

## Computer Simulations

Computer simulations have helped to elucidate the behavior of all types of granular flow. They are useful for two reasons. First there is a dearth of experimental techniques that would allow complete observations of real granular flows and their flow variables such as the local solids fraction; this is particularly the case for interior regions of the flow. Second, it is useful to be able to simplify the particle-particle and particle-wall interactions and therefore learn the features that are most important in determining the flow. The simulations use both *hard particle* models (see, for example, Campbell and Brennen (1985a,b)) and *soft particle* models (see, for example, Cundall and Strack (1979), Walton and Braun (1986a,b)). The hard particle model is, of course, a limiting case within the soft particle models and, though computationally efficient, is only applicable to rapid granular flows (see sections (Npj) and (Npm)). Soft particle models have been particularly useful in helping elucidate granular material flow phenomena, for example the formation and dissipation of force chains (Cundall and Strack 1979) and the complex response of a bed of grains to imposed vertical vibration (Wassgren *et al.* 1996).