Biomechanics of Total Knee Replacement
The Knee
Axes of the Knee
Limb Flex/Extension ROM
Limb Axial Rotation
Flexion-Extension
Flex/Extension Movements
Collateral Ligaments
Cruciate Ligaments
Cruciate Constraints
Condylar Profiles
Knee Axial Rotation
Menisci
Patellar Movements on the Tibia
Patello-Femoral Joint
TKR Design Variants
Parametrics of Bearing Surfaces
## Biomechanical Considerations

<table>
<thead>
<tr>
<th>Functional goals</th>
<th>Biomechanical criteria</th>
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<tbody>
<tr>
<td>Relief of pain</td>
<td>Replacement of all articulating surfaces</td>
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<td>Interface micromotion less than 50 μm between components and bone</td>
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<td>Restoration of function</td>
<td>Similar motion characteristics as in the normal knee</td>
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<td>Soft tissue lengths within normal range</td>
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<td>Similar laxity characteristics as in the normal knee</td>
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<td>The same or larger muscle lever arms as normal</td>
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<td>Durability</td>
<td>Normal stresses at the interface and within the surrounding bone</td>
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<td>Reliability</td>
<td>Minimal wear of the articulating surfaces (less than 0.05 mm depth per year)</td>
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<td>Insensitive to misalignment or size mismatch</td>
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<td>Function insensitive to different kinetics of patients</td>
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</tbody>
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The Design Process

- Statement of the Problem
- Specification of Criteria
- Formulation of Solutions
- Evaluation of Solutions
- Analysis & Testing of Solution
- Optimisation of Design Solution
- Criteria for Clinical Evaln
- Clinical Evaluation
- Final Optimisation of Solution

Design of Joint Replacement

Design

Evaluation
Component-Bone Displacements
Displacement vs. Cruciate Retention
Dependent Tibial Surface
Principal Stresses
Maximum Total Point Motions
UHMWPE Defects
Depth-wise Stress Variation
Contact Stress vs. Curvature
Curvature-Thickness Interaction
Oxidation and Subsurface Cracking
Drawer: Theory vs. Experiment
Cycle Kinematics and Kinetics
Contact Excursions
Custom Design
Uniaxial Mechanical Testing
(Screening) Wear Test
Knee Simulator Schematic
Four-Station Knee Simulator