Precision Cut Test Report

Cricut Explore versus Silhouette Cameo

by

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Approved:

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1 Introduction

1.1 Scope

The “Cricut Explore Competitive Precision Cut Test Report” defines test requirements and methodologies that were performed using the Cricut Explore of Provo Craft & Novelty, and the Silhouette Cameo of Silhouette America. The testing is a competitive cut test to determine how the Cricut Explore compares to the Silhouette Cameo.

The tests and procedures defined in this document were developed by Percept Technology Labs LLC, an independent product test and development firm located at 5541 Central Ave., Ste #110, Boulder, Colorado 80301.

1.2 Description

The products being tested are personal electronic cutting machines.

1.3 Assumptions

The samples Percept Technology Labs LLC purchased are representative of the configurations being investigated.

1.4 Company Restricted Information

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1.5 Abbreviations / Acronyms / Definitions

EUT — Equipment Under Test

1.6 Executive Summary

The precision cut test compared the Cricut Explore electronic cutting machine to the Silhouette Cameo. After cutting the three types of shapes it became clear that each machine type had some difficulties.

Isosceles & Equilateral Triangles:

The differences between the Explore and Cameo were minimal as far as size was concerned. The shape errors were significantly dissimilar between the two. The Explore created shapes truer to the design over the Cameo. Both machines had issues with rounding of the corners or material left in corners leaving a tear.

Figure 1 shows calculated shape error for the isosceles triangles. Figure 2 shows calculated shape error for the equilateral triangles. All measurements are in millimeters.

The shape error was the sum of differences of each side from its design length. A short side produced a negative error and a long side produced a positive error. In order that they don't cancel out, the negative error was converted to positive and added to the positive errors.

Figure 1: Isosceles Triangle Shape Error

	Explore				Cameo		
	Max	Min	Average		Max	Min	Average
EUT #1	0.33	0.02	0.12	EUT #1	0.59	0.05	0.30
EUT #2	0.31	0.03	0.14	EUT #2	0.83	0.09	0.30
EUT #3	0.33	0.02	0.14	EUT #3	1.16	0.06	0.36

Figure 2: Equilateral Triangle Shape Error

	Explore				Cameo		
	Max	Min	Average		Max	Min	Average
EUT #1	0.2781	0.0450	0.1311	EUT #1	0.4388	0.1300	0.2584
EUT #2	0.4891	0.0263	0.1505	EUT #2	0.3782	0.1059	0.2551
EUT #3	0.2874	0.1207	0.1207	EUT #3	0.4723	0.2605	0.3791

Circles:

There was no significant difference between the Explore and the Cameo when it came to the ovality of cut circles. Both machines produced errors in the 2% to 2.5% range. However, the Cameo would often not completely cut all the way around the circle shape; it would leave a small amount of paper either due to not completing the circle cut, or due to the two ends of the cut overlapping and not meeting together.

Figure 3: Circles Shape Error – Explore vs Cameo

	EXPLORE				CAMEO		
	Max	Min	Average		Max	Min	Average
EUT #1	0.34	0.00	0.12	EUT #1	0.34	0.00	0.12
EUT #2	0.23	0.00	0.09	EUT #2	0.18	0.00	0.08
EUT #3	0.24	0.00	0.10	EUT #3	0.22	0.03	0.13

Figure 4: Silhouette Cameo Circles Not Completed

EUT #1	
SHEET #	TOTAL
1	6
2	5
3	5
EUT #2	
SHEET #	TOTAL
1	3
2	4
3	5
EUT #3	
SHEET #	TOTAL
1	4
2	4
3	4

2 Test Conditions and Requirements

2.1 Test Configurations

The Cricut Explore and Silhouette Cameo were purchased through the retail channel.

- Three (3) Cricut Explore samples.
- Three (3) Silhouette Cameo samples.

2.2 Test Entrance Criteria

- All necessary product related materials and support documentation required for Percept Technology Labs LLC to execute this project.
- Packaged samples of the product for testing.
- Access to a technical resource (person) for operational questions.

