This response from the SWGMAT Fiber Subgroup is not all inclusive of all the relevant literature in the field of Forensic Fiber Examinations

RDT&E IWG Fiber Analysis Question List

1. **What is the literature on the transfer and persistence of fiber evidence?**
   -SWGMAT Trace Evidence Recovery Guidelines http://www.fbi.gov/about-us/lab/forensic-science-communications/fsc/april1999/houcktoc.htm
   -SWGMAT Forensic Fiber Examination Guidelines http://www.fbi.gov/about-us/lab/forensic-science-communications/fsc/april1999/houcktoc.htm
   -SWGMAT Forensic Fiber Examiner Training Guide http://www2.fbi.gov/hq/lab/fsc/backissu/april2005/standards/SWGMAT_fiber_training_program.pdf

   - Pounds-C-A; Smalldon-K-W. The Transfer of Fibres Between Clothing Materials During Simulated Contacts and their Persistence During Wear. Part II - Fibre Persistence. J-FORENSIC-SCI-SOC; 1975;
   V15 (1); P29-37
   Taking Locards exchange principle for the basis of this experiment, the authors examined garments made of wool, acrylic, a wool/nylon blend and a cotton lab coat and tested the effect of pressure, recipient garment and repeated contact passes for transference of fibers. The size of the fibers transferred also led to conclusions concerning the breakage of fibers under pressure and the likelihood of transference.

   - Pounds-C-A; Smalldon-K-W. The Transfer of Fibres Between Clothing Materials During Simulated Contacts and their Persistence During Wear. Part 1 Fibre Transference. J-FORENSIC-SCI-SOC; 1975; V15 (1); P17-27
   Independent of fiber size or type, the persistence of fibers is related to the time of wear and generally decreases quickly in the first hour. After four hours only 3-18% of the transferred fibers remained in the experiment.

   - Grieve-M-C; Dunlop-J; Haddock-P-S. Transfer Experiments with Acrylic Fibres FORENSIC-SCI-INT; 1989; V40 (3); March; P267-277
   Some simple experiments on the transfer of acrylic fibres simulating real life conditions are described. The transfer to, and persistence of these fibres on clothing and seating and their secondary transfer under different circumstances was investigated. In all instances the donor fibres were from a red cardigan involved in a homicide case. Interpretation of the case work findings was supported by experimental results. Fibres were shown to persist on seats/car seats despite secondary contacts after their original deposition. Caution is advisable when interpreting the transfer of a very low number of recovered fibres. The fibres were also shown to persist on a variety of garments after they had been washed or dry-cleaned.

   - Jackson-G; Lowrie-C-N. Secondary Transfer of Fibres

TECH-NOTE FSL CHORLEY; 1988; No610; April; P1-16
The results of an extensive series of experiments designed to investigate secondary transfer of fibres are summarised in this report. The numbers and the persistence of transferred fibres are detailed for a variety of garments and seats used in various combinations of contact. Secondary transfer of fibres via clothing, and tertiary transfer of fibres via seats and clothing are shown to be of very limited significance; secondary transfer via seats is shown to be of potential significance

- Palmer-R; Burch-H-J. The Population, Transfer and Persistence of Fibres on the Skin of Living Subjects SCI-JUST; 2009; V49 (4); December; P259-264

Fibres were transferred to the bare arms of living subjects and their persistence determined at intervals up to 24 h, during which normal daily activity was undertaken. Decay curves showed an initial rapid loss followed by an apparently exponential decay. No target fibres remained after 24 h. The length distribution showed a shift towards shorter fibre lengths and the differential shedding results for a polyester/cotton mixture showed a small bias towards the retention of cotton. The population of coloured fibres on bare skin was classified according to perceived colour, length, generic class and presence or absence of delustrant.

- Siegel-J-A. Evidential Value of Textile Fibre - Transfer and Persistence of Fibres FORENSIC-SCI-REV; 1997; V9 (2); December; P81-96
AB: The most common trace evidence encountered in forensic science today probably comes in the form of fibres. Fibre evidence occurs in probably a quarter of all cases involving trace evidence and most crime laboratories characterise textile fibres as a matter of routine. Although much research has been carried out into the characterisation and comparison of fibres, relatively little work has been done to determine the significance of fibre evidence. Here, a summary is presented of the studies of fibre transfer and persistence and the significance of fibre evidence. This will help fibre examiners to better interpret evidence in criminal cases where there has been transfer of fibres between victims and perpetrators.

