Development of an experimental-virtual lab for the investigation of granular materials

Due to the complex behavior of granular materials education of mechanical process engineering is a complex and non-trivial task. During education students should get deep understanding not only about material behavior from theoretical point of view but also to perform various experiments by themselves. In this project it is planned to develop ab experimental-virtual lab, which will significantly help in education of solids process engineering. This lab will consists of a set of pre-defined experiments and numerical tests, which will be used to analyze effects occurring in granular materials, like mixing, segregation, stratification etc.

For numerical investigations the discrete element method (DEM) will be used. DEM allows performing detailed process description and grants the possibility to consider material microproperties. However, the use of DEM is associated with high computational effort, which limits its application scope. The experimental investigation do not face complications related to the amount of investigating material or sophisticated models of its behavior, but also cannot provide complete exhaustive information about all possible aspects of the investigating process. In this way, both numerical and experimental approaches complement each other.

The experiment set-ups, which will be developed in the scope of this project, will be configured and optimized for 3D-printing. Due to the fact that the process of 3D printing is in general not trivial and time-consuming task, not every setup is suited for this goal. Therefore, a list of experiments, supporting program tools and guidelines must be previously designed in such a way, to allow both stages of material investigation in a reasonable time and with moderate complexity.

Working plan:

1. Literature review about existing DEM calculation approaches.
2. Exploring the possibilities and limitations of the 3D printing.
3. Design of suitable experimental setups.
4. Development of supporting tools and guidelines.
5. Experimental and numerical tests.
6. Writing a report.