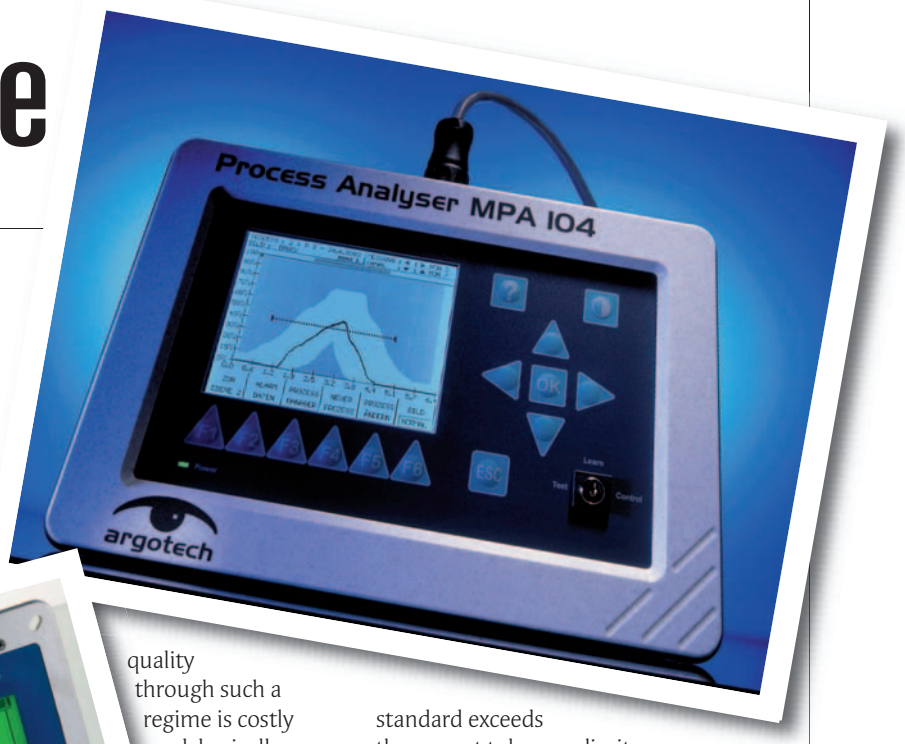
Watchful eye



Automatic process monitoring can save scrap, machine damage and, perhaps most importantly, avoid disappointing customers with reject parts. Andrew Allcock explains

Germany's Argotech supplies in-process monitoring systems for the metalworking/metalcutting industries. In Germany there are some 1,500 installations; as yet, only handful in the UK. Companies such as Star Micronics GB and Citizen Machinery UK have 'bought in' to the system, says Argotech's Marc Braun, business development director. Two UK sliding-head lathe users include Tennable Screw, London, and MSP, Coleshill, Birmingham.

Although it is turning companies in the UK that have shown most interest, the process monitoring technology is applicable to many machining operations, such as milling, grinding and drilling. And most users of process monitoring fall into one of two categories: high volume producers that need to produce as efficiently as possible; and producers of high value items that tend to use expensive tooling and/or materials.

PAST REVISITED

Such process monitoring systems are not new, of course, similar technology has been around for years, yet in the age of 'zero defect' supply, it is worth revisiting the subject and the Argotech solution, obviously popular in Germany, in particular.

Process monitors catch poor quality production parts in process, eliminating scrap and the need for 100 per cent post-production inspection. Guaranteeing quality through such a regime is costly and, basically, a non-value-adding activity which is compensating for uncontrollable changes that occur in the machining process over time. Today's Lean Six Sigma market is unwilling to pay for such non-value-adding process steps, preferring to advocate building quality into the process, so defects are not passed on and waste is eliminated. This is exactly what process monitors do.

Process monitors also protect machine and tools from excessive damage, thereby reducing operating costs and increasing machine uptime. And because the machine is protected, it can be allowed to run unattended, increasing effective manufacturing capacity and efficiency of staff, says Argotech.

Process monitoring systems measure the machining process in real time through a number of strategically placed sensors on the production machine. Sensor input can be the measurement of acoustic emission, effective power, force, pressure, strain, distance or path.

Sensor input is continuously compared against a self-learned 'fingerprint signature', which represents a good production cycle. When a deviation from standard exceeds the pre-set tolerance limit, an alarm is generated and production is shut down.

