Servo press forming applications

Part I: An introduction

By Taylan Altan

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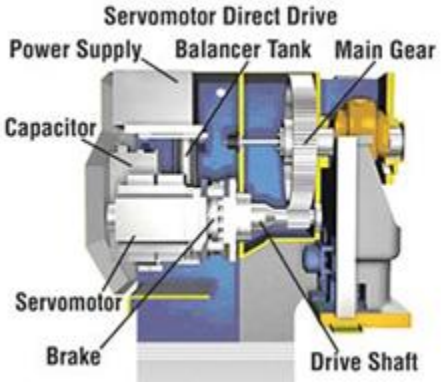

Figure 1
In this view, a high-torque servomotor is directly coupled to an eccentric drive of a gap press.[2] Image courtesy of Aida-America Corp.

Editor's Note: This is Part I of a three-part series on servo presses. Part II, which will appear in April 2007, will focus on servo press-drive systems. Part III, appearing in May 2007, will cover current and future applications.

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Numerous press manufacturers have developed mechanical servomotor gap and straight-side forming presses and press brakes. Servomotor-controlled presses have considerable potential in present and future applications for sheet metal forming, blanking, stamping, and coining.[1]

Servomotor Mechanics

A servomotor gives a press slide motion flexibility and accuracy in terms of speed, motion, and position control. This flexibility produces infinite slide motion variations that may improve part quality and allow additional operations such as painting and assembly during one press stroke.

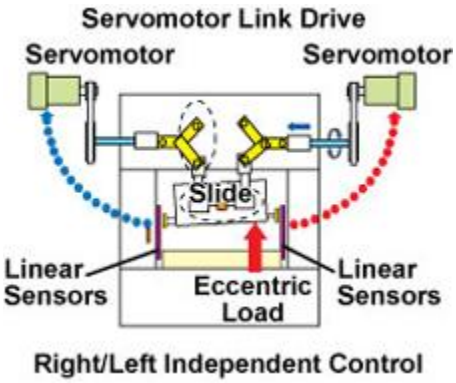

Figure 2

This schematic view shows the independent control of the slide through the servomotors.[3]

Servo presses are available from 35 tons (350 kilonewtons) to 1,000 tons (10,000 kilonewtons). Larger presses for forming large automotive panels currently are being developed. In general, servo presses can be classified based on their drive system (see **Figure 1** and **Figure 2**).

Servo-drive, or free-motion, presses have certain characteristics that can reduce the number of forming operations required, improve tool life, reduce springback, modify stroke position and length, and increase part accuracy.

Flexibility. The most obvious benefit of servo technology is controllable slide motion. This flexibility comes from the ability to program the speed, motion, and slide position in an infinite number of ways with a constant load available throughout the stroke at any speed.

The minimum stroke length can be set to match the forming, stamping, or blanking operation, which provides a shorter cycle time and reduced shock vibrations and noise.[2] For example, top and bottom dead center slide positions can be changed to increase the strokes per minute (SPM) when switching from a drawing process to a blanking process.

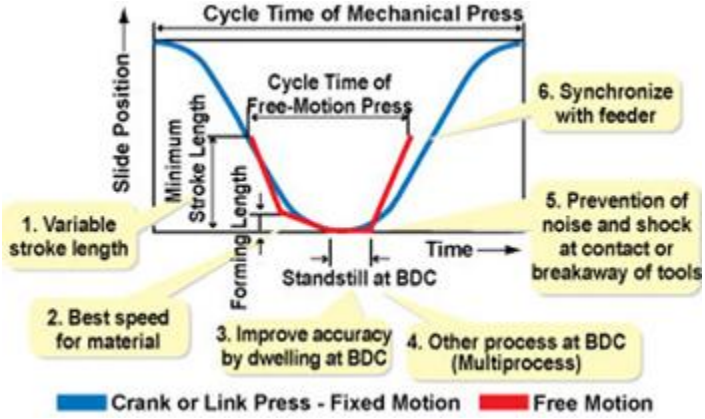

Figure 3

Servo-drive, or free-motion, presses can simplify the timing of automation, such as part transfer, painting, and assembly.[3]

