

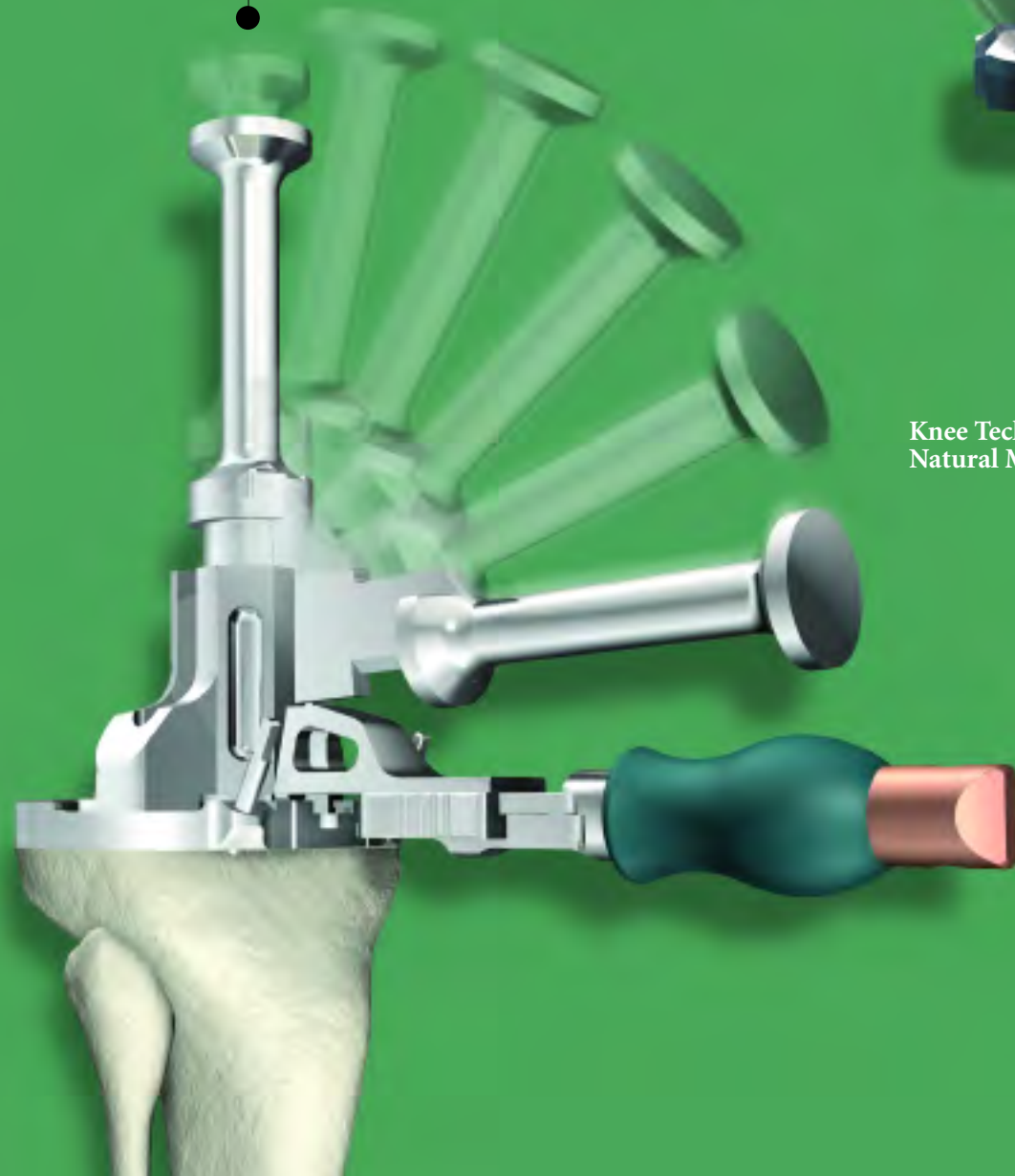
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is intended for healthcare professionals only.**

Triathlon™ Knee System Design Rationale

Surgical Instrumentation
and Implants



Knee Technology For
Natural Motion



Implants

Introduction

The Triathlon™ Knee System is designed to meet patients' expectations for Lifestyle Recovery™. The intuitive and evolutionary design is predicated on the worldwide clinical success of millions of Stryker knee implantations. The Triathlon™ Knee System is designed to provide patients more natural motion and the potential for greater implant longevity.

The Triathlon™ Knee is an evolutionary design developed to more closely reproduce natural knee motion, designed to provide mobility with stability through 150+ degrees of flexion.



Motion

- ▶ Design features such as a patent-pending anatomic radius, deep flexion radius and flared posterior condyles, as well as Rotary Arc and anatomic patellofemoral track allow the Triathlon™ Knee System to maintain substantial contact area throughout the entire range of motion.
- ▶ The deep flexion features of the components are designed to optimize rotation in deep flexion without sacrificing stability.
- ▶ The femoral geometry in conjunction with the Rotary Arc accommodate increasing amounts of internal/external rotation as necessitated by greater degrees of flexion¹.

Fit

- ▶ Size offerings are based on an anthropometric measurement study² for optimal interplay between implant geometry and anatomic structure.
- ▶ Offers a broader range of tibiofemoral sizing options to meet the anatomic realities of TKA.
- ▶ A 7-degree anterior flange is designed to enable downsizing with lower incidence of notching¹.
- ▶ The forgiving design aspects of the implant accommodates surgical realities.

Wear

- ▶ Designed to limit contact stresses even in adverse conditions¹.
- ▶ A precision insert locking mechanism and Anti-Rotation Island inhibits insert micromotion and increases insert/tibial tray surface contact area - all designed to decrease the likelihood of backside wear¹.
- ▶ A high degree of conformity throughout the entire range of motion is designed to reduce contact stresses and wear, offering the potential for enhanced long-term component durability⁷.

