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A Review of the Distribution of Fibre Length in Tops

By

V.E. Fish

Australian Wool Testing Authority Ltd PO Box 190, Guildford, NSW 2161 AUSTRALIA

SUMMARY

The distribution of fibre length in consignments has shifted from a bimodal distribution, as seen during TEAM-2, to a more even distribution. A development in the understanding of blends has been noted over the last 10 years, contributing to this observed shift in the fibre length distribution of tops. A general reduction in the CVH of consignments between TEAM-2 to TEAM-3 was also noted, indicating a lower short fibre content in modern top consignments compared with their TEAM-2 counterparts.

The CSIRO Single Sale Lots Trial and the AWTA Ltd Non-fleece Wool Processing Trial were compared for fibre length distributions. Very little difference was noted between the fibre length distributions of either datasets, showing that sale lots characteristically exist in three main fibre length distribution shapes.

INTRODUCTION

Allen (1991) identified nine (9) different shapes for Hauteur distributions that were evident in the commercial tops produced during the TEAM-2 project (1988). The histogram shapes were also compared to those shapes that resulted from the processing of single sale lots. The shapes ranged from distributions that were heavily skewed to the left to distributions that were heavily skewed to the right. A number exhibited differing degrees of bimodality. The shape is influenced by both the characteristics of the greasy wool and the processing conditions used to produce the top.

The TEAM-3 Processing Trial – Final Report (2004) highlighted the changes that had occurred in processing outcomes (i.e. longer Hauteurs, lower CVHs and higher Romaines) compared to what was observed in 1988 during TEAM-2.

This paper examines the shapes of the Hauteur distributions that characterised the tops submitted during the TEAM-3 Trial. In order to allow comparisons with TEAM-2, the methodology developed by Allen was used to categorise the tops from TEAM-3.

Allen had also categorised tops from the CSIRO single sale lots trials (1991) to compare with the commercial tops being produced at that time. Despite the difference in selection criteria between the current AWTA Ltd Non-fleece Wool Processing Trial and the earlier CSIRO single sale lot trial, it was still considered of value to categorise these tops on the same basis. The sale lot selection criteria for both trials have been discussed elsewhere (Fish et al, 2004; Allen et al, 1990).

Comparing the observed similarities and differences between the shapes of the Hauteur distributions that were the outcomes from the four different processing trials will be the subject of this paper.

METHODOLOGY

The methodology for this trial was based around the previous set of Almeter histograms published by Allen (1991) and numbered from 1 to 9. The description given to each category is reproduced from Allen's report as Table 1 below.

Table 1: Description of Shape Categories (reproduced from Allen (1991))

Shape Category	Point of Intersection of Cumulative Distribution and Histogram (mm)	Relative Position of Histogram Peak	Shape Description
1	<40	left	skewed (short tail)
2	40-100	left	skewed (long tail)
3	40-80	centre	symmetrical
4	80-100	left	bimodal
5	60-100	left	mainly flat
6	>100	left	flat
7	60-100	right	flat bimodal
8	80-100	centre	symmetrical
9	>100	right	flat

For this paper, the Shape Categories were re-ordered to reflect a movement in the skewness of the distribution from left to right. An additional shape category was added to provide further differentiation in the degree of bimodality for one of Allen's shape categories (compare category H with category J in Figure 1).

The ten (10) shape categories, and their corresponding numbers assigned by Allen are listed in Figure 1.

