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TECHNOLOGY & STANDARDS COMMITTEE **BARCELONA MEETING**

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Preliminary Analysis of TEAM3 Database

By

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SUMMARY

This report provides an update on the progress of the TEAM-3 trial. It shows that processing performance has improved since the late 1980's and that mills are producing tops with Hauteur values, on average, 4.5 mm longer than is predicted by the TEAM-2 general formula. Larger differences occur as the Hauteur increases above 75 mm. In addition, mills are producing tops which have, on average, CV of Hauteur values 2.5% less than predicted by the TEAM-2 formula and Romaine values that are, on average, 2.0% greater than predicted. With regards to core/comb relationships, the mean fibre diameter of the top is, on average, 0.3 μm coarser than the mean fibre diameter of the greasy wool.

A statistical analysis was conducted on 163 consignments that were submitted by 16 mills as part of the TEAM-3 trial. The analysis shows that the effects of Staple Length and Staple Strength on Hauteur are similar for both the TEAM-2 and the TEAM-3 databases. At this stage, the only term that could be added to the model to improve the prediction of Hauteur is CV of Length. The new measurements of CV of Diameter and Mean Fibre Curvature do not appear to have a significant impact on the prediction of Hauteur.

INTRODUCTION

For many years the Trials Evaluating Additional Measurement (TEAM) formulae, which utilise measurements of Staple Length & Staple Strength, have been the industry benchmark for the prediction of Hauteur (average fibre length in the top), Coefficient of Variation of Hauteur and Romaine (fibre wastage). Although there have been a number of attempts to provide improved prediction of processing performance during the last 13 years, a survey conducted as late as 1997 (Douglas & Couchman) clearly showed that the TEAM formulae remain the generally recognised world benchmarks. While this survey showed general satisfaction with the current TEAM formulae, it did indicate that there are specific wool types that do not predict accurately. Nevertheless, the use of the TEAM formulae as a benchmark had enabled individual mills to improve processing performance significantly. Due to the shortage of industry funds, research to improve prediction for these difficult types and for a wider range of wools has been left to individual topmakers and their customers.

AWTA Ltd's recent introduction of Laserscan as its standard for all Presale Fibre Diameter tests in Australia and the availability of Staple Length & Staple Strength data on most combing lots in catalogues provided both a catalyst and an opportunity to develop improved predictive formulae at minimal cost. It has been suggested that the new measurements provided by Laserscan, such as Coefficient of Variation (CV) of Diameter and Mean Fibre Curvature, may influence top making performance. If so, their inclusion in the TEAM formulae may improve the accuracy of predicting such performance. In March 2001, at the Shanghai meeting of the International Wool Textile Organisation (IWTO), AWTA Ltd announced the commencement of the TEAM-3 trial.

The purpose of this report is to summarise the progress of the TEAM-3 project and to provide a preliminary analysis of the data collected comparing current processing performance with that predicted by the TEAM-2 formulae.

At the time of writing, a total of 30 mills had signed an agreement to participate in the TEAM-3 trial. A further 6 mills have signalled their intention to participate. Table 1 provides a summary of the worldwide distribution of participating mills. As of 1st March 2002, a total of 163 consignments have been submitted from 16 different mills. This report provides a snapshot of current processing practice. It is possible that some of the trends shown in this report will change once a greater number of consignments are received from all the mills who have agreed to participate. As with the TEAM and TEAM-2 trials, all data provided by participating mills is treated with the strictest confidence. Consequently, this report considers the entire TEAM-3 database and does not link the results to any particular mill.

Table 1. TEAM-3 Participating Mills (as at March 2002)

Country	Number of Mills
Australia	6
China	8
Czech Republic	1
France	2
Germany	1
India	4
Italy	2
Japan	1
Korea	1
Singapore	1
Slovak Republic	1
Taiwan	1
Thailand	1

CONSIGNMENT NOMINATION

For a consignment to be accepted as part of the TEAM-3 trial, there are several essential requirements that must be met:

- Each consignment must contain a minimum of 100 bales of greasy wool.
- Every lot in each consignment must be tested for fibre diameter using the Laserscan technology (IWTO-12).
- 95% (by nett weight) of each consignment must be certified for Length & Strength (IWTO-30).
- Each mill must provide Test Certificate information and processing information as shown in the 'Consignment Nomination' and the 'Processing Report' proformas that are included as appendices to this report.
- Each mill must submit to AWTA Ltd five (5) lengths of twisted top (as per IWTO-17) which has been taken randomly from each processing batch. This sample is retested by AWTA Ltd to confirm the measured fibre length and fibre diameter characteristics of the top.