2.3 Test Exit Criteria

- Completed testing.
- All data collected for specified test cases.
- Completed Test Report.

3 Competitive Test

- Each EUT will be operated using the respective manufacturer's pre-set settings for cardstock.
- New blades were used in each EUT.
- New cutting mats were used for each EUT.
- Blades must be sharp. If a blade dulls or breaks, this must be noted, but must not be counted against the quality of that particular cut.

3.1 Precision Cut Test

Objective:

Determine the cut precision and quality of different shapes produced by the EUTs using appropriate blades and cutting mats obtained from the two respective EUT manufacturers.

Test Configuration:

- Three (3) Cricut Explore samples.
- Three (3) Silhouette Cameo samples.

Test Equipment:

- Boreal Digital Research Microscope
  Model: 57900-03
- Mitutoyo Micrometer
  Model CD-6" CS
  Calibration Due: 9/10/2016
- Dell Laptop
  Model: Latitude E5510

Materials:

The following materials were sourced from local craft stores:

- Cardstock, 80 lb, un-textured, white (or off-white) 304.8mm x 304.8mm (12" x 12").

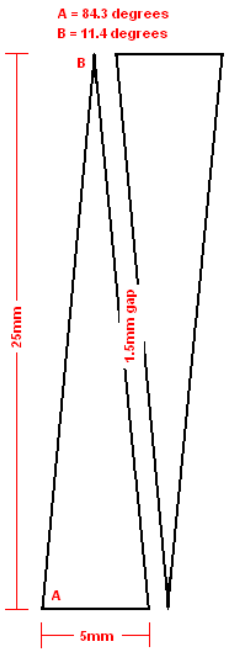
Cuts:

Each EUT was setup according to its user's manual. Recommended cutting mats were used for the particular material being cut. EUTs cut each shape and size of object indicated below into three (3) pages of each of the material being tested.

1. Triangles – Only one type of triangle was cut on a page. The following size and type of triangles were cut:
   a. Isosceles triangle – 5mm (0.197") base, 25mm (0.984") height

      A pair of isosceles triangles, 1.5mm apart were cut in each corner of the page 12.7mm (0.5") from any edge of the page, in the center of each side 12.7mm (0.5") from the edge of the page, and one pair in the center of the page.

Figure 5: Isosceles triangle shape



   b. Equilateral triangle – 2mm on a side (0.08")

      An equilateral triangle was cut in each corner of the page 12.7mm (0.5") from any edge of the page, in the center of each side 12.7mm (0.5") from the edge of the page, and one in the center of the page.

2. Circles – Only one size of circle was cut on a page. The following size of circles was cut:
   a. 5mm (0.197")

      A circle was cut in each corner of the page 12.7mm (0.5") from any edge of the page, in the center of each side 12.7mm (0.5") from the edge of the page, and one circle in the center of the page.

Method:

1. Install recommended cutting mat.
2. Place a page of the test material sample on the cutting mat.
3. Set blade cut pressure, etc. according to the appropriate recommended setting for the particular material to be cut.
4. Perform cuts.
5. Remove cut material and measure for accuracy and quality.

Test Comparison:

The following areas were compared for all materials and EUTs tested:

1. Cut quality (cut edges were examined to determine quality of cut (see Section 4 *Cutting Defects*).
2. Cut size accuracy (5mm circle should be measured to be 5mm). Determine the ovality of the circles by measuring the minimum and maximum diameter of each circle and find the difference.
3. Angle corner accuracy—corners and angles are sharp; no rounding (see Section 4 *Cutting Defects*). Measure all three legs of the equilateral triangles. Subtract the measured dimension from the designed dimension to determine the error.

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3.2 Precision Cut Results:

3.2.1 About Triangle Shape Error:

One of the problems discovered when trying to make the correct size triangles on either machine was that, though the work-space indicated the shapes were the correct size, they didn't actually cut to that size.