Trending the sensor signal from cycle to cycle will reveal the tool wear over time. This wear can also be 'enveloped', allowing the user to maximise each tool's life, reducing unnecessary costs from inspections or premature tool replacements.

Some advanced systems also include in-process dimensional checks (5 micron accuracy), achieved through non-contact sensors. For example, in turning, one of the most common problems is that of short parts. The bar is not clamped properly and then pushed back during the machining process resulting in a part that is too short. The part is measured in process on its critical dimension(s) and sorted automatically if found not to meet specification. There is no extra process step and production can continue without any lost time.

Process monitoring solutions can be implemented on almost any production machine; critical is the space available to mount sensors. Ideally, a free M-function is used for each mounted sensor but the system can also be synchronised with, for instance, the coolant activation/deactivation cycle. The monitor's output relays can activate machine lights, feed stop, emergency

0 = can work ✓ = good ✓✓ = best		Sensor Type				
		Electrical Power	Acoustic Emission	Vibration	Force	Strain
Machining Processes	Turning	✓✓	✓✓	0	✓✓	✓
	Grinding	0	✓✓	✓	✓	✓
	Drilling	✓✓	✓✓	0	0	0
	Stamping		✓		✓✓	✓✓
	Die-Casting		✓✓	✓✓	✓	✓
	Rotary-cycle Machine	✓	✓✓	✓	0	0
	Multi-spindle Lathe		✓✓	✓	✓✓	✓✓
	Machining Centre	✓	✓	0	✓	0
Detection Capability	Missing Tool	✓✓	✓✓	✓✓	✓✓	✓✓
	Tool fracture	✓	✓✓	✓	✓✓	✓✓
	Tool wear	✓✓	✓	✓	✓✓	✓
	Chatter	0	✓✓	0	0	0
	Collision	✓	✓✓	✓✓	✓	✓
	Contact	0	✓✓	✓✓	✓	✓
Optimisation	Tool life	✓✓	✓	0	✓	✓
	Quality	✓	✓	0	✓	0
	Process	✓	0	✓	✓	✓
	Reduction of air grinding	0	✓✓	✓✓	0	0

and/or sorting slide, for example.

It is essential to understand which type of sensor to use (see table, above). This has to be assessed on a machine by machine basis, and is, to a degree, dependent on material(s) machined and cutting tools used, offers Argotech.

Preference is given to monitoring through power consumption, as this sensor is mounted outside the machining area. Power sensing, however, isn't always suitable, especially with combinations of large motors and small drills. Alternatives are acoustic or force sensing.

Process monitoring has a very good return on investment, it is claimed, with user feedback showing that for the right applications the typical payback period for a system is usually between 6 and 12 months (example payback calculations are available at *www.argotech.de*).

Taking the three machining operations of milling, turning and grinding, what are the typical set-ups? For complete monitoring of machining centres it is necessary to use an acoustic emission sensor as well as an 'Effective Electrical Power Module' for the main spindle drive, says Argotech. Wear progression of larger tools can be better monitored with the effective electrical power of the main spindle motor. The wear of small spiral drills and HSS shank-type cutters is normally only detectable in acoustic emission. Acoustic emission enables a rapid reaction to tool breaks even in the smallest tools. If tools >1.5 mm diameter are to be monitored, the acoustic waves can be received from the machine table via the sensor or by the spindle head for tools >3 mm diameter.

In most cases, lathes are monitored with a combination of effective power and acoustic emission measurements. The acoustic measurement is mainly used for quick reacting detection of chipping, breakage and wear of smaller and narrower tools, while the effective power measurement is additionally used for monitoring of wear and break monitoring of large tools.

ACOUSTIC MEASUREMENT

Acoustic measurement is made by connecting the acoustic emission sensor to the turret box, which in turn has good acoustic contact with the turret slide via the Hirth serrations. In this way non-powered drills of >1 mm diameter can be monitored.

In grinding, honing or superfinishing, high frequency acoustic waves are generated which, in addition to measurement of drive power and/or normal force, are used to monitor the machining process.

Argotech offers three levels of system: the entry-level, PA-2; the all-round capability PA-4; and the modular MPA104. The company's UK agent is Emmaco UK, Hinchley Wood, Surrey. □