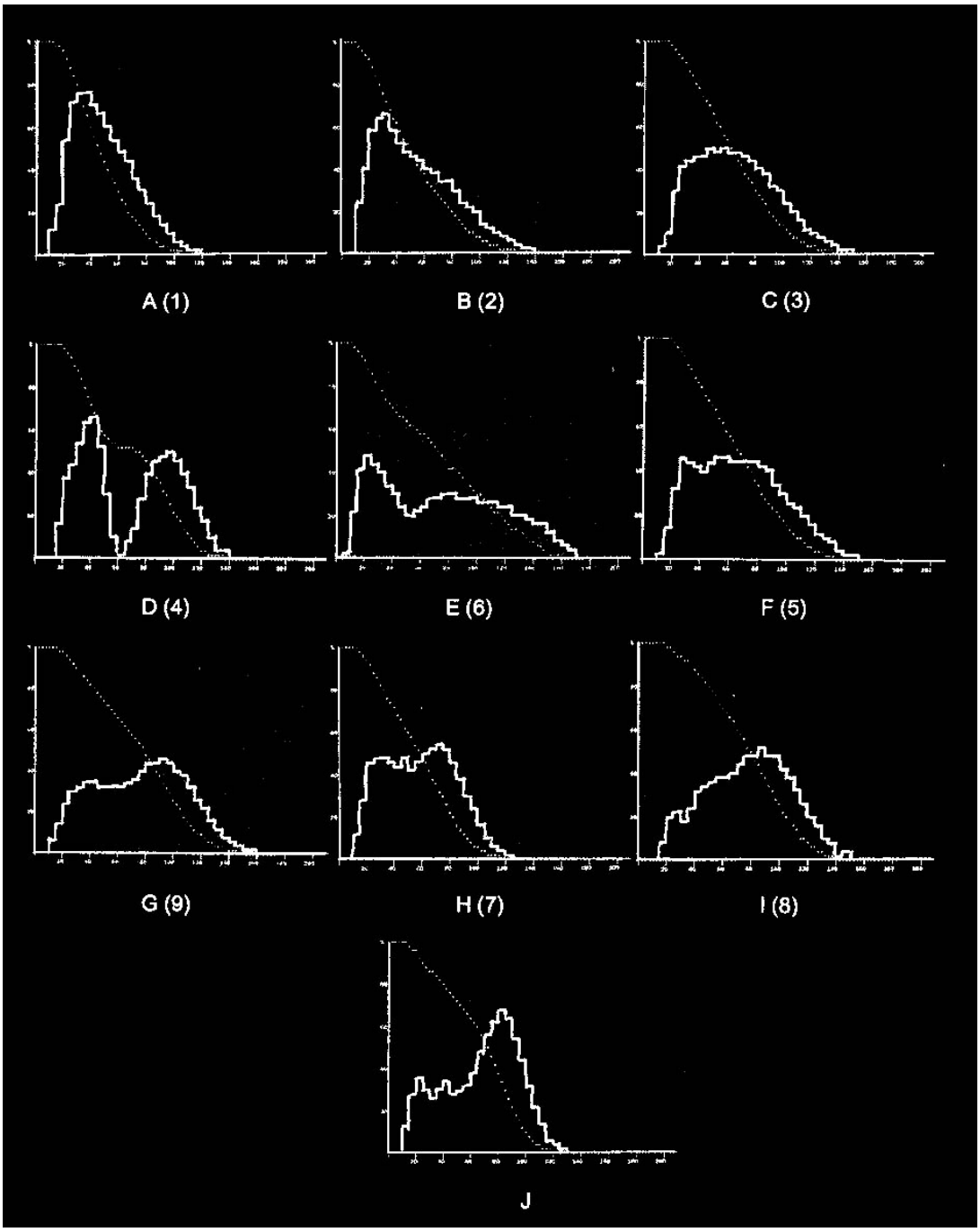

Figure 1: The Almeter Histograms used as the basis of Shape assessment, with there corresponding numbers assigned by Allen in parenthesis.

Three operators were trained in the assessment and recognition of the 10 distribution shapes. The operators then independently assessed the Almeter histograms of 593 tops from TEAM-3 and 189 sale lots from the AWTA Ltd Single Sale Lots Processing Trial datasets. Not all consignments and sale lots were assessed because Almeter histograms were not available in all cases.

Data was collected and analysed using the S-Plus® (Insightful Corp, 2002) data analysis package.

RESULTS AND DISCUSSION

HAUTEUR DIAGRAM SHAPE CATEGORIES FOR CONSIGNMENTS AND SALE LOTS.