CONSIGNMENT DETAILS

Table 2 and Table 3 provide a summary of the major raw wool and processing characteristics of the TEAM-2 and TEAM-3 databases (as at 1st March 2002). A number of characteristics were not reported in the TEAM-2 trials and hence no data is available for these components. The TEAM-3 data reported in Table 2 and Table 3 is derived from 163 consignments totalling 32,558 bales. In contrast, the TEAM-2 database totalled 603 consignments.

Table 2. Range and Mean of the Raw Wool Characteristics of Consignments

	TEAM-1 & TEAM-2 Total Database			TEAM-3 Database (March 2002)		
	Avg	**Max**	**Min**	**Avg**	**Max**	**Min**
Schlumberger Yield (%)	--	--	--	70.2	78.0	62.0
JCSY Yield (%)	--	--	--	71.6	79.2	63.8
Vegetable Matter Base (%)	2.1	10.0	0.1	1.2	3.9	0.4
Mean Fibre Diameter (μm)	22.0	31.0	17.0	20.5	23.5	16.6
CV of Diameter (%)	--	--	--	21.3	23.4	19.1
Comfort Factor (%)	--	--	--	97.1	99.5	91.4
Mean Fibre Curvature (deg/mm)	--	--	--	94	124	80
Staple Length (mm)	86	123	59	86	104	72
CV Length (%)	19	30	12	17	25	14
Staple Strength (N/ktex)	39	60	23	39	49	30
Tip Breaks (%)	--	--	--	21	46	6
Mid Breaks (%)	--	--	--	52	74	28
Base Breaks (%)	--	--	--	27	52	6

Table 3. Range and Mean of the Processing Characteristics of Consignments

	TEAM-1 & TEAM-2 Total Database			TEAM-3 Database (March 2002)		
	Avg	**Max**	**Min**	**Avg**	**Max**	**Min**
Hauteur (mm)	67	97	48	73	89	58
CV of Hauteur (%)	49	61	31	44	53	33
Short Fibre % < 25mm	9	20	0	6.1	12.3	1.1
Length > 5%	--	--	--	126	145	106
Romaine (%)	8	21	1	8.6	16.7	2.3
Top & Noil Yield (%)	64	77	46	71.1	79.3	62.6
Mean Fibre Diameter (μm)	22.1	31	17	20.8	23.7	16.8
CV of Diameter (%)	--	--	--	20.7	22.6	17.3
Comfort Factor (%)	--	--	--	96.7	99.7	90.7

PROCESSING PERFORMANCE AND COMPARISON TO TEAM-2

It has been recognised for some time that mills around the world produce wool tops with significantly longer Hauteur values than those predicted by the TEAM-2 formula. One of the purposes of the TEAM-3 trial is to quantify the magnitude of these differences and to propose any corrections to the existing formulae.

Table 4 shows a comparison between the TEAM-3 actual values for Hauteur, CV of Hauteur, and Romaine and the predicted values based on the TEAM-2 formulae. On average, mills are producing tops with Hauteur values 4.5 mm longer than is predicted by the TEAM-2 formula. In terms of CV of Hauteur, the actual values are, on average, 2.5% less than predicted and for Romaine, the actual values are 2.0% greater than predicted.

Table 4. Comparison between Actual and Predicted Hauteur, CV of Hauteur and Romaine

	HAUTEUR (mm)			CV of HAUTEUR (%)			ROMAINE (%)		
	Predicted	Actual	Diff.	Predicted	Actual	Diff.	Predicted	Actual	Diff.
Mean:	68.6	73.1	4.5	46.8	44.3	-2.5	6.7	8.6	2.0
SD:	4.1	5.6	3.7	3.1	3.5	2.9	1.1	2.3	1.8
Max;	77.4	88.8	15.8	54.3	52.9	4.4	10.9	16.7	8.1
Min:	56.5	57.7	-4.8	40.9	32.6	-12.6	3.9	2.3	-2.7

Figures 1-3 show graphically the differences between actual and predicted Hauteur, CV of Hauteur and Romaine. It is clear that there are differences between the TEAM-2 prediction and current processing performance, and that these differences are not simply an offset. Although the average difference between actual Hauteur and TEAM-2 predicted Hauteur is 4.5 mm, Figure 1 shows that the differences are larger for Hauteur values in excess of 75 mm. The average difference between actual and predicted Hauteur is 7.3 mm for all those consignments with an actual Hauteur of 75 mm or greater.

