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How to Specify Custom Lead Screws

Lead Screws are increasingly being used to produce linear motion when accuracy and reliability are critical. The value offered by custom solutions makes lead screws a favorite whenever price and cost of ownership matter. For many designers and engineers accustomed to the constraints of standard configurations, exploiting the benefits of a custom lead screw can be challenging. Here are some suggestions to help get the most from a custom design.

Hold the mayo

To a person used to getting sandwiches from a vending machine, a fast-food burger without the pickles may seem like something special. But the person with a personal chef in a gourmet kitchen may find the options limited, even in a well-stocked deli. Some companies offer a few options and believe they offer custom products. Unlike Henry Ford's "any color as long as it's black", they also offer white and red! But true custom solutions are limited only by imagination and manufacturing technology.

What is "custom"?

From a manufacturer's perspective, a custom lead screw is one that is manufactured to the customer's specification rather than the manufacturer's specification. So it seems obvious that the first step is to create a specification for the component you want. But unless you are intimately familiar with the range of customization possible, the best place to start is with a performance specification.

- What is the motion – how far, how fast, how often, how precise, what direction, how much load?
- What is the environment – temperature, chemicals, radiation, moisture, vacuum/pressure, cleanliness or lack thereof?
- Where is it going to be – visibility, space, mounting, support structures, mating components?
- Life expectancy?
- How many?
- Budget – unit price, tooling?
- When are they needed?

With as many of these parameters defined as possible, intelligent choices can be made. An analysis of speed, loading, and duty cycle will enable material selection based on limiting PV and friction. Environmental conditions will also impact material selection with respect to corrosion risk, chemical and thermal compatibility. Quantity, budget, and timing will influence manufacturing methods and tooling investment. Following are some examples of the way requirements can drive customization.

Requirement	Possible Choice
Corrosion Resistance – Salt Water	316 Stainless Steel Screw
Autoclave Compatibility Low Volumes	PEEK or PPS Nut Nut Machined from Bar Stock
High Volumes	Injection Molded Nut
High Life Requirement	Self-Lubricating Nut, TFE Coated Screw
Non-Magnetic	Aluminum or Titanium Screw

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There are different degrees of custom. Learn to recognize the differences. A custom solutions supplier challenges you to answer the question, "What if…" What if cost was no object, what would the "perfect solution" look like? What if there was no friction, what would the motion profile be? What if the screw could be as long or short as you want? What if the nut could be any shape or size? How can the device work better? How can assembly be easier or use fewer parts? Answering questions like these can help define the custom solution.

Figure 1 This self-lubricating, custom molded nut includes an insert-molded encoder strip and special guidance features. The lead screw has a low friction, PTFE lubricant coating.

Customization of lead screws may include any of these common elements.

- Special machining of the screws for bearings, couplings, pulleys, etc.
- Special machining of the nuts for mounting features, size constraints, and performance enhancements
- Custom injection molded nuts incorporating added functions
- Special materials for screws and/or nuts
- Special leads and thread forms
- Incorporation of guide features
- Integration with motors

Figure 2 An integrated gear profile on this nut enhances performance, simplifies manufacturing, and reduces total cost for greater overall value.

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Consolidation adds value

An important step down the path to a custom solution is an evaluation of the next level up. This means looking at all the components connected to the lead screw. It is often possible to turn the components attached to the nut into the nut itself. Integration with motors and guides is a real opportunity to save space, reduce component count, simplify assembly, and lower total cost. Here are questions to answer.

- How will the screw be supported?
- How will the screw be driven?
- What will attach to the nut?
- How can the lead screw assembly be utilized as a structural element?

The answers to these questions will reveal opportunities. For example, rather than attaching a nut to a carriage, the carriage, nut, guide bushings, and sensor flags can all be a single component. Or by utilizing a lead screw as a stressed element, it is possible to simplify a frame structure. Or a nut can incorporate the features of a timing pulley or gear. Or using an integrated, motorized axis rather than an assembly comprising a lead screw, nut, bearings, coupling, and rotary motor; this can even extend to incorporation of a complete guiding structure. Any of these strategies will reduce part count and assembly time. Not only is this a good value, but in many cases, the actual component costs are reduced.

Figure 3 This assembly includes the lead screw and nut, along with guide features, motor and drive. The guide system is also a structural aluminum rail.

How to “go custom”

The challenge will be to initiate the design phase with these expectations and goals. Again, the keys to success are imagination and avoiding constraints at the outset. Here are some common misconceptions.

- Custom nuts always cost more.
- Custom parts have long lead times
- Injection molds only make sense for huge quantities
- An assembly of specialized parts will out-perform an integrated solution
- Prototyping custom parts is cost prohibitive

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Many people have formed these opinions from experiences, so it would be misleading to suggest that all manufacturers are equally positioned to provide custom solutions. But it would be equally misleading to suggest that there is a penalty to be paid to get an optimized product. CAD/CAM, CNC machining, rapid prototyping, and lean manufacturing principles allow the same volume- manufacturing processes to be used for moderate runs of custom products.

Most manufacturers will claim to offer custom product but there are some simple questions that will reveal the companies who understand and deliver true custom solutions.

- Does the company actively promote customization?
- Does the company have strong applications engineering support?
- Are lead times for custom parts similar to those for standard configurations?
- Does the company control manufacturing or simply repackage available components?

Companies strong on value-engineered customization will receive “yeses” to these questions. Look for attention to the performance specification, not just a part number. Each company has their strengths and weaknesses but all contenders will exhibit a similar approach to product definition. Finding the right partner will provide both high performance and good value. There is no need to settle for off-the-shelf.