- Bennett-S; Roux-C; Robertson-J The Significance of Fibre Transfer and Persistence - A Case Study PROCEEDINGS-TRACE-EVIDENCE-SYMPOSIUM-CLEARWATER-BEACH-FLORIDA; 2007; August

This paper describes the investigation of a murder case in which the only trace evidence found as a result of the examination of the scene was a number of coarse, dark fibres which were stuck to the soles of the victim's shoes. Nine of the fibres were grey polypropylene, 12 were blue polypropylene, and 50 were black polyester. These fibres were found to originate from the carpet of the suspect's vehicle, with almost all other possible sources of the fibres being eliminated. At trial, the main issue was the persistence of the fibres on the soles of the victim's shoes. Tests were carried out in order to investigate the factors affecting the transfer and persistence of carpet fibres to shoe soles. The results of these experiments formed a vital part of the prosecution's case.

- Scott-H-G. The Persistence of Fibres Transferred During Contact of Automobile Carpets and Clothing Fabrics J-CAN-SOC-FORENSIC-SCI; 1985; V18 (4); P185-199

Transferred fibres constitute an important form of trace evidence. In this study, the aim was to assess the likelihood or frequency of transfer of vehicle carpet fibres by simulating transfers in vehicles fitted with a number of different types of fabric. There was no correlation between increased contact pressure and the number of fibres transferred. The more textured fibres (corduroy and wool crepe) picked up the most number of fibres. Carpeting made from nylon/acrylic shed the most fibres, and carpeting from newer vehicles shed more fibres than carpeting from older vehicles. Consideration was also given to the percentage of nylon and polypropylene carpet fibres which could still be recovered after recipient garments had been worn during normal activity. It was found that the polypropylene fibres were more persistent than the nylon fibres, with textured fabrics retaining more of the fibres than smoother fabrics. Data regarding the type of fibre used by some of the main vehicle manufacturers were collected in order to assist investigators examining cases involving this type of evidence.

-Palmer, R., Banks, M. The secondary transfer of fibres from head hair. 2005. Science & Justice, 45(3), 123-128.
In this study, the effects of fibre type, hair style, time, and fibre persistence on the secondary transfer of mask fibres to pillowcases, via head hair, were studied. Volunteers with a range of hair styles and masks consisting of different fibre compositions were used in the study. Fibres from the masks were found to transfer from donor subjects to the pillowcases up to 14 nights after the mask had been worn. On average, the number of secondarily transferred fibres found decreased with time; however, this decrease appeared to be more 'linear' in nature rather than an exponential decay. The greatest degree of secondary transfer occurred with cotton, followed by acrylic, then wool. In a primary transfer/persistence experiment with a 50% acrylic/50% wool mask, wool was found to persist in the hair more readily than acrylic. The results also showed that the greatest degree of secondary transfer occurred via short, straight and long, straight hair, with no clear pattern emerging between medium-length hair (both straight and curly) and with long, curly hair. The implications of these findings for the assessment and interpretation of casework are considered along with data obtained from related studies.

- Robertson-J; Roux-C From the Crime Scene to the Laboratory - Transfer, Persistence and Recovery of Fibres (Chapter 5.1)
FORENSIC-EXAMINATION-OF-FIBRES-2ND-ED-ED-J-ROBERTSON-AND-M-GRIEVE-PUB-TAYLOR-&-FRANCIS; 1999; P89-100
Locard's theory of every contact leaving a trace forms the basis for the forensic examination of trace evidence. Fibres constitute an important form of trace evidence, and their transfer depends on various factors such as the area of the surfaces in contact, the number of contacts, contact pressure, fibre composition and fabric texture, and the nature of the recipient surface. The number of fibres lost from a surface after transference, and the rate of loss, depend on factors such as the time between transference and examination and the attachment of the transferred fibres to the surface. In order to maximise the potential of fibre trace evidence, it is important that the correct method of retrieval is used. Among the methods discussed in this chapter are tape-lifting and vacuuming, each of which should be considered based on the circumstances of the case. Consideration is

also given to the matter of contamination and how the risk of fibre trace evidence being contaminated can be minimised.

