Renishaw Stonehouse – common sense manufacturing

“Nothing astonishes men so much as common sense.” – wrote Ralph Waldo Emerson in his essay ‘Art’, more than one hundred years before the Japanese were credited with introducing the concept of common sense to the ‘art’ of manufacturing.

Common sense was also the inspiration behind Renishaw’s new Stonehouse machining facility, which astonishes the visitor with a simplicity and pragmatism that, despite Japan’s example, is still uncommon amongst western manufacturers.

In September 2004, Renishaw purchased a capacious factory near Stroud, Gloucestershire for £5million with the eventual aim of moving most of its machining operations from its well-known New Mills headquarters in Wotton-under-Edge, Gloucestershire. Two years later and with a further investment of £2.5million, Renishaw’s Stonehouse factory is fully operational. The transformation from bare shell to what is arguably one of the UK’s most efficient precision-engineering operations, is a story of innovation and vision.

“We started with two simple objectives,” says Gareth Hankins, Renishaw’s General Manager for the Manufacturing Services Division (MSD), “to build one of the best machine shops in the world and to be as self-sufficient as possible; to have everything we need within these four walls.”

Before Stonehouse, Renishaw’s plan was to site the majority of its manufacturing operations in Woodchester, 4 miles away, in a refurbished portal frame building purchased a few years previously.

The new 70,000sq.ft machine hall at Stonehouse.

“The planning restrictions at New Mills meant the cost of building something suitable there was much more expensive. But the alternative, Woodchester, was never really suitable either,” says Hankins. “For a start, the long, thin shape did not allow for a good layout.”

Since the move to Stonehouse, the former machine shop at New Mills has been refurbished and now houses the Development Machine Shop, where the company proves-out products before they’re put into production. Woodchester remains the main assembly plant and Stonehouse is the new home of the company’s machining and piece part manufacturing operation.

The renovation

One of the first things the visitor notices is that Stonehouse, compared to other machine shops of its size and output, is bright and extremely clean.

“When we arrived it was a very dark place housing injection moulding machines,” he said. “Our first job was to completely strip the inside of the building, clean it thoroughly, then build new walls, ceilings, light fixtures and wiring. We also installed a state-of-the art extraction system to eliminate airborne contaminants. First and foremost, we wanted to build a pleasant place to work, but we also wanted people to walk inside and say ‘wow!’”

The building covers a total of 100,000sq.ft, including 20,000sq.ft of office space. There’s an additional 65,000sq.ft outside loading bay area at the rear, 40,000sq.ft of which could be used to expand the building if and when necessary. The machine hall itself is 70,000sq.ft, adjacent to which is a process finishing area of 10,000sq.ft. Throughout, the ceiling is lined with noise reducing tiles to break-up and flatten the acoustics, fooling the ear that the inside is smaller than it actually is.

“Finding ways to manage the space efficiently has proved to be one of the biggest challenges,” says Hankins, “the aim was to design a layout that facilitates flow of raw materials in one side and finished parts out of the other.”

It certainly appeared to be a big space, but once the company started to pencil in all the additional equipment and processes it would need, it didn’t take long for the cavernous shell to look decidedly busy.

“We’ve invested £1.5million in capital equipment, including a long list of new machine tools and processing equipment and an all-new anodising unit to double our previous capacity.”

Gareth Hankins, General Manager of Renishaw’s Manufacturing Services Division.

Stonehouse factory – aerial view.

Stonehouse factory – front view.

The new anodising plant has doubled Renishaw’s capacity.

The anodising plant was installed July 2005. In many factories the anodising area is dirty and usually out-of-bounds to visitors. Not at Stonehouse: like the rest of the facility, the company wanted the area to be a pleasant working environment; somewhere the employees would feel proud of.

Other investments include auto-deburring systems and raw material processing equipment, plus several highly efficient Kasto saws and an automated transfer facility to take raw material directly to where it's needed.

"Our swarf-management system is also something we are particularly proud of," says Hankins.

Breakthrough

One of modern manufacturing's greatest achievements is undoubtedly the paradigm shift from traditional mass production of large lots of products to a flow system that rearranges production, to minimise activities that do not add value to the product.

One of the layouts at Stonehouse was first aired as a rhetorical 'what if…?' by a member of the manufacturing engineering team.

"Someone suggested creating small, self-contained 'hubs' containing all the tooling and inspection equipment required by each group of machines," says Robin Harper, Programming Manager for MSD. "It sounds incredibly simple, but it was a breakthrough."

The machine group hubs are sited to service up to ten adjacent machines. Rather than machine operators hunting around the plant for the tools and equipment, they have everything they need, right where they need it.

"It's a big area, so we invested a huge amount of time and energy making sure that each hub has exactly what's needed locally, including setting tools, cutting tools, CMMs and shadowgraphs," says Harper. "The operators have taken on full responsibility for the hubs and everything that's in them."

Building on the culture of ownership, Renishaw uses a problem solving system based on the Ishikawa (fishbone) diagram. "Process Improvement Cause Analysis" (PICA) is situated on the shop floor adjacent to the machining cells. Operators who identify a problem use post-it notes to flag that problem, or opportunity for improvement, on the PICA board.

Robin Harper, Programming Manager, in front of one of the many PICA boards located on the shop floor.

Self-contained tooling hubs serve groups of up to ten machine tools with setting tools, cutting tools and inspection equipment.

"Again, it's a simple thing but it has really improved communication between the engineers and the guys operating the machines. The sense of ownership for process improvement on the shop floor has also vastly increased," says Harper. "Often, the person who notices the problem is the guy operating the machine. He probably knows how to fix it as well."