Sale Lots

The CSIRO Single Sale Lot dataset (CSIRO) and the AWTA Ltd Non-fleece Wool Processing Trial dataset (AWTA) were compared (Table 2).

Table 2: Comparison of the Shapes of the Hauteur Histograms associated with the CSIRO Single Sale Lots Trial and the AWTA Ltd Single Sale Lots Processing Trial. Underlined numbers designate the three most important Shapes for each dataset.

	Percentage of Lots of Nominated Shape (%)									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
CSIRO Single Sale lots	5	27	8	14	11	12	3	19	1	–
AWTA Ltd Single Sale Lots	8	15	7	24	4	7	2	4	14	15

Despite the differences in the selection criteria for the two processing trials, Table 2 shows that the two datasets are very similar when one compares the relative frequencies of the different shapes. For the CSIRO dataset, the most common Almeter shapes were B, D and H, whereas for the AWTA dataset, the most common shapes were B, D and J. The Shapes B and D were common to both datasets, accounting for 41% of the CSIRO sale lots, and 39% of the AWTA sale lots. The J and H shapes are similar varying only in the amount of short fibre present (less in shape J). The B shape, which accounted for 27% of the CSIRO lots and 15% of the AWTA lots, was heavily skewed towards the shorter fibres whereas the D shape was distinctly bimodal and accounted for 14% of the CSIRO lots and 24% of the AWTA lots.

Table 3 partitions each of the datasets into their Fleece and Non-Fleece components in order to compare any interaction with the shapes.

Table 3: Comparison of the Shapes of the Hauteur Histograms Associated with the CSIRO Trial and AWTA Trial, Partitioned into Fleece and Non-Fleece components.

	Percentage of Lots of Nominated Shape (%)									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
CSIRO Fleece	5	16	9	17	12	13	4	23	1	
AWTA Fleece	6	8	2	25	4	4	2	6	21	22
CSIRO Non-Fleece	7	77	0	0	6	7	0	3	0	
AWTA Non-Fleece	13	29	19	22	3	13	0	2	0	0

The most common shapes for the Fleece component of the CSIRO dataset were the same as for the dataset as a whole (B, D and H), accounting for 56% of the fleece component of the CSIRO dataset. For the fleece component of the AWTA dataset, the common shapes were D, I and J. They accounted for 68% of this component of the dataset.

For the Non-Fleece portion of the CSIRO dataset, shape B on its own accounted for 77%. For the Non-fleece component of the AWTA dataset, three shapes (B, C and D) were favoured and accounted for 70% of the dataset. The wider range of shapes in the AWTA dataset could be related to the wider selection of wool types in this dataset.

No one shape can be considered to characterise Fleece or Non-fleece sale lots. Rather, there are a number of different Hauteur shapes that can result from processing single sale lots.

TEAM Consignments

The commercial consignments processed during either TEAM-2 or TEAM-3 are simply a blend of individual sale lots. It is the role of the topmaker to determine the components required to blend together to produce a top suitable for his spinner client.

Table 4 summarises the frequencies of the different Hauteur shapes for both TEAM-2 and TEAM-3.

Table 4: Comparison of the Shapes of the Hauteur Histograms associated with TEAM-2 and TEAM-3.

	Percentage of Consignments of Nominated Shape (%)									
	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
TEAM-2	6	26	6	16	4	14	6	16	6	
TEAM-3	0	10	15	7	12	16	3	25	8	4

The three (3) most common shapes for the TEAM-2 consignments were B, D and H, which collectively accounted for 58% of all consignments (Table 4). The three (3) most common shapes for the TEAM-3 consignments were C, F and H, which collectively accounted for 56% of all consignments. The shift from shapes B and D to C and F clearly indicates a move away from the bimodal type shapes to a more normal shape.

The author is unaware of any published research that quantifies the importance or otherwise of the different shapes on either spinning performance or end product performance.

