Talyrond, Form Talysurf

Inspection of ball and lead screw actuator components

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Introduction

Taylor Hobson works with leading manufacturers of actuator components to develop unique measurement techniques for the industry. This enables us to provide capability for the reliable inspection of production parts as well as providing detailed information needed to improve the designs and production process.

We understand ball screws, lead screws and bearings and the factors affecting their performance, many of which are documented in ISO, DIN, ANSI and JIS standards. Inspection of these factors is fundamental to ensure product specifications are achieved.

Ball screws and lead screws are routinely used for a wide range of applications from aircraft control surfaces and landing gear, to precision movement of machine tools, as well as various automotive applications. Each of these applications has a different set of priorities in their requirements for actuation, all of which need to be accommodated for.

Ball and lead screw applications

Ball and lead screws are used to convert rotational and linear motion in a variety of applications, the most common being linear actuators such as the ones used for aircraft control surfaces.

These types of actuators are used in a wide range of applications, each with a wide range of requirements. The highest precision parts are required for aerospace and machine tool slides. Other less demanding example applications include automatic gates.

The same components are also used in other applications such as power steering systems to provide a smooth, linear motion as the steering wheel is turned as shown in figure 2.

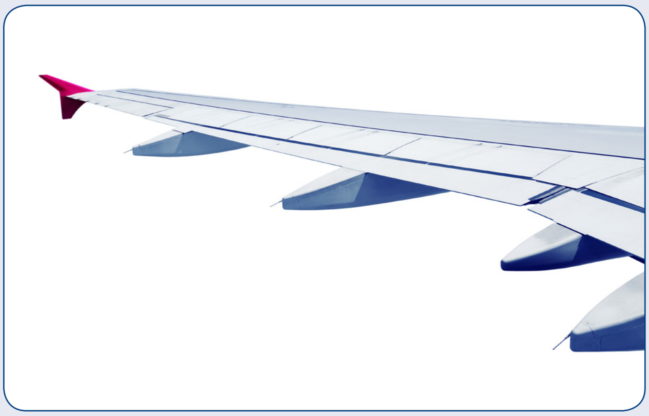


Figure 1 - Linear actuators are used for aircraft control surfaces

Figure 2 - Ball screw used in power steering systems

Example application

Figure 3 shows an example application of a linear actuator, an automatic gate mechanism. This is a linear actuator: made using a lead screw, nut and motor. The principle is the same for the actuators used in modern aircraft control surfaces, though these will use a ball screw.

The typical schematic of parts within such an actuator is shown in Figure 4. It also identifies the key specifications which Taylor Hobson instruments can measure, to help ensure part conformance to specification (see Technical Note T156 for more details on the key specifications).

This type of actuator works by the motor turning the screw shaft, which causes the nut to move along the screw thread, pulling the gate open (or pushing it closed).

Such an application doesn't require the highest positional accuracy; however surface finish and variation in the thread will be important as they will affect the performance and lifespan of the components. Similarly, the quality of the bearings will affect the smoothness of operation and the lifespan of the actuator.

Figure 3 - Lead screw application in automatic gate

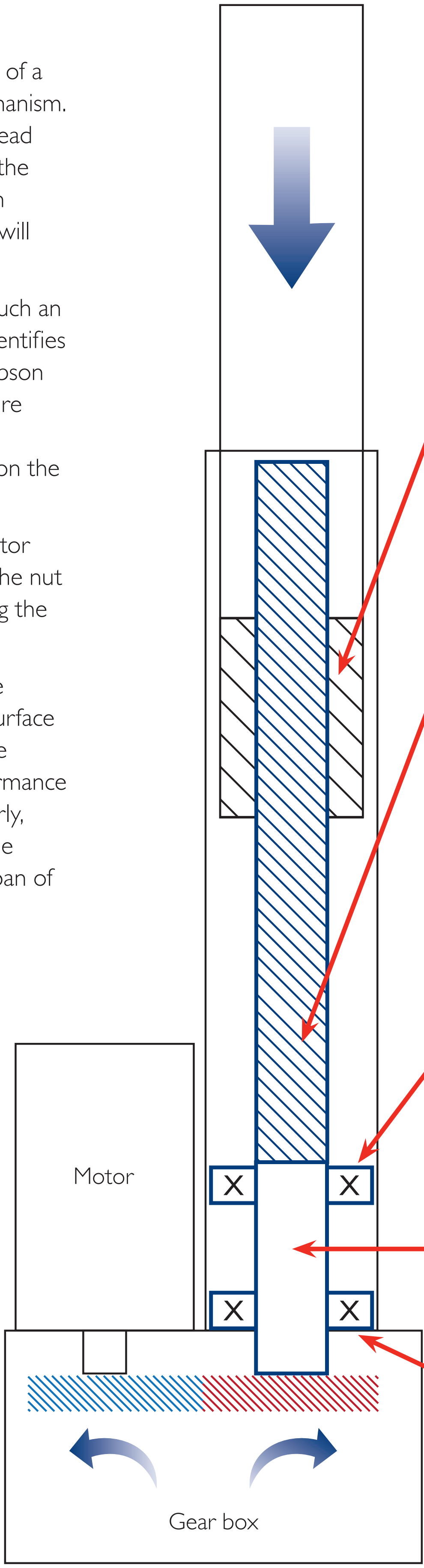


Figure 4 - Linear actuator example schematic

Nut

- Thread / Gothic arch shape
- Contact points
- Surface finish
- Harmonics
- PCD

Ball / Lead screw thread

- Thread / Gothic arch shape
- Contact points
- Axial and Sprial surface finish
- Axial and Spiral harmonics
- PCD