Because of the difficulties in making triangles the correct size, triangles that were clearly not equilateral had less error than those that were the perfect shape, but were the wrong size. In order to be able to accurately assess the quality of the triangles, it was decided to separate the error sources. The size error was calculated for each of the triangles. The size error is the average amount that the perimeter of all triangles was different than the designed perimeter. Then the shape errors were calculated; which was often hidden beneath the size error. The shape error was the sum of differences of each side from its design length. A short side produced a negative error and a long side produced a positive error. In order that they don't cancel out, the negative error was converted to positive and added to the positive errors. There were fairly significant size errors that were often undetectable by the human eye, whereas a relatively small shape error was quite apparent to the human eye.

Figure 6: Example of Error Calculation – Equilateral Triangles

Measured			Size adjusted for Scale Error (Measured + Scale Error)			*Shape Error
Side 1	Side 2	Side 3	Side 1	Side 2	Side 3	
1.8034	1.8145	1.7159	2.0640	2.0751	1.9765	0.1626
1.6569	1.6543	1.6612	1.9175	1.9149	1.9218	0.2459
1.7854	1.7381	1.7157	2.0460	1.9987	1.9763	0.0710
1.7754	1.8000	1.7002	2.0360	2.0606	1.9608	0.1358
1.6499	1.7713	1.6373	1.9105	2.0319	1.8979	0.2235
1.7718	1.7332	1.7160	2.0324	1.9938	1.9766	0.0620
1.7575	1.7895	1.7242	2.0181	2.0501	1.9848	0.0834
1.8028	1.7961	1.7026	2.0634	2.0567	1.9632	0.1569
1.7760	1.8002	1.7155	2.0366	2.0608	1.9761	0.1213
Average		1.7394				
Scale Error (2.0mm – Average)		0.2606				0.1403

* |2.0mm – Side 1| + |2.0mm – Side 2| + |2.0mm – Side 3| = Shape Error

Isosceles Triangles:

Referring to Figure 7 and Figure 8, it can be seen that the scale errors are very close to one another for the Explore and the Cameo; however, the shape errors are very much lower for the Explore.

Figure 7: Isosceles Triangles Scale Error Graph

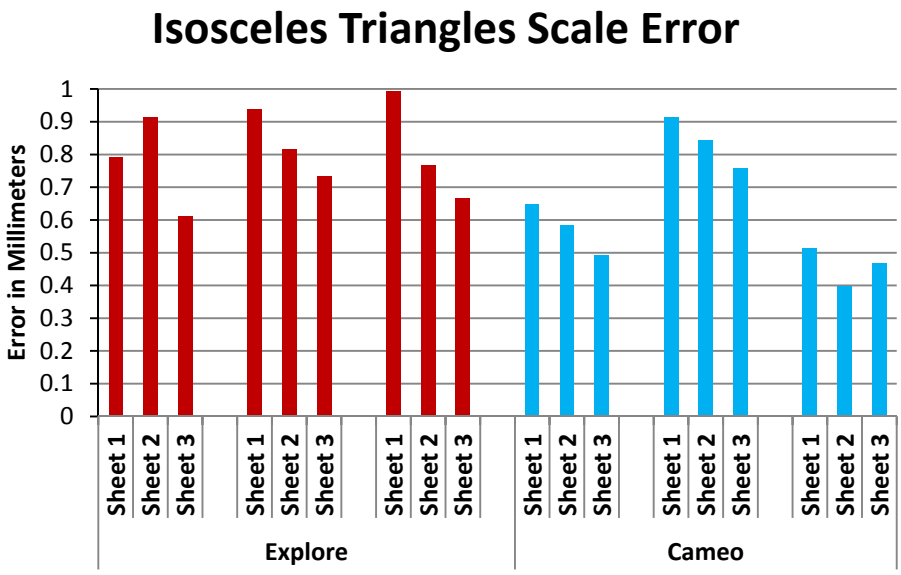
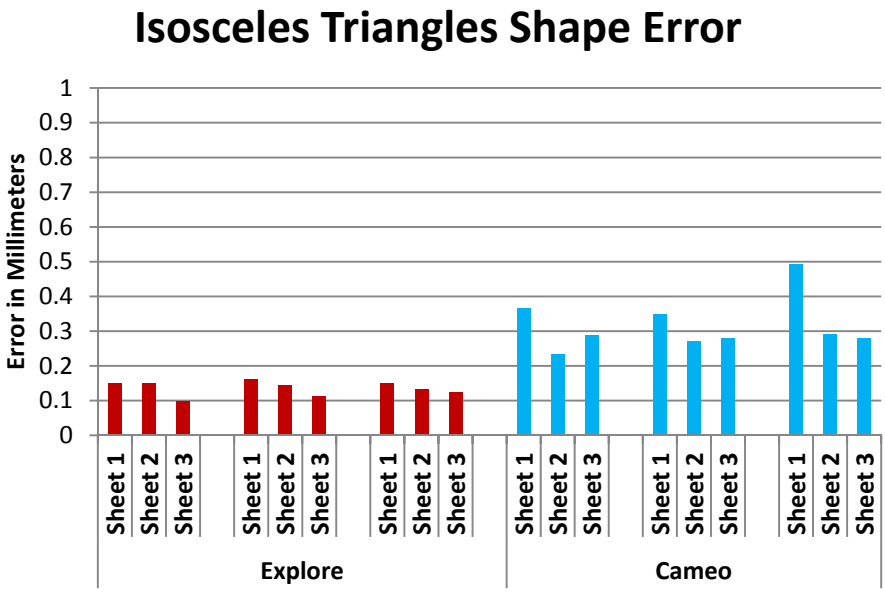


