CPR for your old CNC bender

Before you junk it, try rebuilding

By Kent Horn

In the 1980s, when CNC machinery evolved, tube fabricators made the transition from manually forming each part to allowing a machine to form the parts unassisted. Now in the age of Windows®-based computers and brushless electric servo drives, these machines can seem like relics. But don't take them to the scrap heap just yet.

Have you considered rebuilding and upgrading? Its primary advantage is cost, and cost effectiveness increases as bender size increases. Other advantages include the operator's familiarity with the bender and use of the same tooling.

Let's take a look at two possible rebuilds of a typical 1980s-era, 3-inch-capacity CNC tube bender:

1. A "normal" rebuild, which addresses all the components and system upgrades needed to bring the machine into current technology but leaves the original hydraulic swing-arm drive and hard gibs and slides in place. The total cost for a normal rebuild of a 3-in.-OD CNC bender typically is 50 to 60 percent of a new bender.

2. A "high-performance" rebuild, which increases the throughput of the machine and reduces maintenance requirements by converting the swing arm to electric drive and replacing the original machine slides with linear bearings.

Core

Because this will be a frame-up rebuild, the selection of the core is less stringent than if you were just going to give an old machine a facelift. With a frame-up rebuild, you will strip all the old components and completely gut the hydraulic and control systems, so you need not be concerned with the condition of these components.

Critical items are the swing-arm casting and the bend-head casting. On these parts, you can occasionally find cracks on the surface or cracks that have been welded and repaired.

You also might find spots on the swing arm or bend head that have been ground away to solve part clearance issues. It would be better to move on to another machine than to try to live with a weakened or damaged foundation. Regrind the clamp slide and follower slide if they can be cleaned up with minimal material removed; otherwise, replace them too.

Preparation of the core includes stripping the machine to the bare frame, removing all of the hydraulic lines inside the tank and body tube, and then sandblasting the core to bare metal. Enjoy this part of the job while it lasts; it all gets tougher after the junkyard work is done.

In a normal rebuild that will reuse the existing hydraulic tank, you'll need to pay special attention to the tank's corner seams. The tank reservoir holds the hydraulic fluid, but it also supports all the weight of the bend head and most of the body tube weight. After years of operation, the corner seams get fatigued and tend to leak from the weight of the components and from the inertia force involved with starting and stopping the swing arm for millions of cycles. Sandblasting the machine will make the minor cracks and leaks in the tank apparent. Welding all of the corner seams is a good precautionary measure.

In a high-performance rebuild, the additional weight of the electric bend-arm drive will require a support frame under the bender. By replacing the old tank with a new one, you can get rid of leaks and prevent the problem from happening again by adding a frame support structure that doesn't use the tank body for support.

Swing Arm and Bend Head

Before removing the swing arm, check the runout of the bend head. The top of the bend head should be no more than ±0.005 in. in the perpendicular plane. The centering ring should be no more than ±0.002 in. off concentricity. If the runout is beyond acceptable limits, machine off the top of the die boss and install a hardened tool steel wear plate.

The pivot pins on the swing arm should fit snugly into their machined holes. If they are loose and move around during actuation, rework the holes. When replacing pins, use tough material, such as induction-hardened chromed shafts. Refit older machines that have the fiber-type wear plates with Aluma-Bronze alloy wear plates.

Inspect the clamp slide; the pivot pinholes, sides and top, and the T slot should all be in good condition. If the slide is in poor condition, replace it. If you reuse the clamp slide in poor condition, you'll jeopardize the entire rebuild of the arm.

Bend-head centerline radius adjustment is performed by turning a screw that moves the bend head on a hard way and gib arrangement. Check this for movement and wear. Short of replacing the slide with linear bearings, the best way to cure problems is to tap a series of holes

Figure 1
You can update the existing carriage by eliminating the chain-driven system and installing a direct-drive gear rack system.

Figure 2
For the high-performance rebuild, consider converting the extractor to be reverse-acting. That would allow the hydraulic cylinder to be turned around and face the rear of the machine, and guide rods with linear bearings could be set up on the sides with plates attached at the front and back.

on the bend head and insert set screws that can be adjusted and tightened to prevent the movement. Sloppiness in this area can cause poor bends and premature wiper wear.