Figure 2 compares the mean CVH values across the shape categories for both the TEAM-3 consignments and AWTA Ltd Non-fleece Wool Processing Trial sale lots.

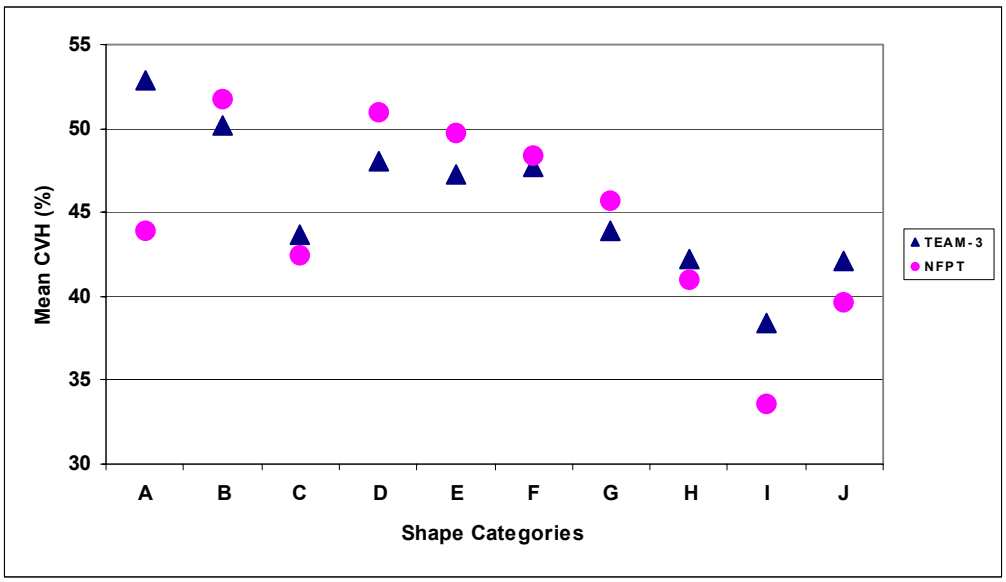

Figure 2: The Mean CVH values for the TEAM-3 and NFPT sale lots, arranged by shape category.

In general, CVH decreases as the histogram skews from left to right, i.e., as the short fibre content of the top decreases. For both datasets, there is a rise in CVH at J, which reflects the more bimodal nature of shape J.

Shapes D, E and F have similar average CVH values but differ significantly in their shapes as do shapes C, E and G. Spinners often set limits on CVH, short fibre content (K15, K20, K25 or K30 depending on the individual processor) and long fibre content (L1 and/or L5 values).

RELATIONSHIP BETWEEN SHAPE CATEGORIES AND RAW WOOL CHARACTERISTICS

The relationships between the shape categories and raw wool characteristics (as the average for each category) are reported in Figures A1 to A6, in Appendix 1. It is important to recall that the categories were ordered from A to J with respect to the skewness of the Hauteur distribution changing progressively from left skewed to right skewed. This decision would automatically result in a trend for the average Hauteur, changing progressively from the lowest values at A to the highest values at J. Hence, any trends observed with the shape category could simply be due to a correlation between the particular characteristic and the Hauteur rather than the shape per se.

As a group, the sale lots exhibit greater variation for the raw wool characteristics when compared to the consignments. As the TEAM-3 consignments are a blend of individual sale lots, this was to be expected. In addition, the selection of the sale lots was structured to favour the extreme wool types.

A slight general increase in Mean Fibre Diameter (MFD) is noted in Figure A1, as we move across shape categories from A to J that is as the average Hauteur increases from left to right. This could simply be a consequence of finer fibres having a greater probability of being broken during processing than coarser fibres.

In the case of Coefficient of Variation of Fibre Diameter (CVD) there was no evidence of a strong relationship with Hauteur shape (see Figure A2).

