The energy industry poses special challenges for suppliers of workholding devices and their users, simply because workpieces cover a wide range of sizes, shapes, and weights for applications in the oil and gas, power generation, nuclear, and, increasingly, wind-power industries. Machining processes as diverse as large bore CNC lathes, VTLs, multitasking mill-turns, and large floor and bed-type HBMs have their own special requirements. One goal of advanced workholding systems is to take as much material handling out of processes as possible. Equally important objectives are minimizing setups and machining parts complete in one setup, whenever possible, and providing safe handling of large and often unwieldy parts.

Opportunities for automation are more limited than for serial production of parts, and solutions often depend on equipping machines with palletizing systems, bar feeders, or introducing robotic solutions to single machines or cells. Many of the largest workpieces, housings for wind power or valve and pump housings, for example, may require dedicated fixturing or hybrids developed from standard fixtures for locating and clamping. Whatever solution is chosen, reduced material handling is very much concerned with safety in handling the largest workpieces—valve bodies weighing as much as 50t for steam turbine/generators, for instance.

Parts may be as regular as consumable pipe for oil and gas applications, or oddly shaped as valve bodies or pump housings are used in the oil sand fields of Alberta, Canada, by Weir Minerals for extraction operations.

Advanced Machine & Engineering designed a single, dedicated Amrok fixture to hold each of two slurry pump housing sections for mounting on a horizontal boring mill. The slurry pumps are used in the oil sand fields of Alberta, Canada, by Weir Minerals for extraction operations.

Fixturing needed for small, large, oddly shaped parts

Jim Lorincz
Senior Editor
housings with multiple features requiring several machining operations. Weir Minerals North America (Madison, WI) was able to reduce setup time by 50% for a pump housing 108” wide × 108” high (2.7 × 2.7 m) by switching to dedicated fixturing. Each Class 40 iron casting pump housing required milling, drilling, and boring of a frame and cover section. Each housing section weighed 5000 lb (2268 kg), and required an A and B load, which meant four setups for a complete housing assembly. Production requirement was two to three sets per week for the slurry pumps, which are used in the Alberta, Canada, tar sand fields for oil extraction.

Weir Minerals contacted Advanced Machine & Engineering Co. (AME; Rockford, IL), as well as several other contract manufacturers, to do the machining on these parts. The weight presented a substantial challenge for fixturing. Rigidity was a key consideration, because of the possibility of vibrational distortion from the workpiece load and tooling masses involved. Although AME began delivering high-quality machined pump sets on time by using nondedicated fixturing, the company determined that setup was taking far too long per part, resulting in much higher cost per pump set.

According to Steve Schubert, AME product manager, changeover took as long as 6–8 hr each time. Locating and clamping the pump housings was tedious, and the methods used raised safety concerns with regard to material handling, strapping, and clamp positioning. In addition, less than optimal clamping forces had a negative effect on manufacturing cycle time and tool life.

The challenge for AME was to significantly reduce the total setup and machining time, as well as to improve operator safety. As a solution, AME designed a single, dedicated Amrok fixture measuring 120” wide × 110” high (3 × 2.8 m) to hold each pump section for both A and B loads. The result was a reduction of setup time to less than 50% of the previous method. In addition, improved locating and clamping methods optimized milling and drilling operations, resulting in a 45% reduction in the overall machining cycle time per pump set. Adjustable jacks built into the fixtures, which allowed proper support for the sections during the machining process on a horizontal milling machine, are credited with being a key contributor to the savings, which AME shared with the customer.

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Switching to using only one fixture, rather than the multiple separate fixtures previously used, also improved machining quality and surface finish, allowing tighter tolerances to be repeated and maintained more easily. Machine operator safety
was also enhanced due to the standardized lifting, locating, and clamping methods that were employed with the fixture design.

One of the most significant continuing requirements for the oil and gas industry is found in the drill strings, which consist of 40’ (12.2-m) sections of pipe that stretch for miles underground and subsea. Each pipe has threaded ODs to facilitate secure fastening together by couplings with threaded IDs. Couplings are tubular pieces 18–24” (457–610-mm) long and 10–12” (254–305-mm) diam that are threaded on the inside of both ends so they can be connected to pipe. Each workpiece poses its own special workhandling challenges.

SMW AutoBlok Corp. (Wheeling, IL) has introduced two chucks to meet the requirements for downhole pipe with through-holes to 560-mm diam. “The BB-SC air open/spring close chuck overcomes the possible loss of clamping pressure over time from seal leakage in conventional air-open/air-close chucks,” says Gary R. Downs, SMW AutoBlok president. “With the BB-SC chuck, the spring close means that pressure is constant and doesn’t change when machining is stopped or left idle for an extended time. It’ll be in the same position you left it in,” says Downs. There are nine spring packs in the chuck, allowing the user to alter the amount of force by using all nine, six, or three springs. This is especially important to avoid deformation of thinner wall tubes.

“Because pipe isn’t perfectly concentric, shimming the machined jaws is generally necessary.” Downs explains: “This involves clamping the pipe, indicating it, and putting a shim in to maintain its position. Normally, what happens on an air chuck is that the jaws have to be opened all the way. With the BB-SC chuck, it’s possible to jog it slightly open to put the shim in. Open and close time for the BB-ZSC chuck is 3 sec vs. 10 sec for standard air chucks. Also, the chuck is sealed against contamination from coolants or chips.”

“Getting more parts to the spindle will allow the user to get as much production as possible out of dedicated machines, even when business slows down.”

