CANTY
PROCESS TECHNOLOGY

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Company:

Canty Abrasives

Sample Identity-

SAM1 Crushed Mineral #1
SAM2 Crushed Mineral #2

AVG size, 40 Mesh, range -8 Mesh, +100 Mesh

Purpose:

This report is an investigation of particle size and shape to determine the relative value of information obtained from the vision analysis in order to better characterize the value of the crushed material in relation to it's intended use.

Lab Setup:

The samples were analyzed for size and shape using a vibratory feeder, Canty SolidSizer TS, discharging a single particle layer onto an angled slide plate viewed by a camera with back light to image each particle without tumbling as seen in free falling particles.

A Canty Vector Computer received images from the Canty SolidSizer TS and used CantyVision Software to processes these images.

Figure 1, Canty SolidSizer TS

Calibration:

Calibration for the size and shape measurement was 49.2 Micron per Pixel allowing the view analysis region to be 29.5 mm by 39.4 mm.

Results:

A typical process view of the SAM1 milled material as produced by the Canty SolidSizer TS is shown in Figure 2. The CantyVision Software processing of this image is seen as a screen image Test Scan shown in Figure 3. The larger particle on the lower left has been selected and is marked by a yellow bounding box. The measurement data for this particle is moved to the top of the Particle Sizing Static Scan Results data table (Particle #25, highlighted blue). Figure 4 shows the full measurement data table from figure 3. From this image it can be seen that there are several particle characterstics displayed from which to choose; i.e. major diameter, minor diameter, average diameter, aspect ratio, perimeter, area. Many more are available and the operator may create their own defining calculations for output based on these basic measurements.

When attempting to define the characteristic of an abrasive particle one should consider the particle function and ideal shape, and then consider what measurements can best define the particles toward that end. It must also be noted that current measurement technologies may not correlate well to new methods. For instance, correlating a bulk density to an aspect ratio distribution in most cases does not work since many varying aspect ratios can have similar bulk densities. To define the intended result in this instance, it is natural to consider aspect ratio as a possible defining feature. It is also recommended to calculate a roundness ratio

which is actually a more complete characterization of the particles. By comparing a perimeter function to area it can be determined that particles either have a spherical shape, a square shape, a triangular shape or a rod shape. Aspect ratio alone only deals with rod shapes.

