International Institute For Cotton

Technical Research Division

Manchester

Research Record No. 106

Evaluation Of The Accuracy Of The Welmstar Electronic Yarn Length Counter In Measuring Run-In On The Knitting Machine

Jill C. Stevens

August 1979

Classification: Fabrics/Knits/Production

Key Words: Instrumentation, Course Length, Stitch Length

Digital Version: July 2011

1. Introduction

As a result of the decision to embark on the single jersey knitting projects Kl and K2, a large quantity of fabric, requiring numerous changes of quality on three gauges of machine, needed to be produced. To enable all of the necessary quality control checks to be carried out, with maximum efficiency and minimum interruption to production, it was felt that an easier and quicker method of measuring course length (run-in) on the machines, than our existing instrumentation could provide, was required. After careful consideration of the different course length meters on the market, and also taking into account previous experience gained with two electronic course length meters, it was decided that the instrument most suited to our requirements was the Welmstar electronic course length/yarn speed meter.

The Welmstar operates by means of a cable plugged into a connecting box on the machine which enables it to receive a pulse via a fixed reed switch from a magnetic block rotating with the cylinder. This arrangement enables a reading for course length in cm to be obtained for each machine revolution, the pulse being activated each time the magnetic block passes the fixed reed switch.

Having equipped our machines with the appropriate hardware, it was decided that a small evaluation trial should be carried out to check the calibration of the instrument with both our existing HATRA mechanical course length counter and stitch length in the fabric as measured by our testing laboratory.

2. Method

For each machine three trials were carried out using each method of stitch length determination.

1. Using the Welmstar electronic course length counter: five feeders were selected arbitrarily and, on each feeder, measurements for course length were recorded for five consecutive revolutions of the machine.

   This was repeated on three separate occasions.

2. Using the HATRA mechanical course length counter: five feeders were selected arbitrarily (not necessarily the same five feeders as used for the Welmstar), and on each feeder a measurement for the total length of yarn knitted in five consecutive machine revolutions recorded.

   This was repeated on three separate occasions.

3. At the same time as measurements were made on the Welmstar and the HATRA instruments, a piece of fabric was cut from the roll and submitted to the testing laboratory for the measurement of stitch length in the fabric, by IIC Test Method K3, May 1978.

   Three pieces were submitted for each gauge of machine.

NB

1. The stitch lengths on each machine were not preselected, but were the settings at which the machines had previously been knitting. In all cases, however, the stitch lengths were within the commercial range and not unreasonable for the gauge of machine.

2. The yarn counts used were also arbitrarily selected as being those already on the machines. In this instance also, however, the counts of yarn were within the commercial range for the gauge of machine (i.e. 1/24 on 24G; 1/20 on 18G; 1/36 on 28G) - standard waxed hosiery yarn with 3.5 T.F.
3. Machine speed: The 24G machine was rotating at a preset speed of about 18 r.p.m. This is fixed by the gearing and cannot be altered on the control box. The 18 and 28G machines both have a variable speed drive motor which allows the speed of the machine to be altered from the control box. The 18G machine was rotating at approximately 12 r.p.m.; the 28G machine at approximately 15 r.p.m.
4. Yarn tensions in all cases were set at between 3 and 5 g. All three machines were using Trip-tape positive feed.

3 Results.

All of the individual measurements and calculations are available in the project file.

To enable a direct comparison of measurements with the testing laboratory results, the readings obtained from the two course length counters were reduced to give stitch length in mm. 95% confidence limits and percent accuracy were calculated. *Tables 1 to 9* show the individual converted results and calculations for each trial, test and gauge of machine. *Tables 10 to 12* summarise the results according to gauge.

18 Gauge

On the 18G machine, the HATRA course length meter overestimates the testing laboratory measured stitch length by about 1.1%, while the Welmstar meter underestimates measured stitch length by about 0.8%. The difference between the two instruments was about 1.9%.

24 Gauge

On the 24G machine the HATRA course length meter overestimates the testing laboratory measured stitch length by about 2.2% and the Welmstar electronic meter underestimates by about 0.7%. The difference between the two instruments was about 2.9%.

