TRC

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RESEARCH ON FIBER/YARN RELATIONSHIP From the early days of modern manufacturing, attempts have been made to relate raw material quality to end-product quality. Determining a fiber/yarn relationship was a subjective effort until recent years when man-made fiber producers took the lead in accurately identifying fiber properties and relating these to yarn and fabric quality. In dealing with natural fibers, most attempts to relate fiber quality to yarn quality were based on experience and personal opinion. A "type" of cotton was often selected for certain textile products simply because it had been found to perform well in the past. Instruments such as the Fibrograph, Micronaire and Pressley strength tester contributed to better selection of a fiber for a desired yarn, and the use of today's electronic instruments give even more information on fiber quality. When properly utilized, this information can give a fairly accurate prediction of yarn quality.

With the advent of open-end spinning, which was found to produce yarns with less strength than would be obtained from the same fiber at ring spinning, the need for predicting yarn strength became more urgent. Research conducted by several organizations, including the American Cotton Growers Textile Division and the Textile Research Center, found that accurate measurements of cotton fiber properties could be used to select cotton that would give increased O-E yarn strength. Further, it was soon learned that consistent strength could be obtained by selecting bales of cotton that possess uniform properties and placing these on the opening room floor in a manner designed to give uniform mixes day after day. As a result, several formulas were developed in which fiber properties were used for predicting yarn strength. At one time these formulas were throught to be well-kept secrets, but today there are likely several dozen used by a number of textile companies.

The Textile Research Center realized quite early that the formulas were not 100% perfect, and we have continued to seek the best information to establish a formula that will give a high degree of accuracy in predicting yarn strength. A program dealing with this subject was conducted at the Center last year for the Natural Fibers & Food Protein Commission of Texas, and a result was the development of a formula that gives a high degree of correlation between predicted and measured yarn strengths.

The report on this was prepared by John B. Price, head of open-end spinning research at the Textile Research Center. We are presenting part of it in the following section, thinking it may be of interest to our readers.

"Many studies . . . have been made to relate cotton fiber properties to yarn properties, particularly yarn strength. By far the most common technique is that of multiple linear regression analysis. The resultant equations have been used in industry to select cottons and determine their laydown in the opening room to achieve a more consistent quality of product."

The report continues by pointing out that one researcher ". . . proposed the use of a Fiber Quality Index to explain the variations of yarn strength (count-strength-product), defined by the relationship:

$$\text{Fiber Quality Index} = \frac{\text{Fiber Strength} \times \text{Length}}{\text{Fiber Fineness (intrinsic)}}$$

"In this study, attempts were made to relate Fiber Quality Indices with the strength of rotor-spun yarns, using the data presented in the [TRC] 1980-81 Annual Crop Survey of Texas Cottons. Various forms of the Fiber Quality Index were determined using individual instrument fiber properties. These indices were related to yarn strength by deriving regression equations. Comparison was then made with multiple linear regression equations derived from the same data. . . . Preference was given to the use of individual instrument fiber properties rather than those determined by high volume instruments since concurrent work was showing that individual instruments tended to explain the variation of yarn strength better in multiple linear regression analyses. Fiber properties were related to mean breaking load (grams) as determined by the Uster single-strand strength tester, since this assessment of yarn strength apparently correlated better with fiber strength measured by the Stelometer instrument.

"Using the data for the twenty-two cottons evaluated in earlier work, a Fiber Quality Index (Q) was determined from the relation:

$$Q = \frac{\text{Stelometer Strength (g/tex)} \times \text{2.5\% Span Length (inches)}}{\text{Nominal Yarn Count } (N_e) \times \text{Micronaire Value}}$$

Using linear regression analysis, Q was related to the mean breaking load (grams) of the three yarns (N_e 10, 16, 22) spun from each cotton on the Rieter M1/1 rotor-spinning machine. Graph 1 shows the resultant equation and dispersion of points about the line.