To compensate without having to shim the jaws, SMW Autoblok offers its BB-FZA six-jaw chuck, which has three self-centering jaws and three compensating jaws. “To compensate for pipe that may be out of round, have a rough surface, or be bent, the three centering jaws move out from the body and clamp and center the pipe into position. The three compensating jaws don’t move out, rather they come right at the face of the chuck and clamp on the pipe to wherever the pipe has been positioned. The self-centering jaws then retract,” says Downs.

The Okuma Oil Coupling Cell developed in conjunction with the Partners in THINC is designed to automate handling of large couplings for drill strings between a VTL and a CNC horizontal turning center.

Working in conjunction with the Partners in THINC, Okuma America Corp. (Charlotte) has developed an Oil Coupling Cell concept to relieve the manual difficulty of handling heavier couplings that have grown in size to match larger pipe. Oil pipe, which used to run to 7” (178 mm) in diam when pumping on land-based rigs, now is getting to be 14–15” (356–381 mm) in diam, making the pipe and couplings heavier and more difficult to manually load in machines.

The Okuma Oil Coupling Cell combines two CNC machines, a VTL, and a horizontal turning center. The coupling cells are complete packages that are set up and ready to run with special workholding, chip evacuation, cutting tools, and programming. Special attention has been paid to chip evacuation, because of the volume of long stringy chips that are produced. With an automated system, there isn’t an operator
available to remove the chips. Special chip processing, using a combination of high-pressure coolant and tooling geometry to break up the chips and special programming routines, has been developed. Okuma uses a number of different machines in these cells, including the 2SP V60 or V80 twin-spindle VTLs and the four-axis LOC 650 horizontal CNC lathe or LU45 horizontal CNC four-axis lathes, and a Fanuc robot.

**Schunk magnetic workholding includes permanent electro milling magnets, grinding magnets, turning magnets, and radial magnets from 8" (203-mm) to 4-m diam.**

Workholding from Schunk Inc. (Morrisville, NC) includes lathe chucks, stationary workholding, and chuck jaws. “We focus on getting more parts to the spindle that will allow the user to get as much production as possible out of dedicated machines, even when business slows down,” says Brad Evans, product manager—workholding. “In addition to workholding for rotating solutions, we offer workholding for turning nonround parts like pump housings with special chucks or the Vero S quick-change palleting systems for horizontal turning of VTLs. Stationary workholding includes complete stationary workholding such as pneumatic, hydraulic, and manual products, and a complete line of magnetic workholding.”

Schunk’s magnetic workholding includes permanent electro milling magnets, grinding magnets, turning magnets, and radial magnets from 8" (203-mm) to 4-m diam. “Magnetic workholding has proven to be especially effective in large prismatic parts or round parts,” says Evans. “With magnetics, for example, we can hold bar stock 10" [254-mm] in diam, up to 7-m long, or fixture prismatic workpieces like housings or blowout preventers on five-axis mills so that five faces can be accessed for machining. This enables reducing setups and improving accuracy.”

In addition, magnetics have carved out some specialized applications. “Magnetics are particularly effective in holding thin-walled workpieces, bearings for turbine applications or housing for wind-power applications, especially where OD and face work must be done without distorting the workpiece,” says Evans. “Getting fixturing right for mill-turns and five-axis milling is especially important so that the machines can be fully used. If the clamp interferes with milling or turning on a mill-turn, you defeat the purpose of the technology.”

Schunk’s Vero S quick-change zero-point pallet system is designed to allow change-out of a machine in a matter of minutes and increase the capacity of the table, because the fixture clamps on the bottom of a pallet or workpiece. “With the clamping pin inserted into the bottom of a pallet or a workpiece, we achieve 5-µm repeatability in moving from machine to machine, as long as both are set up in the same system,” says Evans. “All that has to be changed over are tools and program. This also works for a CMM. A part can be cut on a machine, left on a fixture, taken to the CMM on the fixture, inspected, and returned to the machine for rework if necessary.”

Developments in magnetic workholding are ongoing. “There is a lot of interest in developing a standard bipolar magnet for holding bar stock in the energy industry, which could have applications in other industries for holding bar stock for cutting keyways or for shaft work,” says Evans. “For material handling with magnetics, a 10,000-lb [4536-kg] block of steel for a manifold for the energy industry is no problem. You just turn it on and move the workpiece,” says Evans.

“A lot of people think that zero-point clamping systems won’t work for large workpieces,” says Gerard Vacío, product manager workholding, BIG Kaiser Precision Tooling Inc. (Hoffman Estates, IL). “Zero-point systems have a reputation for high accuracy on location, better than ±0.0002" (0.005 mm). If the acceptable location tolerance for positioning a large raw workpiece form is within ±0.020 [0.51 mm], using a tight tolerance locating system might be a problem for datums that are too far apart in the raw material. When a datum is out of position, the system doesn’t work,” Vacío explains.

“That may be true of some products on the market, but we have modified our Unilock workholding system so that you can have one of your datums up to 0.012” [0.30 mm] out of
position. It will still clamp, but it won’t push it out of position. Zero-point systems historically are designed to do two things: position and clamp. When working with really large parts, sometimes you only want to position or you only want to clamp, not do both. We’ve modified the Unilock system to do either positioning or clamping. One of our customers has used the Unilock workholding system for fixturing a large mold for making a wind vane,” says Vacio.

“For applications in the wind-power and mining equipment industries, for example, workpieces are almost all one-off setups. The workpiece is so big that, once it gets on the machine, it is bumped around for positioning prior to clamping, so it can be cut. I tell them all I need is two datums anywhere on the machine to position the workpiece on the machine. In this instance, there may be a place where they can put a datum on one end of the part and a datum on the other. I can use those two datums to position the part on the table and the operator can go around and clamp it. Just holding it in position can take hours out of the setup process,” Vacio says. ME