Roller Bearing

- Contour
- Cylinder map
- Harmonics
- Velocity analysis
- Surface finish

Shaft mount face

- Form
- Surface finish
- Harmonics
- Twist analysis

Ball Bearing

- Radius
- Form
- Surface finish
- Harmonics

How Taylor Hobson can help

Prevent post assembly performance issues and rejections with early inspection

Inspection capabilities

Screw and nut

- Bearing surface roundness
- Bearing surface straightness
- Bearing surface finish
- Bearing wear (on used sample)
- Thread gothic arch / form
- Thread axial surface finish
- Thread spiral harmonics
- Thread spiral surface finish
- Thread PCD variation

Ball and roller bearing

- Roundness
- Radius
- Form
- Wear (on used sample)
- Twist

Early detection of tight spots for the prevention of performance issues after assembly can be done using axial measurement along the shaft's screw thread. Two key factors affecting tight spots are the thread shape and variation in Pitch Circle Diamater (PCD).

The thread shape can be measured using either a Form Talysurf or a Talyrond. The Talyrond provides the capability to ensure the part axis is aligned to the instrument measurement axis. This means measurements can be analysed relative to each other and the part axis for higher accuracy. This is essential for PCD and parallelism analysis.

Figure 5 shows an example of a ball screw thead being measured on a Talyrond, the results from which can be used for the analysis of a vast array of Gothic arch parameters, pitch and thread PCD.

The additional benefit of Talyrond axial measurements is that they can be taken at multiple rotational positions, relative to the appropriate datum, which is aligned to the instrument axis. This allows inspection of the thread's pitch / lead along its entire length at any rotational position. It also allows inspection of straightness, parallelism and much more.

Ensure smooth operation by controlling surface finish axially and harmonics along the thread's helix profile. Axial measurement along the thread and bearing surface allow you to see and control surface finish. A helical (spiral) measurement along the thread can be analysed for harmonics which affect the performance of the shaft.