The slopes on Figures 1-3 suggest that, based on the data provided so far, the processing performance has changed significantly since the TEAM-2 trial was completed.

Figure 1: Hauteur Differences

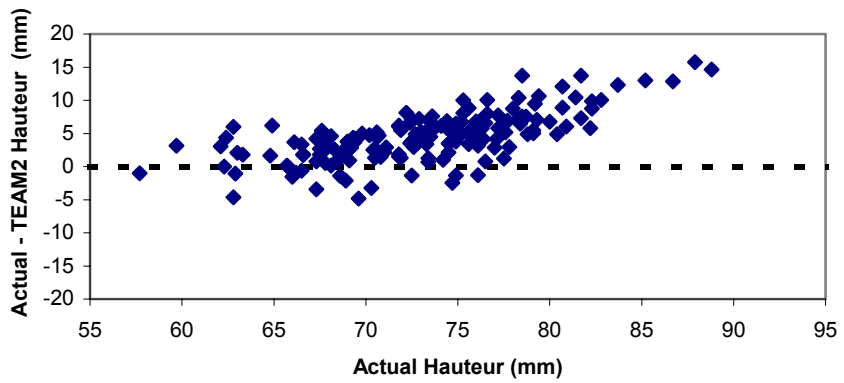


Figure 2: CV of Hauteur Differences

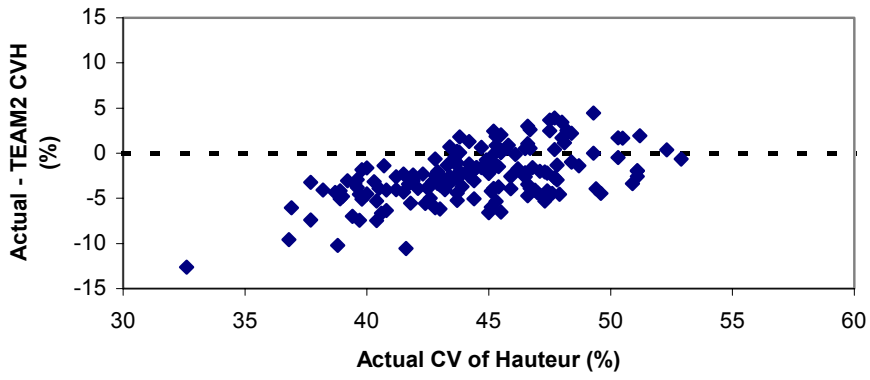
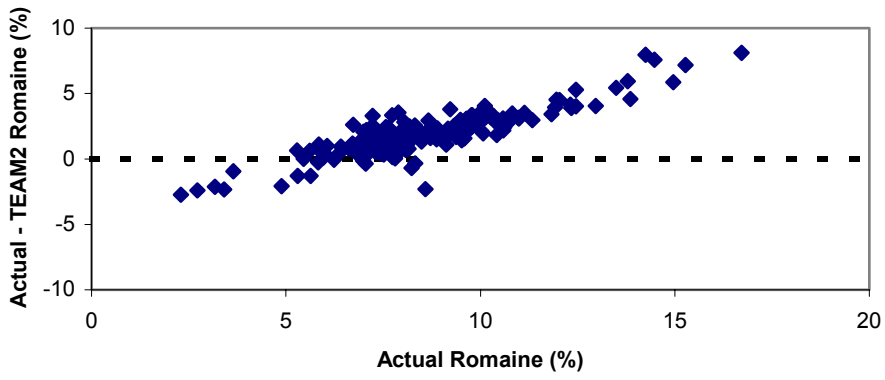


Figure 3: Romaine Differences



CORE/COMB RELATIONSHIPS

Figure 4 shows the relationship between the core mean fibre diameter and the top mean fibre diameter. The diameter of the top that is used in this analysis is that measured by AWTA Ltd using Laserscan on the samples of top submitted by each mill for each consignment. On average, the mean fibre diameter of the top is 0.3 μm coarser than the mean fibre diameter of the greasy wool.

