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FINAL REPORT; ULA-1C:
THE MEASUREMENT AND CONTROL OF PHYSICAL AND CHEMICAL PROPERTIES OF AUSTRALIAN COTTON FIBRES.

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The report almost corresponds to the Ph.D. thesis of Stuart G. Gordon, which is almost complete. I have reviewed this thesis thoroughly and he is at present working on the many minor changes that I and others have recommended. To do justice to this research, I suggest reading the thesis. During this work he has achieved mastery over such apparatus as the Technicon Near Infra Red (NIR) InfraAnalyser, the Cue-2 System Image Analyzer (IA), the Optical Fibre Diameter Analyzer (OFDA), the Advanced Fibre Information System (AFIS), the computer and Statistica software, the Shirley Fineness-Maturity Tester (FMT), the Shirley/OM Miniature Spinning Plant, as well as dyeing, bleaching and other testing equipment. This mastery has extended to helping establish interfaces with some of our other projects and assisting others with some of this equipment.

His co-operation was helpful in our inconclusive CRDC-funded project "Physical and Chemical Studies of Cotton Fibre Maturity". He also played a major part in the pilot study for the TexSkill project "Factors Affecting Dyeability of Australian Cotton Varieties". In some respects, the results we obtained as part of the pilot project were more practical than those derived from the narrow range of properties in the main TexSkill project.

Despite the broad title, the project has concentrated on transverse dimensions of fibres, notably maturity in all of its aspects. There is no consensus about the definition of maturity, only a rough idea of what it means to the cotton market and to spinning mills and dyeing plants. Consequently, he has tested a range of 59 cottons, or in some instances a selection of 14 in the following ways :

1. Micronaire, fineness (hair weight), maturity and standard hair weight by FMT.

Reflecting Australian industrial practice, we did thorough testing of the 59 cottons in the FMT.

Spinoffs include :

use of standard hair weight to characterise Australian varieties;
estimates of coefficient of variations in results;

micronaire	2%
fineness, maturity	5%
standard hair weight	8%

the development of a theoretical basis for these findings;
the consequential testing of 10-12 specimens per sample in our part of the TexSkill trials;

a trial to measure disturbance to results by changes in atmospheric pressure.

2. Degree of thickening, cross-sectional area, perimeter, Martin radius, wall area, their variability and derived maturity by IA.

Computerised IA measurement was perfected over two years. The results were consistently coarser than those obtained by other methods, enabling a constant correction to be applied when required. Of the various techniques developed, IA, especially of relative wall thickness, turned out to be a good predictor of maturity-related yarn properties. Abundant detailed information will be presented in the thesis, and Mr. Gordon is likely to write at least one paper on this aspect.

3. NIR absorption at 4 or 18 wavelengths and derived maturity by NIR.

The Infra Analyzer, rented from Bran and Lubbe, was likewise used on the whole range of cottons. Absorption in the NIR region can be expected to correlate with fibre coarseness; and with maturity, because of fibre concavity, possibly different molecular structure and reactive sites, and thinner secondary walls. These expectations were borne out in practice, but we must caution that the calibrations are done at 18 wavelengths, with both positive and negative fitting possible at each. That is, the equation contains 18 arbitrary constants and must be expected to correlate with almost any property, as it does with moisture regain, grease content, etc. As a check, we input not the 59 cottons, but 59 random numbers, and obtained a correlation coefficient of +.69. This result becomes, at least for the special case of 59 samples and 18 wavelengths, the zero value for comparing correlations with properties. The method has still proved useful in measuring cotton maturity.

4. Neppiness after carding.

This revival of a former ASTM manual method was used in conjunction with a Shirley miniature card to count neps; results correlated closely, and inversely, with maturity. However, newer apparatus is needed for assessing neps, trash and microdust in lint.

5. Fibre "Diameter" Distribution.

The arrival of a OFDA at the Melbourne College of Textiles provided the opportunity of measuring diameters of large numbers of fibres quickly by a semi-automatic IA technique. The concept of diameter is even more problematic with cotton than with wool, and the instrument sees some of the most bent ribbon-like fibres as if they were mature. Further development of the OFDA with lightfield/darkfield imaging to measure modullation in wool holds promise for measuring lumens, wall thicknesses and hence maturity. An alternative technique of scanning fibres longitudinally may help to measure maturity in a fundamental and accurate way by estimating the extent to which they are rod-like or ribbon-like.

6. Spinning performance, Yarn strength and Evenness, and Related properties.

Using the miniature spinning plant at the University of New South Wales, Mr. Gordon processed 14 lots into yarn during a two-week stay. This included several calibration cottons having a wide range of maturity and other properties. The procedure consisted of passages through the trash analyser (once or twice), card (twice), drawframe (twice) and the OM ring spinning frame. all were spun to the same count; twist was a function of fibre length. He recorded end breaks and measured yarn tenacity and evenness. Full details are in the thesis. The effect of maturity on yarn properties was severe when low, otherwise negligible.

7. Dye uptake of cottons, with and without bleaching preparation.

. The above yarn samples, with quadruple feed, were knitted into a length of plain fabric, with different cottons adjacent. This was cut longitudinally, and half was bleached in buffered hydrogen peroxide for 24 hours. The other half had no preparation. Both lengths were dyed in Direct Blue 1 under standard conditions. We then measured L, a and b of all samples in a Macbeth Colour-Eye. Bleaching did not improve dye uptake, but produced a paler shade even after dyeing. In both lots we have been able to explain at least 81% of reflectance in terms of coarseness and maturity; the remainder being probably due to experimental error. As others have reported, simple micronaire gave a better guide to dye uptake than either of the more-refined properties, reflecting the greater precision in its measurement (above).

8. Differential dyeing by the Goldthwaite test.

. Mr. Gordon improved the technique of measuring maturity by differential dyeing, in which cotton is treated simultaneously with a large-molecule red dye and a small-molecule green dye, the former being a measure of maturity. He then treated samples in carboxymethyl cellulose solution and concentrated them into porous discs in a vacuum filter. In this blended form the samples lent themselves well to colorimetry.