Genium® Microprocessor Knee
Genium Features and Benefits

Hydraulic Swing and Stance Phase Knee

- Genium has hydraulic swing and stance phase control.
- Hydraulic swing phase control allows patients to vary cadence. The hydraulic fluid flows through narrow channels, providing a frictional resistance, which increases with the speed of compression; a faster gait speed allows quicker knee extension. The hydraulic also provides swing extension dampening to prevent a hard impact at terminal swing that may cause vibrations in the prosthesis and, as a consequence, an unsafe feeling in the patient.
- Hydraulic stance phase control allows for knee flexion during weightbearing. This is necessary for walking with physiologic stance flexion on level ground, and natural step-over-step slope and stair descent and negotiation of uneven terrain. The hydraulic also provides sufficient knee flexion resistance for full weightbearing for “stumble recovery” during tripping.

Optimized Prosthetic Gait (OPG) with pre-flex function

- The Genium provides autoadaptive microprocessor control of the (hydraulic) swing and stance phase. Using simulated physiologic rule sets with multi-modal proprioceptive input (six separate sensors) run by a state-of-the-art microprocessor.
- Unlike all other microprocessor controlled knees that have to be (unphysiologically) fully extended at heel strike, these simulated physiologic rule sets allow Genium for optimized prosthetic gait (OPG) with a nearly physiologic pre-flexion of the knee at heel strike.
- Pre-flexion allows for easier “riding into the knee” with a reduction of braking forces during walking (reduction of the feeling to have to “climb over the prosthesis”) and easier use of physiologic knee stance flexion for shock absorption.
- Pre-flexion facilitates earlier foot-flat and increased prosthetic weightbearing resulting in improved safety and more physiologic step-over-step gait pattern during slope descent.

- Pre-flexion supports easier and more physiologic step-over-step slope ascent by reducing the need to “climb up over the limb”.
- Pre-flexion facilitates a consistent positioning of the foot for step-over-step stair descent, resulting in more confidence and prosthetic side weightbearing.
- The improvements in safety and gait patterns in slope ambulation also facilitate the negotiation of uneven terrain that is basically a permanent switchover between inclines and declines.

Obstacles and Stairs Function

- The Genium allows for nearly normal stepping over bigger obstacles with the prosthetic leg first – the knee can be normally flexed and the prosthesis be moved over the obstacle like taking a long step. Genium is safe while loaded bent past the obstacle. All other MPK´s require that the patient has to move the extended/stiff prosthetic leg around obstacle using circumduction, which is associated with a high risk of catching the toes, stumbling and falling.
- The Genium also enables nearly normal stepping over bigger obstacles with the sound leg first. The trailing prosthetic leg can be normally bent and moved over the obstacle. All other MPK´s require that the patient moves the trailing extended/stiff prosthetic leg around the obstacle using circumduction or to hop forward on the sound leg and drag the stiff prosthetic leg over the obstacle. Both ways are associated with a substantial risk of catching toes, stumbling, and falling.
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- Genium allows for ascending stairs in the natural step-over-step manner with a prosthetic knee that bends to maximize clearance of the stair with each step. In the walk upstairs mode, the bent prosthetic knee produces enough flexion resistance that the patient can use the prosthesis as a counter bearing to lift his/her body up to the next step using his/her hip and residual limb muscles. (The conventional method for ascending stairs with a prosthetic knee is to take two steps at a time with the sound-side limb and ascend stairs with a straight knee on the prosthetic side, which results in a significant strain to the sound limb joints and muscles).

Dynamic Stability Control

- The Genium allows for safe multi-directional motion and transitional gait by controlling the switch from stance to swing.
- It also provides stability in crowds and confined areas, because of its ability to reliably transition from stance into swing phase while taking small and shuffling steps.
- The Genium also offers an optimized swing phase control with a nearly physiologic swing knee flexion angle of 64° independent of walking speed. This provides improved toe clearance in slower walking speeds as well as timely Shank swing in higher walking speeds – that patient doesn’t have to wait for a lagging Shank to swing forward.
- The optimized swing phase control also results in increased knee flexion and thus toe clearance and safety when ascending and descending slopes.