Figure 4: Core/Comb Fibre Diameter Differences

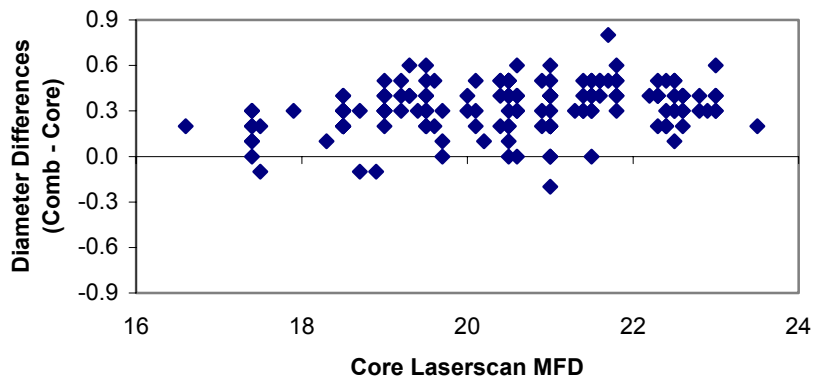
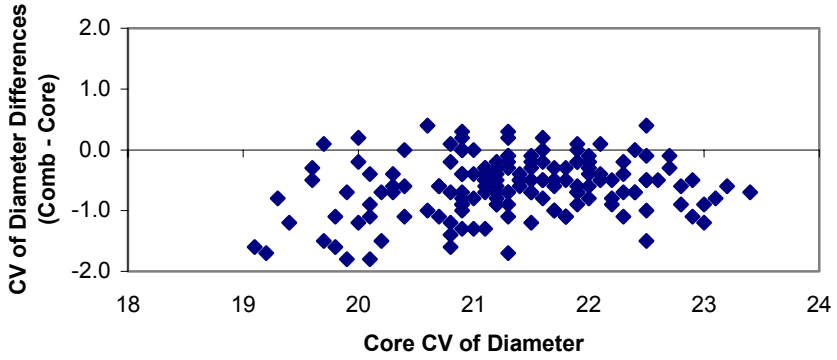


Figure 5 compares the CV of Diameter of the greasy wool and the top. It shows that the CV of Diameter is, on average, 0.6% lower in the top than it is in the core. This is an expected result as processing is understood to remove fine fibres as noil. This has the effect of increasing the fibre diameter in the top (Figure 4) and decreasing the fibre diameter variation (CV of Diameter) in the top.

Figure 5: Core/Comb CV of Diameter Differences



YIELD COMPARISON

Figure 6 shows a comparison between the actual Top and Noil yield achieved by the processing mills and the predicted yield using the Schlumberger Dry Top and Noil Yield (SDRY) formula. It shows that, on average, actual yield is 0.9% higher than the yield predicted by the SDRY formula.

Figure 7 shows a comparison between the actual Top and Noil Yield achieved by the processing mills and the predicted yield using the Japanese Clean Scoured Yield (JCSY) formula. It shows that, on average, actual yield is 0.5% lower than the yield predicted by the JCSY formula.

Figure 6: Actual and SDRY Yield Comparison

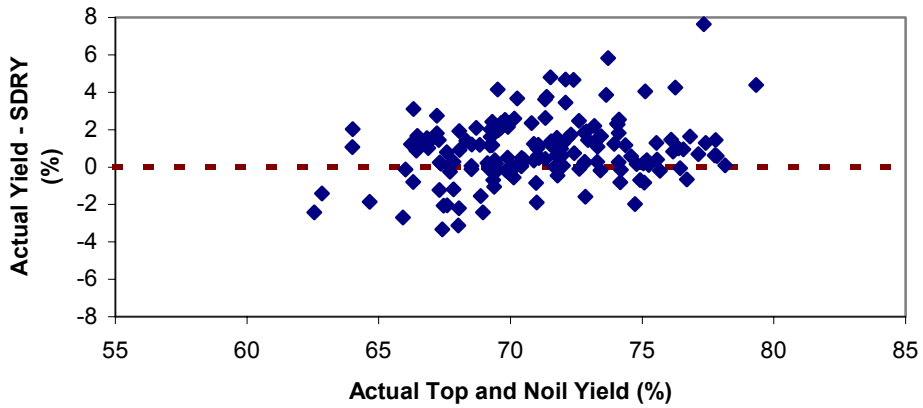
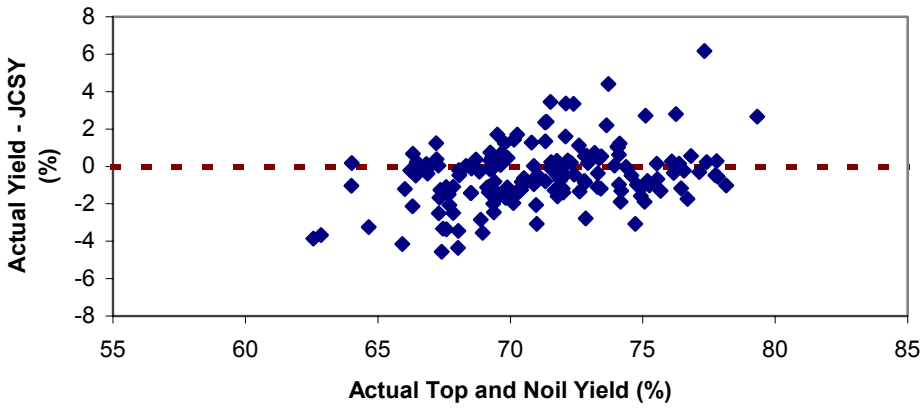


