Basic Methods of Length Control
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Why are we here?

- Explain the main types of length control systems typically used in the metal construction industry
- Help decide which system is best for your needs
- Get the most out of your existing equipment
Mechanical Length Control

Consistent lengths, but...

- Limited speed, die weight & part length
- Length changes mean delays & scrap
- Not well suited for other in-line operations
Electronic Length Control

- Electronic length control relies on an encoder to “see” material move through the machine.
- None of the limitations of mechanical control
- Possible to achieve as good if not better repeatability

Each pulse represents a linear distance
Four Basic Application Types

- **Stopping or Flying**
  - Stopping: material stops for each operation; presses are in fixed locations
  - Flying: material moves continuously; presses/dies on slides and must match speed

- **Open or closed loop**
  - Closed loop systems use feedback information to make constant adjustments to speed or position.
  - Open loop systems rely on information known before the action is started, but cannot make mid-course corrections
Open Loop Feed-to-Stop Pre-Cut Line
Open Loop Feed-to-Stop

Material Stopping Reaction Diagram

Length Controller Motion Output

Material Speed

Deceleration distance/time. Distance traveled during time required to stop material from run speed.

Press cycle occurs here.

$t = $Stopping Reaction time
Open Loop Feed-to-Stop

Single Speed Machine Motion Profile

2-Speed Machine Motion Profile
Open Loop Feed-to-Stop

Leading Edge
Manually referenced at the start of the run,
there is no length error due to stopping reaction.

Contact Point
Cut Off Press Target

\[ d = \text{overall length of first part} \]
\[ e = \text{error due to Stopping Reaction} \]

Direction of Material Flow
Open Loop Feed-to-Stop

• **Uncompensated Systems**
  - Produces a Long Part on Startup
  - Sensitive to Speed Changes
  - Sensitive to Environmental Changes
  - Sensitive to Material Changes

• **Compensated Systems**
  - Part Lengths More Accurate from First to Last
  - Compensates for Shifts in Machine Timing
  - Lower Throughput When Compensating for Machine Timing Changes
  - Parameters Must be Set Properly
Open Loop Feed-to-Stop

- **Key Points**
  - Low Cost
  - Low Throughput
  - Moderate Accuracy ± 0.032” (0.8 mm) or better
  - Sensitive to Timing / Tracking Variations
  - Press Variations Do Not Affect Length
  - Typical metal construction applications:
    - Roofing panels
    - CTL / slitting
    - Metal studs
Open Loop Flying Die

Open Loop Flying Die Post Cut Line
Open Loop Flying Die

Press Fire Timing State Diagram

Length Controller
Press Fire Output

Press Tooling
Vertical Position

Electro-mechanical delay between when the output is fired, and when the press starts its downward stroke.

Press tooling moving from top to bottom of stroke.

\[ t = \text{Press Reaction time} \]
Open Loop Flying Die

- Leading Edge: Manually referenced at the start of the run, there is no length error due to press reaction.
- Contact Point
- Cut Off Press Target
- Direction of Material Flow
- $d = \text{overall length of first part}$
- $e = \text{error due to Press Reaction}$
Open Loop Flying Die

- **Key Features**
  - High Cycle Rates / High Line Speeds (4+ hits per second)
  - Low Cost
  - Moderate Accuracy
  - Boost system needed for higher speeds or heavier presses
  - Higher Accuracies Require Regular Maintenance
  - Sensitive to Timing
  - Typical metal construction applications:
    - Metal studs
    - Roofing panels
Closed Loop Feed-to-Stop

Closed Loop Feed-to-Stop Pre-cut Line
Closed Loop Feed-to-Stop

- **Closed Loop Feed-to-Stop Key Features**
  - Very High Accuracy ($\pm 0.003''$ (0.08 mm) or better)
  - Higher Cost (Servo System and Associated Components)
  - Gagged Dies Allow for Extremely Flexible Punching Operations
  - Material encoder can compensate for feed roll slip
  - Supports Continuous Press Operations
  - Typical metal construction applications:
    - Purlins
    - Cut to length lines
Closed Loop Flying Die

Closed Loop Flying Die Post Cut Line
Closed Loop Flying Die

Servo Motor and Ballscrew Actuator
Closed Loop Flying Die

Belt Driven Actuation System
Closed Loop Flying Die

Rack & Pinion Actuation System
Closed Loop Flying Die

• Rotary systems:
  – Pure rotary press
  – Crank press
  – Eccentric press
Closed Loop Flying Die

Closed Loop Flying Die Key Points

- High Accuracy
- High Throughput
- High Cost
- Not Sensitive to Timing Variations of Equipment
- Sensitive to Encoder Tracking Variations
- Requires Higher Expertise for Startup and Troubleshooting

Typical metal construction applications:

- Metal studs
- Roofing panels
Combination Example

Closed loop pre-punch + hole detect + closed loop flying shear

- Pre-punch Systems Should Include Gagged Tool Specifically Used for Hole Detect
- Hole Detect Systems Require Careful Placement of Photo-Eye
  - Coolant
  - Material Control
  - Hole Shape
  - Speed
Summary

• Key Points
  - There are 4 basic types of length control – most roll forming machines use one or a combination of these
  - Selecting the best choice is a balance between
    - Throughput
    - Accuracy
    - Cost