2017 ACCES Visualization Contest - Example A

Entry title: *Pétanque: a model system for granular dissipation*

Group members: *Student A (simulation), Student B (visualization)*

Category: *Static*

Computational Thinking

The following steps have been defined in the planning of the entry, which represents a carreau shot in the game of pétanque as a pre-study of a critical problem in the steel-making industry.

Industrial problem

The filling of a blast furnace involves successively loading the input system with mineral ore and coke; their subsequent motion in the upper region of the blast furnace determines the filling uniformity and hence the quality of the final product. Different systems have been proposed in the past in an attempt to optimize the filling process. For this particular study, the ore and coke particles are spread using a rotating chute. During this filling process, particles dissipate kinetic energy as they fall onto the granular bed of previously loaded raw material particles. The goal of the study is to assess the importance of the granular bed in the global particle dynamics.

Abstraction

As a pre-study for the examination of the filling of a blast furnace, a model system is studied to allow removal of unwanted geometrical complexity. This model system, the well-known game of pétanque, allows direct comparison with behaviour that is already familiar to pétanque players. Pétanque is played by launching large steel boules on a gravel surface, and involves dissipative multi-particle collisions. In this pre-study, an attempted "carreau" shot - the replacement of the stationary boule with the thrown boule - is analysed for two boules on a solid surface using analytical tools. The influence of the addition of gravel on the surface was then determined by numerical simulation.

Decomposition

The numerical simulation is divided into three principal phases: pre-processing, solving, post-processing. Pre-processing involves establishing the initial positions and motion of the two boules and the (spherical) gravel particles. Computing the subsequent movement is performed using an in-house Discrete Element Method (DEM) code. The DEM results provide the time-evolution of all the particles and their kinetic and potential energies. Post-processing involves the qualitative (visualization) and quantitative (statistical) analysis of the DEM results.

Visualization

While the time evolution of the individual particle motions is computed, a composite image of three stills is the preferred media for our entry. This representation involves the challenge of illustrating the movement of specific boules and gravel particles. To assist in the communication of the physical results, the *Blender* software has been employed to produce a photorealistic rendering of the carreau shot. Texture is applied to both the boules and gravel particles. Shadowing is also used, assisting in the 3D visual interpretation. In addition, motion blur is added to the moving boule to provide the required impression of movement.