



Prosthetic Knee Systems

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Prosthetic knee systems are among the most complex of all components. This is because knees must give support when people stand, allow smooth motion when people walk, and permit movement when people sit, bend or kneel.



Prosthetic knees range from simple systems that have been used for hundreds of years to advanced computer-based systems that are popular today. While the perfect prosthetic knee has yet to be invented, research shows great promise with many new types of technology.

Today, there are over 100 types of knee systems to choose from. Doctors, prosthetists and rehabilitation specialists consider an amputee's age, health, activity level, and lifestyle when making suggestions about which types of

knees and their options for stability and motion control would work best for them.

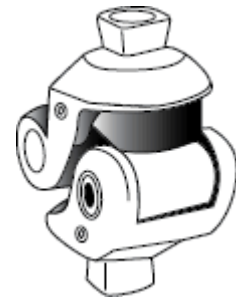
There are two major types of knees — mechanical and computerized. Each type has advantages (what works well) and disadvantages (what doesn't work as well).

MECHANICAL KNEES

Mechanical knees can also be divided into two types: single-axis and polycentric (more than one axis).

Single-axis knee. This type of knee works like a simple hinge. It:

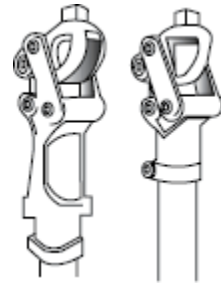
- is durable (lasts a long time)
- is lightweight
- costs less than other knee systems
- has no stance control, which means that amputees must use their own muscles to remain stable when standing
- often uses a manual lock to compensate for lack of stance control



- often uses friction to keep the leg from swinging forward too fast when moving to the next step.

Polycentric knee. This type of knee is more complex, allowing more freedom of motion. It also:

- may need to be repaired or replaced more often than other types of prosthetic knees
- weighs more than single-axis knees
- is very stable during early stance phase (at the beginning of a step)
- reduces the leg's length when beginning a step, lowering the risk of stumbling
- bends in the swing phase (when one leg is in the air) or when the user sits down
- works well for many amputees, including those who have had problems with other prosthetic knees or have knee disarticulation, bilateral leg amputations, or long residual limbs
- has a simple swing control that allows for an ideal walking speed
- often has a fluid swing control (a piston inside a cylinder containing air or oil) to allow different walking speeds



- may restrict some knee motion, but not enough to be a problem.

Stability Options

There are two types of stability options for mechanical knees — manual locking knees and weight-activated stance-control knees.

Manual locking knee. This type of knee:

- is the most stable knee available
- automatically locks in extension to prevent buckling
- can be unlocked easily
- takes a lot of energy and causes a stiff, awkward gait when the knee is locked
- can be used by amputees who are weak or unstable as well as those who are more active but walk on uneven ground.

Weight-activated stance-control knee. This type of knee:

- is very stable
- applies constant friction to the axis during leg swing
- will not bend when a person's weight is on the prosthesis

- is often an amputee's first prosthesis or used by those who are older or less active.

Motion Control Options

All knee systems need some type of swing control to keep a steady gait.

There are two options — constant friction and variable friction motion control.

Constant friction. These systems:

- are simple
- are lightweight
- are dependable
- can only be adjusted to one walking speed at a time.

Variable friction. These systems:

- give increased resistance as the knee bends from full extension
- allow variable walking speeds
- need frequent adjustment and replacement of moving parts

- perform similarly to fluid control systems but are considered less advanced in design.

Fluid Control Systems

Fluid control systems work like pistons to provide varying degrees of resistance during swing phase, allowing amputees to walk comfortably at different speeds. There are two types of fluid control systems — pneumatic (using air) and hydraulic (using fluid).



Pneumatic control. These systems:

- compress air as the knee is flexed, storing energy, then returning energy as the knee moves into extension
- can have a spring coil to add more gait control
- provide better swing control than friction systems
- are less effective than hydraulic systems.

Hydraulic control. These systems:

- use liquid (usually silicone oil) to respond to a wide range of walking speeds

- provide nearly normal knee function
- are heavier, need more maintenance, and cost more than pneumatic systems
- are often used by active amputees.

COMPUTERIZED (MICROPROCESSOR) KNEES

Computerized knees are relatively new types of prosthetic technology. There are several types now available, and others are in development. Although each model has slightly different features and performance characteristics, all computerized knees:

- are usually smaller and more lightweight than mechanical knees
- are initially programmed to “learn” the user’s walking characteristics
- have timing, force, and swing sensors that take readings 50 times per second or faster, and instantly adjust the fluid control system accordingly
- take less effort to control timing, which means that amputees have a more natural gait, longer walking endurance, and better control on uneven surfaces, even when going down stairs
- are appropriate for moderately to very active amputees.

Translated from Prosthetic Knee Systems
<http://www.amputee-coalition.org/military-instep/knees.html>

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