Figures A4 to A6 show the relationships for the ATLAS measurements (Staple Length, Coefficient of Variation of Staple Length, Staple Strength and Percentage of Midbreaks). As these all have been shown to have an effect on the Hauteur of a top (TEAM-3, 2004), it is not surprising that, with one exception, they show clear trends with respect to the ordered shape categories. TEAM-3 Staple Length does not show a strong relationship with the shape category.

CONCLUSION

A wide range of Hauteur diagram shapes is possible when greasy wool is processed into a top. Selecting different types of greasy wool as the source material can vary the shape. This report confirms the conclusion drawn by Allen in 1991 that all the shapes found for individual sale lots are evident in consignments as well.

It has also been reported that comb settings can be adjusted to change the shape of the Hauteur distribution by removing more or less short fibre. Hence, the difference between sale lots and consignments is in the dominant three shapes for each group.

The three (3) most common shapes for the TEAM-2 consignments were B, D and H whereas the three (3) most common shapes for the TEAM-3 consignments were C, F and H. The shift from shapes B and D to C and F clearly indicates a move away from the bimodal type shapes to a more normal shape.

The author is unaware of any published research that quantifies the importance or otherwise of the different shapes on either spinning performance or end product performance.

Shapes D, E and F have similar average CVH values but differ significantly in their shapes as do shapes C, E and G. Spinners often set limits on CVH, short fibre content (K15, K20, K25 or K30 depending on the individual processor) and long fibre content (L1 and/or L5 values).

REFERENCES

Allen, D.J. (1991) *Variability of Fibre Length in Tops.* IWTO T&S Committee, Nice, Report 11

Allen, D.J., Mooy, L.M., Brown, G.H. and Rottenbury, R.A. (1990) *Development of Techniques to Predict the Processing Performance of Sale Lots. International Wool Textile Organisation.* Technical Committee, Nice Meeting, December 1990, Report 12.

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Trials Evaluating Additional Measurement (1988) Report to the Raw Wool Measurement Research Advisory Committee of the Australian Wool Corporation, December 1988.

APPENDIX 1

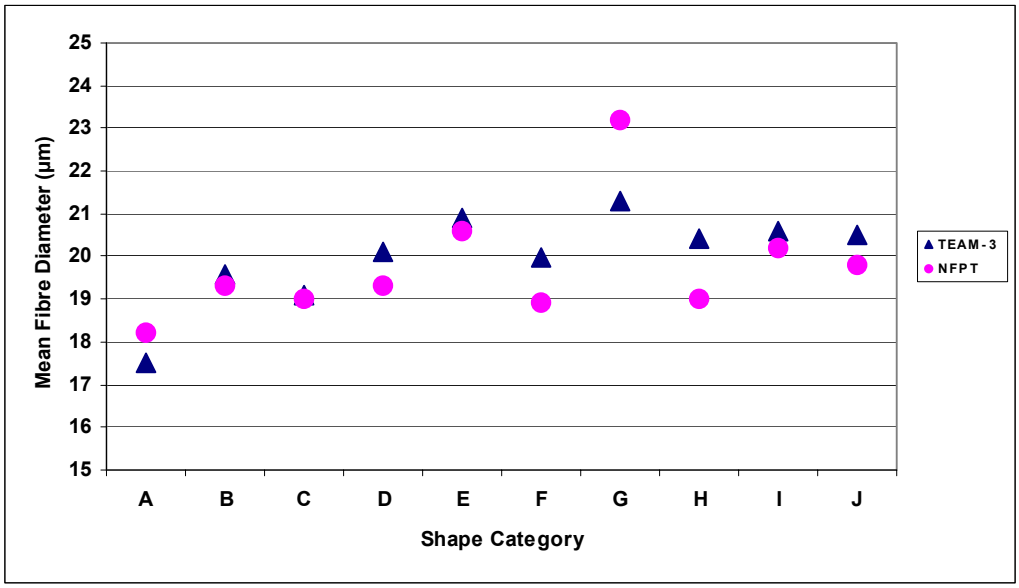

Figure A1: The Relationship between Shape Category and Mean Fibre Diameter for the TEAM-3 Consignments and AWTA Ltd Non-fleece Wool Processing Trial (NFPT).

