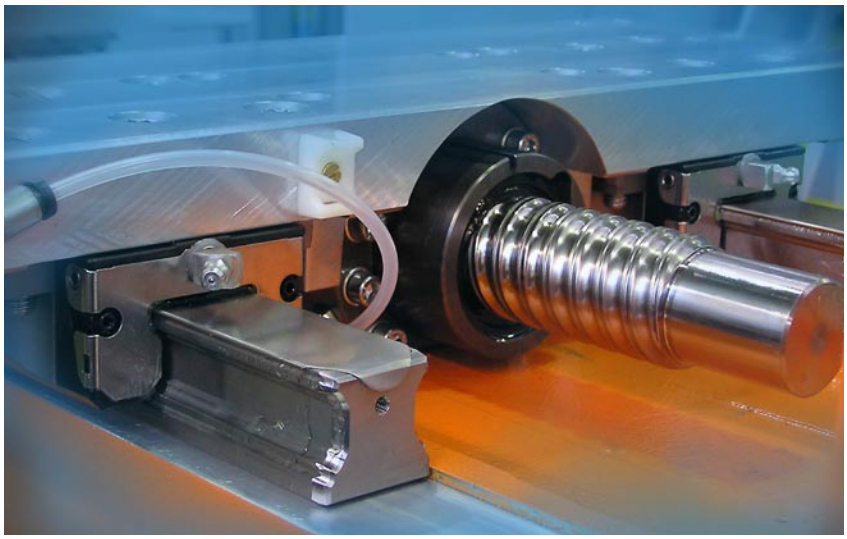
Drive & Control profile

How "LOSTPED" Can Help With Sizing and Selecting Linear Motion Systems



LOSTPED is a simple acronym to help specify linear motion components.

Virtually all manufacturing processes incorporate some type of linear motion. As manufacturers become familiar with the flexibility and simplicity of modular linear motion systems, these systems—whether one, two or complete three-axis Cartesian robotics systems—are finding their way into more areas of production.

A common mistake that engineers and designers make when sizing and selecting linear motion systems is to overlook critical application requirements in the final system. This can lead to costly redesigns and re-works but may also result in an over-engineered system that is more costly and less effective than desired. With so many possible solutions, it's easy to become overwhelmed when tasked with designing a linear motion system. How much load will the system need to handle? How fast will it need to move. What is the most cost-effective design?

What is LOSTPED?

Load. The weight or force applied to the system

Orientation. The relative position or direction in which the force is applied

Speed. Speed and acceleration

Travel. The distance or range of motion

Precision. Travel accuracy, positioning accuracy, repeatability, accuracy of the return position at the end of a stroke

Environment. The surrounding conditions in which the system will operate

Duty Cycle. The amount of time it takes to complete a cycle of operation

All of these questions and more were considered when Bosch Rexroth's Linear Motion and Assembly Technologies group developed "LOSTPED"— a simple acronym that guides the engineer or designer in gathering the information needed to specify the appropriate linear motion components or modules in any given application.

What Is LOSTPED?