Also be sure to check the toggle position while the clamp slide is closed. This seems to be an inconsistent source of trouble with these machines. For some reason, the cylinder stroke on some of the machines is too short to fully actuate the toggle mechanism and lock the toggle in place by extending slightly over center. If the toggles don't lock up, the clamp can slip during demanding bend applications.

To fix the problem, install a longer-stroke cylinder and then add a spacer under the trunion bushing blocks that mount the clamp cylinder. This will allow full extension of the toggles and full retraction of the clamp slide to clear the advancing tube.

In a normal rebuild process, you'll need to rebuild the hydraulic cylinder that drives the arm and replace the chain drive system. Inspect the chain rollers and tensioning mechanism and replace any damaged parts. Of course, you'll also need to replace the swing-arm bearings and check or remachine the chain landings on the swing-arm shaft.

For high-performance rebuilding, remove and discard the swing-arm shaft. You'll need to have a new shaft made with a long extension on the bottom that fits into the hollow output shaft of the gearbox. You'll also need to machine the mountings on the bottom of the bend head and pressure die arm to secure the gearbox. This system eliminates maintenance adjustments and chain failures and increases the speed and accuracy of the bend arm.

Pressure Die Arm

Remove and inspect the pressure die holder and slide tray. Replace the wear strips and regrind the slide to bring it back into tolerance. If you used the bender for years as a dedicated setup, then the slide will be worn unevenly. It can be difficult to replace wear strips and get consistent tolerance out of the slide throughout its travel. The same is true for the follower bar: Replace the wear strips and regrind or replace the follower bar.

For the high-performance rebuild, remove the tray and pressure die holder and throw them in the scrap bin. These items with hard gibs are a constant source of wear and are difficult to renew. Then bolt on a new plate with linear bearings for the pressure die slide and a new holder with linear bearings for the follower slide. This takes a bit of engineering work; you'll need to select and size the linear bearings correctly and replace both the pressure die and pressure die assist hydraulic cylinders.

Carriage System

You can update the existing carriage by eliminating the chain-driven system and installing a direct-drive gear rack system (see **Figure 1**). This is done by machining some additional aluminum plates and bolting them onto the carriage housing. The new plates will mount the Y- and B-axis servomotors and have additional cam followers to support the extra weight of the servomotors and gearboxes.

Bolting a series of flat bars onto the bottom of the carriage rail will provide support for the Y-axis gear rack. While you're at it, install a new cable carrier and replace the B-axis spindle bearings and thrust bearing for the collet closer. Also inspect and rebuild the pusher nose assembly.

The high-performance rebuild would involve the same retrofit, but you'd remove the cams that guide the carriage on flat bar rails and install new linear bearings and rails that give the carriage more accuracy and service life. This requires a completely new carriage base.

Hydraulic System

You've completely gutted the old hydraulic system and gotten rid of all the tank lines and bulkhead fittings that used to leak. The new system you'll install incorporates a pressure-compensated pump with a through-shaft design that allows a gear pump to be piggyback-mounted. The gear pump will serve as a kidney loop, which continually pulls fluid from the tank and pumps it through a filter and cooler, thus maintaining the fluid.

Of course, you'll need to inspect and rebuild all of the old hydraulic cylinders. Be sure to rechrome cylinder rods and bores. Installing a new manifold that has internal porting onto the outside of the tank will eliminate the old interconnecting lines inside the tank. Also be sure to install all-new valves, lines, hoses, and gauges.

If setup time and consistency are issues, consider upgrading the system with programmable pressure controls for the pressure die force and the pressure die assist force. You can do this by installing a 0- to 10-VDC valve that sets the pressure from the control system instead of using manual adjustment knobs.

In a high-performance rebuild, the swing arm will be driven by an electric motor and gear reducer. This means that you can reduce the size of the main hydraulic motor. However, if the machine throughput is of primary importance, stick with the 30-horsepower motor for fast actuation of the remaining hydraulic system.