Instruments

Introduction

The Triathlon™ Knee System Instrumentation has been developed based on Stryker's 30 year orthopaedic history. The system combines the engineering expertise of Human Factors Engineers with the experience of surgeons and OR staff worldwide. The Triathlon™ Knee System Instrumentation provides optimal OR efficiency and intra-operative flexibility through an Orthonomic™ design.

Orthonomic™ Features: Incorporation of ergonomic principles into the design of orthopaedic instruments.

Efficiency

The Triathlon™ Knee System Instrumentation design team focused on identifying ways to increase the accuracy and simplicity of the surgical procedure; two variables that may affect OR efficiency. The features incorporated include:

- ▶ Open design cutting blocks to enhance visualization.
- ▶ Bold markings and color coding for ease of use and clear identification.
- ▶ Quick attach and release mechanisms to facilitate easy assembly.
- ▶ A logically organized tray layout based on the operational sequence for a streamlined process.



Flexibility

The proprietary instrumentation design also delivers intra-operative flexibility. The following features accommodate surgical preferences and help surgeons adapt to multiple surgical realities:

- ▶ System modularity facilitates a customized surgical flow.
- ▶ A common platform that is designed to allow for seamless intraoperative transitions.
- ▶ Navigation ready.
- ▶ Minimal incision capability.

Orthonomic™ Features

The Triathlon™ Knee System Instrumentation is designed to be the new gold standard in the industry. Advanced design principles incorporating Orthonomic™ features include:

- ▶ Ergonomic soft grip handles for optimized fit and comfort.
- ▶ Instrument surface treatment for reduced glare and enhanced readability.
- ▶ Procedural enhancing mechanisms.
- ▶ Lightweight trays for ease of handling.



Motion

A critical design goal of the Triathlon™ Knee System was to optimize rotation in deep flexion while providing stability. The unique design of the Triathlon™ Knee System replicates proper tracking of the epicondyles, creating natural soft-tissue tension that promotes stability, allows for deep flexion and facilitates the tibial rotation necessary to support deep flexion activities⁴. Enhanced patellofemoral mechanics reproduce natural knee motion through deep flexion.

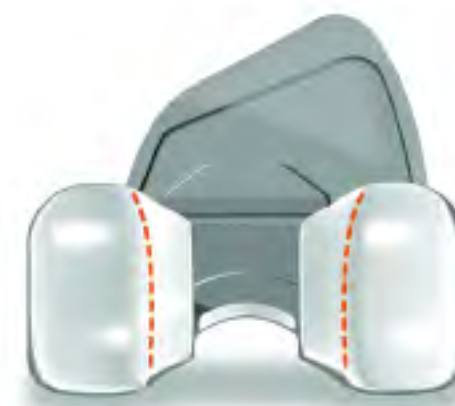
The Triathlon™ Knee design criteria are realized through component features including a patent-pending anatomic radius, deep flexion radius and flared posterior condyles, a patented Rotary Arc and a best-in-class anatomic patellofemoral track.



Anatomic Radius

Studies of kinematics and biomechanics have identified a constant radius in natural knee motion centered about the transepicondylar axis^{3,4,5}.

The Triathlon™ Knee System is the first of its kind with a patented anatomic radius. Centering the anatomic radius about the transepicondylar axis provides ligament isometry, not only in full extension and 90-degrees of flexion, but through the entire range of motion. The anatomic radius is designed to mimic natural knee motion, enhancing stability and mobility in activities such as descending and ascending stairs, gardening, or any similar activity requiring stability at deep flexion angles.



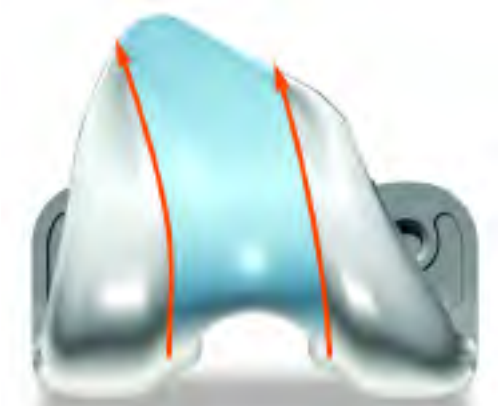
Deep Flexion Radius and Flared Posterior Condyles

The shorter posterior condyles facilitate the relaxation of soft-tissues to enable deep flexion. The condylar geometry is designed to allow for rapid flexion, enhanced contact area and natural knee rotation through 150+ degrees of flexion.

Flaring the posterior condyles accommodates increased angles of tibial rotation as the knee approaches deep flexion, culminating in up to 20 degrees of rotation while maintaining excellent contact area¹.

Rotary Arc

Natural tibial rotation is optimized through the unique Rotary Arc, which is designed to allow internal and external rotation about a central pivot. A proprietary four-axis machining process creates a tibiofemoral design that facilitates conforming, yet functionally constrained articulation.



Anatomic Patellofemoral Track

The Triathlon™ Knee patellofemoral track shares the same design as preceding Stryker® total knee systems, bringing over a decade of superior clinical performance and the industry's lowest revision rate (0.3%)⁶ to this knee system. The patellofemoral track has been enhanced with a deepened trochlear groove. This feature relaxes the extensor mechanism and is designed to enable deeper flexion and reduce the contact stresses exerted across the patella in deeper angles of flexion.

