Energy parts are complex and big

Machining systems can meet every need, if proper attention is given to process design and machine capabilities.

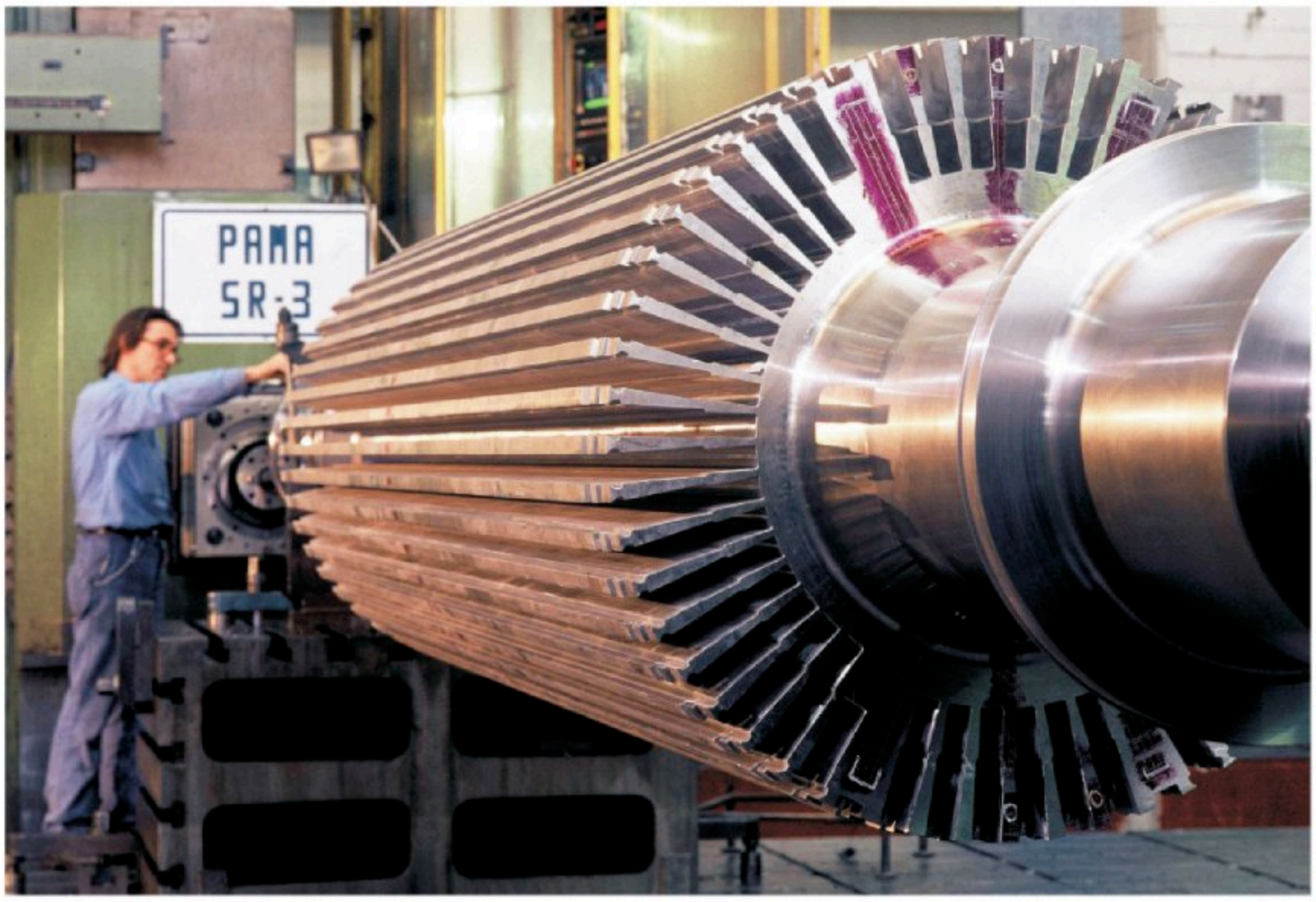

Photo: Pama

BY JIM LORINCZ

Energy-industry components require precision machining of the toughest metals, increasingly in smaller lot sizes. Large-bore CNC lathes, multifunction mill-turns, and the latest 5-axis multitasking machining centres all have carved out a role in machining components that often must operate in environments where temperatures and pressures can reach more than 176°C and 138 MPa, 3048m to 7620m underwater in the search for and production of deep-sea oil, or when burrowing through abrasive oil sands.

