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## Designing for Fine Powders

### Material Flow Solutions, Inc.

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Most often formulators and design engineers are faced with creating the ideal product to be run through an existing process. Therefore, successful design of fine powder mixtures must address the relationship between the particle scale properties, the bulk flow properties and the expected flow behavior in typical processes. The effect of moisture content, flow additives, particle size, particle size distribution, polydispersity, shape, and mixture structure must be measured. The current trend in industry is to add small amounts of very fine or nano-particles to existing products in hopes that the combination of particles will exhibit some enhanced behavior.

A science is developing around the addition of these small particles and the appearance of certain chemical or physical behaviors in the bulk material. Yet, knowledge of how modifications on the particle scale will affect the bulk flow properties is lagging behind our current product development understanding. At Material Flow Solutions, our goal is to assist engineers and formulators to “get it right the first time.”

“Right the first time design” begins with direct measurement of the key material properties for each ingredient or component, as well as for the mixture as a whole. The properties to be measured include: unconfined yield strength at actual expected process conditions, density and permeability, wall friction angle, particle size, propensity of the mixture to segregate, and degradation tendency. There are two primary product design criteria:

- Calculate strength directly from models involving particle scale properties and validate by direct measurements of bulk properties.
- Understand the mechanistic role of particle scale properties on bulk unconfined yield strength.

First, designers must recognize that understanding the role of particle scale properties on bulk unconfined yield strength is a key relationship. All other important properties are affected by the degree of cohesive strength in the bulk. Second, most current modeling does not allow direct calculation of strength from particle scale properties alone. Generally, the particle system is too complex to allow this. Thus, the engineer must rely on direct measurement of key properties and extrapolate system behavior from there. The key is minimizing the test(s) required. The goal is to measure key properties of pure components in a mixture and combine these properties in such a way as to predict the properties of any mixture containing the same components.

At Material Flow Solutions, measuring the key material properties, we have applied scale laws to real mixtures such as clays, detergents, pharmaceuticals, food mixtures, plastics, and granular and powder fuels with very good success. We can also measure segregation tendencies with a variety of bulk mixtures. Engineers who understand and utilize this methodology shorten the time to market as they are able to control processes based on accurate product scale up equations, thereby increasing company revenue. Let us help you design your next product to enhance flowability, or let us provide you with custom design constraints specific to your material to prevent bad acting product.