28 Gauge

On the 28G machine the HATRA course length meter overestimates the testing laboratory measured stitch length by about 1.6% and the Welmstar electronic meter underestimates by about 1.4%. The difference between the two instruments was about 3.1%.

4 Discussion

At the start, it should be said that the true value(s) for stitch length can not be deduced from these measurements, although one may elect one or other (or none) of the methods to serve as a standard, against which all others will be judged. The best candidate for such a standard is that which returns the best reliability, between specimens, between samples, between fabric types and qualities, and (most importantly) over time. In principle, this ought to be the laboratory test method - either as it stands or after improvement - but only time will tell.

The HATRA mechanical course length meter consistently overestimates course length (stitch length) compared to that measured in the testing laboratory.

This may be due to the method of operation. The starting and finishing points of a measured test length - in this case five machine revolutions - have to be estimated by the operator by watching when a particular rotating section of the machine passes a given static point on the machine. Inevitably there must be some delay between the operator seeing the finishing position and stopping the counter. This is suggested by the fact that, the overestimate of stitch length was greatest for the machine rotating at the fastest speed - the 24G machine. One may suppose that, the faster the machine is rotating when measurements are carried out, the greater the possible error, due simply to the delay in seeing the mark and operating the stop watch on the counter.

On the other hand, one may also suggest that the error should be approximately the same at both starting and finishing points and, moreover, one may also speculate that an operator is as likely to anticipate the arrival of the rotating part at the designated reference point and, therefore, the net errors should be random. This would lead to the conclusion that the apparent overestimation of course length is simply a matter of calibration.

The matter could presumably be settled by making separate measurements over a greater number of revolutions (say 50), in which case errors of perception would be relatively reduced whereas calibration errors would remain constant.

The Welmstar electronic course length meter consistently underestimates stitch length measured in the fabric. One possible explanation for this is the individual lengths of yarn are taken from the fabric for measurement after it has been released from machine tensions, take-down etc., and conditioned in a standard atmosphere. In addition, the length of the test specimen is measured under a certain (low) tension, to reduce the effect of yarn crimp on the measurement. The degree of underestimate - on average 1% - could be explained by a small growth in the loop size during the dry relaxation of the fabric. If this is true, then fabric tightness, i.e. stitch length and yarn count, could affect the size of the underestimate.

For example, in the absence of agitation, moisture and heat, one would expect a tight construction to move less easily than a slack construction. This however is not clearly shown in this trial because, although all three machines were knitting within commercial limits of tightness, the 18 and 24G machines were on the slack side and the underestimate was 0.8% and 0.7% respectively whereas the 28G machine was knitting on the tight side and the underestimate was nearly double at 1.4%. This point may become clear at the end of knitting the fabrics for K1 and K2, as measurements for a range of tightness qualities will be available for comparison against testing laboratory measured stitch length.

Again, the alternative explanation is one of calibration.

Although each method of estimating stitch length differs, one from the other, within themselves each method has been shown to be very consistent in its prediction of stitch length. Generally speaking, the spread of results is smaller for the Welmstar and testing laboratory methods than the HATRA, but in all cases, the accuracy is better than 0.5%.

The other main point to emerge from this small investigation is the importance of not taking the results given by different instruments at face value without checking them both one with another and with a standard physical testing procedure. It is not difficult to imagine the case of a mill working with several different course length meters in fact getting consistently dissimilar measurements from their different instruments. If this is never checked, the mill could be using a minimum of 1.5-2% more yarn to reach a given stitch length specification than is in fact necessary and, over the course of a year this can amount to a very large sum of money, at today's yarn prices, with obvious effects on profitability. Also, a knitting specification may be set at one point in time, and with one particular instrument and that particular fabric quality may be manufactured for a long time period. Over this time, the quality may be set up on the machine using different instruments, or instruments that have been drifting out of calibration. Thus, the performance of the quality may be deteriorating over time, even though the knitting conditions are apparently being set correctly for each new batch.