Every facet of successful machining with modern coolant-through CNC machine tools, including tooling, fixturing, inspection, and simulation software are essential. Components used in oil and gas fields, for example, include drilling and extraction tooling, completion tools, cementing tools, logging, measurement, and reservoir-mapping tools. Materials like Inconel and high-chromium alloys, tubular steel, and large castings for valves and couplings pose their varying degrees of challenge to precision machining. Increasingly, precision components for wind-power turbines, blades and blisks, and massive gears are drawing investments in the machining capacity required to produce them.

"It's not just the type of part being run in oil and gas industry applications, as much as it's the lot sizes," suggests Dana Scott, Regional General Manager, Mazak Corp., KY, US. The types of parts that are required include drill bits, valve bodies, couplings, valve tubing heads, and fishing tool slips.

Tough materials, multiple features

The order may be for a specific component used on a rig for a specific engineered function needed where downtime is counted in hundreds of thousands of dollars a day. In a contract-manufacturing culture, companies have to maintain a production-on-demand capability to turn components around quickly. Mr Scott explains: "Not only are they machining really tough materials like titanium and Inconel, but parts often have multiple features that would require four or five machining operations. Fifteen years ago, they would simply run additional inventory to amortise setups, but not today. Management doesn't want the expense of carrying additional inventory, especially if the part isn't likely to be called for again."

Advanced technology like 5-axis multitasking machining has transformed shop economics. Mr Scott explains: "A critical component of a valve tree is a 610mm diameter tubing head, something that looks like a thread spool with flanges on the top and bottom to connect to a valve tree. Typically, the shop will try to run these in batches of ten and ship a couple of times a month, machining in the traditional method in which there would be two turning operations, set up on two different lathes and three different milling operations. Using the e-1060 VMC with pallet changer, both vertical and horizontal machining required on this part is performed in two operations, flipping the part one time. Every time the pallet is indexed, a completed part comes off the machine. Ten parts can be shipped in two days," Mr Scott points out.

"A slip is something like a Chinese finger trap, and it works in the same way to retrieve a drill string from the hole," says Mr Scott. "Fingers on one end have to be machined at a specific angle. They interlock with teeth to fish a drill string out. It's a 244mm piece of tubing about 762mm long with an OD of 305mm. There are two different turning ops and three different milling ops that used to take 40h to machine. Using the e-650 HMC we've reduced time to machine to 1h," says Mr Scott.

Increased multifunction machining needs

Multifunction machining continues to grow in importance for oil drilling industry suppliers. Hamilton Machine, TX, US a manufacturer of aftermarket replacement parts for the fracturing, acidising, cementing, and drilling industries has increased throughput, decreased cycle time, and reduced costs with a Multus mill-turn from Okuma America, NC, US. "It does the work of three machines at one time," says Ed Fletcher, Hamilton programmer and foreman. "You put the raw material [A36, 10-18 soft material] in and the Multus completes all the lathe work,

then transfers the part and does the millwork on the other end, producing a completed unit."

Last year, Hamilton bought the Multus B300, and recently bought the Multus B400 to handle some of the larger-capacity parts. According to Shane Hamilton, Operations Manager, "the Multus decreased production time for a service pump component. By changing the machine on which the part was processed, manufacturing went from two machines, three operations, and 35min to one machine, one operation, and 13min."

A drill string comprises 12.2m sections of pipe that often stretch for miles and have threaded ODs securely fastened together by couplings with threaded IDs. "Couplings are tubular pieces 610mm long and 254 to 305mm in diameter that are threaded on the inside of both ends so they can be connected to pipe, which is threaded on the OD at both ends," explains Sid Roth, president, SMW Autoblok, IL, US.