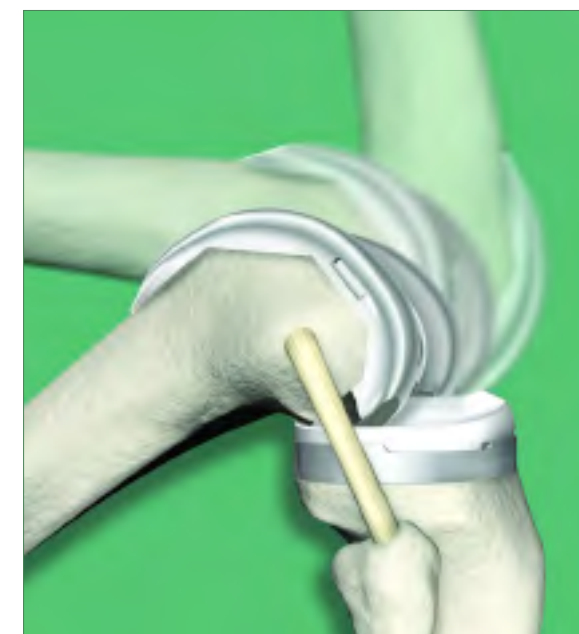
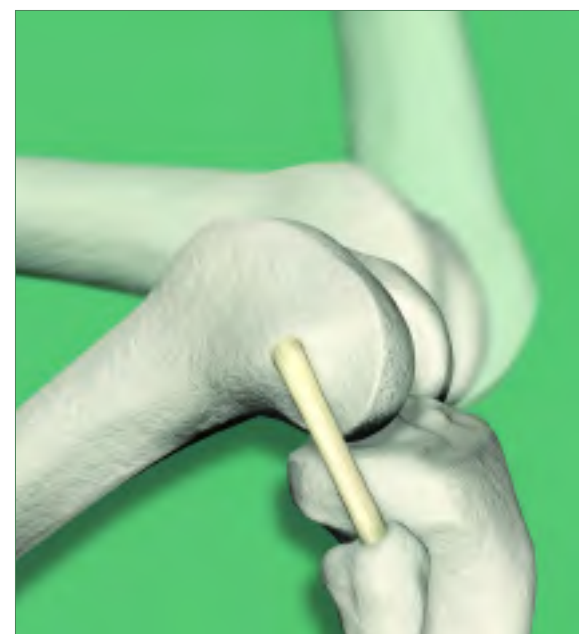
Traditional Rotary Arc



Traditional fixed bearing insert designs (above left) machine linear articulation troughs. The Triathlon™ Knee System four-axis machining process adds rotational capability to a fixed bearing insert (above right).

Bone Model of Natural Motion

By tracking the insertion point of the Lateral Collateral Ligament (LCL), studies have demonstrated that the LCL in the natural knee tracks posteriorly during early flexion and then distally towards the tibia in deep flexion (greater than 120 degrees)^{4,5}.



Implant Replicating Natural Knee Motion

The features embodied in the Triathlon™ Knee System are designed to allow the implant to work with soft-tissues to replicate more natural knee motion and stability.

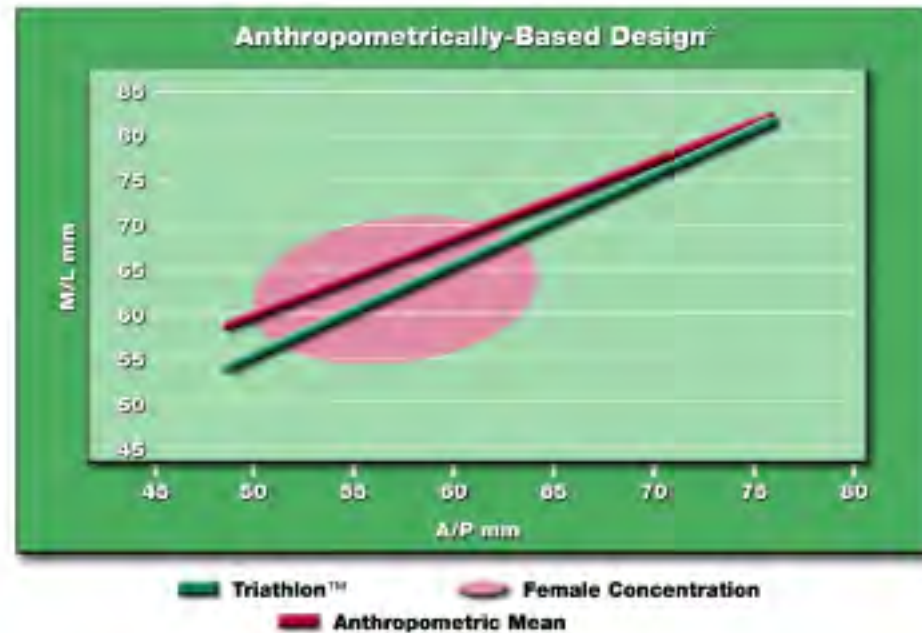


Fit

The anthropometrically-based design, unique implant geometry, and femoral sizing options provide surgeons the flexibility to respond to anatomical and surgical realities.

Anthropometrically-based Design

The Triathlon™ Knee System sizing options are based on an anthropometric study² for optimum interplay between implant and anatomic structure. With eight sizes growing by no more than 3mm in the sagittal plane, the closely linked dimensions of the components offer optimal fit to a wider spectrum of patients.

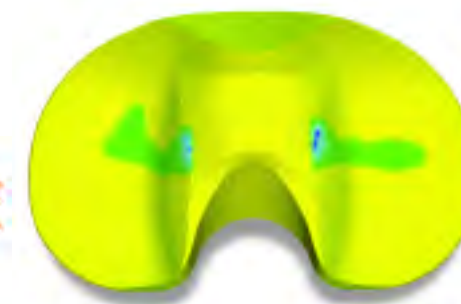
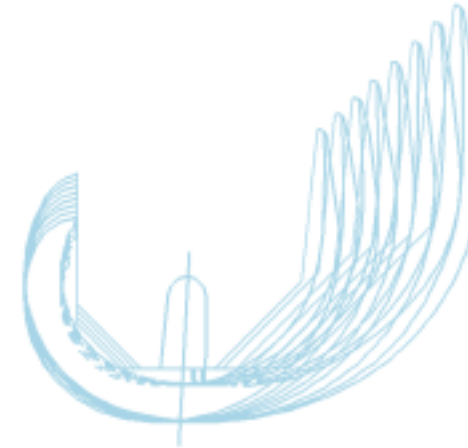


The Triathlon™ Knee System addresses smaller anatomies, often found in female patients, heavily concentrated in the region shown, while still accommodating larger patient sizing requirements.



