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LUBRICATION MODEL OF THE HUMAN KNEE IMPLANT

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Summary: Degenerative action, whether due to natural ageing, disease or injury, is a common occurrence during the lifetime of a human joint. 3.48 million patients in the US alone are expected to undergo knee replacement surgeries by 2030. However, these implants are not without complications. There are numerous areas of incompetency in current designs as they suffer from wear and loosening, together accounting for more than half of knee implant failures. While there are numerous experimental studies into wear of implants, numerical modelling is a less explored aspect to implant design. Both are necessary for the validation of an implant design.

Further to the difficulty in modelling the geometry of the knee implant, the system involves elastohydrodynamic lubrication, due to the presence of synovial fluid between the contact zones being modelled. This involves a highly non-linear set of equations that prove difficult to solve. The rheology and composition of synovial fluid also presents a challenge to the modelling of implants, as fluid behaviour derived from experimental results are complex to replicate numerically.

A stable lubrication mechanism for the implant is required as a pre-requisite to explore wear. Current models are based on approximations of the geometry, simplifying to spherical and elliptical contact models. A new model of the knee implant will be presented, with the intent to provide a basis for simulating realistic wear modelling of the implant. This model will attempt to capture the complex geometry of the knee implant, and move beyond current geometric simplifications, resulting in a more accurate representation of the knee implant, while retaining a stable solution scheme.