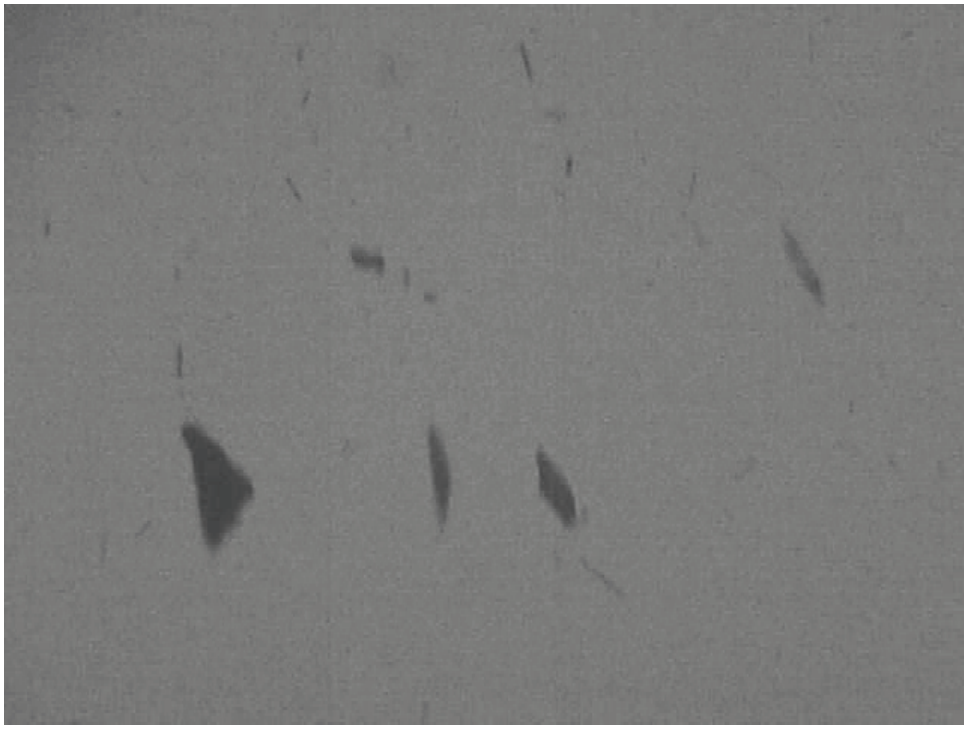
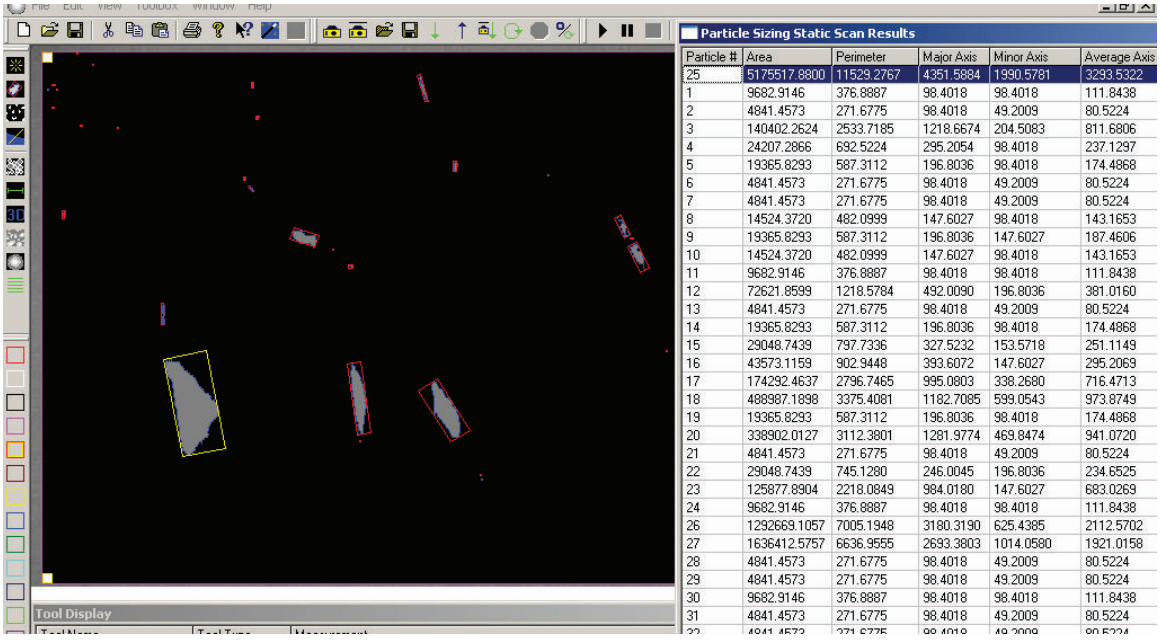
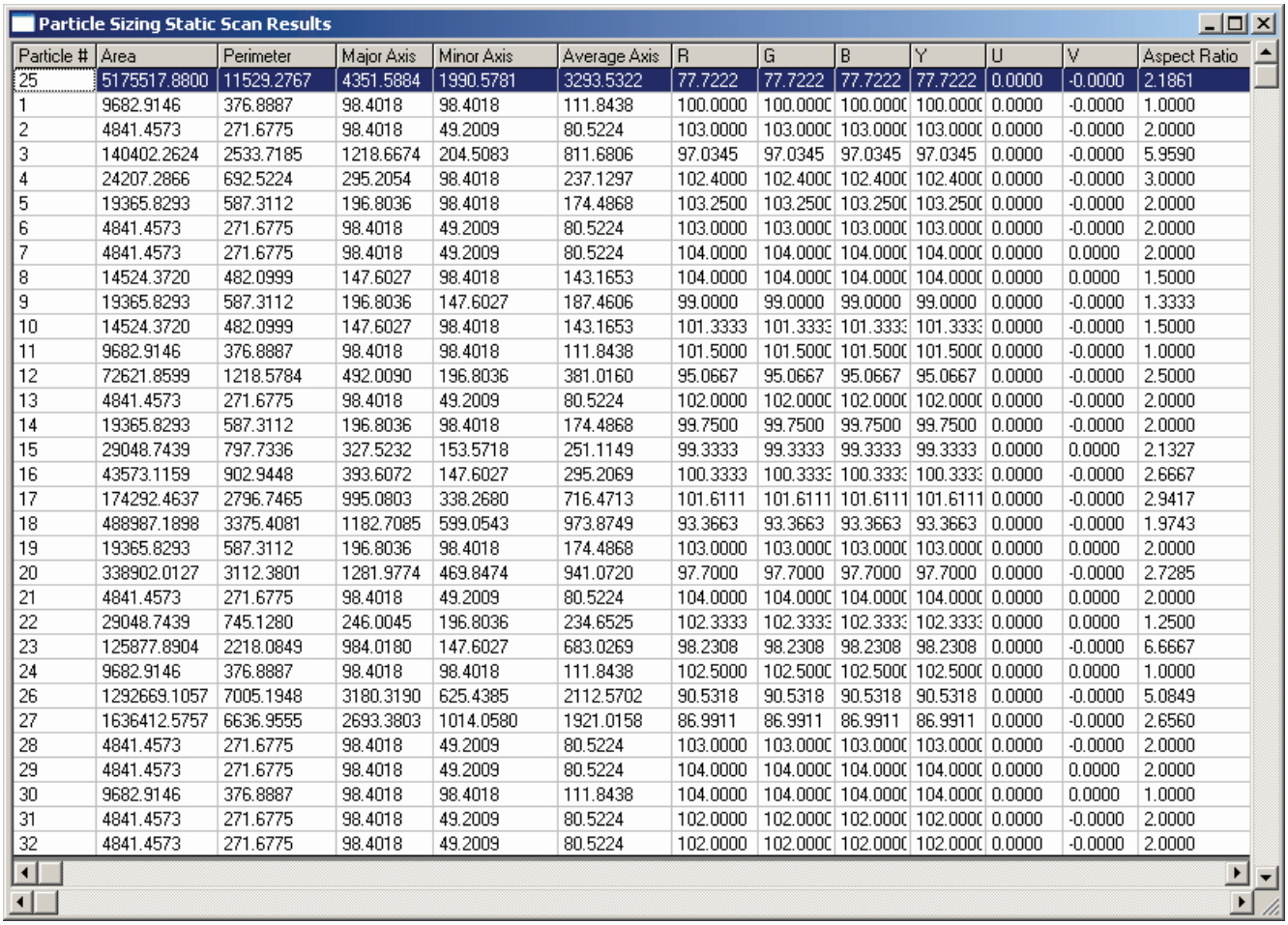


Figure 2, back lighted process view of the SAM1 milled material from Canty SolidSizer TS



