

Spark of genius

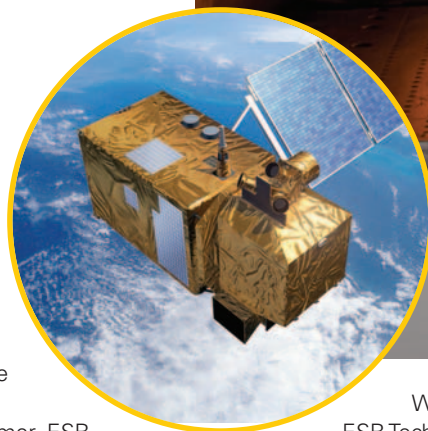
Steed Webzell recently headed north to hear the story of B-Tek Precision Engineering, a small but ambitious EDM shop playing a critical role in a major space programme

Machining projects for space programmes are the preserve of established, large manufacturing companies, backed by shareholder investment and endless streams of quality accreditations, right? Well, no actually. If a machine shop can demonstrate problem-solving know-how, capable technology and on-time delivery, the door to the space sector is wide open.

This is ably shown by Sheffield-based B-Tek Precision Engineering, a three-man business formed in early 2011 and which has just completed the machining of tolerance-critical hardware, destined for use on the European Space Agency's (ESA) Sentinel-2A earth observation spacecraft, due for launch in 2013 (see

box, p16). It's one of a number of projects within the European Commission's GMES (Global Monitoring for Environment and Security) programme for which ESA has responsibility.

The parts in question, structures for Bearing Active Preload Systems (BAPS) developed by B-Tek's customer, ESR Technology Ltd – part of Hyder Consulting Group – were wire and spark-eroded from solid titanium to tolerances of, in some cases, ± 2 μ m. Total on-machine time for each part was around 200 hours.



Warrington-based ESR Technology operates the European Space Tribology Laboratory (ESTL) – ESA's established centre of excellence for tribology – the science and technology of interacting surfaces in relative motion. Tribology includes the important factors of

Perceived gap in the market underpins expansion plans

B-Tek Precision Engineering is the result of bringing together the assets of two EDM subcontract businesses, namely Pro-Spark Ltd and Ace Industrial Ltd. In total, there's £440,000 worth of investment in three wire EDM machines, which is in addition to spark erosion and EDM hole technology. But, from small origins, this ISO9001:2000-accredited company has big plans.

"We've spotted a gap in the market for a high service level EDM company – already we've made big inroads into the oil and gas sector to complement our success in the space industry," says Mr Sitek, who considers himself more a professional investor than the MD of B-Tek.

The upshot is that he wants to open a national network of pure subcontract EDM shops. Already the company has acquired a second facility in Leeds, which will be open for business in the coming weeks, and Mr Sitek is actively seeking further investment opportunities in the form of assets or companies – distressed or

otherwise – to help develop his vision of a UK chain of EDM branches to support local industry. Birmingham has been identified as a potential location for the third B-Tek facility.

"Leeds will be our head office and centre of excellence," says Mr Sitek. "However, we will retain both Leeds and Sheffield moving forward – 90% of our existing customers are in the 'S' postcode and they like us being local.

"The time is right to grow now," he adds. "The UK is manufacturing its way out of recession and we're seeing more work return to these shores, as locations such as China become more expensive. We have a meticulously planned strategy that will see us achieve rapid growth as a pure subcontract EDM shop, charging for labour and machine hours, but selling not just on competitive prices, but on service and quality. We were in the black after just four months of trading and we're actively taking market share – we want to be the best in the country at EDM, bar none."





Steve Batt, operations director, left, with B-Tek managing director/owner Tony Sitek holding a synchro-ring – Far left, Sentinel-2



The right machines and deep EDM process knowledge were critical to the success of the venture – B-Tek has demonstrated both

lubrication, friction and wear, which impact on the efficiency, reliability and performance of many industrial machines and processes operating in the vacuum environment of space. Over the past 39 years, ESTL has been involved in virtually every major European space programme, with no known failures in orbit.

Most spacecraft have a common problem in rapidly and reliably transmitting the truly massive amount of data gathered, either to other spacecraft or to ground stations. To help combat this, Sentinel-2A will offer a very high resolution capability and carry an optical communications terminal consisting of a laser device and very precisely directed mirrors. The laser device can transmit Sentinel-2A's data at a rate equivalent to 20 million pages of A4 text or 700 DVDs per hour. However, it simultaneously needs to accurately point and track the receiver, which may be a spacecraft or ground station thousands of kilometres away. This task is deemed by ESR as the equivalent to shining a laser beam from London to New York and hitting a target the size of an aircraft window.

ESR Technology's patented hardware,

BAPS, provides the solution. It enables the ball bearings that support the mirrors attached to the laser devices to run smoothly and with insensitivity to thermal gradients during the mission, yet demonstrate suitable high pre-load and stiffness to protect the super-precise bearings against vibrations at launch.