One further hydraulic upgrade would be to convert the pressure die and pressure die assist cylinders to a servo control system. This gives automatic positioning and following at each setup by using a proportional valve to control the cylinders and position feedback from each to the control. It's a good feature that reduces setup time and scrap.

Mandrel Extractor

The mandrel extractor is fairly straightforward to rebuild. Inspect and rebuild the extractor cylinder and inspect and replace any damaged or worn parts on the adjustment mechanism.

For the high-performance rebuild, consider converting the extractor to

Figure 3

A Windows®-based PC control with digital servomotor technology can increase productivity and reduce downtime.

be reverse-acting. That would allow the hydraulic cylinder to be turned around and face the rear of the machine, and guide rods with linear bearings could be set up on the sides with plates attached at the front and back. The front plate has a receiver that accepts the mandrel rod, and the back plate has a tapped hole for the cylinder rod. This upgrade gives about 30 percent more extraction power and relieves the cylinder rod from carrying the weight and shock load of the mandrel rod (see **Figure 2**).

Controls

After you've completed all of the mechanical and hydraulic work and stripped the old electrical panels and machine sensors, it's time to put on the new control system and breathe some life back into the bender (see **Figure 3**).

The choice of controls is fairly limited for tube bending machines; only a couple of Windows-based industrial computer systems exist on the market. You could either buy a PC-based system or develop a programmable logic control if you're a code-savvy repairman. If you're going for high performance, consider purchasing a proven Windows-based system with good support and readily available off-the-shelf, nonproprietary components.

The older machines originally were equipped with mechanical limit switches for sensing machine positions. It can be beneficial to remove these and use noncontact proximity sensors. These devices have solid-state electronics and are sealed to prevent contamination.

Also, the bend-arm encoder on older machines was mounted with the encoder shaft pointing up and coupled directly to the bend-arm shaft. This allowed mandrel lubricant and other contaminants to migrate down the shaft and enter the encoder. Try mounting the encoder behind the bend-arm shaft with the encoder shaft pointing down, using a gear belt to connect the encoder to the bend-arm shaft. This protects the encoder from being hit and damaged by a tube and eliminates problems with contamination.

Install a new safety system too; light beam and floor mat systems are industry standards. Make sure the system complies with all applicable standards and protects against all potential hazards. Review the Association for Manufacturing Technology's (AMT) related bending machine standard B11.15R-2001. A visit from your local Occupational Safety and Health Administration inspector can be helpful, and most OSHA agencies have a free service for consulting on safety equipment related to machine tools.

Start-up

When you've completed the rebuild work, be sure to retain all paperwork and data sheets for the components for future use. Also carefully review the electrical and hydraulic schematics and parts list for accuracy.

Be sure to place safety stickers around the tooling area and on the electrical system that warn of hazards. You can purchase these stickers from industrial suppliers or have them custom-made at a print shop.

Before you attempt start-up, save a lot of time and grief by taking care of a few minor maintenance concerns:

- Clean out the hydraulic tank thoroughly and remove all debris and dirt.
- Blow out all lines, hoses, and fittings.
- Remove all the pressure controls and proportional valves for start-up.
- Flush the system with hydraulic oil and run a filter system overnight to clean up the fluid.
- Prime the main pump and start the system, and actuate all valves and cylinders manually.
- Continue to run the filter system and clean up the fluid before installing the pressure controls and proportional valves.
- Check all electrical connections and tighten all screw terminals.
- Perform a final review of the machine upgrades, machine accuracy, documentation, safety procedures, and setup procedures.

Now you're finally ready to start the machine, tune the servos, and check all the various components for proper function. Be sure to look at all the hydraulic components for leaks; sometimes they don't appear until the system heats up and cools down a few times or until the system is running under load. After a break-in period of at least 40 hours, recheck the mechanical and hydraulic components and retighten the fittings.

With the new, modern technology onboard, the machine should perform better than its original new specifications, with less maintenance and downtime. The bender's accuracies, throughput, and setup time should be greatly improved and rival that of a new machine. ■

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