Particle #	Area	Perimeter	Major Axis	Minor Axis	Average Axis
25	5175517.8800	11529.2767	4351.5884	1990.5781	3293.5322
1	9682.9146	376.8887	98.4018	98.4018	111.8438
2	4841.4573	271.6775	98.4018	49.2009	80.5224
3	140402.2624	2533.7185	1218.6674	204.5083	811.6806
4	24207.2866	692.5224	295.2054	98.4018	237.1297
5	19365.8293	587.3112	196.8036	98.4018	174.4868
6	4841.4573	271.6775	98.4018	49.2009	80.5224
7	4841.4573	271.6775	98.4018	49.2009	80.5224
8	14524.3720	482.0999	147.6027	98.4018	143.1653
9	19365.8293	587.3112	196.8036	147.6027	187.4606
10	14524.3720	482.0999	147.6027	98.4018	143.1653
11	9682.9146	376.8887	98.4018	98.4018	111.8438
12	72621.8599	1218.5784	492.0090	196.8036	381.0160
13	4841.4573	271.6775	98.4018	49.2009	80.5224
14	19365.8293	587.3112	196.8036	98.4018	174.4868
15	29048.7439	797.7336	327.5232	153.5718	251.1149
16	43573.1159	902.9448	393.6072	147.6027	295.2069
17	174292.4637	2796.7465	995.0803	338.2680	716.4713
18	488987.1898	3375.4081	1182.7085	599.0543	973.8749
19	19365.8293	587.3112	196.8036	98.4018	174.4868
20	338902.0127	3112.3801	1281.9774	469.8474	941.0720
21	4841.4573	271.6775	98.4018	49.2009	80.5224
22	29048.7439	745.1280	246.0045	196.8036	234.6525
23	125877.8904	2218.0849	984.0180	147.6027	683.0269
24	9682.9146	376.8887	98.4018	98.4018	111.8438
26	1292669.1057	7005.1948	3180.3190	625.4385	2112.5702
27	1636412.5757	6636.9555	2693.3803	1014.0580	1921.0158
28	4841.4573	271.6775	98.4018	49.2009	80.5224
29	4841.4573	271.6775	98.4018	49.2009	80.5224
30	9682.9146	376.8887	98.4018	98.4018	111.8438
31	4841.4573	271.6775	98.4018	49.2009	80.5224

Figure 3, Particle size measurement for SAM1 milled material by CantyVision Software

