The purpose of this project is to create a mathematical model of cartilage degradation and bone sprouts growth during degenerative joint changes - osteoarthritis. Verification of this model is an idea as well.

Researchers and medics are in agreement that one of the osteoarthritic main causes is excessive or non-physiological mechanical loading. Mechanically overloaded cartilage cells start to die and cartilage tissue loses its shock absorbing properties and as a result its compressive strength is reduced. Following that, greater focal stresses are transferred to the bone. Sensor cells in the bone can sense mechanical loads. They emit signals with the information about necessity of bone growth into the cartilage domain to stiffen it. The mechanical loads can lead to apoptosis - death of cartilage cells. The apoptosis is possible if the value of the loads exceeds load value acceptable for the cells. Dying cells release bio-chemical signals in the form of proteins. These factors bring forward an information about demand for nutrients. Blood vessels react to the received signals and grow towards the desirable region. The bone spurs development is determined by presence of the blood vessels. They deliver nutrients to bone cells. Tissue micro-structure is further affected and influence growth and orientation of vascular network as well as bone spurs. Simultaneously, following the mechanical overloading micro-cracks develop in the subchondal bone, calcified cartilage and cartilage. These micro-cracks increase tissue permeability and influence vascular network spread ipso facto. Described degenerative changes favour osteophytes growth with blood vessels into the cartilage tissue.

Osteoarthritis is one of the most common types of disease of affluence. Osteoarthritis predominantly affect not only the elders, but also sportsman, obese people. Despite degeneration of the joint is social issue roots of the disease are not investigate and recognise yet. There is no certainty that osteoarthritis is a disease of bone or cartilage tissue as well. Correctly formulated model permit to better cognise and understand the phenomenon. The model should provide for the main biological, chemical and mechanical parameters as well as intercellular communication. Valid model may provide medical industry with a tool enabling verification of the effectiveness of selected treatments against the disease as well as help to confirm how different effects impact the rate and path of the osteophyte development. The minimum but sufficient number of variables should characterise the model. If the results of the numerical calculations of this model are comparable with informations obtained from *in vivo* experiments in future a selection of inhibitors and activators of the disorder may be supported.

The applicant described osteoarthritic changes with micro-structure evolution, angiogenesis and static mechanical loading as the main effects included in the model. Due to complexity of described phenomenon and its dynamic nature proposed mathematical formulation even now depends on quite a lot variables and parameters. This is related to the timescale and amount of calculations.

New generalized mathematical model will include new mechanical effects. Identification of the parameters introduced in the structure of new model will enable estimation of appropriate values of these parameters. The series of numerical calculations will be conducted for different combinations of boundary, initial and loading conditions. The numerical results of planned calculations will be compared with research data available from literature and results from the experiments conducted on cell cultures. Due to a collaboration with laboratory of Tissue Structure and Computer Microtomography in the Department of Experimental and Clinical Physiology of Warsaw Medical University the conduction of the tests with cell cultures will be possible. The cell cultures tests will be conducted on the chips designed and manufactured in the Faculty of Production Engineering Warsaw University of Technology. Based on these results the model will be verified and improved model will be numerically tested once more. Results from computations will be verified again. These actions will be repeated until satisfactory results are achieved.