With the proper precautions and without losing sight of reality, this trial indicates that consistent control of stitch length to at least ± 1% is not impossible or unreasonable.

5 Conclusions

1. In all cases, the mechanical course length counter overestimated stitch length, compared to the testing laboratory. The range of "error" was 1 - 2.2%, with an average of 1.65%.
2. In all cases, the electronic course length counter underestimated stitch length compared to the testing laboratory. The range of "error" was 0.6 - 1.5% with an average 0.97%.
3. In all cases, the instruments differed in their measurement of stitch length in the range 1.8 - 3.1% with an average 2.65%.
4. Within themselves, all three methods are capable of measuring stitch length consistently, with better than 0.5% accuracy.
5. A larger trial should be carried out to isolate and thoroughly investigate whether the apparent course length, measured at the machine, is affected by parameters such as:
    a. machine speed,
    b. fabric tightness, i.e. stitch length, yarn count,
    c. machine gauge,
    d. within-machine differences between feeders.

Table 1

18 G Hatra — Readings over 5 reels converted to SL in mm

Trial 1

Feeder 1	4·3467
2	4·3333
3	4·3200
4	4·3467
5	4·3333
$\bar{x}$	4·3360
95% CL	0·0139
% A	0·3206

Trial 2

Feeder 1	4·3467
2	4·3333
3	4·3467
4	4·3467
5	4·3200
$\bar{x}$	4·3387
95% CL	0·0089-
% A	0·2051-

N = 15
$\bar{x}$ = 4·3351
95% CL = 0·0086
% A = 0·1984

Trial 3

Feeder 1	4·3200
2	4·3333
3	4·3333
4	4·3467
5	4·3200
$\bar{x}$	4·3307
95% CL	0·0233-
% A	0·5380-

Table 2

18G Welnistar   Readings over 5 rers converted to SL in mm

Trial 1

Feeder 1	4.2493
2	4.2707
3	4.2507
4	4.2560
5	4.2520
$\bar{x}$	4.2557
95% CL	0.0278
% A	0.6532

Trial 2

Feeder 1	4.2493
2	4.2467
3	4.2427
4	4.2493
5	4.2680
$\bar{x}$	4.2512
95% CL	0.0139
% A	0.3270

N = 15
$\bar{x}$ = 4.2545
95% CL : 0.0036
% A : 0.0846

Trial 3

Feeder 1	4.2493
2	4.2720
3	4.2613
4	4.2533
5	4.2467
$\bar{x}$	4.2565
95% CL	0.0233
% A	0.5474

Table 3

18 G TEST LAB   Individual test length readings converted to S.L in mm
IIC Test Method K3 May 1978

TRIAL 1	
Test Length 1	4.26
2	4.225
3	4.25
4	4.25
5	4.25
6	4.24
7	4.205
8	4.23
9	4.245
10	4.24
$\bar{x}$	4.2395
95% CL	0.0102
% A	0.2406

TRIAL 2	
Test Length 1	4.3
2	4.29
3	4.3
4	4.26
5	4.25
6	4.335
7	4.32
8	4.325
9	4.295
10	4.33
$\bar{x}$	4.3005
95% CL	0.0204
% A	0.4744

TRIAL 3	
Test Length 1	4.3
2	4.325
3	4.336
4	4.325
5	4.335
6	4.33
7	4.34
8	4.34
9	4.3
10	4.305
$\bar{x}$	4.3236
95% CL	0.0118
% A	0.2729

N = 30
$\bar{x}$ = 4.2879
95% CL = 0.0139
% A = 0.3242

Table 4

24 G Hatra   Readings taken over 5revs converted to SL in mm.

Trial 1

Feeder 1	3·6458
2	3·6563
3	3·6667
4	3·6875
5	3·6875
$\bar{x}$	3·6688
95% CL	- 0·0231
% A	- 0·6306

Trial 2

Feeder 1	3·6771
2	3·6563
3	3·6771
4	3·6667
5	3·7083
$\bar{x}$	3·6771
95% CL	0·0233
% A	0·6337