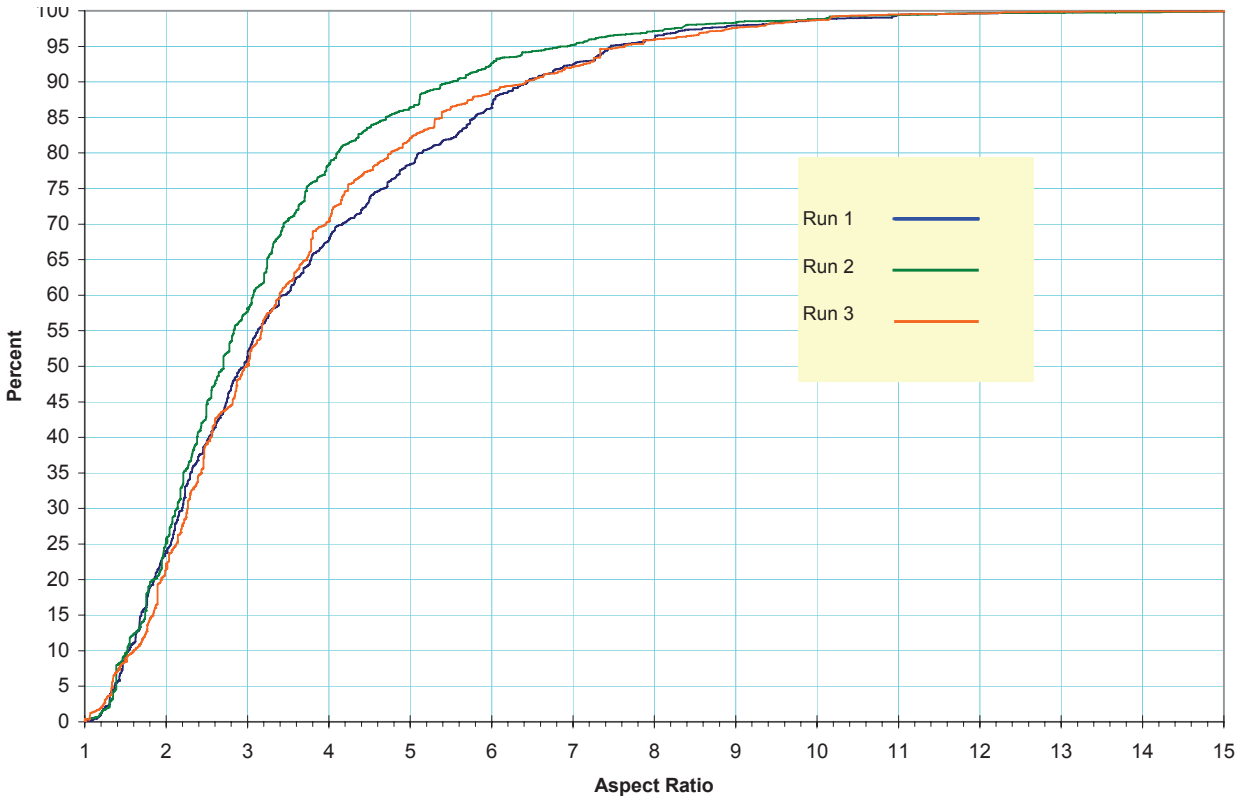


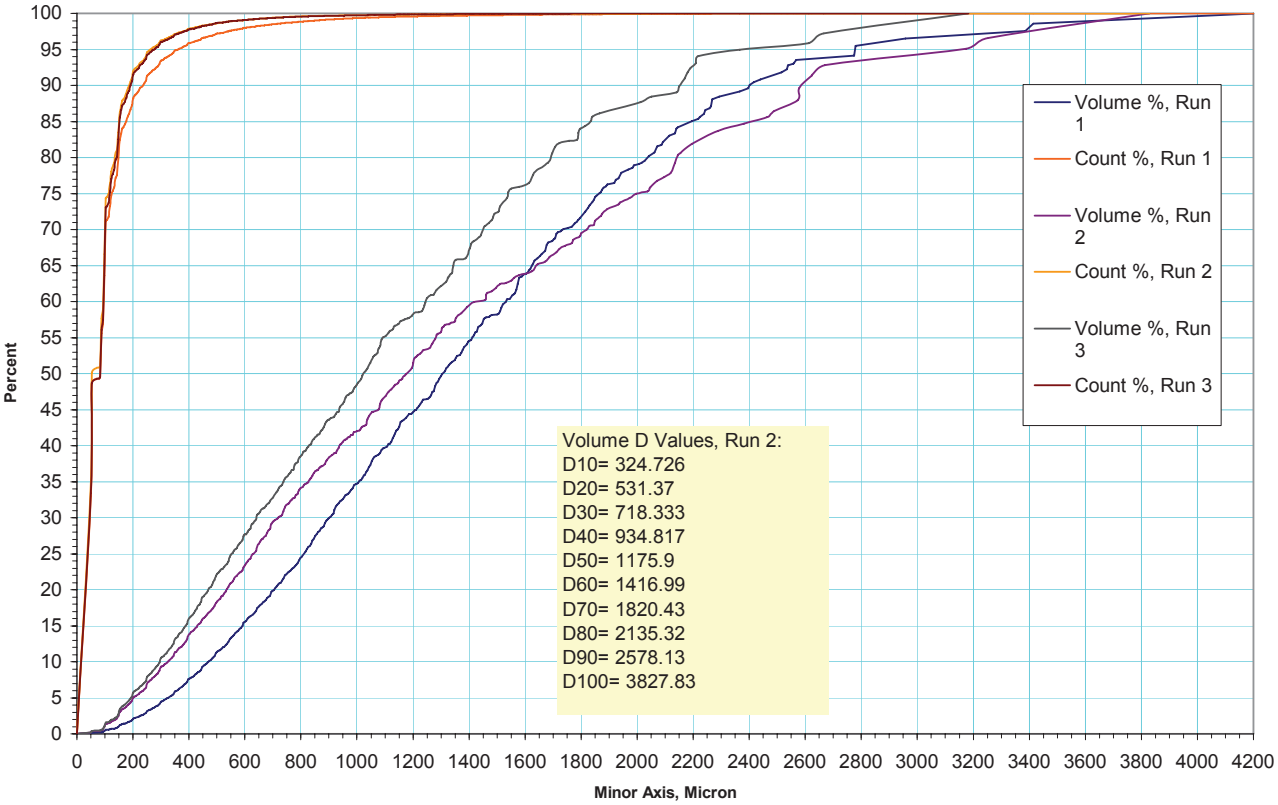
Particle Sizing Static Scan Results

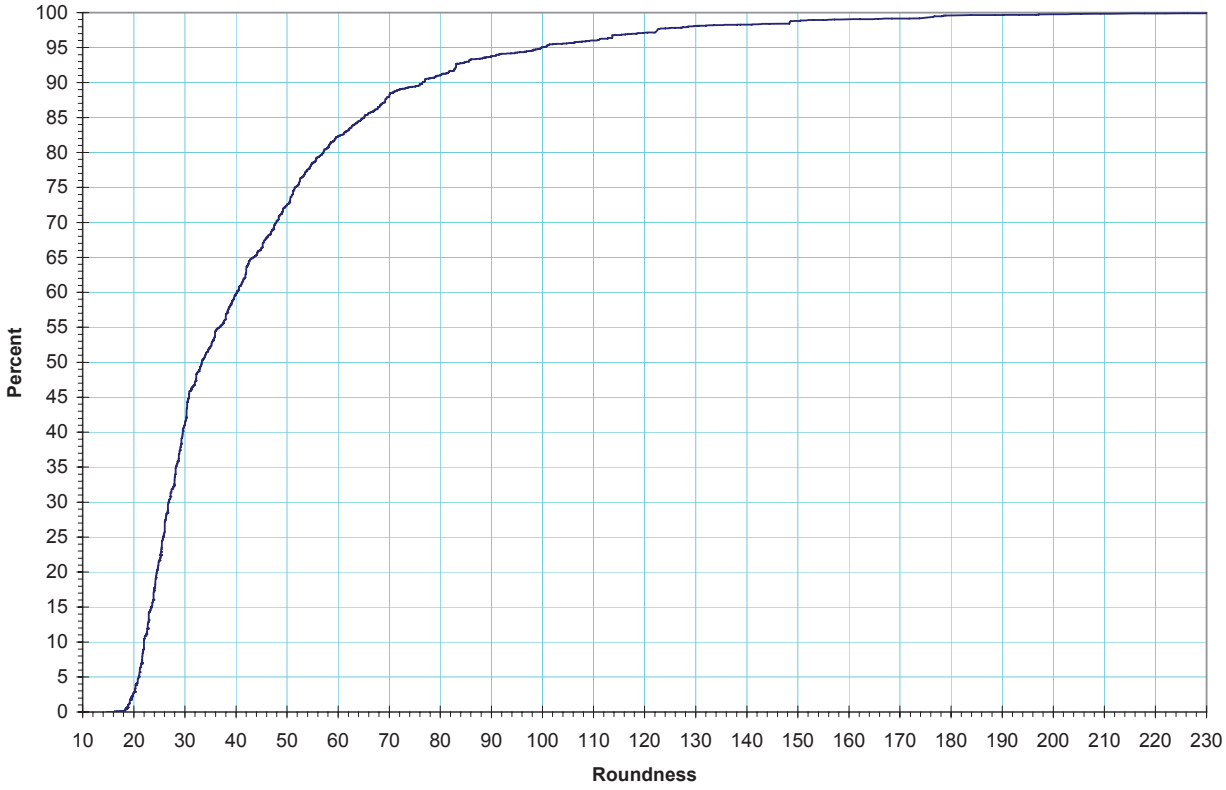
Particle #	Area	Perimeter	Major Axis	Minor Axis	Average Axis	R	G	B	Y	U	V	Aspect Ratio
25	5175517.8800	11529.2767	4351.5884	1990.5781	3293.5322	77.7222	77.7222	77.7222	77.7222	0.0000	-0.0000	2.1861
1	9682.9146	376.8887	98.4018	98.4018	111.8438	100.0000	100.0000	100.0000	100.0000	0.0000	-0.0000	1.0000
2	4841.4573	271.6775	98.4018	49.2009	80.5224	103.0000	103.0000	103.0000	103.0000	0.0000	-0.0000	2.0000
3	140402.2624	2533.7185	1218.6674	204.5083	811.6806	97.0345	97.0345	97.0345	97.0345	0.0000	-0.0000	5.9590
4	24207.2866	692.5224	295.2054	98.4018	237.1297	102.4000	102.4000	102.4000	102.4000	0.0000	-0.0000	3.0000
5	19365.8293	587.3112	196.8036	98.4018	174.4868	103.2500	103.2500	103.2500	103.2500	0.0000	-0.0000	2.0000
6	4841.4573	271.6775	98.4018	49.2009	80.5224	103.0000	103.0000	103.0000	103.0000	0.0000	-0.0000	2.0000
7	4841.4573	271.6775	98.4018	49.2009	80.5224	104.0000	104.0000	104.0000	104.0000	0.0000	0.0000	2.0000
8	14524.3720	482.0999	147.6027	98.4018	143.1653	104.0000	104.0000	104.0000	104.0000	0.0000	0.0000	1.5000
9	19365.8293	587.3112	196.8036	147.6027	187.4606	99.0000	99.0000	99.0000	99.0000	0.0000	-0.0000	1.3333
10	14524.3720	482.0999	147.6027	98.4018	143.1653	101.3333	101.3333	101.3333	101.3333	0.0000	-0.0000	1.5000
11	9682.9146	376.8887	98.4018	98.4018	111.8438	101.5000	101.5000	101.5000	101.5000	0.0000	-0.0000	1.0000
12	72621.8599	1218.5784	492.0090	196.8036	381.0160	95.0667	95.0667	95.0667	95.0667	0.0000	-0.0000	2.5000
13	4841.4573	271.6775	98.4018	49.2009	80.5224	102.0000	102.0000	102.0000	102.0000	0.0000	-0.0000	2.0000
14	19365.8293	587.3112	196.8036	98.4018	174.4868	99.7500	99.7500	99.7500	99.7500	0.0000	-0.0000	2.0000