Figure 7: Actual and JCSY Yield Comparison



PRELIMINARY STATISTICAL ANALYSIS OF TEAM-3 DATA

The data from the consignments submitted for the TEAM-3 trial was analysed using the S Plus statistical package. The analysis included re-determining the coefficients for the current TEAM formula and then adding either one, two or three new variables to the model. The variables added were Mean Fibre Curvature (MFC), CV of Diameter (CVD), and CV of Length (CVL). Eight different multiple regression analyses were conducted which plotted Hauteur against the factors shown in Table 5.

Table 5. Variables for Regression Analysis

Regression	Variables Used
1	TEAM (SL, SS, MFD, VMB, M*)
2	TEAM + MFC
3	TEAM + CVD
4	TEAM + CVL
5	TEAM + MFC + CVD
6	TEAM + MFC + CVL
7	TEAM + CVD + CVL
8	TEAM + MFC + CVD + CVL

For reference, the TEAM-2 general equation, as published in 1988, is as follows:

$$H = 0.52L + 0.47S + 0.95D - 0.19M^* - 0.45V - 3.5 + [MA1]$$

Where: H = Hauteur (mm)

D = Mean Fibre Diameter (μm)

L = Staple Length (mm)

S = Staple Strength (N/ktex)

V = Vegetable Matter Base (%)

M* = Adjusted percentage of middle breaks (for M = 0-45%, M* = 45, for M >46%, M* = M)

MA1 = Mill Adjustment Factor (negative or positive)

IS TEAM-2 STILL RELEVANT?

The results from the regression analysis are shown in Table 6. The first row (*TEAM*) shows the coefficients of the TEAM-2 equation. The second row (*Regression 1*) shows the coefficients from the same terms used in TEAM-2, re-calculated using the TEAM-3 database. The Standard Error (SE) is lower for the TEAM-3 data analysis, suggesting improved repeatability. It is too early to determine if this is a real effect since the database is small and the range of raw wool measured characteristics is relatively small in comparison to the original TEAM trials. It should be pointed out that this data does not form the basis for a new TEAM-3 equation. This is indicative only of the relatively small data set available at the time of the analysis. In addition to the coefficients reported here, a constant term also needs to be calculated once more data becomes available.

Nevertheless, there are some interesting inferences from the second row of data in the statistical analysis. Firstly, it shows that the effects of Staple Length & Staple Strength on Hauteur are very similar between the TEAM-2 and TEAM-3 analyses (the coefficients are almost identical). However, the effect of Fibre Diameter (D) is more significant in TEAM-3 than it was in TEAM-2. A possible cause of this is the decreasing average fibre diameter of processing consignments and the smaller fibre diameter range in the TEAM-3 database. This can be clearly seen in Table 2.

The effect of Vegetable Matter Base (V) is markedly different between the two trials. In TEAM-2, VMB had a negative effect of Hauteur (-0.45), as would be expected. However, the TEAM-3 analysis shows that VMB has a positive effect (0.61, although it is not statistically significant), i.e. as VMB increases so too does Hauteur, likely to be due to the very small range of VMB in the TEAM-3 database (Table 2). The average VMB of the database was 1.2%. The range was from 0.4% to 3.4% but there were only 15 consignments out of 163 outside the range of 0.5 to 2.0. For such a narrow range, it would be expected that VMB would have a minimal effect on Hauteur.

