Ball Screws and Lead Screws – The Real World Difference

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Machine Builder Question -- "Ballscrews and leadscrews often are not interchangable, and there's always a trade-off between precision, rigidity and load capacity. I'm also told that specs don't always predict performance. I'd like some experienced views on their real-world differences."

There is a general distinction between the applications for a ball and lead screw. Lead screws are applied in OEM applications where a "just right" solution is required. Lead screws can be easily tailored to provide the required performance for the right applications at the lowest cost. This sometimes requires life cycle testing in the design phase but for an OEM, the extra up front work is well worth the product cost savings. The ability of ball screws to carry much higher loads, achieve faster speeds with continuous duty cycles can be well worth their added cost. For end users, the predictability of ball screws makes them the best choice for fast integration and reliability. Factory automation relies heavily on ball screw technology for instance. Of course there are many OEM applications where a ball screw is required such as in the machine tool industry. For OEM's, performance & cost, not analytical predictability, ultimately dictate the technology.

The key difference between a ball screw and a lead screw is in the way the load is carried between the moving surfaces. A ball screw uses recirculating ball bearings to minimize friction and maximize efficiency while a lead screw depends on low coefficients of friction between sliding surfaces. A lead screw therefore typically cannot achieve the efficiency of a ball screw (~90%). A quick review of tribology (study of wear and friction) leads one to conclude that sliding friction is inherently less predictable than power transmission utilizing recirculating ball technology. The fatigue life equations (e.g. L10 life) are fairly reliable within their range of applicability. Thus, there is a fundamental difference in application of a ball screw and a lead screw due to the ability to predict performance and life.

With all the advantages of a ball screw (load capacity, rigidity, efficiency, duty cycle, predictability) there is a price to be paid. Although their performance to cost ratio is very high when compared to other means of translating linear motion, a ball screw design is more complex, requiring hardened precision bearing surfaces and a ball recirculation mechanism. On

the other hand, a lead screw is very compact, offers great design flexibility, is quiet when properly applied, generally corrosion resistant and can be made to self lock for vertical applications. They are very capable in many applications, but they do have their limitations as well.