15	29048.7439	797.7336	327.5232	153.5718	251.1149	99.3333	99.3333	99.3333	99.3333	0.0000	0.0000	2.1327
16	43573.1159	902.9448	393.6072	147.6027	295.2069	100.3333	100.3333	100.3333	100.3333	0.0000	-0.0000	2.6667
17	174292.4637	2796.7465	995.0803	338.2680	716.4713	101.6111	101.6111	101.6111	101.6111	0.0000	-0.0000	2.9417
18	488987.1898	3375.4081	1182.7085	599.0543	973.8749	93.3663	93.3663	93.3663	93.3663	0.0000	-0.0000	1.9743
19	19365.8293	587.3112	196.8036	98.4018	174.4868	103.0000	103.0000	103.0000	103.0000	0.0000	0.0000	2.0000
20	338902.0127	3112.3801	1281.9774	469.8474	941.0720	97.7000	97.7000	97.7000	97.7000	0.0000	-0.0000	2.7285
21	4841.4573	271.6775	98.4018	49.2009	80.5224	104.0000	104.0000	104.0000	104.0000	0.0000	0.0000	2.0000
22	29048.7439	745.1280	246.0045	196.8036	234.6525	102.3333	102.3333	102.3333	102.3333	0.0000	0.0000	1.2500
23	125877.8904	2218.0849	984.0180	147.6027	683.0269	98.2308	98.2308	98.2308	98.2308	0.0000	-0.0000	6.6667
24	9682.9146	376.8887	98.4018	98.4018	111.8438	102.5000	102.5000	102.5000	102.5000	0.0000	0.0000	1.0000
26	1292669.1057	7005.1948	3180.3190	625.4385	2112.5702	90.5318	90.5318	90.5318	90.5318	0.0000	-0.0000	5.0849
27	1636412.5757	6636.9555	2693.3803	1014.0580	1921.0158	86.9911	86.9911	86.9911	86.9911	0.0000	-0.0000	2.6560
28	4841.4573	271.6775	98.4018	49.2009	80.5224	103.0000	103.0000	103.0000	103.0000	0.0000	-0.0000	2.0000
29	4841.4573	271.6775	98.4018	49.2009	80.5224	104.0000	104.0000	104.0000	104.0000	0.0000	0.0000	2.0000
30	9682.9146	376.8887	98.4018	98.4018	111.8438	104.0000	104.0000	104.0000	104.0000	0.0000	0.0000	1.0000
31	4841.4573	271.6775	98.4018	49.2009	80.5224	102.0000	102.0000	102.0000	102.0000	0.0000	-0.0000	2.0000
32	4841.4573	271.6775	98.4018	49.2009	80.5224	102.0000	102.0000	102.0000	102.0000	0.0000	-0.0000	2.0000

