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Report on research projects under the IDEA League Student Grant

Personal information				
Full Name:		Aksel Gudde		
Field of study:		Biomedical Engineering		
Degree pursued:		Masters	**Current year of studies:**	7th
Home University:		Technical University of Delft		
Sponsoring professor at home university	**Name:**	Harrie Weinans		
	Email address:	H.H.Weinans@umcutrecht.nl		

Information about the research stay					
Host University:		ETH Zürich			
Sponsoring professor at host university	**Name:**	Ralph Müller			
	Email address:	ram@ethz.ch			
Dates of research stay		**from:**	03-10-2016	**to:**	03-04-2017

Summary of the research project
(200 words max.)

This study aimed at finding an approach to model bone mechanics with the discrete element method (DEM). The reason for exploring the use of DEM, is the simplicity with which nonlinear phenomena can be mapped. The concept of DEM is explained by describing the calculation cycle the method is based on. Since DEM is developed to model the dynamics of discrete particles that form a granular assembly, different inter-particle bonds are proposed to build bone from. The assessment of parameters needed to formulate constitutive behaviour is described for each bond. Additional failure criteria for fragmentation of the models could then be derived. The potential of all bond types are evaluated. The most promising bond for the application and the related parameter values are chosen. To give an impression of a discrete element model, compression

of a cubic assembly of spheres using the molecular dynamics framework LAMMPS is presented. In addition, by both assigning linear and nonlinear interaction equations to the cube, the ease of simulating nonlinear mechanics could be clearly shown. However, the functions offered by LAMMPS showed limitations for modelling solids constructed from DEM. Therefore, suggestions are made for future research to the application of DEM to bone mechanics.

Experience report
Please tell us about your experience at the host university and give us an evaluation of the benefits of the research stay for the course of your studies

The bone-group of the Institute for Biomechanics (IfB) welcomed me really kindly and immediately gave me the impression of a friendly, though challenging and professional environment. I noticed the continuous concern of researchers towards their field of expertise, also outside working hours. This atmosphere gave me the mental boost to dive into my project with a lot of energy. I knew the computational work of the assignment would be very challenging for me, as my experience was little beforehand. This aspect also depicts one of my main learning experiences. Since I have a lot to do with computational mechanics in my studies at the TU-Delft, the practice during the period added to an important skill within that field.
Each week, students from different technical backgrounds came together in a meeting to discuss the accomplishments of the last week, the problems they faced and tasks to do before the week after. The diversity of the projects and discussing them together required all of us to think and communicate outside our own specializations.
Since I had to get familiar with an unknown computational method (DEM) for our research-group, I had to face difficulties on my own often. Therefore I learned how to work independently and solve problems individually.
Finally, the last week's meeting the students presented their projects and results to the whole bone-group. The critical attitude of experienced Phd-ers, post-docs and professors, showed how to be critical to our own work. Besides, explaining theory unknown for the audience taught me how to communicate an in-depth topic in a simplistic manner. Here, I also had the opportunity to discuss some problems with the department of Computer Science. An out-of-the box opinion gave me new insights.
In summary, I enjoyed my time at the ETH, IfB, a lot. The things I learned, I will not forget and I am sure they will help me frequently in my future carreer.

Picture
Please provide a picture of you at the guest university