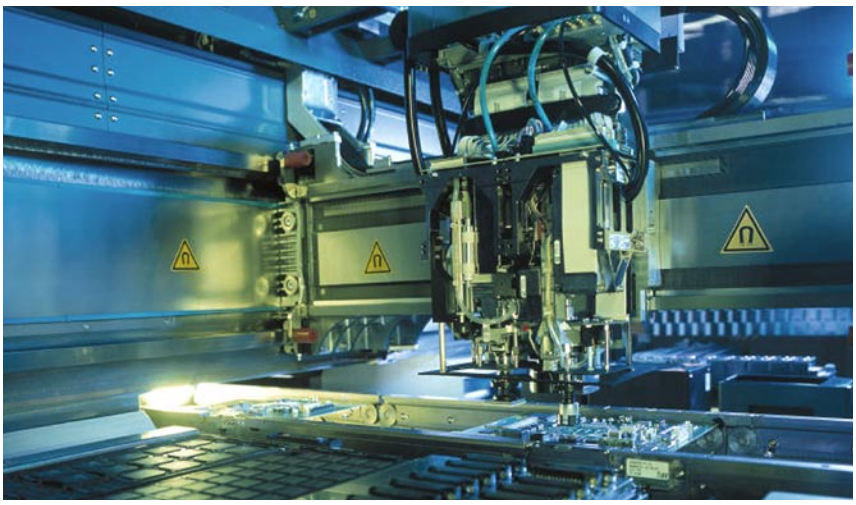
LOSTPED is an acronym that stands for **L**oad, **O**rientation, **S**peed, **T**ravel, **P**recision, **E**nvironment and **D**uty cycle. Each letter represents one factor that must be considered when sizing and selecting a linear motion system. Each factor must be considered individually as well as in conjunction with the others to ensure the best overall system performance. For example, the load imposes different demands on the bearing system during acceleration and deceleration than during constant speed movements. As more linear motion

Rexroth CKK and CKR Compact modules are frequently used in applications requiring side-mounted loads.

solutions move from individual components to complete linear module or Cartesian systems, the interactions between system components—i.e. linear bearing guides and ball screw, belt, or linear motor drives—become more complex, and designing the right system becomes more challenging. The LOSTPED acronym can help designers avoid mistakes by simply reminding them to consider all of the interrelated factors during system development and specification.

How to Use LOSTPED

Below are descriptions of each LOSTPED factor, as well as key questions to ask when determining the criteria to size and select a linear motion system.



Speed and acceleration also affect the selection of a linear motion system.

LOAD

Load refers to the weight or force applied to the system. All linear motion systems encounter some type of load, such as downward forces in material handling applications or thrust loads in drilling, pressing or screw driving applications. Other applications encounter a constant load, such as a semiconductor wafer-handling application, in which a FOUP (Front-Opening Unified Pod) is carried from bay to bay for drop-off and pick-up. A third type is defined by varying loads, such as a medical dispensing application, where reagent is deposited in a series of pipettes one after another, resulting in a lighter load at each step.

While considering load, it's also worth taking a look at what type of tool will be at the end of the arm to pick up or carry the load. Although not specifically related to load, mistakes here can be costly. For example, if a highly sensitive workpiece is picked up in a pick-and-place application, it may be damaged if the wrong type of gripper is used. So although it's highly unlikely that a designer would forget to consider general system load requirements, he or she may indeed forget to consider certain aspects of those requirements. LOSTPED is a way to ensure completeness.

KEY QUESTIONS TO ASK:

- What is the source of the load and how is it oriented?

Which linear drive will best address the speed and acceleration needs?

- Are there special handling considerations?
- How much weight or force must be managed?
- Is the force a downward force, lift-off force or side force?

ORIENTATION

The orientation, or relative position or direction in which the force is applied, is also important but often overlooked. Some types of linear modules or actuators can handle higher downward/upward loading than side loading because of the linear guide system used in the module design. Other modules, using different linear guides, can handle the same loads in all directions. The Rexroth Compact Module CKK, for example, uses a dual Ball Rail System for guidance and is called upon frequently in applications requiring side-mounted, or axial, loads. Since most high-quality linear motion suppliers make modules and actuators to handle various situations, it's important to make sure that the modules specified can handle the load requirements in the orientation needed to achieve success in the application.

KEY QUESTIONS TO ASK:

- How is the linear module or actuator oriented?
- Is it horizontal, vertical or upside down?
- Where is the load oriented relative to the linear module?
- Will the load cause a roll or pitch moment on the linear module?