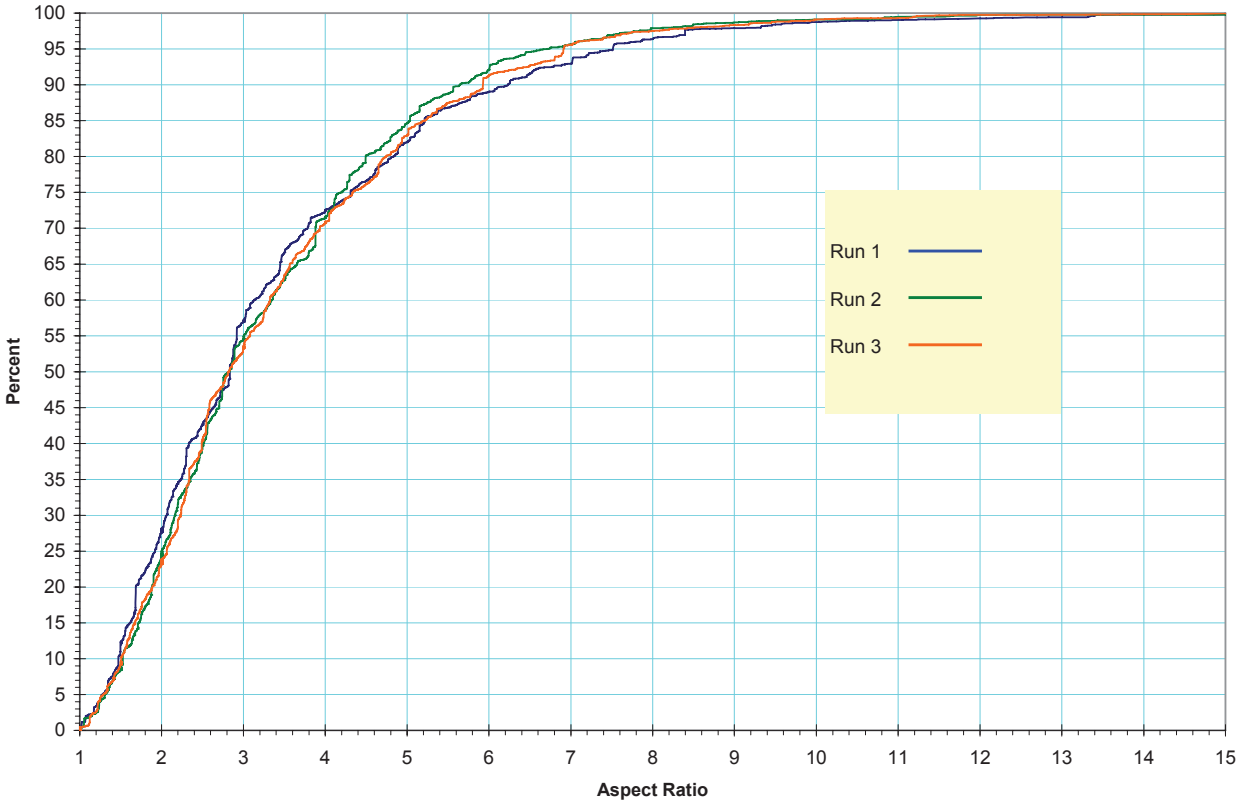
Figure 4, Particle size measurement data table from Figure 3.