Figure 8: Isosceles Triangles Scale Error Graph



The photographs of Figure 9 and Figure 10 show typical triangles cut by the Explore and the Cameo. Note that the gap between triangles for the Explore is wider than that of the Cameo. This was a problem encountered with the design software of the Explore; precise placement was difficult compared to the Cameo design software.

As can be seen in the photographs, both machines had difficulties with the corners.

Figure 9: Explore isosceles triangles

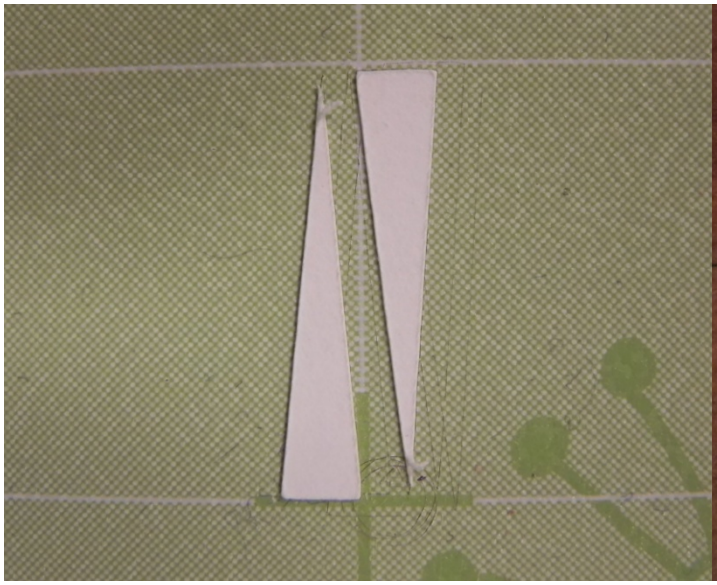
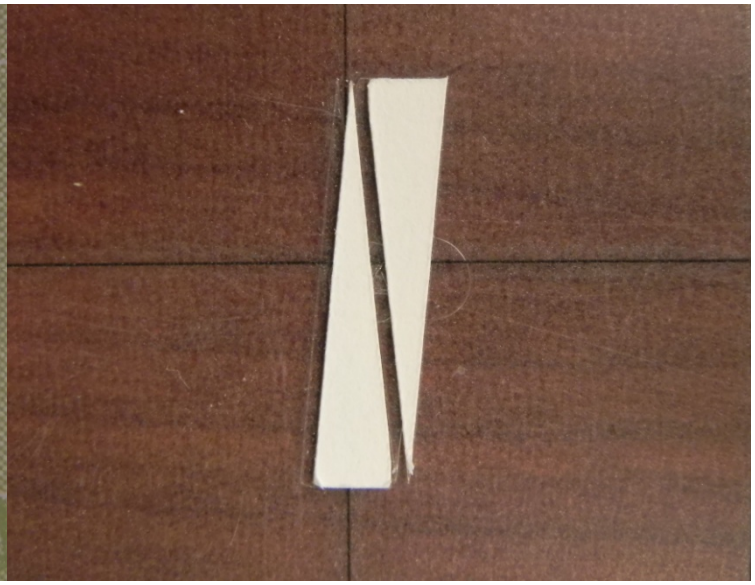


