Outline

• Roller screw utilization and trends
• BEAST model of roller screws
• Some simulation results
• Verification
• Summary
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Roller screw utilization and trends
Planetary roller screw
Roller screw applications

- Industrial Guns
- Injection Molding
- Steel industry
- Broaches
- Servo-presses
- Heavy presses
Trends in the market

• The trend is to move from hydraulic to electro-mechanical system (power consumption, productivity, accuracy, flexibility, noise level, ...)
• The reason of this trend is mainly due to improvements of the AC servo motors, the driver, the electronics, etc
• Roller screws allows higher speeds, higher loads, and higher reliability compared to other solutions, e.g., ball screws, rack & pinion, pulley & belt, acme screws

• BUT, better knowledge of the limits of the roller screw is needed, based on experience, tests, basic research, and calculation models
BEAST model of roller screws
BEAST - a virtual test rig

- Multi-body simulation software
- Specialized in contact problems
- Detailed surface description
- Accurate tribology
- Application operating conditions
- Focus on creating understanding of systems with contacts
- BEAST was originally developed for rolling bearings, but can be used for any “contacting” machine element
Main roller screw components - shaft
Main roller screw components - rollers
Main roller screw components – roller guides
Main roller screw components - gears
Main roller screw components - nut
Working mode of planetary roller screws

- Translates rotation to axial displacement.
- Rollers roll perfectly in the nut. This is ensured by the gear mesh.
- The load is distributed over a large number of contacts, giving high load capacity.
- Shaft and nut may have several thread starts, to give higher axial speed and maintain a large number of contacts.
Roller screw analysis in BEAST

- **Contact conditions**
  - Contact pressure
  - Load distribution
  - Sliding speed
  - Friction
  - Smearing
  - Wear
  - ...

- **Global conditions**
  - Efficiency
  - Stiffness
  - Thermal management
  - ...
Some simulation results
Roller – shaft contact force distribution

- Perfect geometry
- No clearance
- Structurally rigid bodies
Roller – shaft contact force distribution

- Perfect geometry
- Clearance
- Structurally rigid bodies
Roller – shaft contact force distribution

- Perfect geometry
- No clearance
- Elastic bodies
Roller – shaft contact force distribution

- Geometrical deviations
- Clearance
- Elastic bodies
Roller – shaft contact pressure distributions
Roller – slip speed distributions

Roller - Shaft

Roller - Nut
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Verifications
Stiffness
Stiffness

![Graph showing stiffness with deflection vs. axial load](attachment:image.png)
Efficiency

- Bi-directional sensor
-_inside temperature sensor_
- Outside temperature sensor
- Nut
- Screw
- Hydraulic actuated cylinders
- Oil
- Bi-directional sensor
Efficiency

\[ \eta = \frac{F_{ax \ lead}}{2 \pi M} \]
Summary

- Roller screw is a growing segment
- Roller screws are high performance, but complex machine elements
- Simulation models will:
  - help building product understanding
  - facilitate product optimization
  - provide a basis for right-sizing