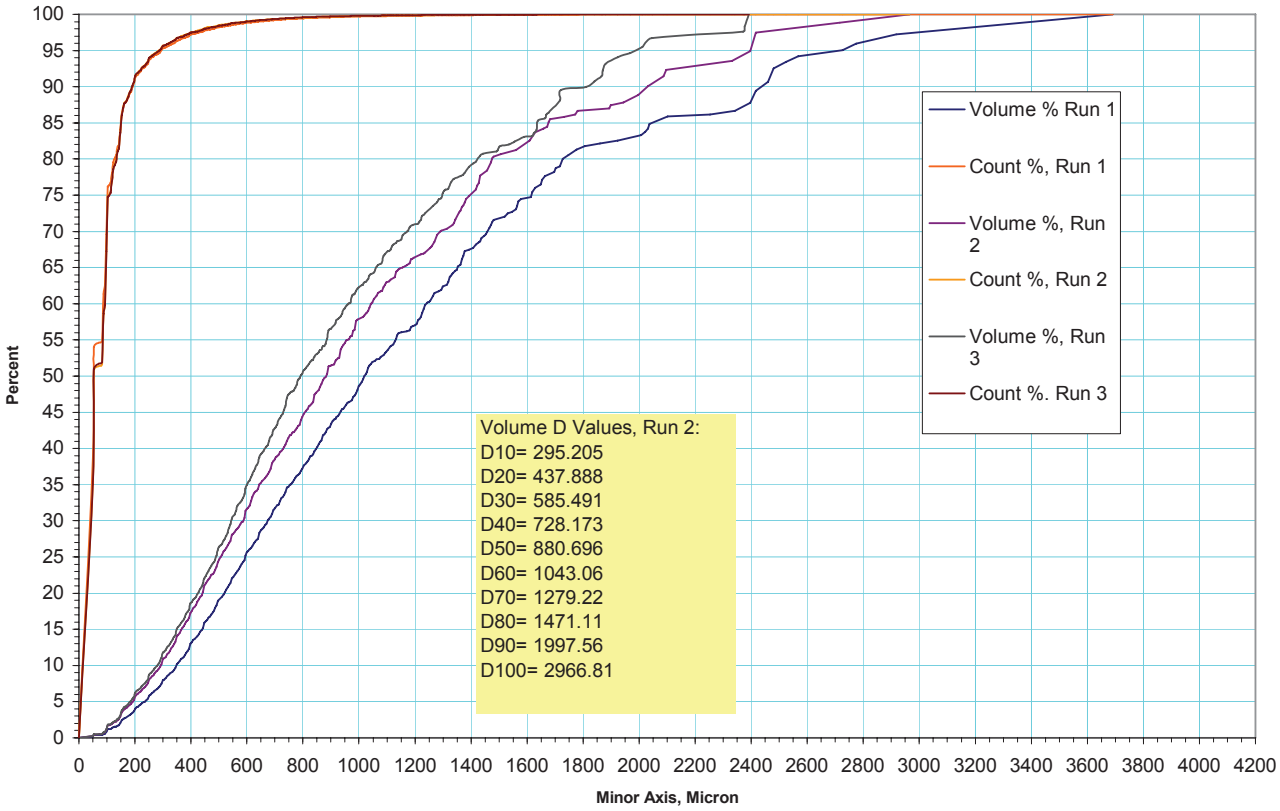
Particle Size and Shape measurements:

