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## Designing Multi-Component Mixtures

### Material Flow Solutions, Inc.

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Most formulators and process engineers face the assignment to create a multi-component product that performs a consumer-dictated task while maintaining product quality. Typically, much time is spent getting the consumer-dictated task correct. Tasks such as adding enhanced brightening to detergents, developing the drug that cures disease, or producing a food product that tastes good are high on the priority list. Tasks focused on creating a mixture that will not segregate during typical handling are typically afterthoughts. However, these tasks may be as important to the successful deployment of product as the product core function. Ideally a formulator should develop the core product behavior in conjunction with the quality characteristics.

Most manufactured products are mixtures of several components. Generally, ingredients in a mixture separate (or segregate) during processing, resulting in inconsistent final product. No matter the root cause of segregation, the end result is a box of Lucky Charms® with too many (or too few) marshmallow hearts – an Advil® caplet with too much (or too little) ibuprofen content – or a box of Tide® with too much (or not enough) color-safe bleach particles. Each results in customer dissatisfaction and, ultimately, loss of company revenue. Segregation of granular and powder materials is one of the three main causes of process failure in systems that handle powder materials. It is a global problem, affecting all industries, and conservative estimates suggest that 30% of all unscheduled downtimes are due to segregation and resulting quality issues. Therefore, when designing multi-component mixtures, the most serious quality issue facing formulators today is arguably that of product segregation.

One common design issue arises when the practicing engineer has either created or found sources to all the key ingredients in a dry blend. There may be several choices of raw ingredients that must be mixed together and maintained in a mixed condition until they are placed in a package for transportation to some customer's facility. The blender choice, as well as all subsequent process vessel designs, depends in large part on the tendency of the dry blend to segregate. If possible, the engineer would like to use existing mixing equipment and processing vessels. The task boils down to selecting the right combination of raw materials to yield a material mixture that will minimize segregation in the proposed process.

At Material Flow Solutions, we analyze multi-component mixtures for segregation potential due to sifting, air entrainment, impact fluidization, percolation, and differences in repose angle, particle size and chemical composition. Knowing the segregation mechanism and some key particle scale properties allows us to design a product to minimize segregation. Using this information, a reliable solution to complex segregation problems can be designed to put you on track for quality production.