7-Degree Anterior Flange

The unique 7-degree anterior flange design of the Triathlon™ Knee System is designed to provide the flexibility to downsize the femoral component while avoiding the incidence of notching the anterior cortex of the femur. This feature culminates in the potential to provide patients with a more customized fit.



Even in hyperextension, the Triathlon™ Knee System articular surface continues to exhibit excellent contact area and low stress.

Hyperextension

The Triathlon™ Knee System accommodates component hyperextension by offering a unique, patent-pending, load-sharing capability that is designed to shield the post in the posterior stabilized component and prevent point loading on the cruciate retaining component. This feature provides the surgeon the flexibility to make necessary intraoperative decisions while reducing the adverse trade-offs⁷.

Forgiveness

The interaction of advanced features in the Triathlon™ Knee System are designed to provide maximum flexibility to accommodate anatomic and surgical realities⁷. The Triathlon™ Knee System is designed to maintain high contact area in adverse conditions, exemplifying the forgiveness of the design.



Wear

The Triathlon™ Knee System is designed to reduce rotational stresses, increase overall contact area, and minimize backside wear.

Recent studies have shown that large amounts of volumetric wear emanating from the backside of the tibial insert are often due to high tibiofemoral articular forces translated to this interface. The Triathlon™ Knee System design addresses the issues of articular and backside wear through the reduction of articular forces in conjunction with a best-in-class locking mechanism.



Similar to the normal knee, the Triathlon™ Knee System is designed to allow increasing amounts of rotation as the knee moves through deep flexion. As shown above, less force is needed to achieve Internal/External rotation at 120 degrees of flexion than at zero degrees of flexion.

Decreased Articular Forces

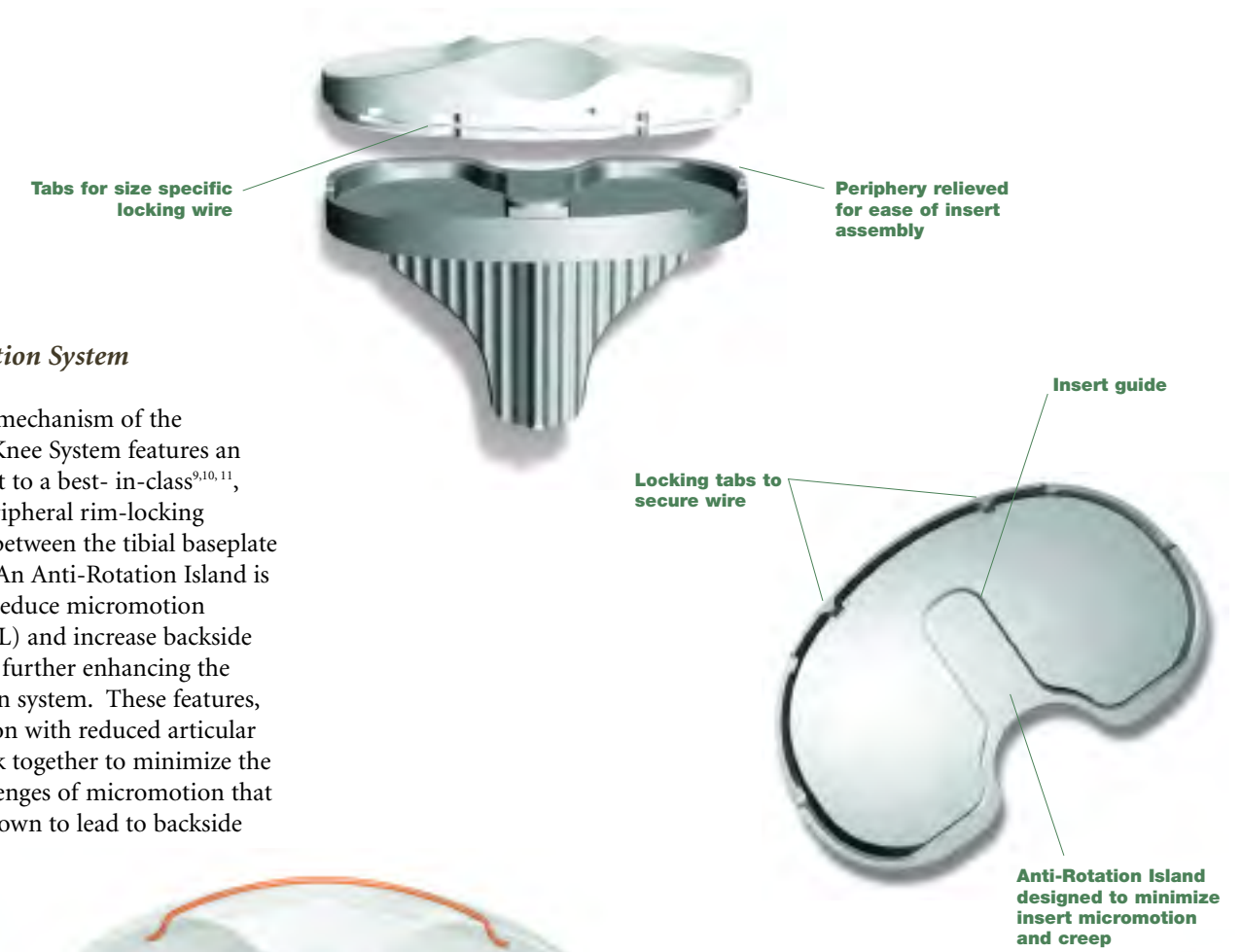
Wear in knees is a function of conformity versus constraint. Through the Rotary Arc design, anatomic radius, and flared posterior condyles, the Triathlon™ Knee System balances conformity with constraint to mimic natural knee kinematics and the potential for enhanced wear properties⁷. The Triathlon™ Knee System maintains conformity with high contact area throughout the entire range of motion while allowing for the necessary amount of internal and external rotation to reduce torsional stress⁸.