SPEED

Speed and acceleration also affect the selection of a linear motion system. An applied load creates far different forces on the system during acceleration and deceleration than it does during a constant speed movement. The type of move profile — trapezoidal or triangular — must also be considered, as the acceleration required to meet the desired speed or cycle time will be determined by the type of move required. A trapezoidal move profile means that the load accelerates quickly, moves at relatively constant speed for a period of time, and then slows down. A triangular move profile means the load accelerates and decelerates quickly, as in point-to-point pick-up and drop-off applications. Speed and acceleration are also critical factors in determining the appropriate linear drive, which is typically a ball screw, a belt, or a linear motor.

KEY QUESTIONS TO ASK:

- What speed or cycle time must be achieved?
- Is it a constant speed or variable speed?
- How will the load impact acceleration and deceleration?
- Is the move profile trapezoidal or triangular?
- Which linear drive will best address the speed and acceleration needs?

TRAVEL

Travel refers to the distance or range of motion. Not only must the travel distance be considered, but also overtravel. Allowing some amount of "safety travel," or additional space, at the end of the stroke ensures the safety of the system in case of an emergency stop.

KEY QUESTIONS TO ASK:

- What is the distance or range of motion?
- How much over travel may be required in an emergency stop?

PRECISION

Precision is a broad term that is often used to define either travel accuracy (how the system behaves while moving from point A to point B), or positioning accuracy (how closely the system reaches the target position). It can also refer to repeatability, or how well the system moves back to the same position at the end of each stroke. Understanding the difference between these three terms — travel accuracy, positioning accuracy, and repeatability — is often critical to ensuring the system meets the performance specifications and that the system is not overcompensating for a high degree of accuracy that may be unnecessary.

But the main reason to think through the precision requirements is drive-mechanism selection: belt drive, ball screw, or linear motor. Each type offers trade-offs between precision, speed, and load-carrying

capacity, and the best choice is dictated mostly by the application.

KEY QUESTIONS TO ASK:

- How important are travel accuracy, positioning accuracy, and repeatability in the application?
- Is precision more important than speed or other LOSTPED factors?

ENVIRONMENT

Environment refers to the surrounding conditions in which the system will be expected to operate. For example, extreme temperatures can affect the performance of plastic components and lubrication within the system, while dirt, liquids, and other contaminants can cause damage to the bearing raceways and load carrying elements. This is an often-overlooked performance factor that can greatly influence the life of a linear motion system. Options such as sealing strips and special coatings can help prevent damage from these environmental factors. In addition, options such as special lubrication and positive air pressure can make the module or actuator suitable for use in a cleanroom application.

KEY QUESTIONS TO ASK:

- What types of hazards or contaminants are present—extreme temperatures, dirt, dust, liquids, etc.?
- Conversely, is the linear motion system itself a potential source of contaminants for the environment (ESD, lubricants, or particulate)?

DUTY CYCLE

Duty cycle is the amount of time it takes to complete a cycle of operation. In all linear actuators, the internal components will generally determine the life of the final system. Bearing life inside a module, for example, is directly affected by the applied load, but is also affected by the duty cycle that the bearing will experience. A linear motion system may be capable of meeting the previous six factors, but if it runs continuously 24 hours a day, seven days a week, it will reach the end of its life much sooner than if it runs only eight hours a day, five days a week. In addition, the amount of in-use time versus rest time influences heat build-up inside the linear motion system and directly impacts system life and cost of ownership. Clarifying these issues in advance can save time and aggravation later.

KEY QUESTIONS TO ASK:

- How often is the system in use, including any dwell time between strokes or moves?
- How long does the system need to last?

Overtravel must be considered in the range of motion.

Some Final Advice

While LOSTPED provides seven basic factors and key questions to ask when sizing and selecting a linear motion system, for best results designers should consult a reputable distributor or the manufacturer's application engineering department. These resources typically have experience with hundreds of applications, and may be able to make substantial time- and cost-saving recommendations. After all, the end objective is to get the best linear motion system possible with the lowest cost of ownership. Skilled application engineers familiar with LOSTPED can make sure their customers get just that.

For more information on LOSTPED, visit ***www.boschrexroth-us.com*** *and enter web code* US0356.

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