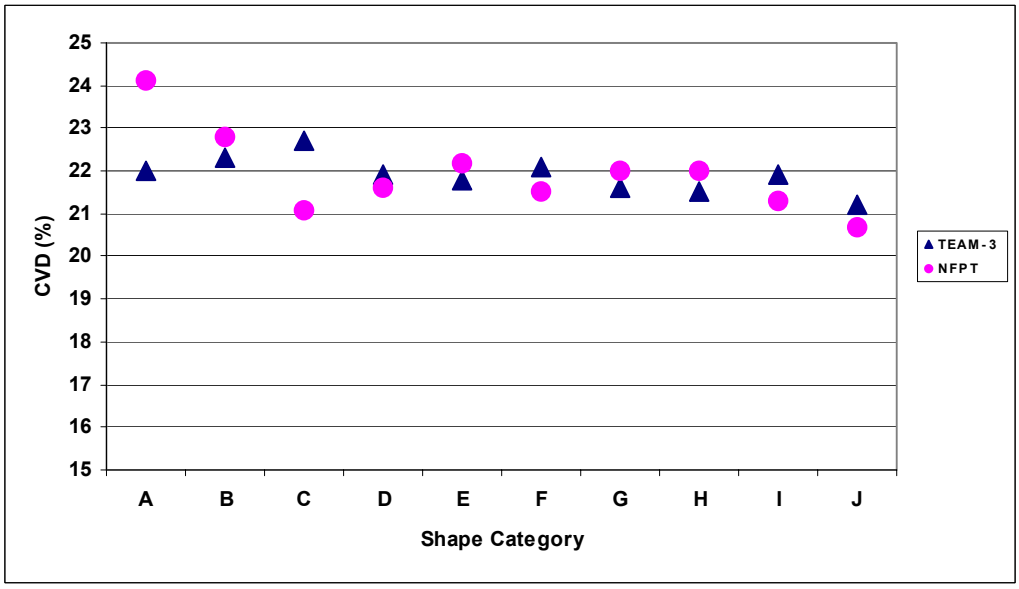

Figure A2: The Relationship between Shape Category and CVD for the TEAM-3 Consignments and AWTA Ltd Non-fleece Wool Processing Trial (NFPT).

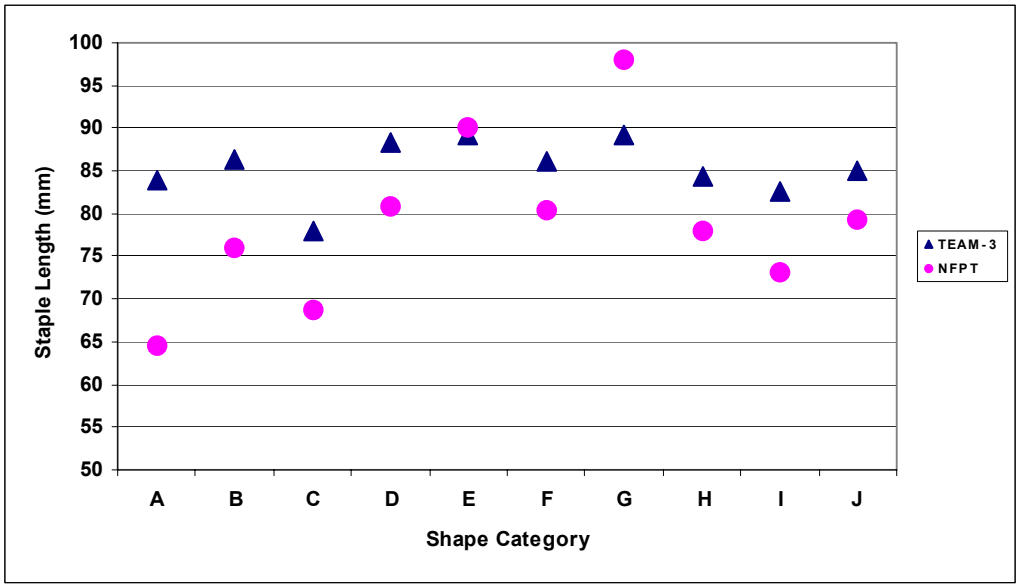

Figure A3: The Relationship between Shape Category and Staple Length for the TEAM-3 Consignments and AWTA Ltd Non-fleece Wool Processing Trial (NFPT).

