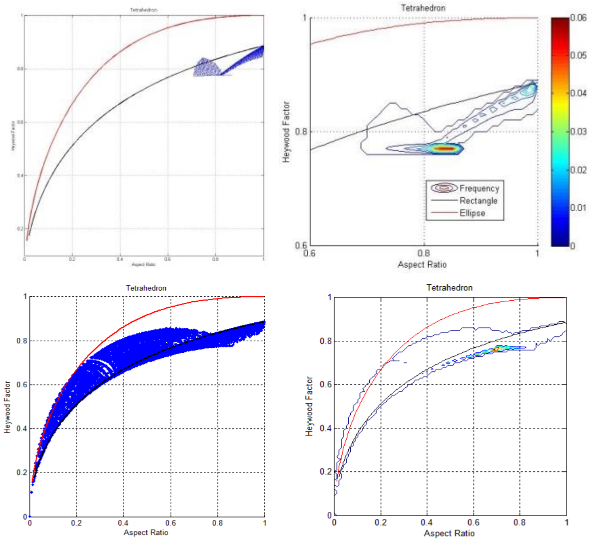
Particle Shapes of 3D Populations from 2D Numerical Modeling. Joshua Knicely[1] and Blake Lohn-Wiley[2] and Dr. Douglas Rickman[3], [1]Texas A&M University, [2]Tarleton State University, [3]Marshall Space Flight Center

Introduction: Particle shape affects many things, such as the bioavailability of drugs, the electrical properties of metals used in batteries, and the macroscopic behavior of lunar regolith. Most methods of particle shape analysis involve either a plane of section or a plane of projection. Both methods acquire 2D information from a 3D object. With either method, a specific 3D particle can produce a variety of 2D shapes, and the 2D shapes cannot be uniquely inverted to a specific 3D object. However, we can compute all possible 2D shapes that a convex 3D object creates. Therefore, the probability density function (PDF) for selected measures of shape can be evaluated for possible 3D objects. We have developed these PDFs for several 3D convex shapes. Now generated, 2D measurements compared to these PDFs will determine the likely 3D particle shapes, allowing for a more accurate characterization of the particles.

Background: Our selected measures are Heywood factor (a measure of circularity) and aspect ratio (a measure of elongation). Plane of section creates a polygon by taking a slice of a shape, and plane of projection creates a polygon by mapping the silhouette of the 3D object onto a plane.

Methodology: We create several convex 3D objects. We define ‘n’ equidistant points on a sphere centered at the origin. Each point on the sphere and the origin define a normal to a plane. For plane of section, we translate the plane along the normal from the origin at a fixed step size and determine the points of intersection. For plane of projection, we project the points of the object onto a plane defined by a point on the sphere and the normal and create a convex polygon from the projected points. This gives us the polygon from which we calculate aspect ratio and Heywood factor. We bin this data, and then create a contour from the number of occurrences in each bin.

Results: We have obtained the datasets and PDFs for several 3D shapes. In the next column is an example of this information for a tetrahedron. Clockwise from the top left, there is the data for plane of projection, the PDF for plane of projection, the PDF for plane of section, and the data for plane of section.



Conclusions: We have produced datasets and the corresponding PDFs for the plane of projection and plane of section. Plots of the PDFs show the combinations of aspect ratio and Heywood factor are limited to specific regions. The comparison of real data to the PDFs will determine the likely 3D shapes responsible for these 2D measurements. This new particle characterization will advance pharmaceuticals, metallurgy, geology, and more.

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