". . . for the three yarns . . . the equations relating count-strength-product (C) and the mean breaking load (S) were as follows:

$$N_e\ 10:\ C = 2.657S + 257.0$$
$$N_e\ 16:\ C = 4.178S + 83.9$$
$$N_e\ 22:\ C = 5.699S + 5.3$$

"The mean breaking load could be estimated by means of the linear relationship with the Fiber Quality Index, which in turn could be used to provide an estimate of the count-strength-product of a particular count of yarn spun from a particular cotton. The result of this technique is shown in Graph 2, in which the values of count-strength-product estimated for each yarn count with a knowledge of fiber strength are shown plotted against the measured count-strength-products. The points shown in Graph 2 show some deviation from the theoretical relationship but the correlation coefficient was 0.9386. The coefficient of variation about regression was 4.1%, a surprisingly low value considering that many estimates of relationships were made.

"Rather than use an equation to estimate the mean breaking load of a yarn from its fiber strength, and then convert to count-strength-product by further estimation, the count-strength-product can be related directly to fiber strength and yarn count by multiple linear regression analysis. Using the same data source of twenty-two cottons, the following relationship was derived:

$$CSP = 559.0 + 82.9s - 26.4\ N_e \quad [\text{where } s = \text{fiber strength in g/tex}],$$

having a correlation coefficient of 0.9386 and a coefficient of variation about regression of 4.4%.

"For this particular sample of cottons, the use of a Fiber Quality Index . . . modified to accomodate more frequently encountered fineness-related instrument readings, failed to give encouraging results. Relating fiber strength directly to yarn strength was found to be superior to compounding with other major fiber properties.

"Exploration of the relationships between count-strength-product and mean breaking load strongly indicated linear behavior appearing to be dependent on yarn count. In conjunction with the seemingly linear relationship between fiber and yarn strengths, estimates of count-strength-product were obtained which correlated well with measured count-strength-products. Consequently, it was feasible to determine a multiple linear regression equation relating count-strength-product directly with fiber strength and yarn count.

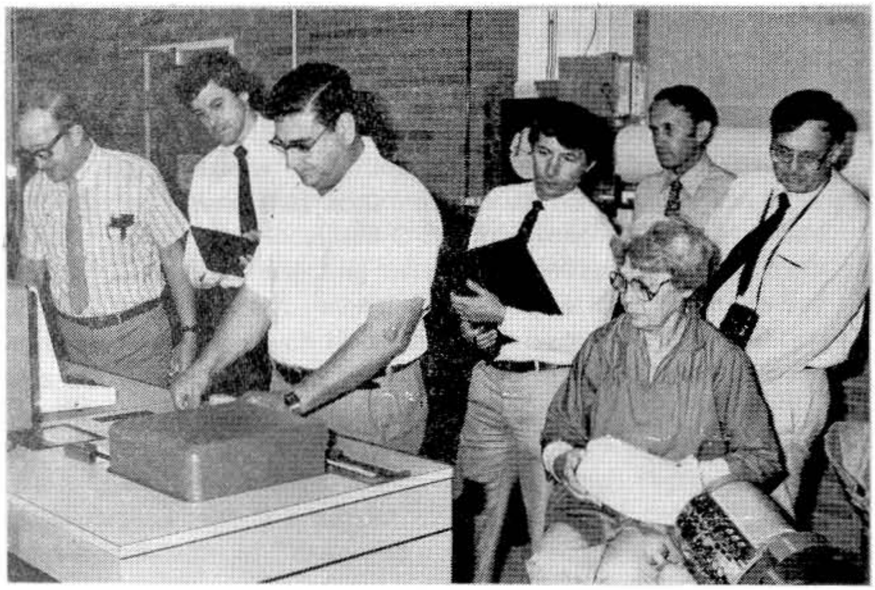
"The usefulness of such an equation relies upon the relationship and count being independent of fiber properties. For the 1980-81 crop sample this appeared to be so, but a more recent study has provided contrary results. It is intended to verify such relationships when larger samples of cotton are evaluated.