The favorable degree of conformity demonstrated by the Triathlon™ Knee System components throughout the range of motion leads to reduced contact stresses and offers the opportunity for enhanced long-term component durability without constraining the knee's functionality⁷.

Insert Fixation System

The locking mechanism of the Triathlon™ Knee System features an improvement to a best-in-class^{9,10,11}, complete peripheral rim-locking mechanism between the tibial baseplate and insert. An Anti-Rotation Island is designed to reduce micromotion (A/P and M/L) and increase backside contact area, further enhancing the insert fixation system. These features, in conjunction with reduced articular stresses, work together to minimize the clinical challenges of micromotion that have been shown to lead to backside wear¹².



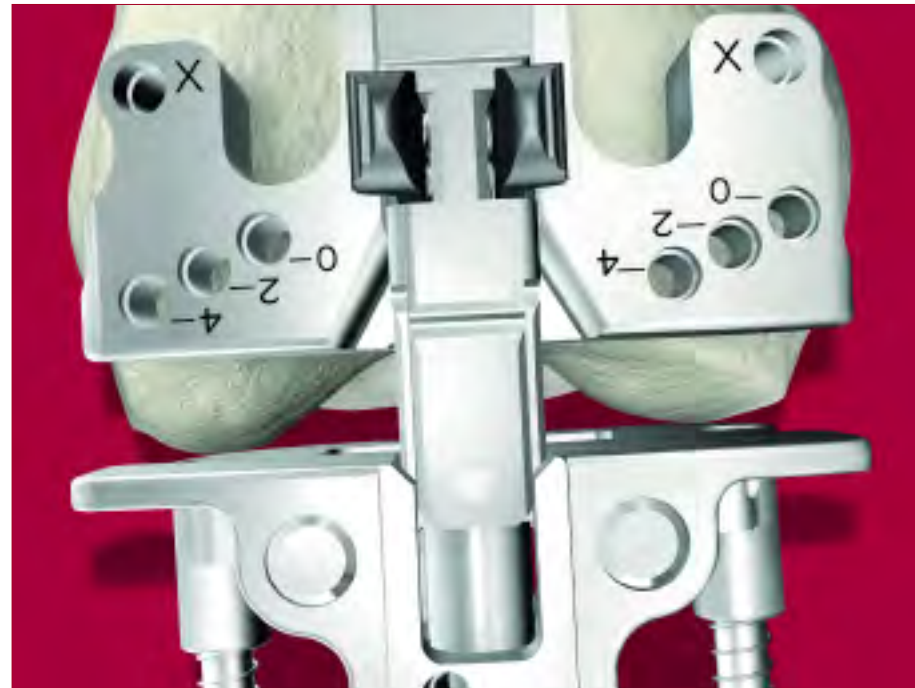
Efficiency

Efficiency in the Triathlon™ Knee System Instrumentation is achieved by increasing functionality leading to greater accuracy and simplicity.

Accuracy

Increased Visibility

The Triathlon™ Knee System Instruments increase visibility for the surgeon and OR staff by instituting an open design with clear markings for the alignment and resection guides.



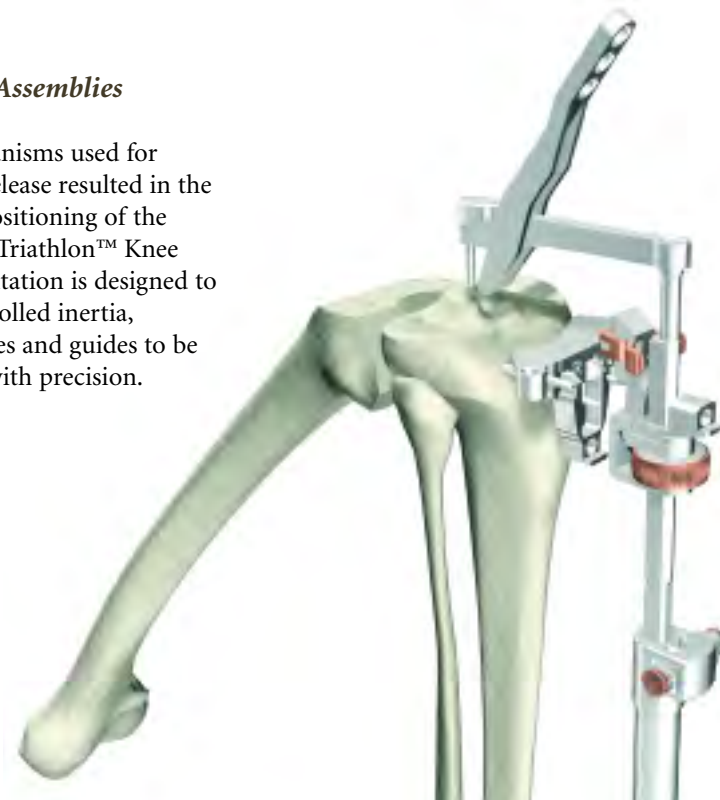
The open designs of measurement instruments and cutting surfaces aid in the visualization of bone preparation.

Reproducible Alignment and Resection

Assemblies are designed to translate towards the bone. Decreasing this distance reduces pin and blade skiving and allows for more accurate fixation and resections.

Attachments & Assemblies

Traditional mechanisms used for attachment and release resulted in the inadvertent malpositioning of the instruments. The Triathlon™ Knee System Instrumentation is designed to eliminate uncontrolled inertia, allowing assemblies and guides to be placed and used with precision.