N = 15
$\bar{x}$ = 3·6674
95% CL = 0·0071
% A. = 0·1936

Trial 3

Feeder 1	3·6458
2	3·6458
3	3·6563
4	3·6458
5	3·6875
$\bar{x}$	3·6562
95% CL	0·0333
% A	0·9108

Table 5

249 Welmstar Readings taken over 5 Revs converted to SL in mm.

Trial 1

Feeder 1	3.5583
2	3.5552
3	3.5677
4	3.5688
5	3.5750
$\bar{x}$	3.565
95% CL	0.0108
% A	0.3029

Trial 2

Feeder 1	3.5500
2	3.5594
3	3.5604
4	3.5510
5	3.5469
$\bar{x}$	3.5535
95% CL	0.0222
% A	0.6247

N = 15
$\bar{x}$ = 3.5634
95% CL = 0.0075
% A. = 0.2105

Trial 3

Feeder 1	3.5531
2	3.5771
3	3.5813
4	3.5813
5	3.5656
$\bar{x}$	3.5717
95% CL	- 0.0152
% A	- 0.4247

Table 6

24G TEST LAB

Individual test length readings converted to S.L. in mm

IIC Test Method K3 May 1978

TRIAL 1	
Test length 1	3.57
2	3.575
3	3.565
4	3.585
5	3.565
6	3.64
7	3.58
8	3.65
9	3.57
10	3.62
$\bar{x}$	3.5920
95% CL	0.0224
% A	0.6236

TRIAL 2	
Test Length 1	3.58
2	3.585
3	3.58
4	3.63
5	3.57
6	3.59
7	3.58
8	3.58
9	3.565
10	3.585
$\bar{x}$	3.5845
95% CL	0.0133
% A	0.3710

TRIAL 3	
Test Length 1	3.61
2	3.57
3	3.61
4	3.62
5	3.58
6	3.595
7	3.575
8	3.59
9	3.56
10	3.58
$\bar{x}$	3.589
95% CL	0.0143
% A	0.3984

N = 30

$\bar{x}$ = 3.5885

95% CL = 0.0090

%A = 0.2508

Table 7

28G Hatra. Readings taken over 5rvs converted to SL in mm.

Trial 1.

Feeder	1	2.5379
	2	2.5379
	3	2.5379
	4	2.5568
	5	2.5189
	$\bar{x}$	2.5379
	95% CL	0.0108
	%A	0.4255

Trial 2

Feeder	1	2.5758
	2	2.5568
	3	2.5379
	4	2.5379
	5	2.5379
	$\bar{x}$	2.5493
	95% CL	0.0061
	%A	0.2393

N = 15
$\bar{x}$ = 2.5398
95%CL = 0.0049
%A = 0.1929

Trial 3

Feeder	1	2.5189
	2	2.5284
	3	2.5379
	4	2.5568
	5	2.5189
	$\bar{x}$	2.5322
	95% CL	0.0164
	%A.	0.6477

Table 8

28G Welnustar   Readings taken over 5 revs converted to SL in M.M.

Trial 1

Feeder	1	2.4697
	2	2.4583
	3	2.4725
	4	2.4640
	5	2.4735
	$\bar{x}$	2.4676
	95%CL	0.0125
	%A	0.5066

Trial 2

Feeder	1	2.4564
	2	2.4669
	3	2.4555
	4	2.4697
	5	2.4678
	$\bar{x}$	2.4633
	95%CL	0.0153 –
	%A	0.6211 –

N = 15
$\bar{x}$ = 2.4627
95%CL = 0.0047 –
%A = 0.1908 –

Trial 3

Feeder	1	2.4555
	2	2.4555
	3	2.4564
	4	2.4583
	5	2.4602
	$\bar{x}$	2.4572
	95%CL	0.0108 –
	%A	0.4395 –

Table 9

28G TEST LAB   Individual test length readings converted to SL in M.N.
IIC Test Method K3   May 1978