"Couplings have to be able to resist high pressure and high temperature and possible surges in pressure that can cause blowouts. Handling couplings that weigh 68 to 91kg requires the use of some type of lifting device to load the coupling on a two-axis CNC lathe so that one end can be threaded. Then the coupling must be turned around 180° so the other end can be threaded," says Mr Roth. "Done manually, the process is cumbersome, time-consuming, and inaccurate."

Using the Ring-Indexing Chuck developed by SMW Autoblok, the connector can be indexed 180° in 2s, so that the other end of the coupling can be threaded without removing it from the machine. The Ring-Indexing Chuck, which is fitted to a standard 2-axis CNC lathe, is available in four different sizes. "The 950mm chuck will hold a 375mm diameter coupler and weighs about 1t. Among the first to offer the ring-indexing chuck, installed on a turnkey basis to its oilfield lathes, is Danobat Group's Lealde CNC lathes for a number of applications running in Mexico," says Mr Roth.

Ansaldo Energia, Genoa, Italy, selected two Speedram 4000 floor-type boring and milling machines from Pama to increase its capacity to meet orders that had increased 70% year-on-year. 33% of Pama's customers come from the energy sector.

Below: Advanced technology like 5-axis multitasking machining has transformed shop economics. Mazak's Integrex e-650H targets markets such as oil & gas, aerospace and transportation.

Photos: Schulz

Accurate inspection

Complex workpieces like impellers used in power-generation systems are always a challenge to inspect accurately and quickly for form analysis. GE Oil and Gas, Florence, Italy, has retrofitted a DEA Global CMM with a Revo retrofit scanning probe system from Renishaw. The CMM produces higher data-collection rates to allow form analysis and perform dimensional inspections on components varying in size and geometry to 1000mm in diameter. Previously, the function wasn't practical because of the lengthy inspection times required. Impeller inspection is done four times faster, and additional data can be used to compare inspected surfaces with 3D CAD models.

The retrofit involved installing the Renishaw Renscan5 system, including the Revo 5-axis scanning head, UCC2 controller, and Modus software. Revo is a contact-scanning probe with two integral measuring axes that can work in a 5-axis measuring mode when using the three axes of the CMM.

The Renscan5 system has been integrated fully into GE Oil and Gas' production systems, with the Renishaw Modus software executing inspection moves generated by a Unigraphics CAD/CAM system. The compatibility of Modus with DMIS is important, because the 3-D CAD model generated in the original design of the component is used for everything from machining the component to verifying its quality. Each component is tracked throughout the process by its serial number, with a full record of each stage of production.

A need for increased capacity

Ansaldo Energia, Genoa, Italy, selected two Speedram 4000 floor-type boring and milling machines from Pama, Rovereto, Italy, to increase its capacity to meet orders that had increased 70% year-on-year. The Finmeccanica company is Italy's largest manufacturer of thermal and hydroelectric power-generation systems, which include gas turbines of 70 to 280 MW and steam turbines/generators of 80 to 1200 MW. The company has installed capacity of more than 170,000MW in more than 90 countries.

The Speedram 4000 was exhibited at EMO for machining large components for the wind industry where 3t of material must be removed from components measuring 5m x 5m x 6m

and weighing 50t. The Speedram 4000 features a 200mm spindle with 100kW and CAT 60/Big Plus taper. Machine strokes are 15m in the x-axis and 6.5m in the y-axis. The machine supports a high level of automation, and comes with a 100t rotary table with a 4m x 4m table top and an CAT 60-tool magazine capable of handling CAT 50 or CAT 60 taper tools and automatic head attachment change.

Pama also offers two series of machines for production of critical energy-industry components. The horizontal Speedmat boring and milling machines are designed for single-piece runs, as well as large production batches of components for the energy, fabrication, aerospace, and engine industries. For medium-to-small-size work envelope, the Speedcenter machining centre line can be equipped with horizontal, horizontal/vertical, and 5-axis tilting heads. A line of gantry machines is also available.