Figure 10: Cameo isosceles triangles



Equilateral Triangles:

Referring to Figure 11 and Figure 12 it can be seen that the scale errors are very close to one another for the Explore and the Cameo, however, the shape errors are very much lower for the Explore than the Cameo.

Figure 11: Equilateral Triangles Scale Error Graph

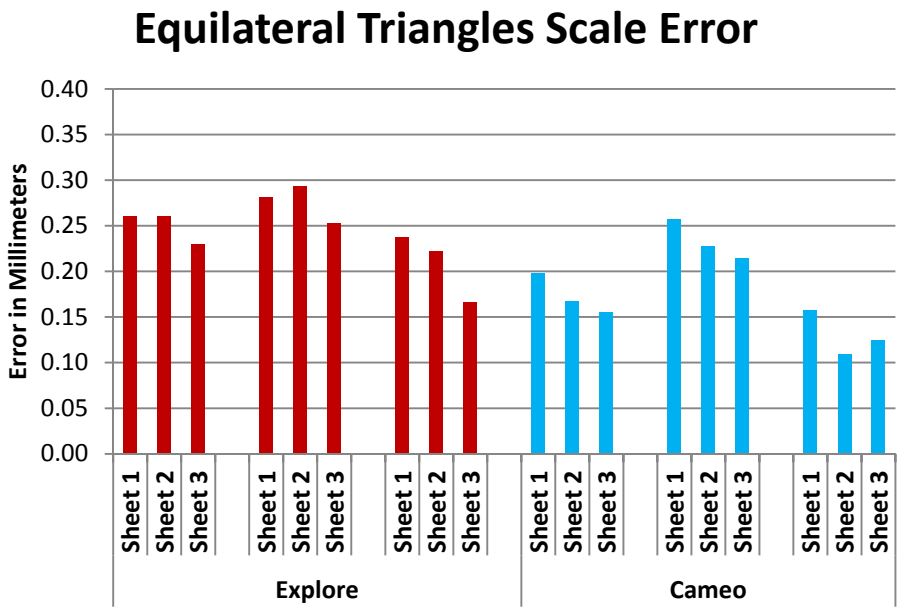
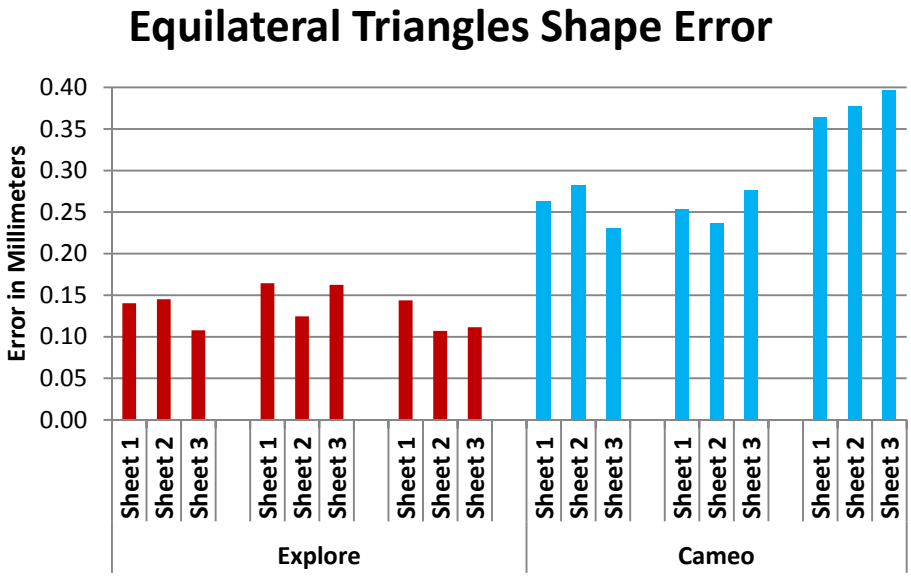
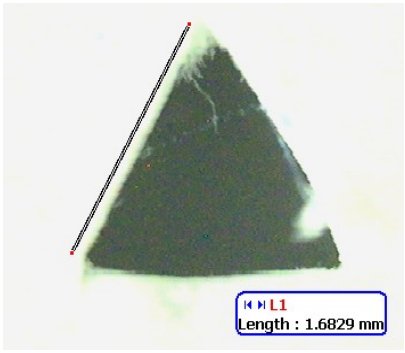