Unmanned

Empowering operators and giving them responsibility is important and almost always challenging, but an equally difficult thing when designing manufacturing processes is knowing what to take out of human hands.

Renishaw's Automated Milling, Turning, and Inspection Centre (RAMTIC) allows the company to more efficiently manage its precision machining operations by reducing set-up time when changing between different parts and eliminates the need for manual quality checks during a machining run. The company uses the RAMTIC system in a line of 25 Mazak vertical machining centres, which have been modified to include an indexer and transfer mechanism.

The RAMTIC uses a portable carousel that is stocked at an adjacent off-line kitting station where, depending on the products to be manufactured, it is loaded with raw

Paul Maxted, Principal Engineer, in front of a line of RAMTIC machines, where Renishaw's own probes help assure the quality of parts and control all aspects of the manufacturing process.

material and tools. Once loaded next to a RAMTIC machine, the operator involvement is finished. Renishaw's probing systems assure the quality of the parts and control all aspects of the process during the manufacturing cycle. Multiple operations of parts for a product kit are manufactured in sequence with 'job set-up' being automatic and unmanned.

Use of calibrated master 'artefacts' on the machine, allow traceable measurement despite the variable thermal environment, as they are made from the same material as the workpiece and consist of similar features. The artefact allows comparative measurements to be made before updating the process.

Principal Engineer Paul Maxted explains that the artefact system is the key to reliable unmanned operations.

"The artefact allows us to understand and quantify any errors introduced by the machine tool or environment. We store that data and use it to compensate all the subsequent measurements.

Overall, RAMTIC provides a major reduction in manufacturing lead times. The system can run unmanned for up to 140 hrs a week and the automated machine calibration and in-process inspection helps achieve consistently high levels of quality and reduced cycle times.

Of course, correctly stocking the RAMTIC unit is vitally important and is the responsibility of machine shop kitters, but otherwise the only manned input is the operator removing a finished RAMTIC carousel and docking a new one. The changeover operation takes about 15-20 minutes per machine and normally happens once a day.

The concept of unmanned part set-up and quality assurance on the machine using Renishaw probing systems is also applied to a line of six Mori Seiki mill-turn machines.

Design for manufacture

Keeping the manufacturing processes running efficiently starts well before a product reaches Stonehouse.

"Manufacturing engineers are part of the design function," says Robin Harper. "We have a major influence on what a product looks and feels like before it reaches production. The aim is that when products are handed over to Stonehouse, any potential manufacturing problems have already been addressed."

When a new product is in its feasibility stage of development, cross-functional teams are established to bring all disciplines together and the product and its potential manufacturing processes are closely scrutinised.

“We have an example of each class of machine tool at New Mills. We also have what we call assembly ‘nursery cells’ where processes and capabilities are established before moving them into mainstream production,” says Harper. “As a new product moves from feasibility through to production, your ability to influence manufacturing costs progressively diminishes. We need to design and engineer products for manufacture right from the start.”

The move to the new plant also gave the company a chance to rationalise its growing range of tooling brands, configurations and types, ending up with a standard tooling library and a greatly reduced set of tools.

“We’ve also rationalised our classes of machine tools so we’ve now got an expert understanding of what we can and can’t achieve,” adds Harper. “The goal is to release processes that take advantage of the factory’s capabilities and run unmanned. Overall, we’ve ended up with better products that are easier to make at lower cost.”

A clean start

As well as doing things more efficiently, the new location has provided an opportunity for Renishaw to make its manufacturing processes cleaner and more environmentally friendly.

For example, to stay ahead of solvent and emissions regulations, the company has invested in four new MecWash automated aqueous part-cleaning machines. Two are used for general cleaning, two for final cleaning.

“We’re making precision measurement and probing equipment, so typically designers specify machined parts as ‘very clean’,” says Principal Manufacturing Engineer, Mark Buckingham. “To achieve these high standards means we have to use the latest and most advanced cleaning systems. The Solvent Emissions Directive (SED) is already partly implemented into UK law so we’ve invested in water based washing machines and cut our solvent emissions.”

Swarf-management has also been rethought. Instead of selling tons of coolant soiled waste metal for a fraction of its potential worth, Stonehouse’s machines dump swarf into central conveyor systems that transport it to a compactor where it’s dried and formed into briquettes.

Previously, the scrap merchant would only pay a low price for metal waste because it comprised of different metals and was contaminated with coolant.

Principal Manufacturing Engineer, Mark Buckingham, holding a briquette formed from reclaimed swarf.

“The price for scrap aluminium is around £900 a ton,” says Buckingham. “We create many tons of aluminium swarf every year. That’s £’000s a year we can now recover that we didn’t before, just for aluminium. Steel and brass are even more expensive. It wasn’t difficult to convince the Board to make the investment.”

The added advantage is that the system also allows the reclamation of cutting oil, up to 1000 litres every two weeks!

“As well as looking into alternatives to mineral based cutting oils, we can now reuse our reclaimed oil in some of our lower grade machining activities.”

Beyond ‘lean’

The transformation of Stonehouse was completed in December 2005 and as well as providing the company with an increase of more than 160% in manufacturing space, has also resulted in far more effective and efficient ways to manage its manufacturing operations. The facility isn’t ‘lean’ in the strictest sense of the word – Renishaw’s make-to-stock is ‘push’ rather than ‘pull’ manufacturing - but organisation at the plant certainly engenders the same philosophy of efficiency and waste elimination first implemented by the Japanese. The techniques employed at Renishaw’s Stonehouse facility are the epitome of good manufacturing sense, whether common or otherwise. For the visitor, the overall impression is still astonishing, whatever you choose to call it – the Renishaw “wow” factor has been achieved.