Simulation software

It's commonly accepted that precision manufacturing is required for oilfield components, but what about ensuring the most efficient cutting process. Before the advent and perfection of simulation software, the only way to guard against crashes that could ruin or damage fixtures and cutting tools was through on-machine prove-outs. ReedHycalog, a global designer, manufacturer, and marketer of drill bit technology has been using Vericut simulation software from CGTech, CA, to do all of its prove-outs. Initially adopted at its Stonehouse site in Gloucestershire, UK, the Vericut software's success has led to its adoption in two facilities in Houston.

"In 1998 when Vericut was chosen, 5% of production of steel drill bits were new prove-outs," says Matthew Tolner, Senior Production Engineer. "Typically, the prove-out times were taking twice the time of a proven job. Back then, the average cycle time for a proven job was 15h.The majority of our programs are for 5-axis machining centres and are extremely complex," says Mr Tolner.

"All new 5-axis and 3-axis G-Code programs are run through Vericut to check for machine and tooling collisions, dimensional accuracy, and time checks before being made available to the shop floor," says Mr Tolner. "Currently this equates to about 150 programs per year with an average cycle time of 5h."

"Prove-out times are now no longer than proven job-cycle times. On some of our multiaxis machining centres, the operator presence is only required at toolchange operations just to double-check correct tool loading. Collisions are now extremely rare. Scrap rates are very low and quality is up," says Mr Tolner.

Threading and holemaking

Where the latest modern CNC machine tools are available, threading and holemaking pose a minimum problem. However, machine constraints posed by older machines can challenge manufacturers to find new tooling strategies. Andrew Strauchen, Vice President Engineering & Marketing, OSG Tap & Die Inc., IL, US, explains: "On the holemaking side, many manufacturers struggle to produce deep holes efficiently, because they may be limited by somewhat outdated machine tools. This seems to be a predominant trend because of the sheer size and expense of the massive machines needed to produce the large components associated with the oilfield and wind energy industries."

"From a drilling standpoint, older machines typically lack the coolant-through capability and run-out accuracy needed to run the latest carbide coolant-through drill technology. As a result, manufacturers are forced to use high-speed steel gun drills, feeding them at 25 to 50mm/min, and pecking every diameter or more," says Mr Strauchen. As a solution, OSG has added a new

Increasingly, precision components for wind-power turbines, blades and blisks, and massive gears are drawing investments in the machining capacity required to produce them. *Photo: Soraluce*

twist on HSS parabolic drills. "The new design, called Helios, combines the forgiveness of HSS drills with the non-peck efficiency of carbide coolant-fed drills. Shops can process holes at higher feeds without pecking with the older machines and water-soluble flood coolant," says Mr Strauchen.

Tools for wind turbine components

Emuge Corp., MA, US, has introduced a lineup of tools optimised specifically for the production of wind-turbine components. The Wind Power program offers a complete solution for precise, affordable machining of wind turbine parts. For the production of internal and external threads, the program provides taps up to 114-mm diam, roll form taps up to 51mm diameter, and thread mills to 102mm diameter. These tools are designed for all thread sizes – with a special focus on large and deep threading – for materials used in the manufacture of wind turbines. Also included in the new line are the tap and workpiece holders, available from stock or custom engineered for wind turbine applications. Gauging tools are also available for quick and reliable process control.

The new Wind Power program also offers a wide range of both solid carbide and HSS milling cutters, milling tools with indexable inserts and other milling accessories. The program includes end mills, slot drills, die-sinking cutters, shell end mills and gear cutters, in addition to the most complex-profile milling tools.

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CGTech (www.cgtech.com)
Emuge Corp. (www.emuge.com)
Mazak (www.johnhart.com.au)
Okuma (www.okumaaustralia.com.au)
OSG Tap & Die (www.osgtool.com)
Pama Inc. (www.pama.us)
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