FLEXIBLE CONNECTION

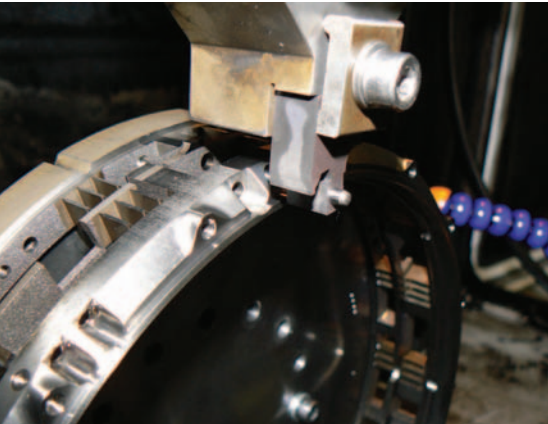
BAPS essentially consists of three rings: upper and lower thrust rings and a central 'synchro-ring'. This middle ring is connected to the thrust rings via flexible 'flex-struts', which, at their thinnest point, are roughly the thickness of a human hair. Rotation of the synchro-ring causes slight axial deflection of the thrust rings, producing pre-load of 4,000-5,000 N for launch, protecting the bearing surfaces and lubrication against vibration. When in orbit, the device is able to switch to low pre-load for smooth operation. The controlled tolerance of ± 2 micron achieved by B-Tek on the flex-struts is vital to ensure the correct levels of pre-load are attained – too thick or too thin presents negative effects.

"The story of finding a capable EDM

shop to supply the structures for BAPS dates back some time," admits Simon Lewis, ESTL's product manager for mechanisms. "We had some initial machining attempts at another UK subcontractor that proved both slow and expensive. After extending our search globally, we discovered many potential suppliers didn't enjoy the pressure exerted by our precision/quality demands. We even attempted manufacture with a fully space-experienced subcontractor in California, but they were forced to admit defeat and gave up after five months.

"By chance, B-Tek was recommended to us and we liked what we heard – it was evident their knowledge level was over and beyond what we'd found elsewhere. Any project is only as good as the team assembled, and B-Tek has certainly become vital to this one."

With a commitment to give things a shot, B-Tek undertook machining the two highly complex structures required for BAPS. Supplied as blanks of Ti6Al4V titanium alloy (approximately 200 mm diameter) with only a hole pattern to start wire erosion, the first operation was to



B-Tek made fixturing to support manufacture

wire-erode the 96 ultra-thin flex-struts using an AC Progress VP4 machine from Agie Charmilles (02476 538666). Indexing around the component using special fixturing developed by B-Tek, it took seven passes across the face of each flex-strut to achieve the $\pm 2 \mu\text{m}$ tolerance.

"Once we'd established the correct offset and completed the first flex-strut, the process repeated every time on the VP4," explains Steve Batt, B-Tek's operations director. "The fixtures are vital and need to be flat to within 12 μm over their entire area, as well as being square to the base of the machine."

According to ESR, a previous subcontractor had attempted to produce the entire part using only wire EDM, predominantly with a 'turn and burn' strategy, but this was taking far too long. B-Tek had a different approach, moving the parts to an AgieCharmilles Form 30 die-sink EDM (modified to take parts up to 1,000 mm diameter) to produce 96 'windows', before producing smaller slots – all using electrodes specially developed by B-Tek, comprising 30% copper and 70% graphite. The parts were then returned to the wire EDM for the production of eight final slots. In total, there were 192 operations on each structure, commanding a machining time of around 200 hours (60% spark erosion, 40% wire). Furthermore, due to ESR only discovering B-Tek late in the programme, schedule pressures demanded 24-hour machine operations at Sheffield.

SUCCESSFUL COLLABORATION

The successfully machined structures supplied by B-Tek have now been assembled and tested by ESR and moved up the supply chain, which is fairly extensive, to say the least. After departing from Warrington, further partners in the Sentinel-2A project are: Swiss technology group RUAG Space,

which produces the optical communications terminal; specialist telemetry company and system integrator Tesat Spacecom GmbH; DLR, Germany's national research centre for aeronautics and space; Astrium GmbH, the prime contractor and a subsidiary of EADS; and, finally, the European Space Agency (ESA), which manages the programme on behalf of the EU.

"The collaboration that has produced this hardware is an excellent example of a successful partnership between a small and innovative manufacturing company and an established space technology developer and the extended supply chain," says a proud Tony Sitek, B-Tek's managing director. "We may only be a small EDM shop in Sheffield, but we have good kit and, arguably, the best EDM engineer in the UK [Steve Batt – 32 years' EDM experience]. We are both small enough to offer the flexibility needed to respond to customer needs rapidly, yet large enough to provide leading-edge technology and capacity, whenever required, and be absolutely dependable as a supplier. We've proved we can achieve an extremely high level of precision and this project emphasises the importance of our contribution to the whole European community." □

Keeping an eye on the Earth

The pair of Sentinel-2 satellites will routinely deliver high resolution optical images globally (10–20 m), providing enhanced continuity of SPOT and Landsat-type data. Since 1972, Landsat satellites have collected information about Earth from space. Landsat sensors have a moderate spatial-resolution – you cannot see individual houses on a Landsat image, but you can see large man-made objects, such as highways. SPOT colour satellite images, however, capture geographical information at a resolution of 2.5 m.

The Sentinel-2 mission will also offer more frequent visits than current systems. The satellites will orbit at a mean altitude of approximately 800 km and, with the pair of satellites in operation, will have a location revisit time of five days at the equator (under cloud-free conditions) and 2-3 days at mid-latitudes. By comparison, the US Landsat-7 has 16-day revisits and Spot 26-day revisits, and neither provides systematic coverage of land.



Data from Sentinel-2 will benefit services associated with, for example, land management by European and national institutes, the agricultural industry and forestry, as well as disaster control and humanitarian relief operations. Images of floods, volcanic eruptions and landslides will also be acquired by Sentinel-2.

Find out more about Sentinel-2 here
http://www.esa.int/esapub/bulletin/bulletin131/bul131b_martimort.pdf