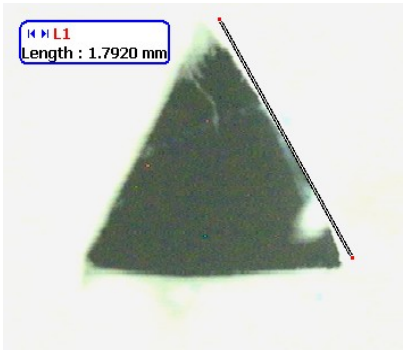
Figure 12: Equilateral Triangles Shape Error Graph



The following photographs in Figure 13 and Figure 14 are typical equilateral triangles from the Explore and Cameo. Note that the Cameo's side #2 is typically longer than the other two sides.

Figure 13: Explore Equilateral Triangles





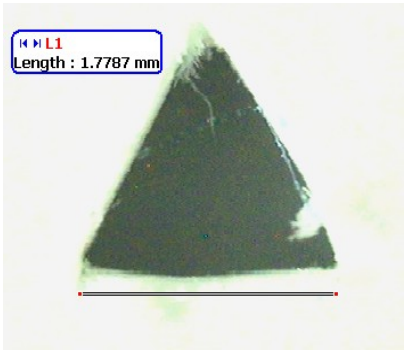
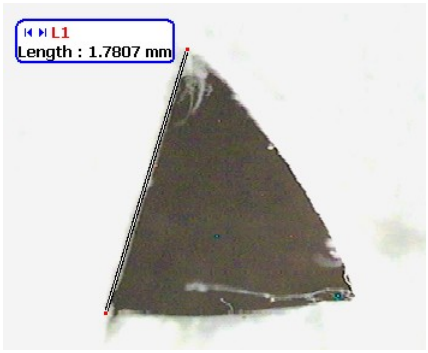
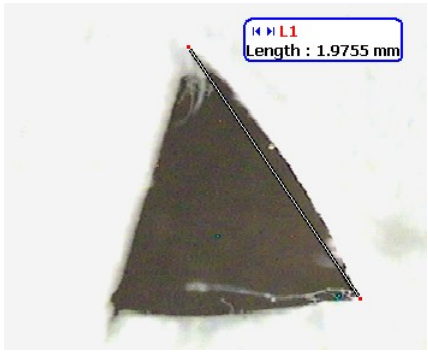
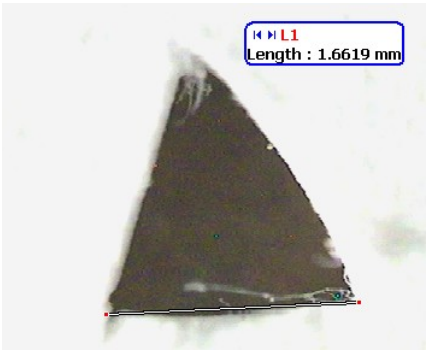


Figure 14: Cameo Equilateral Triangles







Circles:

Circles were measured on the horizontal, vertical, and the two 45-degree planes. The difference between the horizontal and vertical measurements was computed, and the difference between the two 45-degree measurements was computed. These calculated values were then used in the table below (see Figure 15). All measurements are in millimeters.

