Requirements on the design

Derived from design and properties of linear direct drives, the machine design must meet various requirements. For example, the moved masses should be minimized whilst the rigidity is kept at a high level.

Mass reduction

To ensure a high acceleration capability, the mass of the moved machine elements must be reduced to a minimum. This can be done by using materials of a low specific weight (e.g. aluminum or compound materials) and by design measures (e.g. skeleton structures).
If there are no requirements for extreme acceleration, masses up to several tons can be moved without any problems. There is no control engineering correlation between the moved slide mass and the motor's mass, as this is the case with rotary drives. Precondition therefore is, a very stiff coupling of the motor to the weight.

Mechanical rigidity

In conjunction with the mass and the resulting resonant frequency, the rigidity of the individual mechanical components within a machine chiefly determines the quality a machine can reach. The rigidity of a motion axis is determined by the overall mechanical structure. The goal of the construction must be to obtain an axis structure that is as compact as possible.

Natural frequencies

The increased loop bandwidth of linear drives required higher mechanical natural frequencies of the machine structure in order to avoid the excitation of vibrations. To ensure an adequate control quality, the lowest natural frequency that occurs inside the axis should not be
less than approximately 200 Hz. The natural frequencies of axes with masses that are not constantly moving (e.g. due to workpieces that must be machined differently) change, so that the natural frequency is reduced with □ ≈ sqrt (1/□m) as the mass increases.

Mechanically linked axes

The elasticity's of the axes (both, the mechanical and the control engineering component) add up. This must be taken into account with respect to the rigidity of cinematically coupled axes. If several axes must cinematically be coupled in order to produce path motions (e.g. cross-table or gantry structure), the mutual effects of the individual axes on each other should be minimized. Thus, cinematic
chains should be avoided in machines with several axes. Axis configurations with long projections that change during operation are particularly critical.

Reactive forces

Initiated by acceleration, deceleration or process forces of the moved axis, reactive forces can deform the stationary machine base or cause it to vibrate.