Instruments with bold laser-etching contrast well under surgical conditions, and potentially eliminate procedural inaccuracies due to malalignment, misread markings and measurements.

Simplicity

Consolidation

The Triathlon™ Knee System Instrumentation is designed to maximize efficiency through instrument consolidation. For example, the introduction of a Universal Driver, which drives all drills, pins, and reamers, reduces the number of coupling devices to a single instrument.



Ease of Assembly

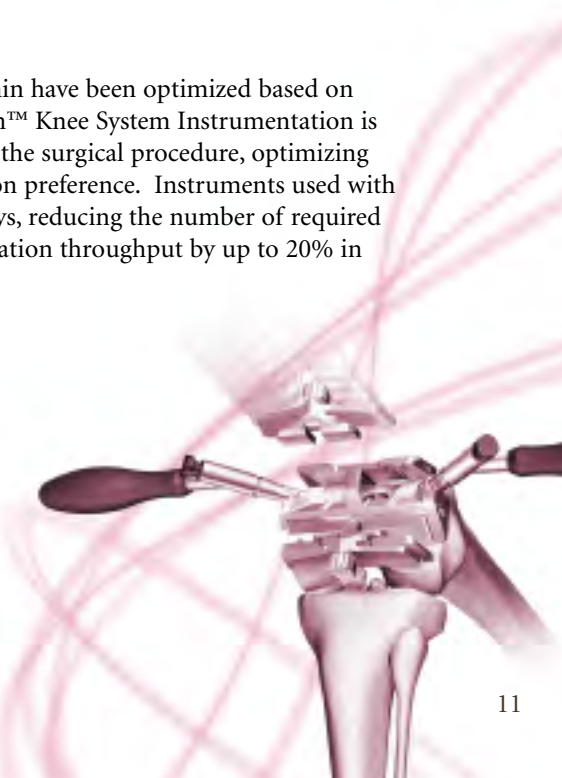
The assembly process is made easy with the intuitive quick attach-and-release mechanisms, resulting in a system designed to greatly reduce intraoperative delays and increase the efficiency of the surgery.

Instrumentation Case Configuration

Cases and the instrumentation layout within have been optimized based on operative usage pattern metrics¹. Triathlon™ Knee System Instrumentation is configured in modules that correspond to the surgical procedure, optimizing surgical flow while accommodating surgeon preference. Instruments used with less frequency are available in optional trays, reducing the number of required instruments and simplifying hospital operation throughput by up to 20% in the majority of cases¹.

Color Coding

The simple and effective color-coded system identifies instrumentation flow by identifying the actuating mechanisms: femoral instruments are black, tibial instruments are bronze and patella instruments are gold.

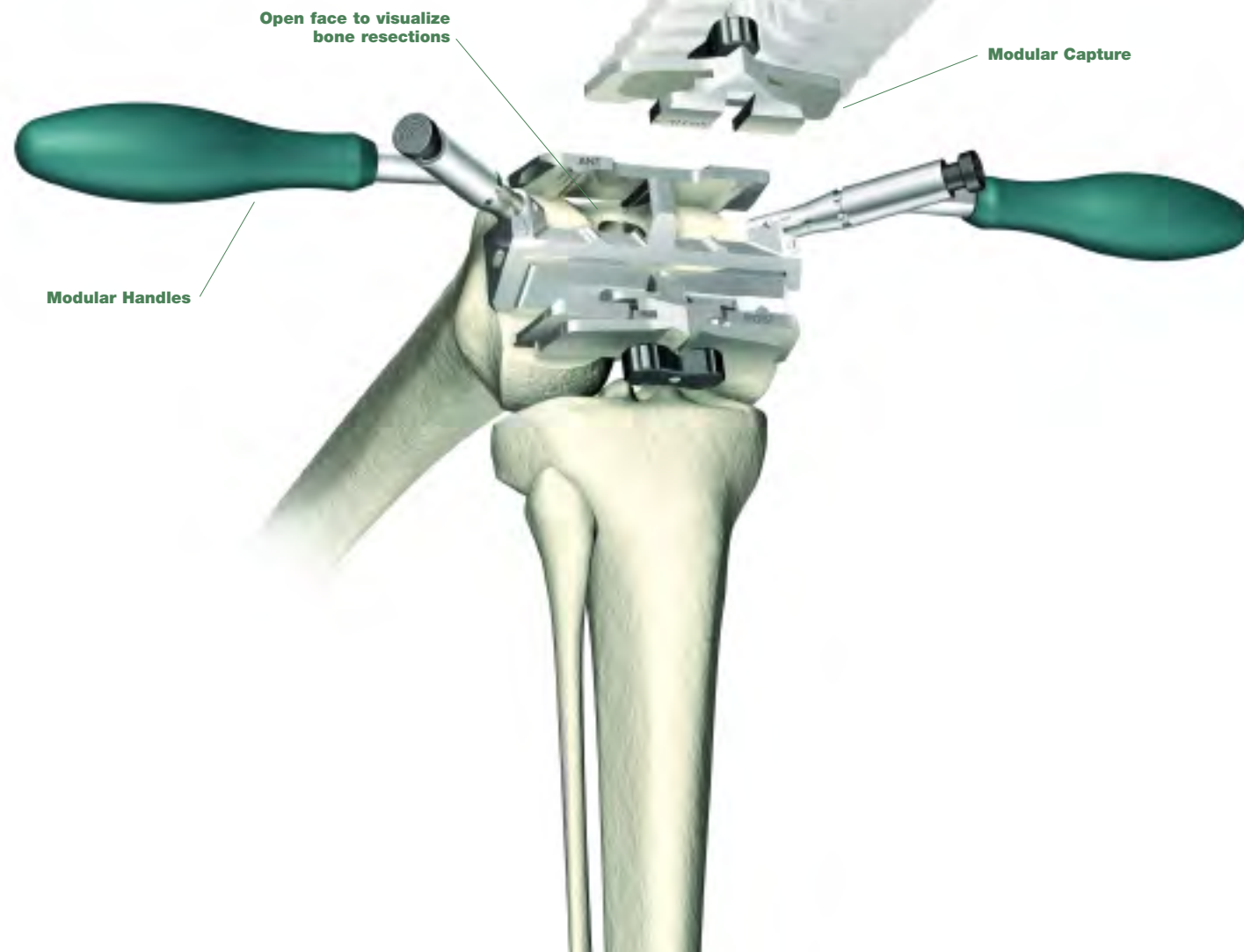


Flexibility

The Triathlon™ Knee System offers surgeons complete intraoperative flexibility with instrumentation designed to accommodate surgical realities and a multitude of techniques.