Figure 3 compares cycle times for a traditional mechanical press and a servo press that can be programmed for the best forming velocity, dwell at a certain stroke position, and performing secondary operations within the same stroke.[3]

Servo-drive Advantages

Slide Motion. In an automated process, slide slowdown at the top of the stroke would be beneficial because this provides additional time for part transfer. Thus, a multipress transfer line can be run in continuous mode instead of single-stroke mode.

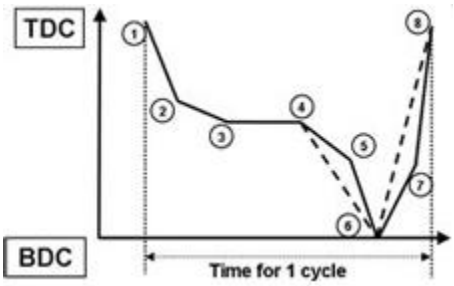

Figure 4

Sample servo-press slide motions were used to warm-form magnesium- and aluminum-alloy sheets.[4]

Another significant benefit is the ability for a quick approach, a slowdown to reduce vibrations at impact, and a quick return. The CPF, in cooperation with Aida-America Corp., Dayton, Ohio, conducted slide motion experiments. **Figure 4** and **Figure 5** show an example slide motion used for elevated-temperature forming of aluminum and magnesium components.[4] Using servo presses for specific forming operations will be discussed in the May 2007 issue.

Part Quality. In terms of part quality and tolerances, the ability to match slide motion to a particular forming process, such as deep drawing, blanking, coining, or bending, seems to have a positive effect. For instance, it's well-known that in deep-drawing operations, deformation at a low velocity improves metal flow because of the effect of punch velocity on friction conditions.

1-2	Fast approach
2-3	Slower approach reduces impact and vibrations. Both tools are in contact at 3.
3-4	Dwell (blank heating)
4-5	Slower forming velocity for forming sharp corner radii
5-6	Higher velocity for faster forming
6-7	Slower exit from the tool
7-8	Faster return to TDC

Figure 5

Press and Tool Life. The ability to reduce impact speed and variable forming speed can greatly help in reducing press and tool vibrations. Thus, stresses on the tooling and press are reduced, and the life of the equipment is increased.

Accuracy. Figure 2 shows a servomotor press with a link mechanism that obtains the ram stroke by a reciprocating motion. By measuring the position of the slide on the left and right sides with linear sensors, we can control the motion of the two servomotors so that slide parallelism with respect to the bolster is maintained.

In the future we can expect blank holder pressure control to be possible with servomotor-controlled die cushions. Such a system will provide flexibility to program blank holder pressure variation in time and location. Precise blank holder pressure control will lead to higher formability in stamped parts.

Notes:

1. T. Nakagawa, "Servomotor Driven Press and Market Trend in Japan," in proceedings from 56th CIRP GA, Kobe, Japan, August 2006.
2. Dennis Boerger, "High-tech Presses, Servo Technology Meets Mechanical Presses," STAMPING Journal, Vol. 15, No. 6 (2003), p. 32.
3. K. Miyoshi , "Current Trends in Free Motion Presses," in proceedings from 3rd Japan Society for Technology of Plasticity (JSTP) International Seminar on Precision Forming, sponsored by Stamping Press KBU - Komatsu Industries Corp., March 2004.
4. S. Kaya and T. Altan, "Warm Forming Aluminum and Magnesium, Part I: Forming a Round Cup," STAMPING Journal, Vol. 17, No. 12 (2005), p. 36.

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The CPF conducts research and development; educates students; and organizes workshops, tutorials, and conferences for the industry in stamping, tube hydroforming, forging, and machining.