Autoliv Master Thesis Proposal:

# Fall and impact injuries using Human Body Models

## Background

Fall injuries among the elderly are a worldwide problem, especially hip fractures. 1.7 million hip fractures occurred worldwide in 1990 and this figure is estimated to rise to 6.26 million by 2050. A total of 1662 people died due to fall related injuries in 2013 while 70,000 were admitted to a hospital. These numbers are expected to increase sharply with the increase in number of elderly people. Additionally, the risk of hip fractures is also sex dependent, which means that elderly women are most at risk.

There is a significant body of research on fall-induced femoral loads and femur strength. These can be classified into volunteer experiments, ex-vivo studies, observational studies and analytical modelling approaches. Even though these studies provide valuable information for model validation, they have many limitations. Fall events are usually reduced to free-falling masses due to missing muscle activations, whole body kinematics and by applying rigid boundary conditions. Inaccurate representation of pre-impact movements, preventive reactions, and subject specific aspects are other important limitations, particularly in analytical modelling.

FE models of human bodies are a good option for fall and impact simulations and thus hip fracture risk prediction. Human Body Models (HBMs) aim to be a realistic representation of the human and allow for predicting injury risk based on physical quantities such as stress or strain. They enable a comprehensive evaluation of impacts and thus eliminate some of the above-mentioned limitations. However, they are developed for crash safety applications and validated for high energy impacts.

Thus, this master thesis project is designed to evaluate the extent to which the SAFER HBM can be used to simulate falls and impacts to the hip and predict the risk of hip fractures.

## Aim

The aim of this project is to develop and validate a femur model to be able to predict and assess fall related femoral neck fracture risk. A further aim is to integrate this femur model in the SAFER HBM model.

## Study design

- Literature review:
  - Hip fractures (femoral neck): fall mechanisms and injury risks
  - Human data suitable for evaluation and model validation for lateral (fall related) load to the pelvis
  - Femur data such as geometry, cortical bone thickness, material properties etc.
- Define geometry of femur suitable for development of a finite element model
  - Build geometry model of femur
  - Mesh femur model
  - Assign material properties and material thickness
- Tune the femur model by means of component level tests with human subjects identified in the literature review
  - Compare force and moment
  - Propose a method to assess femoral neck fracture risk
- Validate the femur model by means of human test data
- Integrate the femur model in the SAFER HBM model
- Evaluate a concept for hip protection in the model

## Suitability

- 1-2 Master students with Engineering background
- Impact Biomechanics and Finite Element Method background is meritorious
- Experience with LS-DYNA simulations
- Location: Autoliv Research at Vårgårda or Chalmers

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