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2. What literature describes the optical, morphological/structural, physical or chemical properties and features useful for fiber examinations and their variation?

-Robertson and Grieve Forensic Examination of Fibres second edition 1999
-Identification of Vegetable Fibers. Caitling and Grayson. 1982, CRC Press.
-Identification of Textile Fibers. Houck, ed.2009
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-ASTM Standard Guide for Microscopical Examination of Textile Fibers E228-10 (taken from SWGMAT guidelines)

Identification of Textile Fibers (Luniak), 1973

Identification of Textile Materials (Textile Institute) 1975
Microscopy of Animal Textile Fibers (Wildman) 1954
Understanding Textiles (Collier, Bide and Tortora) 6th ed 2001

-Akrap-I; Mrsic-G; Zupanic-S; Vujasinovic-E Forensic Approach to Aramid Fibre Identification PROCEEDINGS-4TH-INTERNATIONAL-TEXTILE,-CLOTHING-AND-DESIGN-CONFERENCE.-MAGIC-WORLD-OF-TEXTILES,-OCTOBER-5TH-TO-8TH,-2008,-DUBROVNIK,-CROATIA; 2008; October; P42-47
As fibre and textile evidence is often encountered in forensic casework, it is important that the forensic fibre examiner is familiar with the different types of fibres - common and rare - on the market. This may prove challenging because the textile market is always changing, with new fibres, finishes, colours and shapes being produced. This paper looks at aramide fibres, a high-performance fibre type rarely encountered in forensic casework.

- Houck-M-M Forensic Fibre Examination and Analysis
FORENSIC-SCI-REV; 2005; V17 (1); January; P29-49
Although it is incorrectly perceived that fibre evidence has relatively little evidential value, textiles are a valuable form of trace evidence because of their ubiquity and their many variations. Textile fibres are transferred between surfaces and persist on different surfaces for different periods of time. The distinctiveness of fibres is enhanced by their distribution and use. Numerous analytical methods have been applied to forensic fibre examination, although colour analysis is not universally used in forensic laboratories despite the millions of colour shades possible. Numerous transfer studies have demonstrated the rarity of finding unrelated fibres at random with the same microscopic characteristics and optical properties. Casework examples also illustrate the usefulness of textile fibre analysis for establishing links between people and places in criminal investigations. Further research should be carried out in order to support and verify the conclusions reached from the analysis of textile fibres.

-Houck, Inter-comparison of Unrelated Fiber Evidence, Forensic Science International, 2003.

Compared 2083 fibers collected from items of evidence in 20 unrelated cases, for a total of 2, 168,403 total comparisons. No two fibers were found to exhibit the same microscopic characteristics and optical properties.

-Grieve, Biermann, The Individuality of Fibres Used the Provide Forensic Evidence- Not All Blue Polyesters Are the Same, Science and Justice, 2005.

Compared fibers from 255 samples for a total of 32, 385 comparisons. 9 total pairs could not be distinguished, 6 of those pairs were found the same brand name. Only 3 random matches were found.

-Grieve, Fibres and Their Examination in Forensic Science, Forensic Science Progress, 1990.

Discusses transfer, persistence, and recovery; fiber identification, fiber comparison and evidential value. Separates fibers into three categories: common fibers, uncommon fibers and everything else. Summarizes other articles-

"Cook & Wilson- searched 335 items of clothing for five fibre types indistinguishable from those found in four popular brands of garment made from commonly encountered fibers. A total of only 11 matching fibers, nine of which were 1 type (blue wool) were found ten garments, with a maximum of 2 fibers on any one item. The fibers were examined by comparison microscopy (brightfield and fluorescence), MSP and TLC."

"Jackson & Cook- the front seats of 108 vehicles were examined for the presence of two common target fiber types. These were red wool from ladies pullovers offered by a major chain store and brown polyesters from popular make of men's trousers. 8436 "suspect" fibers were recovered, 8 were indistinguishable from the brown polyester, 37 from the red wool. The same methods of comparison were employed. The maximum number of fibers (red wool) found on any seat was 13; in any one vehicle 20. Matches with both types of target fibers were found in only one vehicle."

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3. What is the literature on the classification of fibers, dyes, and pigments?