THE ADDITION OF NEW VARIABLES TO THE TEAM MODEL

The remainder of Table 6 shows a summary of the results from the additional regression analyses that were conducted. For the current data set available, the addition of CVD or MFC to the linear regression model does not improve the prediction of Hauteur. However, the addition of CVL does improve the model with the Standard Error (SE) decreasing and the R^2 increasing.

It appears from Table 6, that the addition of CVL is the only factor which improves the precision of the Hauteur prediction. By adding CVD or MFC, the Standard Error and the R^2 remains largely unchanged. However, by adding CVL to the standard model the Standard Error decreases from 3.4 mm to 2.6 mm and the R^2 increases from 80% to 82%. If various combinations of CVL, CVD or MFC are added to the standard model, no improvements to the Hauteur prediction are made.

This data indicates the only term that would improve prediction of Hauteur is CVL. The influence of CVL is not altogether surprising. The TEAM-2 report suggested that CVL had an impact on Hauteur for some mills and specific equations were developed for those mills which showed this effect.

Since the TEAM-2 report was published in 1988, there has been some criticism of the use of M* in the TEAM-2 general equation. M* is the adjusted percentage of middle breaks and all values of M up to 45% are replaced by a value of 45% for M* in the TEAM-2 formula. For values of M greater than 45%, the measured value itself is used as M* in the formula. At this point the use of M* has not been reviewed but this will be done as more data becomes available.

Table 6. Statistical Analysis using Additional Factors of CVD, MFC and CVL.

		SL	SS	D	M*	V	CVD	MFC	CVL	SE	R^2
TEAM	***TEAM-2***	***0.52***	***0.47***	***0.95***	***- 0.19***	***- 0.45***				***3.4 mm***	***84%***
Regression 1	TEAM-3	0.51	0.47	1.21	-0.12	0.61				2.7 mm	80%
Regression 2	TEAM-3 + CVD	0.38	0.27	1.71	-0.14	0.33	-1.2	- - -	- - -	2.7mm	81%
Regression 3	TEAM-3 + MFC	0.51	0.47	1.07	-0.12	0.65	- - -	-0.03	- - -	2.7mm	80%
Regression 4	TEAM-3 + CVL	0.43	0.41	1.42	-0.10	0.58	- - -	- - -	-0.70	2.6mm	82%
Regression 5	TEAM-3 + CVD + Curve	0.36	0.26	1.42	-0.14	0.37	-1.34	-0.07	- - -	2.7mm	81%
Regression 6	TEAM-3 + CVD + CVL	0.36	0.31	1.66	-0.12	0.43	-0.64	- - -	-0.62	2.6mm	82%
Regression 7	TEAM-3 + MFC + CVL	0.43	0.41	1.40	-0.10	0.58	- - -	0.00	-0.70	2.6mm	82%
Regression 8	TEAM-3 + CVD + Curve + CVL	0.36	0.30	1.54	-0.12	0.45	-0.71	-0.03	-0.60	2.6mm	82%

CONCLUSION

This report has provided an update on the progress of the TEAM-3 trial. It has been shown that processing performance has improved since the late 1980's and that mills are producing tops with Hauteur values, on average, 4.5 mm longer than is predicted using the TEAM-2 general formula. Larger differences occur as the Hauteur increases above 75 mm. In addition, mills are producing tops with CV of Hauteur values, on average, 2.5% less than predicted by TEAM-2 and Romaine values 2% greater than predicted.

The core/comb comparison for the data set shows that the diameter of the top is, on average, 0.3 μm coarser than the diameter of the core. In addition, the CV of diameter decreases by 0.6% in the top.

Given the relatively small amount of data available at this time, no conclusions or recommendations have been provided. Further analyses will be conducted when more data becomes available. Using the current TEAM-3 data, the new measurements of CVD and MFC do not appear to have a significant impact on the prediction of Hauteur. However, the inclusion of CVL does result in a small improvement in the prediction of Hauteur.

REFERENCES

Douglas, S.A.S. and Couchman, R.C. (1997). Industry Review of the TEAM Prediction Formulae. *International Wool Textile Organisation. Woolgrowers, Traders & Early Processors Committee*. Nice Meeting, December 1997.