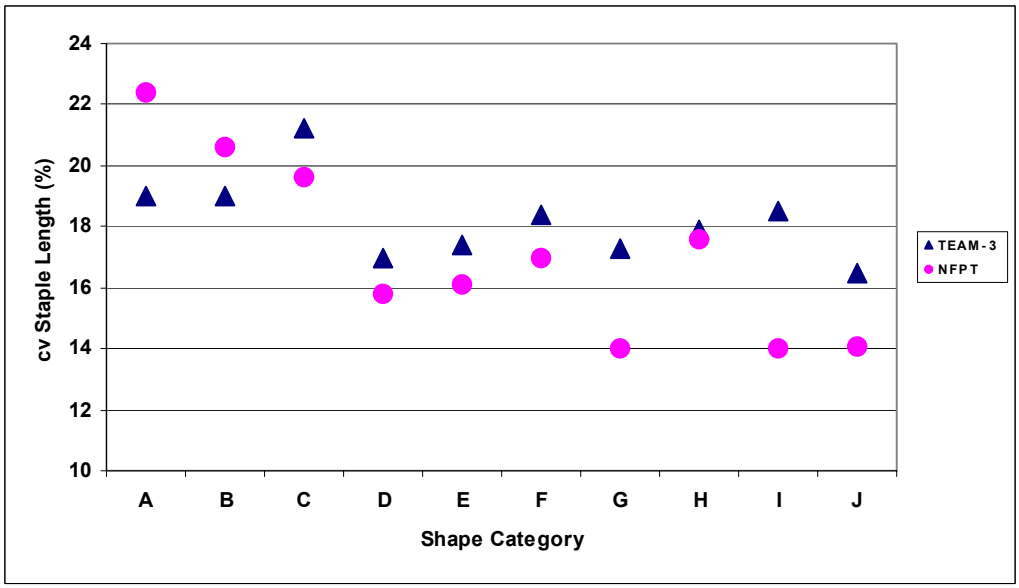

Figure A4: The Relationship between Shape Category and Coefficient of Variation of Staple Length (CVL) for the TEAM-3 Consignments and AWTA Ltd Non-fleece Wool Processing Trial (NFPT).