Figure 15: Circles Shape Error – Explore vs Cameo

	EXPLORE				CAMEO		
	Max	Min	Average		Max	Min	Average
EUT #1	0.34	0.00	0.12	EUT #1	0.34	0.00	0.12
EUT #2	0.23	0.00	0.09	EUT #2	0.18	0.00	0.08
EUT #3	0.24	0.00	0.10	EUT #3	0.22	0.03	0.13

As can be seen, there was not a significant difference between the Explore and the Cameo when it came to cutting circles. Many of the circles cut by the Cameo EUTs would not detach cleanly from the negative because the cut was not completed (see Figure 17). This problem did not occur with the Explore (see Figure 16).

Figure 16: Explore circles

Figure 17: Cameo circles

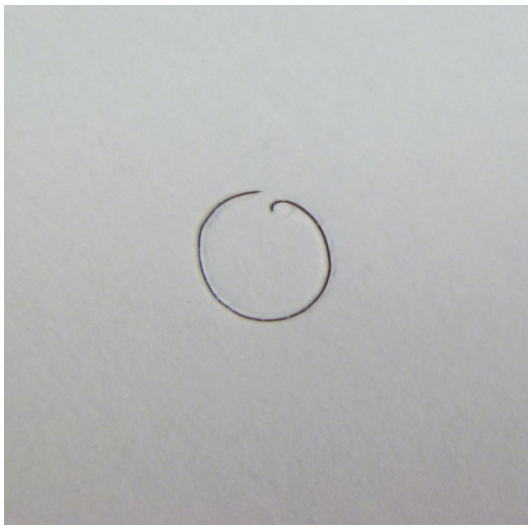


Figure 18 indicates how many of the circles the Cameo did not completely cut all the way around.

Figure 18: Silhouette Cameo Circles Not Completed

EUT #1	
SHEET #	TOTAL
1	6
2	5
3	5
EUT #2	
SHEET #	TOTAL
1	3
2	4
3	5
EUT #3	
SHEET #	TOTAL
1	4
2	4
3	4

4 Cutting Defects

Given that one has a sharp blade to begin with, some defects can be categorized as follows:

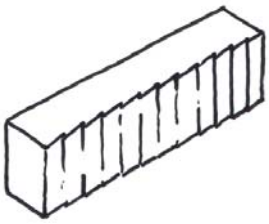
- Jagged edge (see Figure 19).

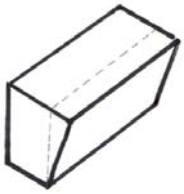
  A cut edge that is not smooth, has "cupped" or "jagged" features, or discontinuity of the cut. This defect can be brought about by the blade "tugging" on the material being cut—lack of adherence of the material to the cutting mat, or material that is too dense to be cut properly.
- Slanted edge, not perpendicular (see Figure 20).

  Cut is not perpendicular to the plane of the material being cut. May be caused by material that is rolling upwards or under while the blade is passing through it. Could be a mechanical mis-alignment of the blade-holder or other setting.
- Corners that have a cusp, or overshoot, or not square (see Figure 21).

  Corner is not at the proper angle, i.e., 90° corner doesn't meet cleanly, has cusp, is rounded or squared with an intermediary angle, or shows unintentional overshoot at the vertices.
- For adhesive materials with backing (such as vinyl and iron-on, or heat-transfer materials), cuts should make it completely through the material. A cut depth of up to 30% into the backing is acceptable.
- Failure to cut all the way through the material (for materials lacking backing).

Figure 19: Jagged edge *Figure 20: Slanted edge* *Figure 21: Defective corners*





Note - The defects shown above may be indicators of a worn blade or other assembly, or material too dense to be cut by the EUT, or by cutting too close to the edge of the material being cut.