Careful review of your linear actuator application can help to eliminate costly mistakes and provide for optimal system performance.

Linear actuators are used in a variety of applications across numerous industries, including medical equipment, agriculture machinery, high-voltage switch gears, train and bus doors, and factory processes and assembly machinery. Typical end uses include medical beds, patient lifters, wheelchairs, adjustable tables and workstations, diagnostics, to name a few. Each linear actuator application has unique requirements. There are many manufacturers throughout the world that offer innumerable models of linear actuators in a wide variety of stroke sizes, speeds, voltage and types. With the availability of so many manufacturers, models and options, selecting the right linear actuator for your application can be a daunting task. When a system is tailored for an application, the specific requirements will influence both the design and the manufacturing processes. Regardless of end use, an actuation system is designed by first identifying basic needs, then evaluating certain key parameters that ultimately affect the overall system operation.

Electromechanical linear actuators are designed to provide precision, efficiency, accuracy, and repeatability in effecting and controlling linear movement. These devices serve as practical, efficient, and relatively maintenance-free alternatives to their hydraulic or pneumatic actuator counterparts. Depending on type and manufacturer, today's electromechanical linear actuators can handle loads up to 3,000 pounds (13 kilonewtons) and deliver speeds up to 6 inches/second (150 millimeters/second), with strokes ranging from 2 inches (50 millimeters) to 60 inches (1,500 millimeters). Actuators can be self-contained in aluminum, zinc, or polymer housings and ready to mount for easy plug-in operation (using either AC or DC power supplies).

What's more, actuators featuring both modular design and open architecture enable interchangeable internal and external components, according to specifications.

Please note that standard components, including the types of drive screws, motors, front and rear attachments, controls, and limit switches used, will allow for desired customization without the costs typically associated with special modifications.
Starting the Process

Step One: The Basics

Describe and discuss the application in as much detail as possible with a knowledgeable and experienced supplier. At this stage, focus on basic specifications for load, actuator, and power and control in the selection process:

1. How much force (in newtons or pounds-force) and in what directions (push, pull, vertical, and/or horizontal) will the actuator need to move? (Force is a function of maximum and average dynamic loads.)
2. How far will the actuator need to move? (This will factor in both the stroke and retracted lengths and is usually expressed in millimeters.)
3. How fast (millimeters/second or inches/second) will the actuator need to move?
4. How often will the actuator operate, and how much time will elapse between operations? (This refers to the "duty cycle," which will be based on the number of expected repetitions per unit of time in hours/day, minutes/hour, and/or strokes/minute.)
5. What is the desired lifetime for the end product? (This will impact virtually every component within a linear actuator system.)
6. How will the actuator be mounted? Will front and/or back mounts require special configurations?
7. Does the application suggest particular safety mechanisms (e.g., "manual operators" for use in case of emergency)?
8. Will environmental factors (temperature variations, moisture, vibration, or end-product shock) pose a challenge to operation?
9. Is space limited? (If so, the actuator will have to be designed to fit in a specific footprint.)
10. What are the power supply options (motor vs. battery)?
11. If a motor is utilized, what are its type (AC, DC, or special) and voltage?
12. Is feedback required for speed and/or position? (This will indicate a need for add-on components, such as encoders.)

Note: The specific parameters that play a crucial role in every electromechanical actuator application is the: electrical power in, duty cycle, and actuator efficiency.
Step Two: The Power Factor

A linear actuator is a device that produces linear motion by utilizing some external energy source. As far as the source of energy used is concerned, it can be piezoelectric, pneumatic, hydraulic, mechanical, electro-mechanical, etc. A linear actuator system draws principles from both electrical and mechanical engineering disciplines. Consequently, power (defined in watts) is usually the first requirement to be calculated. In order to get mechanical power out of an electric linear actuator, it’s necessary to put electrical power into the system. Mechanical power out is usually the easier of the two to define because all that's needed for its calculation is the force, or the load that will be moved, and the speed required.

If the parameters are in metric (SI) units, multiply the force (in newtons) by the speed (in millimeters/second) to obtain watts. (To convert pounds to newtons, multiply by 4.448; to convert inches to millimeters, multiply by 25.4.)

Mechanical power out ($P_o$):

$$ P_o = F \times v $$

$F$ = Force (N)
$v$ = Velocity (meters/sec)

Information regarding electrical power can be ascertained through performance graphs and charts from suppliers’ specification sheets. Suppliers chart this information differently, but more often than not, there are graphs for force vs. speed and force vs. current draw at a specified voltage. This data is often presented in two graphs or combined in one. The current draw may also be presented in tabular form. In addition, factors will be given based on a duty-cycle curve. The relevant formula is as follows:

Electrical power in ($P_i$):

$$ P_i = E \times I $$

$E$ = Voltage (V)
$I$ = Current (A)

Step Three: Calculating Duty Cycle

Users will want to establish the duty-cycle factor (sometimes called the "derating factor"). Duty cycle is important. Sometimes the preliminary actuator selection may not meet all of an application’s operating requirements. The duty cycle indicates both how often an actuator will operate and how much time there is between operations. Because the power lost to inefficiency dissipates as heat, the actuator
component with the lowest allowable temperature (usually this is the motor) establishes the duty-cycle limit for the complete linear actuator system. Please note: There are some heat losses from friction in a gearbox, and via ball-screw and acme-screw drive systems.

To demonstrate how the duty cycle is calculated, assume an actuator runs for 10 seconds cumulative, up and down, and then doesn't run for another 40 seconds. The duty cycle is 10/(40+10), or 20%. If duty cycle is increased, either load or speed must be reduced. Conversely, if either load or speed decreases, duty cycle can increase. The duty cycle is relatively easy to determine if a linear actuator is used on a machine or production device. In other, less predictable applications or those where the linear actuator will be used infrequently, it's advisable to estimate the worst-case scenario in order to assign a meaningful duty-cycle calculation. It is not advisable to operate on the edge of the manufacturer's power curves because this might cause the linear actuator and other components to run too hot. However, in some applications where the duty cycle is 10% or less, the actuator can run to the limit of its power curves.

**Step Four: Ascertaining 'Efficiency' and Expected Life**

A system's "efficiency" is usually missing from most manufacturers' literature, but it can tell the user how hot the actuator may get during operation; whether holding brakes should be specified in the system if the actuator uses a ball screw; and how long batteries may last in battery-powered systems, among other pertinent data. Calculating efficiency from performance curves is simple: Divide mechanical power out by electrical power in. This yields the efficiency percentage.

While these factors are being calculated and decision making is moving toward final selection, one additional parameter should be addressed:: the application's expected lifetime. Although linear actuator components (e.g., the motor or screw) can be replaced, most actuators can't be easily repaired. In addition, it's important to cover application life expectancy because suppliers will sometimes indicate acme or ball screw life at a certain load, or include mathematical formulae to calculate life based on application parameters. A good design practice is to strive to have the screw and motor life expectancies match as closely as possible.
In those cases where an existing linear actuator must be replaced, ensure that the application engineer has all the necessary information to ensure a good fit. Whenever a linear actuator is subject to replacement, it is recommended to review the application as if it were new.

**Other Selection Considerations: Budget and Experience**

Having a clear picture of a linear actuator system budget in your mind will help in selecting the best product at an affordable price. Advance budget planning can definitely save the user a lot of time in the selection process by eliminating some types that are too expensive for the application. As mentioned earlier, there are many companies providing linear actuators to the customers based on their requirements. It is important to choose a reliable company for the best results in terms of the actuator features and price.