Intraoperative Decision Making

The Triathlon™ Knee System Instrumentation incorporates modularity as a principal design feature to provide surgeons the flexibility to customize the procedure.

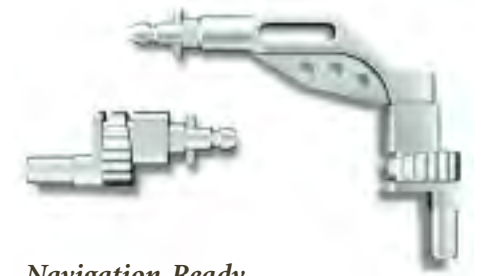
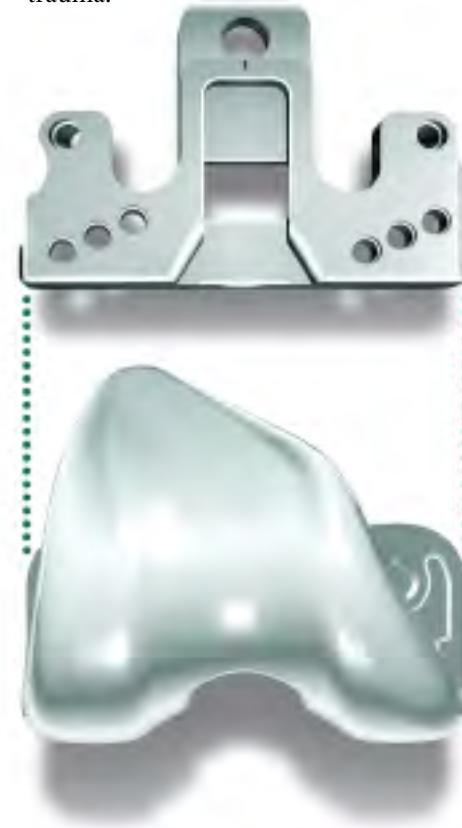


Modularity

Modular captures offer the flexibility of using captured or un-captured resection guides, as well as the ability to assess bone preparation without removing the resection guides. Modular handles feature universal quick attach-and-release mechanisms that lead to efficient procedural flow and minimizes instrument count. Case and tray modularity allows for customizable surgical flow.

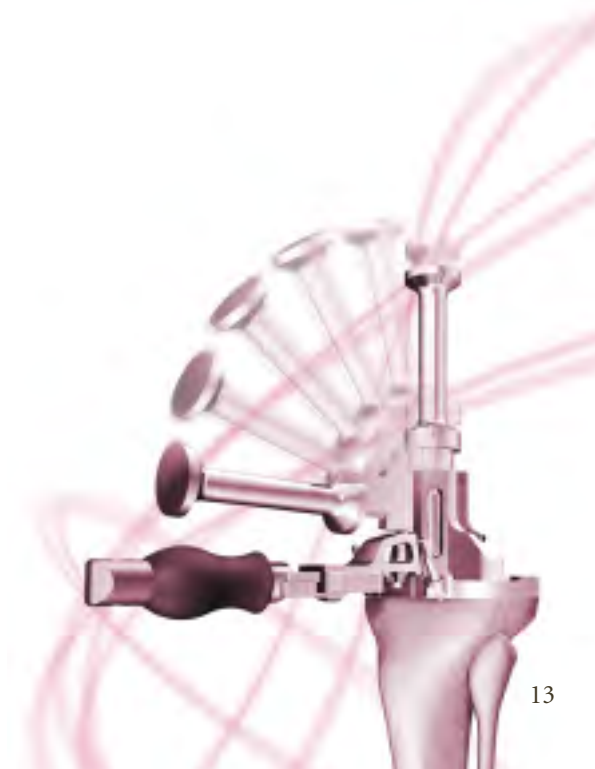
Minimal Incision Capability

Triathlon™ Knee System Instrumentation is downsized to accommodate smaller incisions, open to enhance visibility, and soft-tissue friendly to fit within a limited incision envelope. Instrument designs are comparable to implant geometries allowing instruments to fit within the window necessary to insert the implant. Proprietary instrumentation features enable surgeons to easily locate resection surfaces and complete resections within a small incision environment. The sum of these features maximizes visibility and accuracy while minimizing soft-tissue trauma.