TRIAL 1	
Test Length 1	2.5
2	2.46
3	2.5
4	2.5
5	2.515
6	2.475
7	2.46
8	2.51
9	2.5
10	2.54
$\bar{x}$	2.4960
95% CL	0.0181
% A	0.7252

TRIAL 2	
Test Length 1	2.5
2	2.52
3	2.49
4	2.49
5	2.57
6	2.465
7	2.59
8	2.48
9	2.475
10	2.495
$\bar{x}$	2.5075
95% CL	0.0290
% A	1.1565

TRIAL 3	
Test Length 1	2.505
2	2.49
3	2.5
4	2.49
5	2.5
6	2.5
7	2.47
8	2.505
9	2.485
10	2.48
$\bar{x}$	2.4925
95% CL	0.0063
% A	0.2528

N = 30
$\bar{x}$ = 2.4987
95% CL = 0.0094
% A = 0.3762

Table 10

189 COMPARISON OF STITCH LENGTHS.

HATRA	TRIAL	1	4·3360 ± 0·0139	
		2	4·3387 ± 0·0089	4·3351 ± 0·0086
		3	4·3307 ± 0·0233	
WELTISTAR	TRIAL	1	4·2557 ± 0·0278	
		2	4·2512 ± 0·0139	4·2545 ± 0·0036
		3	4·2565 ± 0·0233	
TEST LAB	TRIAL	1	4·2395 ± 0·0102	
		2	4·3005 ± 0·0204	4·2879 ± 0·0139
		3	4·3236 ± 0·0118	

H = 4·3351 + 4·3437
− 4·3265

W = 4·2545 + 4·2581
− 4·2509

T.L. = 4·2879 + 4·3018
− 4·2740.

HATRA > TEST LAB BY 1·1008 %.
WELTISTAR < TEST LAB BY 0·7789 %.
HATRA > WELTISTAR BY 1·8945 %.
WELTISTAR < HATRA BY 1·8592 %

Table 11

24 G COMPARISON OF STITCH LENGTHS

HATRA	TRIAL	1	3·6688 ± 0·0231	3·6674 ± 0·0071
		2	3·6771 ± 0·0233	
		3	3·6562 ± 0·0333	
WELMSTAR	TRIAL	1	3·5650 ± 0·0108	3·5634 ± 0·0075
		2	3·5535 ± 0·0222	
		3	3·5717 ± 0·0152	
TEST LAB	TRIAL	1	3·5920 ± 0·0224	3·5885 ± 0·0090
		2	3·5845 ± 0·0133	
		3	3·5890 ± 0·0143	

H = 3·6674 + 3·6745
− 3·6603

W = 3·5634 + 3·5709
− 3·5559

T.L. = 3·5885 ± 3·5975
− 3·5795

HATRA > TEST LAB BY 2·1987%.
WELMSTAR < TEST LAB BY 0·6995%.
HATRA > WELMSTAR BY 2·9186%
WELMSTAR < HATRA BY 2·8358%

Table 12

28G COMPARISON OF STITCH LENGTHS

HATRA	TRIAL	1	2·5379 ± 0·0108	
		2	2·5493 ± 0·0061	2·5398 ± 0·0049
		3	2·5322 ± 0·0164	
WELTISTAR	TRIAL	1	2·4676 ± 0·0125	
		2	2·4633 ± 0·0153 -	2·4627 ± 0·0047 -
		3	2·4572 ± 0·0108 -	
TEST LAB	TRIAL	1	2·4960 ± 0·0181	
		2	2·5075 ± 0·0290	2·4987 ± 0·0094
		3	2·4925 ± 0·0063	

H = 2·5398 + 2·5447
− 2·5349

W = 2·4627 + 2·4674
− 2·4580

TL = 2·4987 + 2·5081
− 2·4893

HATRA > TEST LAB BY 1·6449 %
WELTISTAR < TEST LAB BY 1·4407 %
HATRA > WELTISTAR BY 3·1307 %
WELTISTAR < HATRA BY 3·0357 %