

# A PROGRESSIVE MOVEMENT IN TUBE FORMING

How a series of steps can lead to good, consistent parts



By George Winton, P.E.

**PROGRESSIVE** die sets commonly are used in stamping. The raw material is coiled on a spool; the process uncoils the material and feeds it into a series of dies that transform the original flat material into a useful component. The idea of using a series of dies to form a part has been around for a long time.

The concept of forming a tube by using a set of progressive dies may be more common than you think. Tube mills use a progressive process for forming a tube from a strip of material (see **Figure 1**). In this case, the flat strip is transported through a series of dies, which change the shape from flat to round, square, rectangular, oval, or some other shape.

Without the incremental, or progressive, approach, it would be next to impossible to change the flat strip to a round cross section. A progressive approach is critical to forming the metal consistently.

Progressive forming is used for other fabrication processes, too, including bending and end forming tubes.

## ONE HIT OR TWO?

When it comes to end forming, manufacturers would prefer to make an end form in one hit. However, sometimes trying to form the end of a tube in just one hit can cause problems. Trying to do too much with one tool can lead to inconsistent results as calculated by process capability ( $C_p$ ) and process capability index ( $C_{pk}$ ). A cone is one such part (see **Figure 2**).

The end form itself looks simple enough. However, if the required angle is too severe, inconsistent results can occur from trying to make this in one hit. In the case of the cone, a single-hit process may

produce too much axial force, causing a beadlike feature to develop behind the intended cone (see **Figure 3**).

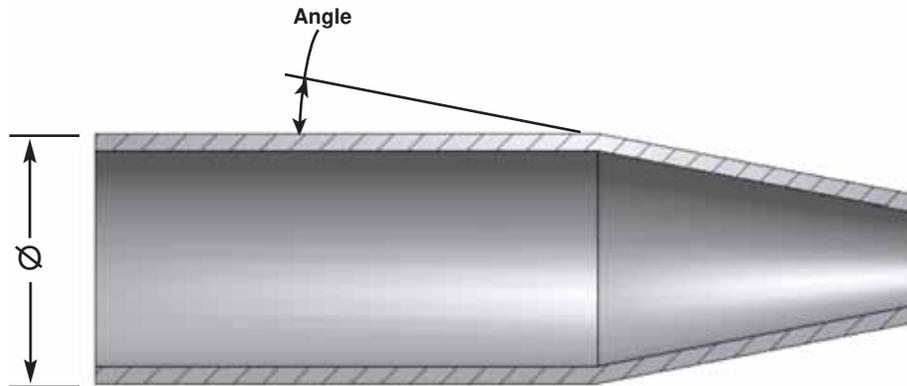
A progressive process is useful for applications like this. Forming this shape in two hits allows the metal to flow in a more controlled manner, thus preventing unwanted axial forces.

Some applications aren't as clear-cut, and you may be on the fence when trying to decide how many hits to use. Extensive computer analysis can help you figure out the most efficient path for production needs. In addition to that, input from a sharp machinist with quite a bit of experience in metal forming can be extremely valuable. In the end, the proof comes with building the tooling and making some live tests.



**Figure 1**

*A tube mill relies on a series of dies that use a progressive forming process to form a tube from a flat strip. Photo courtesy of Rafter Equipment Corp.*



**Figure 2**

*A simple end form, such as a cone, might require a single hit. However, depending on the material type, strength, and thickness, a single hit might result in a malformed part.*

### **BENDING: THE PENDULUM PROCESS**

Bending a tight radius on a roll bender is not too common. Some other bending machine types can make a tight-radius bend more efficiently. However, in some cases, a roll bender can use a progressive process to make a tight-radius bend.

For example, bending a 3.25-in. tube with 0.160-in. wall thickness to a 13-in.

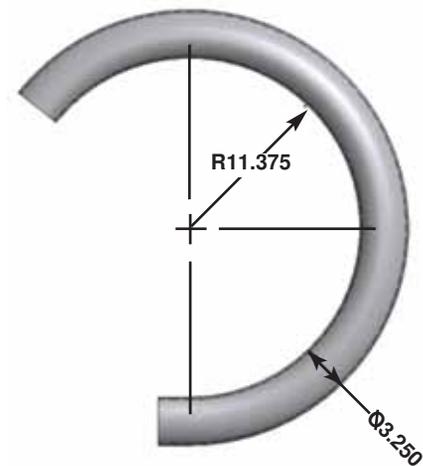
bender would lead to wrinkles (see **Figure 4**). However, working the metal in a series of back-and-forth steps could lead to a successful bend. **TPJ**

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**Figure 3**

*In some cases, attempting to do too much work in a single hit leads to excessive force. Excessive force leads to unwanted characteristics, such as this bead that formed at the end of the tapered section.*



**Figure 4**

*A bend of more than 180 degrees also is a candidate for roll bending. Removing this part from a draw bender would be difficult, but it would be a snap to remove it from a roll bender.*