width and groove depth needing to be held to 0.004 inches. Moreover when the existing features have been re-metalled the ribs are already slotted so there is a high proportion of interrupted cut work.

"The latest cases are manufactured from Waspalloy which is exceptionally difficult to machine," Mr Kavanagh added. "Material hardness is around HRc 43/46 on the case and HRc 30 on the weld metal. With the old tooling machining performance was poor as both speed and depth of cut were low and insert breakage was common."

Tooling development work was completed by Flatley, working with PWA personnel. In this instance Horn 312 inserts offered a straight swap from the previous tooling, allowing continued use of existing cartridge-type tool holders.

"Performance is much improved," Mr Kavanagh confirmed. "In addition tooling costs have reduced due to it not being necessary to replace the tips with the same frequency. Depending on the extent of the repairs carried out to an individual casing we can be looking at between 16 and 30 hours of machining time on the VTLs. Use of Horn tooling means this is around half the time that we needed previously. Moreover the cycle time is predictable - which it wasn't before - so we can plan our machining throughput with much more confidence."