-SWGMAT Trace Evidence Recovery Guidelines, SWGMAT Forensic Fiber Examination Guidelines, SWGMAT Forensic Fiber Examiner Training Guide
-ASTM Standard Guide for Microscopical Examination of Textile Fibers E228-10 (taken from SWGMAT fiber guidelines)
-ASTM Standard Guide for Forensic Examination of Non-Reactive Dyes in Textile Fibers by Thin-Layer Chromatography E2227-02 (reapproved 2008) taken from SWGMAT fiber guidelines
- EFG Best Practices Guide

-- Abrahart. Dyes and their Intermediates. New York: Chemical Publishing, 1977.
Chapters covering:

- the classification of dyes
- intermediates
- azo dyes
- anthraquinone dyes
- Disperse Dyes
- Indigoid, Thioindigoid and Sulphur Dyes
- Triarylmethane and Related Dyes
- Miscellaneous Dyes
- Reactive Dyes
- Pigments

- The manufacture of Intermediates, Dyes and Pigments
- Stilbene dyes and Fluorescent Brightening Agents

Grieve MC, Dunlop J, Haddock P. 1990. An Investigation of Known Red, Blue, and Black Dyes Used in the Coloration of Cotton Fibers. Journal of Forensic Science. 35(2):301-315.

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Goodpaster, J.V. and E.A. Liszewski. 2009. Forensic analysis of dyed textile fibers. Anal Bioanal Chem 394:2009–2018.

- Biermann-T-W. Blocks of Colour IV: The Evidential Value of Blue and Red Cotton Fibres SCI-JUST; 2007; V47 (2); September; P68-87
Light and fluorescence microscopy, UV/Vis microspectrophotometry and fluorescence microspectroscopy were used to record the degree of fluorescence and spectral variation in samples of blue and red cotton fibres, with particular attention being paid to the recurrence of certain spectral patterns. The importance of spectral information in the UV range is re-emphasised, as is the importance of colour in the forensic comparison of cotton fibres. Usually, fibres with frequently-observed spectral patterns will be of less evidental value because the potential number of sources will be greater. Also, blue and red cotton fibres are frequently encountered in forensic casework. Combining light microscopy, fluorescence microscopy, and UV/Vis microspectrophotometry can give a high power of discrimination, enhancing the evidential value of red and blue cotton fibres in fibre transfer cases.

- Grieve-M-C; Biermann-T-W; Schaub-K. The Individuality of Fibres Used to Provide Forensic Evidence - Not All Blue Polyesters Are The Same SCI-JUST; 2005; V45 (1); P13-28
Target fibre studies, population studies and research into 'blocks of colour' have confirmed the polymorphism of textile fibres - especially man-made fibres - and have demonstrated that when a questioned fibre is believed to have a specific putative source, the chance that it came from another source by coincidence is very small. A previous study by Houck (Forensic Science International 2003; 135: 146-149) demonstrated that no coincidental matching fibres were recovered from items of clothing examined during the investigation of 20 unrelated crimes (over 2 million comparisons). This study goes further, using blue polyester fibres to show that, even within a narrow segment of the entire general fibre population, many examples of a specific colour/type of man-made fibre obtained from random sources can be compared and the chance of any two being identical is remote. This work supports the evidential value of transferred fibres.

- Grieve-M-C; Deck-S. Black Cellulosic Fibres - A "Bete Noir"?
SCI-JUST; 2002; V42 (2); P81-88
In certain fibre transfer cases, black viscose fibres may be recovered. However, their evidential value may be questioned due to the inherent difficulties associated with their comparison and identification, given the frequency of such fibres in the general population. Other problems associated with the examination of such fibres include the

assessment of the degree of delustrant present, and discriminating between viscose and modal. In this study, samples of black, spun-dyed viscose/modal were obtained from manufacturers for examination. Casework fibres were also examined in order to assess the degree to which the samples could be differentiated from one another. Brief consideration is also given to the identification of other types of black cellulosic fibres.

- Grieve-M. The Occurrence & Individuality of Green & Orange Cotton Fibres PROC-EUROPEAN-FIBRES-GROUP; 2002; V10; June; P98-102
Studies of fibre populations have shown that the random occurrence of cotton fibres of certain colours is low and, therefore, of considerable evidential value. The aim of this study was to examine cotton fibres of relatively uncommon colours (green and orange) to demonstrate that the overall category can be broken into many smaller spectral groups occurring with different frequencies, based on microspectrophotometric analysis of the dyes used. The results obtained confirm the evidential value of orange and green cotton fibres in fibre transfer cases.

