Tearing up the rule book

What do you do when you’ve originated a revolutionary grinding process? Do the same again by undertaking empirical development to generate new processes, as Andrew Allcock reports

Raysun is housed in a newish, small industrial unit on Rugby’s Triton Park, Swift Valley Industrial Estate much like its neighbours. Only the company’s full name - Raysun Innovative Design – gives a clue to the, quite literally, cutting-edge thinking that occurs within.

This 10-man company has originated a process for the grinding of titanium which goes well beyond the existing low-volume metal removal, finish grinding processes that already existed. The new process – christened DIATI 50 (DIAmond grinding of TItanium) – has a Qw value of 50: that is, it can remove up to 50 mm^3/mm/sec. Existing processes have a Qw value well below that.

So how and why has the company arrived at yet another revolutionary grinding process? Once again, it is related to the control of coolant supply, just as it was with the Viper (Very Impressive Performance Effective Removal) and subsequent Viper upgrade process, Viper + (see box item).

Although Viper was the first of its activities to hit the headlines, it was not Raysun’s first foray into grinding process development. The company’s creation 10 years ago was based on a perceived need to deliver process engineering, fixturing and coolant systems alongside Tyrolit grinding wheel technology, and so aid the sale of Tyrolit grinding wheels.

One of the three Ray brothers, Charles Ray, works in field technical sales for Tyrolit and it was he that saw this need, within Rolls-Royce, where there was a tension between grinding wheel performance and grinding process conditions, specifically in the area of coolant control.

The process in question was the grinding of nickel alloy nozzle guide vanes using large diameter (4/500 mm) vitrified wheels having dressed forms on traditional creep-feed grinding machines. Flood coolant was directed at the wheels, but it was not a precisely controlled application of coolant.

Charles brought in brother Steve, who at the time was employed as a design engineer at a special-purpose machine manufacturer, to take a look. Unencumbered by traditional grinding thinking, he came up with a manifold nozzle system that directed all coolant onto only the wheel feature that was currently working, with the system switching between nozzles and features as required. Rolls-Royce’s No 3 shop in Bristol was subsequently kitted out with this system, which laid the foundations of what is now Raysun.

CREATING NEW RULES

Having achieved this success, Rolls-Royce’s MANTECH operation and Tyrolit went looking for other improvements, particularly on fixturing concepts for turbine blades, and Raysun/Tyrolit were set to work on these. About seven years ago, with credentials established, Rolls-Royce funded the development of what became Viper grinding – the use of small diameter vitrified wheels dressed by diamond rolls to support creep-feed grinding on machining centres, plus programmable coolant nozzle and high pressure delivery – Makino and, subsequently, Bridgeport.

So six years ago, Raysun moved into its current building as Rolls-Royce started to install 10 Makino/Viper machines at its brand new high pressure turbine blade facility at Derby (see Machinery, 21 May, page 10). To date, some 50 to 60 Viper installations have been made, with these split pretty evenly between Makino and Bridgeport machining centres. Tyrolit supplies the wheels and diamond dressers and frontline applications support.

But the Viper/Viper + process, which Rolls-Royce owns the rights, is only applicable to hot engine parts. In the cold part of the engine, titanium is used. But titanium is a a sticky, gummy, soft, ductile material. “The old technology for producing titanium dovetail forms was large broaching machines and now more
often milling. But everybody in the aerospace industry was saying ‘you can grind nickel, surely you can grind titanium,’ explains director Anthony Ray. “People have tried and there are patents for grinding processes, but the $Q_w$ value is just 2 or 3. That’s just a 20th of what Viper grinding delivers in nickel. It’s a finishing process only.”

So with the need a given, Raysun moved ahead on its own account, with Tyrolit support and encouragement. But this time the research was based around the use of undressable superabrasive, diamond-plated wheels.

Because of that, it was imperative the machine be thermally stable. So, the 5-axis Hermle C800U (superseded by C40) with its granite structure, elevated slideways outside the working area, good access above the spindle for coolant delivery-related modifications, high spindle speed and power, plus large trunnion-type table and the right CNC (Heidenhain 530) was selected as the perfect candidate. And the machine tool builder provided a machine to support development at Raysun.

DIATI 50 makes use of externally and internally delivered coolant, the latter exiting through the wheel via holes in the periphery. Furthermore, exit can be controlled to one of four quadrants – once again directing coolant at the working part of the wheel as was the case in its very first improvement process. DIATI 50 is a two-stage process involving a roughing wheel and a finishing wheel, and can reducing milling cycle times by up to 30 per cent. “The biggest development has been to get a wheel that was stable and which could be manufactured and plated,” offers Steve Ray. With wheels operating at up to 120 m/sec, dimensional stability was a key area to establish and a number of different designs were tested before the current concept was adopted. The lead-time to make and plate wheels has governed the speed of development. The second major area of development has been the software to control the coolant delivery system. All along the company has made sure that the metallurgy of the produced parts is as it should be.

SECRET OF SUCCESS
Raysun is reticent to reveal exact parameters. The process is patented and covers both wheel design, particularly as it relates to internal coolant delivery, and process parameters. But in the case of the latter, only a range is specified, with the exact process parameters for a given situation the very heart of the process’ secret of success. And with an aerospace market potential at least as big as that for Viper, Raysun understandably wants to fully benefit from its efforts and its £100,000-plus investment. In fact, the process will also work for other difficult-to-grind materials such as ceramics, carbides and glass. A package based around a Hermle C40 is expected to be between £350,000 to £400,000.

A demonstration, involving the production of hundreds of parts, took place last month with a company that wants to move away from broaching. Other interested parties are looking to move away from milling.