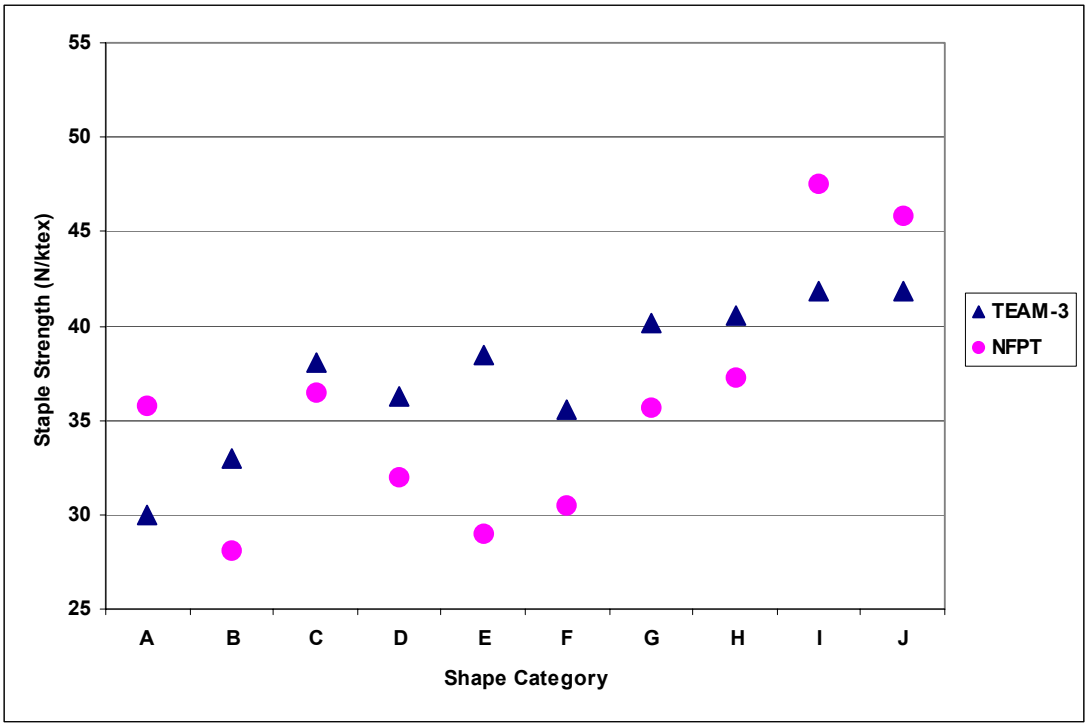

Figure A5: The Relationship between Shape Category and Staple Strength for the TEAM-3 Consignments and AWTA Ltd Non-fleece Wool Processing Trial (NFPT).

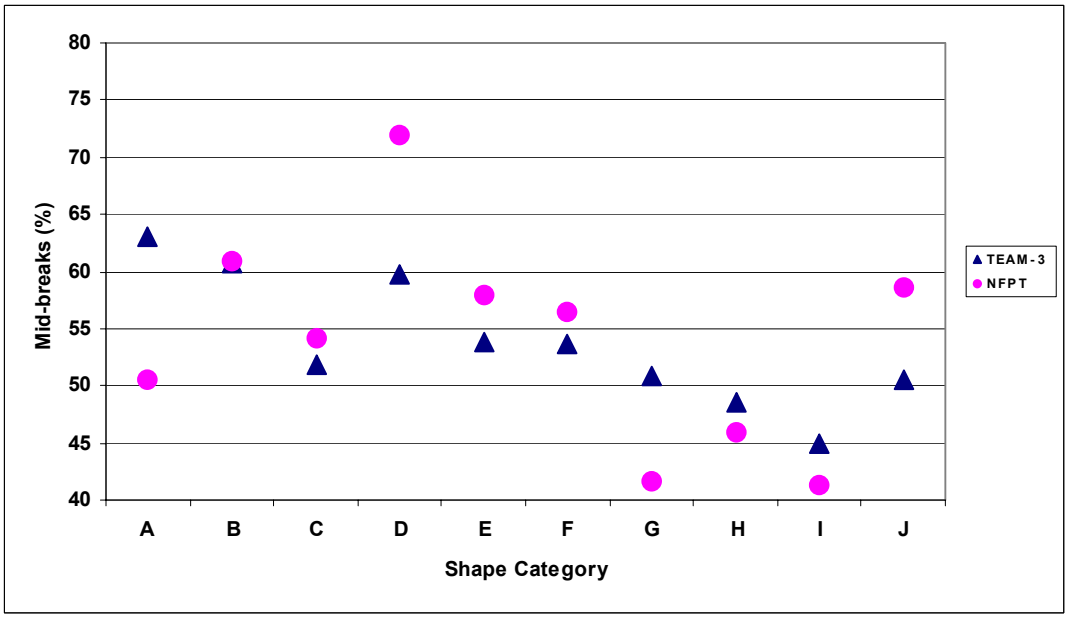

Figure A6: The Relationship between Shape Category and Percentage of Midbreaks for the TEAM-3 Consignments and AWTA Ltd Non-fleece Wool Processing Trial (NFPT).