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

AWTA LIMITED

TEAM3 TRIALS EVALUATING ADDITIONAL MEASUREMENTS

TEAM-3 PROJECT: CONSIGNMENT NOMINATION

A. IDENTIFICATION

Participating Company Name .....

Consignment / Batch Reference .....

Date of Combing .....

Processing Mill .....

B. GREASY WOOL TEST RESULTS

Test Number of IWTO Combined Certificates* – Yield/Micron

– Length/Strength

***** Where an IWTO Combined Certificate has not been created for the consignment by AWTA Ltd, **please attach a list of the individual AWTA Ltd Test Numbers** for both Core Test and Staple Measurement Certificates comprising the consignment. Or, for wool of non-Australian origin, attach copies of the relevant NZWTA Ltd or WTB-SA Certificates.

C. CONSIGNMENT WEIGHT AND OUTSOURCED WOOL

Total Bales	…….	Bales
Greasy Weight	…….	Kg
Tare	…….	Kg
Net Weight	…….	Kg
Outsorts (if any)	…….	Greasy kg

NOTE: *It is preferable that there should be no sorting of wools and/or removal of bales unless considered to be absolutely necessary. If sorting exceeds 1% of the greasy weight, it is unlikely that a valid greasy wool test/combing comparison can be made. So, the amount of any outsorts should be determined accurately and the reasons for removal noted below.*

Reason for Outsorts:.....

Please attach the Processing Report (either the Mills own combing report, or the proforma TEAM-3 Processing Report) to this Nomination form, then despatch it and the required top samples to:

AWTA Ltd

Attn: Andrew Lindsay, Sampling Operations Manager – NSW & Qld

Cnr Byron and Military Roads

GUILDFORD, NSW 2161

AUSTRALIA

Fax number: +61 (0)2 9892 3195

E-mail address: andrew.lindsay@awta.com.au

AWTA LIMITED

TEAM3 TRIALS EVALUATING ADDITIONAL MEASUREMENTS

TEAM-3 PROJECT: PROCESSING REPORT

Note: The Mill Combing Report and Top Test Results can be used instead of this proforma, if they provide the equivalent information.

A. IDENTIFICATION

Participating Company Name .....

Consignment / Batch Reference .....

Date of Combing .....

Processing Mill .....

B. PROCESSING DATA

***** Please indicate whether cardwastes have been recycled YES / NO

Results by item (as applicable)	Nett kg	%
- Tops, conditioned	.....	.....
- Noils, conditioned	.....	.....
- Other wastes	.....	.....
Romaine (Noil)	..... %	
IF AVAILABLE Combing Line Reference - Scouring Line: - Carding / Combing:	....	

C. MILL TEST RESULTS

Conditioning:	Top moisture regain	.....%
	Noil moisture regain	.....%
Fatty Matter:	Top, total fatty matter (on dry fat free weight)	.....%
	Solvent used	.....
Top Length:	Almeter Hauteur	.....mm
	CV Hauteur	.....%
	% < 25mm	.....%
	Length (Hauteur) > 5%	.....mm

NOTE: *If Almeter results are not available, please provide alternative measurements clearly noting the method used.*

Top Fineness: (Please supply all available results)

	LASERSCAN	OFDA	Airflow	
Mean Fibre Diameter	…….	…….	…….	micron (μm)
Coefficient of Variation of Diameter	…….	…….		%
Fibres <30 micron	…….	…….		%

D. OTHER TESTS OR PROCESSING INFORMATION (if considered relevant):

.....

.....

.....

E. SAMPLING FOR TESTING AND FUTURE REFERENCE

Tops:

A minimum of 5 samples of top, each 1.2 metres in length, are required from each processing batch. These samples will be retained by AWTA Ltd and used as a reference sample should there be any discrepancy in results. Each top sample should be taken sequentially throughout combing so that they are representative of the whole consignment. The most practical method of sampling is to take 2 lengths of top when sampling for in-house mill testing.

Each sample should be identified by the name of the participant, the consignment reference number and a suffix to indicate the production sequence.

NOTE: *1. The sampling requirements are based on those set out in the IWTO Regulations for the testing of Wool Slivers for Mean Fibre Diameter & Mean Fibre Length.*

2. Each 1.2 metre length of sample sliver should be twisted as per the requirements of Section 6.1.1 (i) of IWTO-17-85 or wrapped onto formers.