Orthopedic implants have greatly increased the quality of human life; however, when it comes to friction and wear properties, they have much room for improvement. “Percolation” is a mechanism of lubricant entrainment that increases the volume of lubricant in a bearing when a load is applied, theoretically reducing both friction and wear. Percolation effects can be divided into surface transport effects and volume transport effects. The former relies on changes in surface geometry to increase lubricant entrainment, while the latter relies on the material properties of the bulk material. This research tests the uses of surface transport to improve the tribological performance of artificial hips, and the uses of volume transport in developing a new biomaterial for cartilage replacement.

For the improvement of artificial hips, dimpled surfaces were created using laser surface texturing (LST) and then tested in a reciprocating wear tester. Friction and wear
were measured and compared to surfaces without dimples for both metal-on-metal and metal-on-plastic contacts. The results showed a positive effect of surface texturing on the friction coefficients and wear rates of the textured surfaces, consistent with increased lubricant entrainment.

A numerical model of a lubricated contact was made using a multilevel relaxation approach. The lubrication of smooth, roughened, and dimpled contacts was modeled. Numerical studies showed an increase in the theoretical central and minimum film thickness for dimpled surface. Numerical studies also show an optimized dimple placement and morphology for future studies.

A new biomaterial, consisting of a three-dimensional woven composite of selected polymers was also examined for wear properties in bi-directional wear. Results of wear testing were mixed, at first showing increases in life due to specific woven parameters but being difficult to repeat.