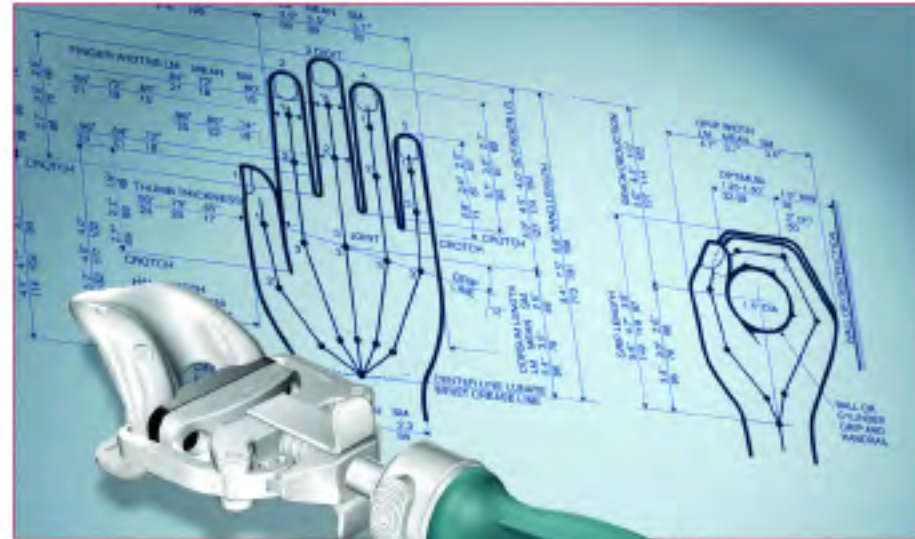


Navigation-Ready

The Triathlon™ Knee System Instrumentation has been designed for use with computer navigation technology. All alignment and resection instruments include ports for navigation, allowing for easy transition to a navigated procedure.



The Triathlon™ Knee System Instrumentation introduces Orthonomics™; the infusion of ergonomic design principles into Orthopaedics. Through the enlistment of Human Factors Engineers, the Triathlon™ Knee Design Team used Orthonomics™ to make the instrument an extension of the surgeon. These elements result in a system maximizing procedural function, instrumentation comfort and operating room efficiency.



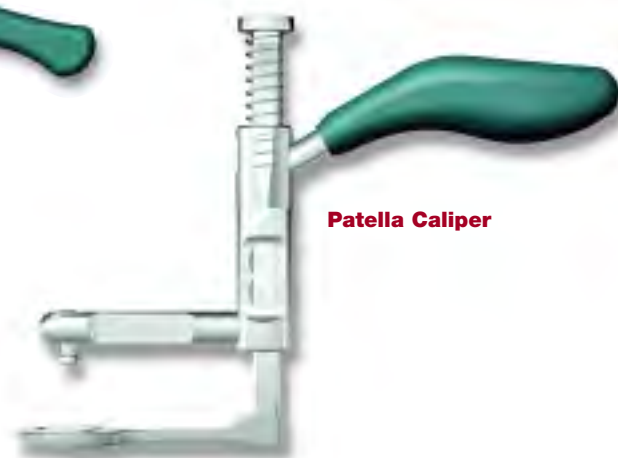
Procedural Enhancing Mechanisms

Unique mechanisms are used to enhance the safety and accuracy of the procedure. A cantilever mechanism controls the inertia required to remove the tibial keel preparation instrument facilitating easy extraction and step reduction.

The quick attach-and-release mechanisms save time in assembly and attachment, they also limit the forces exerted over precision-placed instruments to help ensure reproducible results. Mechanisms in the Triathlon™ Knee System Instrumentation have the potential to significantly increase operating room efficiencies, enhance safety, and improve accuracy.



1/8" Headless Pin Extractor



Patella Caliper

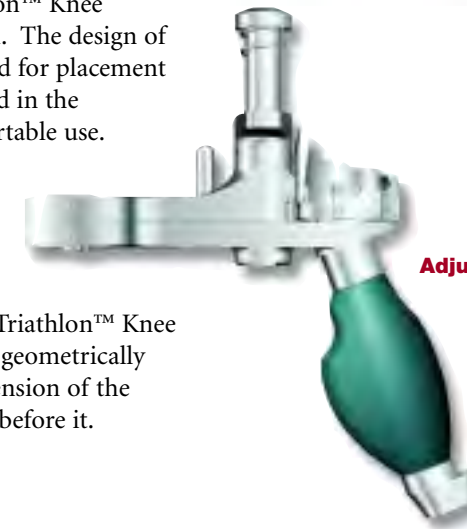
Comfort

The use of Human Factors Engineers resulted in the unique comfortable geometry of the Triathlon™ Knee System Instrumentation. The design of all handles are optimized for placement in the hand and oriented in the position of most comfortable use.

Actuating mechanisms are placed within a finger's reach and function with minimal effort for easy use. The Triathlon™ Knee System Instruments are geometrically configured to be an extension of the surgeon, like no system before it.



4:1 Cutting Block



Adjustable Spacer Block

Material Properties and Weight

Materials for the Triathlon™ Knee System Instrumentation were chosen to enhance efficacy and reduce weight. Non-slip handles provide a consistent grip and tactile feel under surgical conditions, whether wet or dry.

The contrast of etchings on instruments enhances visibility of critical markings.

The materials, along with the critical design features, combine for a lightweight durable instrumentation system. These materials and features culminate in the next generation of knee replacement instrumentation – The Triathlon™ Knee System Instrumentation.



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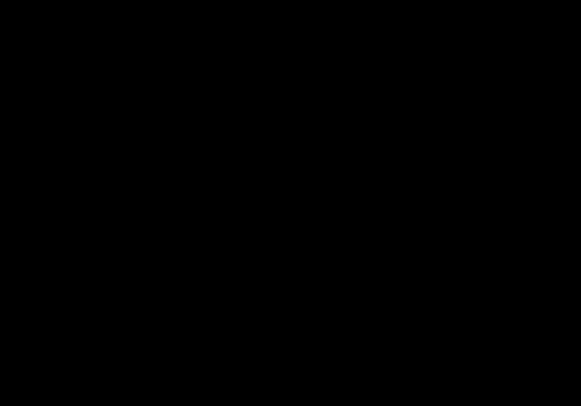
Navigation

Endoscopy

Communications

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Triathlon™ Knee System is marketed in the United States for use with bone cement.

A surgeon must always rely on his or her own professional clinical judgment when deciding to use which products and/or techniques on individual patients. Stryker is not dispensing medical advice and recommends that surgeons be trained in knee implant surgeries before performing any knee surgeries.

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