"For the sample of cottons evaluated in the 1980-81 crop study spun on the Rieter M1/1 rotor-spinning machine:

1. The correlation between mean breaking load of yarn and fiber strength was superior to any compound relationships involving fiber length or micronaire value.
2. Reasonable correlation was obtained when count-strength-product was equated with fiber strength (Stelometer, 1/8" gauge) and yarn count."

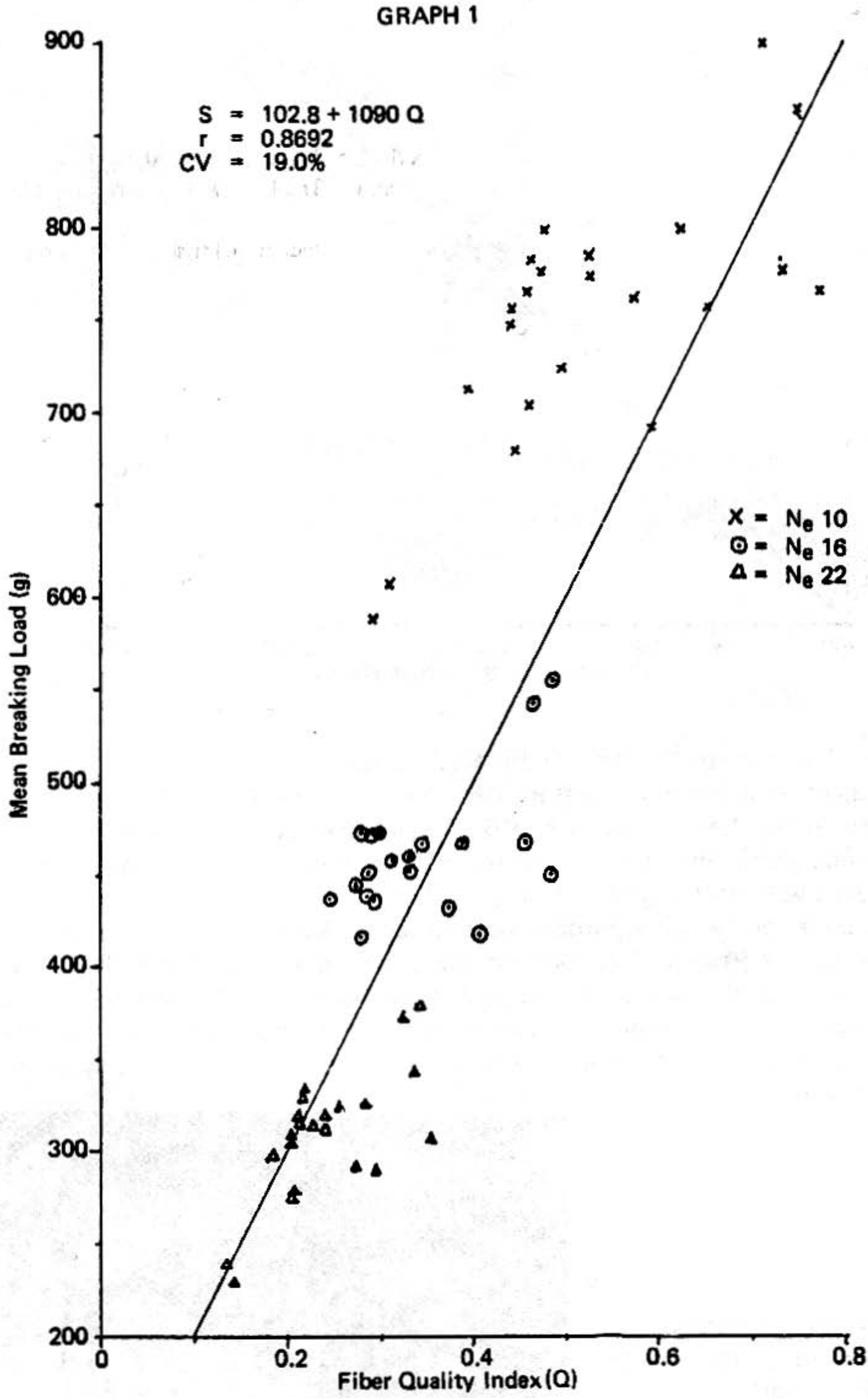
The full report prepared by Mr. Price is considerably more extensive than that presented here. We ope the preceding portions carry enough information to be meaningful. We wish to acknowledge the cooperation of the Natural Fibers & Food Protein Commission in permitting the reproduction of a eport on one of its research programs.