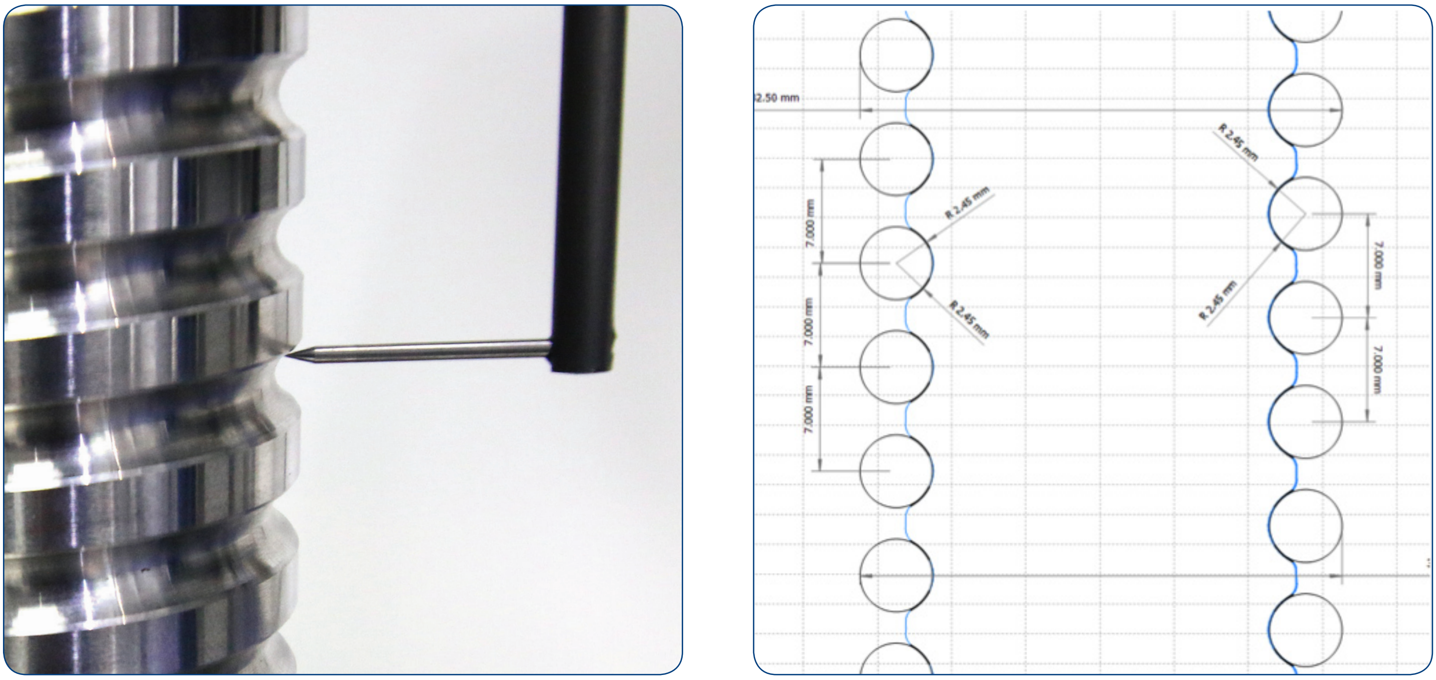


Figure 5 - Ball screw thread measurement on Talyrond

Thread analysis

Analysis of the thread can provide all of the following information:

- Form deviations
- Pitch
- Diametric distances between ball centres for PCD analysis
- Parallelism of ball centres from opposing traces
- Contact points
- Many other gothic arch parameters

Figure 6 shows an example analysis of a thread from a ball screw, although the process can be applied to a lead screw as well. All critical gothic arch parameters can be analysed and exported for use in statistical analysis packages.

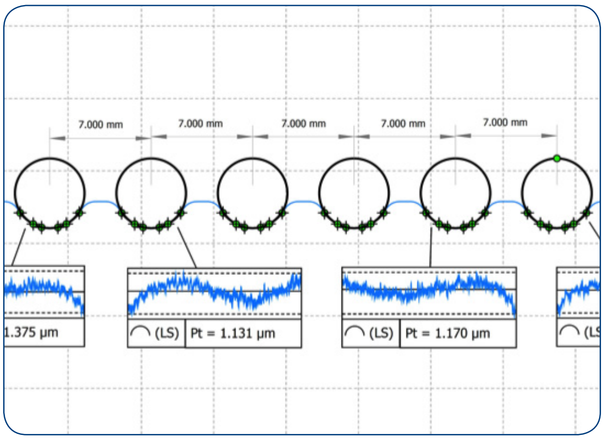
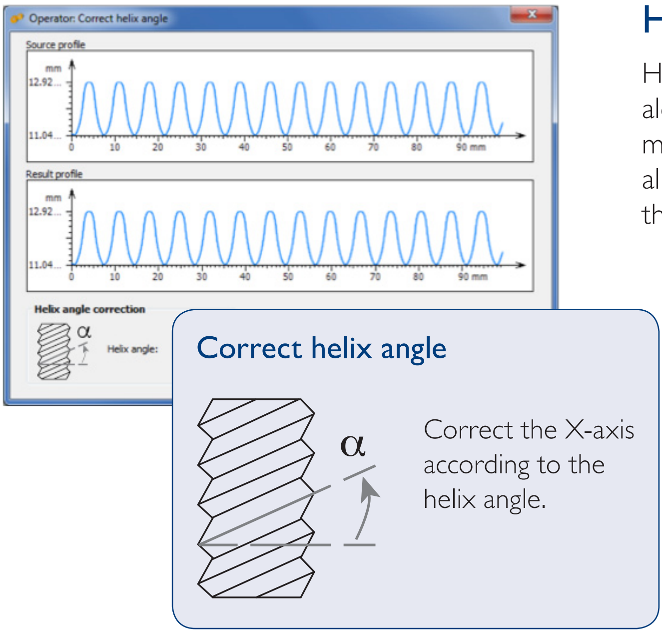
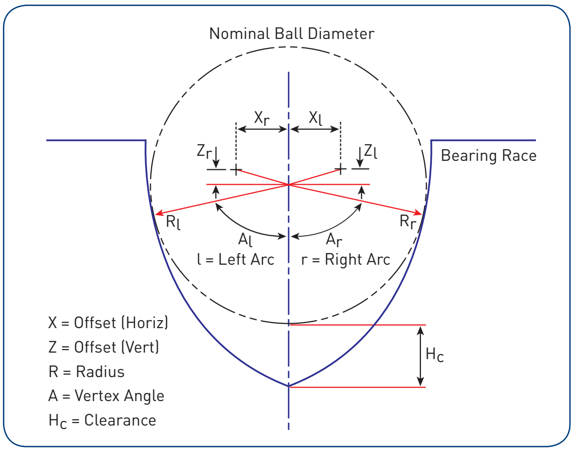


Figure 6 - Thread Analysis



Helix angle correction

Helix angle correction allows us to take an axial measurement along a thread profile and transform it so that it represents a measurement taken perpendicular to the thread angle. This allows for tolerancing of the profile as it is usually defined in the design drawings.



Thread shape / form ✓ Surface finish ✓ Harmonics ✓ Twist ✓ Contact points ✓ Gothic arch parameters ✓

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