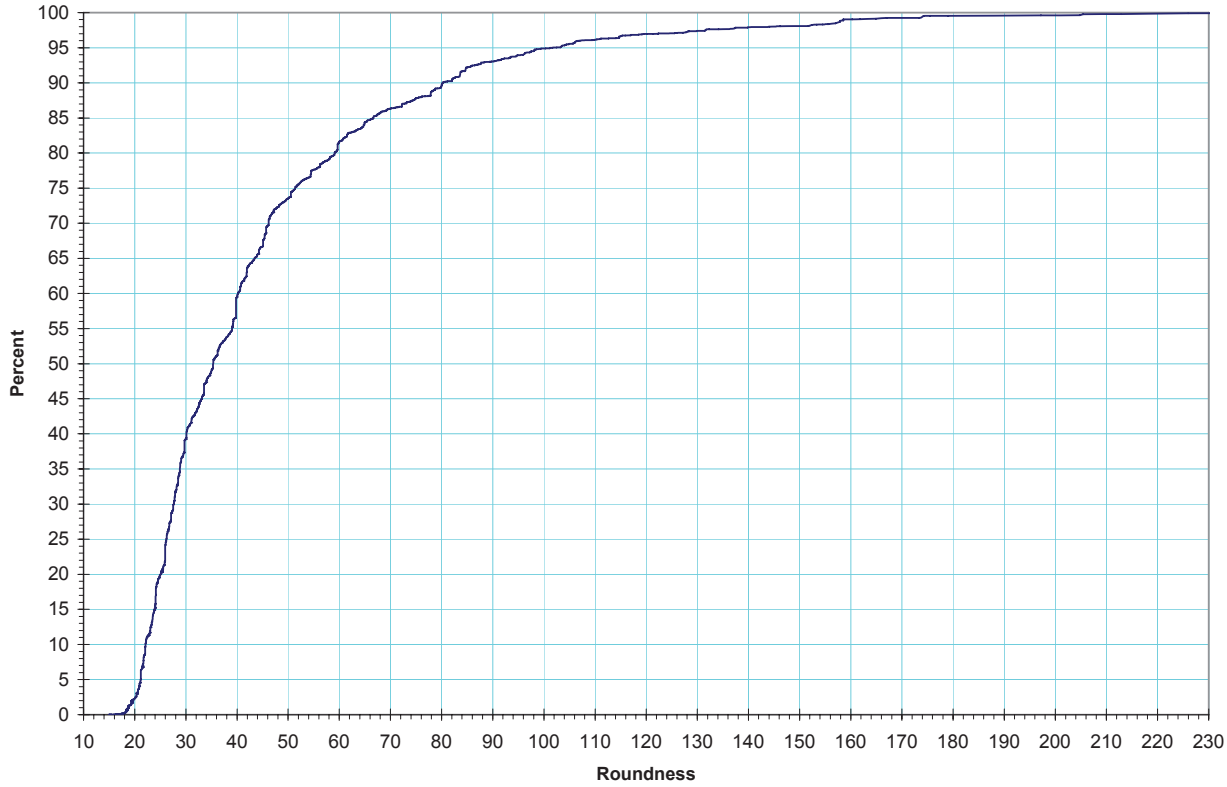




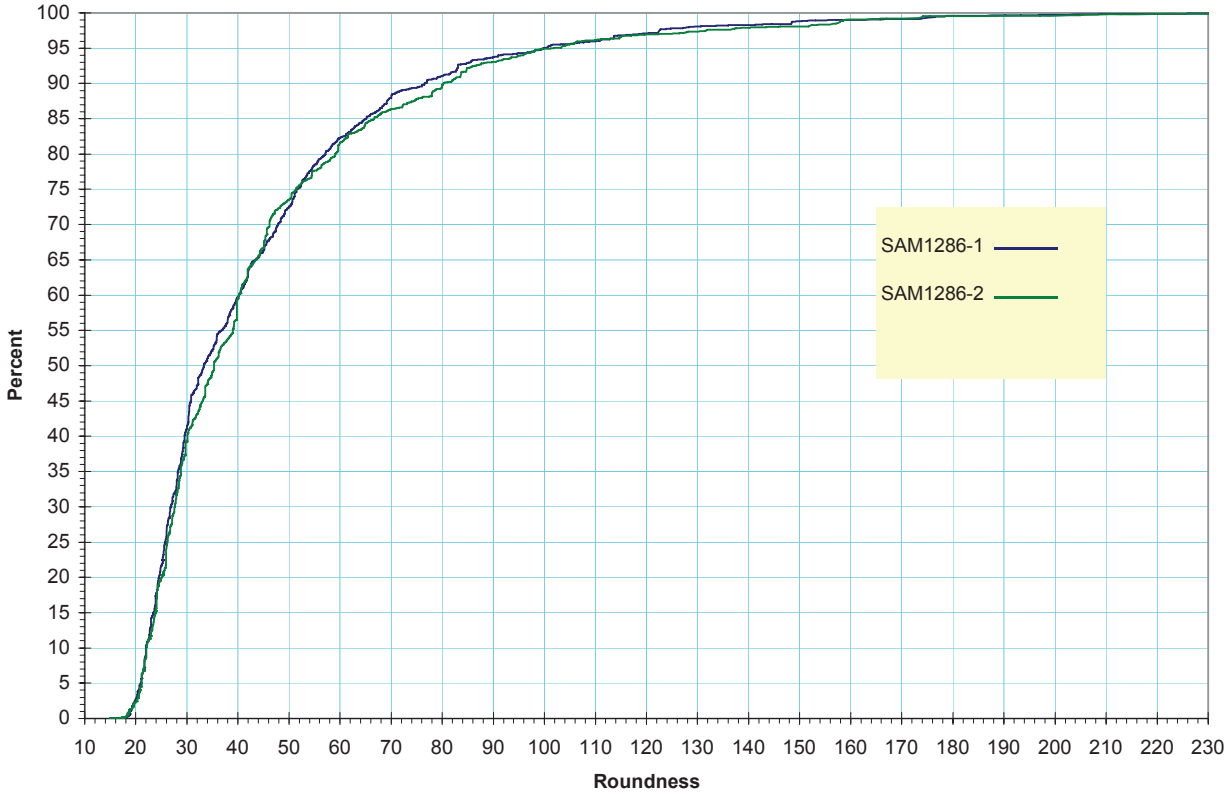

Percent
Roundness
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230


Percent
Aspect Ratio
Run 1
Run 2
Run 3
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15


Percent
Minor Axis, Micron
Volume % Run 1
Count %, Run 1
Volume %, Run 2
Count %, Run 2
Volume %, Run 3
Count %. Run 3
Volume D Values, Run 2:
D10= 295.205
D20= 437.888
D30= 585.491
D40= 728.173
D50= 880.696
D60= 1043.06
D70= 1279.22
D80= 1471.11
D90= 1997.56
D100= 2966.81


Percent
Roundness

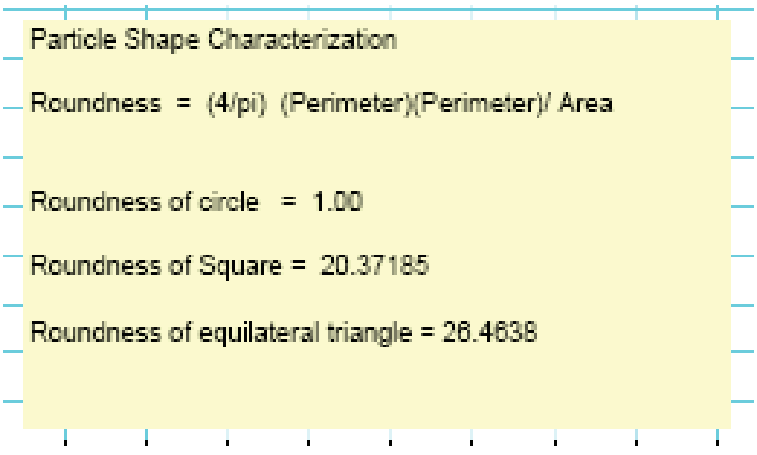
Roundness comparison:



Aspect Ratio –
The size and shape measurements are reported as two charts for each of the two mill samples. The first SAM1 chart shows a composite plot of Aspect Ratio (Major Axis divided by Minor Axis) by Volume Percent Less than. It is seen that 100 % of the particle volume has Aspect Ratio less than 15, and 50% has Aspect Ratio less than 3.0.

Minor Axis Percent Passing –
The second chart shows particle size by minor axis by both count and volume. Tabular listings of the extreme measurement values are provided as well as numerical values along the percent passing curves.

Roundness - Canty computes a perimeter area ratio to characterize the particle data. This feature, termed "Roundness", allows particles to be identified by their approximate shapes.



By computing a roundness value for each particle the data can be used to characterize the population based on deviation from a round particle. Graphs attached to this report are presented as volume percent passing based on roundness. A shape format will have to be determined depending on what yields the best indicator of product quality.

Discussion:

Aspect Ratio and minor axis size distribution are extracted and plotted as candidate process control indicators. Where the user knowledge or experience indicates that a more sensitive process control can be achieved with alternate particle shape properties, these alternate parameters may be able to be calculated from the standard measurement data. An example of an alternate characterization is the ratio of particle area to perimeter squared used to characterize the particle circularity.