The Motion Control 3000 HVI System is observed by Mr. Filellini. Mrs. Whitt explains the operation while technicians Whitney Womack (left) and Renett Feazell demonstrate sample preparation and fiber measurement.

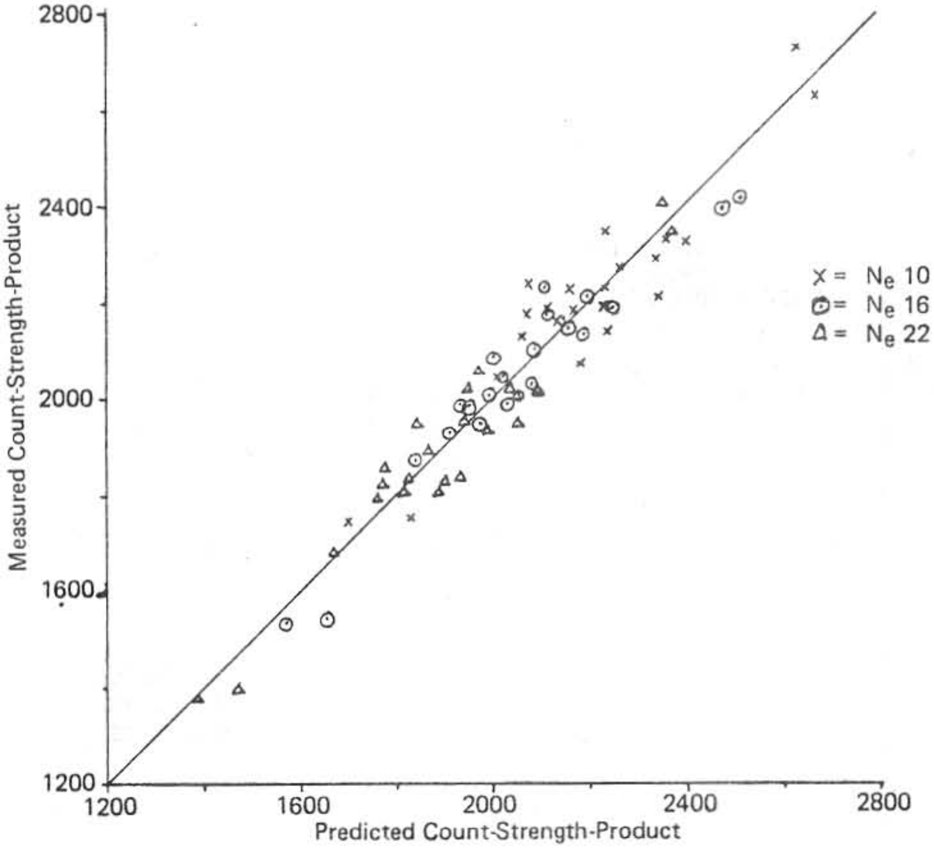


Australian visitors to TRC study the operation of the Spinlab 800 Series HVT equipment while Gus Abdalah (standing, center) and Renett Feazell (seated) of the TRC staff prepare and test samples. Shown from left are Bruce Mackay, Dr. Peter Booth, Abdalah, David Ward, Dr. Robert Steadman of the TRC staff, Feazell, and Dr. Murray Andrews.

David Ward, Dr. Booth, Dr. Andrews and Bruce Mackay concentrate on the testing sequence of the Motion Control 3000 System. Fiber technicians Billye Rhodes and Sheryl Shaw operate various positions of the unit.