Inertial Motion Unit

- The Inertial Motion Unit (IMU) consists of a separate microprocessor that processes the information of a 3D-gyroscope and a 3D-accelerometer to calculate the position and movement directions of the prosthesis to feed it into the main microprocessor board of Genium.

- This patented technology allows the patient to intuitively stand on a flexed and stable knee on level, uneven, or inclined surfaces (ramps or hills). The user does not need to activate or deactivate the stance function; both occur intuitively. Stance function is ended with a simple step (prosthesis side or sound side). With traditional prosthetic knees it is imperative that the user cognitively ensure at all times that the center of mass stays ahead of the knee axis in order to prevent unexpected flexing of the prosthetic knee, which can cause the knee to collapse. In this situation, the user will uncomfortably stand with the hip extended in order to attempt to stabilize the knee.

- This IMU also provides stability when taking steps backwards. Traditional microprocessor knees do not accommodate backward walking, because the knee is programmed to go into swing when the toe is loaded, causing the knee to collapse when stepping backward.
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Stumble Recovery Feature
- The Genium is there for the patient should the toe catch during midswing, providing a “stumble recovery” feature. As soon as the knee stops flexing and maximum heel rise is achieved, this feature is immediately activated; thus, if at any point the toe catches a supporting resistance is available. This allows patients enough time to bring their contralateral side through to catch themselves, thus preventing a fall and keeping it at a controlled “stumble.” This feature of the Genium allows this resistance to be angle dependent, meaning it will provide additional resistance compared to normal stance phase resistance. From that point on, the further the knee bends (or the further the patient is into the fall) the higher the resistance that will be provided.

Stance Flexion Yielding
- When the prosthesis initially contacts the ground, this feature allows the patient to mimic the natural gait pattern by loading the knee in a flexed position. Benefits include shock absorption, reducing the modulation of the center of gravity throughout the gait cycle (reduction of the feeling of having to “climb over the prosthetic leg”), energy efficiency (less energy spent on “pulling back” on hamstrings to lock a fully extended knee), and an overall more natural gait pattern. Hip and lower back stress will also be minimized.
- This feature also allows patients to “ride” the knee (the knee supports patients’ weight on flexed knee without buckling and lowers them into desired position) when sitting into a chair, kneeling, and when descending stairs and slopes.

Stance Extension Damping
- After the knee is flexed during stance phase (stance flexion), it needs to extend again to advance the body forward through mid- and terminal stance. This feature provides increased resistance to this extension. Without this dampening the patient will feel a pronounced “snap back” or “jerk” at the knee that may cause a feeling of insecurity, and will also present with an unnatural looking gait pattern. Energy is conserved by having this feature, as the patient will not have to attempt to use hamstrings to control this motion.

Additional Features
- **Walk2Run feature:** The Genium’s knee joint is able to detect transition from walking to running automatically while in basic mode and reacts accordingly, by switching into a larger swing phase angle suited for running (higher swing flexion angle, decreased swing extension resistance, with no Preflex behavior). This innovative Walk2Run mode is ideal for running short distances and start-and-stop running such as across a street, down the hall or to catch a bus.
- **Deliberate Stance Function:** When enhanced stability is needed (e.g. bilateral, hip disarticulation, etc.), the Genium has a deliberate stance function feature that can be programmed by the prosthetist. Deliberate stance function is initiated by simply holding the prosthesis still for just 125 milliseconds. This stance function is ended when the user takes the weight off the prosthesis or extends it slightly.
- **Activity Report:** The provider can track and document the user’s progress towards rehabilitation goals. The tracking system can also be used to satisfy reimbursement requirements or optimize service of the device.
- **Patient App:** A Cockpit app is available for some devices, which allows the patient to control some of the functions. The app also displays information such as the battery level.
Genium X3 Clinical Studies