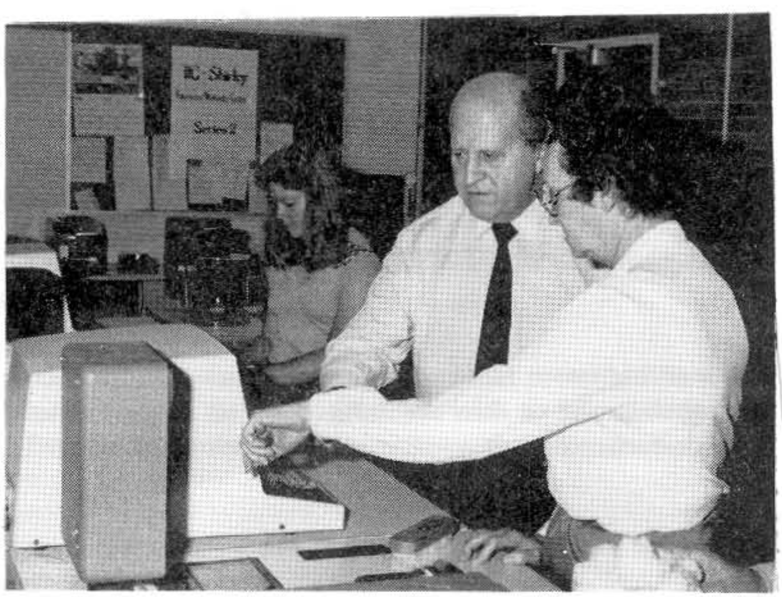

GRAPH 1
S = 102.8 + 1090 Q
r = 0.8692
CV = 19.0%
X = Ne 10
⊙ = Ne 16
Δ = Ne 22
Mean Breaking Load (g)
900
800
700
600
500
400
300
200
0
0.2
0.4
0.6
0.8
Fiber Quality Index (Q)

GRAPH 2



VISITORS Several visitors to the Textile Research Center during June came specifically to study high volume instrument evaluation of cotton. Mr. Victorio Filellini of Empresas Texteis Santista, Sao Paulo, Brazil was at the Center June 13 - 15 studying the use of the Motion Control and Spinlab instruments. His interest was in the operation of the HVI systems, results obtained from them, and how fiber properties correlate with resulting yarn quality.

Coming to the Center for the same purpose were Bruce H. Mackay, Manager of Special Projects, and Dr. Peter Booth, Manager of Research and Development, Australian Wool Corporation, Sydney; David J. Ward, Managing Director of the Australian Wool Testing Authority, Melbourne; and Dr. Murray W. Andrews, Deputy Chief, CSIRO Division of Textile Physics, Ryde, NSW, Australia. The interest expressed by the Australians was in the evaluation of cotton and the potential use of HVI systems for measuring physical properties of wool.



Victorio Filellini discusses the Spinlab 800 Series instruments with Mrs. Reva Whitt, head of TRC's materials evaluation department. In the background is Sheryl Shaw, fiber technician at the Center.

OTHER VISITORS Also visiting the Textile Research Center in June were Mr. & Mrs. Floyd Teltnik, Killeen, TX; Roger Bolick, Allied Fibers & Plastics, Hopewell, VA; Glenn Morton, Cotton Incorporated, Raleigh, NC; Wade Webb, Valdese Manufacturing Co., Valdese, NC; Roland Maillard, Picanol of America Inc., Greenville, SC; Denys Bonduel, Bonduel S.A., Roncq, France; Etienne Sadin, Filature de la Gaie Perche, Comines, France; J. T. Mitchell, Shirley Institute, Manchester, England; Alejandro and Ignacio Rivero, Envases y Fibras, Pachuca, Hidalgo, Mexico; R. C. Lin and Eric Chou, Talent Electronics Corp., Taipei, Taiwan; and Sam Cheng, Talent Investment Corporation, Olney, MD.