Grieve M.C. , Griffin R.M.E, Malone R. Characteristic dye absorption peaks found in the FTIR spectra of coloured acrylic fibres, Science and Justice-JFSS, Jan 1998, 38/1 (27-37).

Hartshorne, A. W. and Laing, D. K. Microspectrofluorimetry of fluorescent dyes and brighteners on single textile fibres, Part 1: Fluorescence emission spectra, *Forensic Science International* (1991) 51:203-220.

Hartshorne, A. W. and Laing, D. K. Microspectrofluorimetry of fluorescent dyes and brighteners on single textile fibres: Part 2. Colour measurements, *Forensic Science International* (1991) 51:221-237.

Hartshorne, A. W. and Laing, D. K. Microspectrofluorimetry of fluorescent dyes and brighteners on single textile fibres: Part 3. Fluorescence decay phenomena, *Forensic Science International* (1991) 51:239-250.

4. **What is the literature on the variation, including regional and seasonal variation, of manufactured fibers and dyes/pigments?**
- Wiggins-K; Davis-E; Schennum-C; Drummond-P. An Investigation into Fibre Variation Across Garments GLOBAL-FORENSIC-SCIENCE-TODAY; 2008; NO. 6; P2-16
The aim of this project was to examine individual fibres sampled across garments in order to determine the extent of any variation in their properties. This work was limited to investigating colour variation across garments using microspectrophotometry. The garments studied were a green cotton sweater and a red acrylic sweater. The morphology and polymeric composition of the fibres in the red sweater were also examined in more

detail using white light and fluorescence microscopy together with Fourier transform infrared (FTIR) spectroscopy.

- Holness-J-A; Wiggins-K. A Further Study of Dye Batch Variation in Textile and Carpet Fibres SCI-JUST; 2005; V45 (2); P93-96
Four sets of acrylic fibre samples were obtained from a company that dyes fabrics for the fashion industry. Between seven and ten different batches of fibres constituted each set. Comparison microscopy, visible and UV range microspectrophotometry and thin layer chromatography (TLC) were used to compare the dyes on each batch of fibres within the sets. Only one of the four sets exhibited variation when both microscopical and analytical techniques were used. In addition, two further sets of samples had been obtained from a company that produces carpets for the car industry. The first set consisted of 26 batches of acid-dyed orange nylon fibres. The second consisted of 21 batches of acid-dyed, mustard-coloured nylon and direct-dyed brown viscose fibres blended together. When the first set was viewed under UV light, one batch had more pale orange fibres present, and they fluoresced more brightly than the other fibres. This could be due to the blending with a different dye batch of fibre or to poor dye uptake - the latter being more likely. When tested using visible and UV range microspectrophotometry and TLC, further dye batch variation was not detected. The second set was examined after separating the nylon and viscose fibres from each other. The nylon fibres were indistinguishable when a range of microscopical and analytical techniques were employed; however, the viscose fibres showed dye batch variation when TLC was used.

- Grieve-M-C; Biermann-T; Davignon-M. The Occurrence and Individuality of Orange and Green Cotton Fibres SCI-JUST; 2003; V43 (1); P5-22
UV-visible microspectrophotometric examination of orange and green cotton fibres revealed the degree of spectral variation in each colour. Particularly noteworthy was the recurrence of certain spectral patterns, particularly those which were associated with dyes often used in the manufacture of textiles. The importance of spectral information in the UV-range is highlighted, as is the part played by colour in the forensic comparison of cotton fibres. It is usually the case that fibres which produce commonly seen spectral patterns are of lower evidential value, with fibres having less common spectral patterns being of greater evidential value. A study in which fibres were collected from 112 seats in the German Federal Police Office confirmed the low frequency of occurrence of orange and green cotton fibres in the general fibre population. Such a low frequency, combined with the high discrimination power of microspectrophotometry, gives such fibre types considerable evidential value in cases where fibre transfer evidence is used.

5. What literature describes the various environmental effects, such as temperature and sunlight exposure, on various fiber types?

-*Atlas of fibre fracture and damage to textiles* (Hearle, Lomas and Cooke) 1998
-*Quality Assessment of Textiles-Damage Detection by Microscopy* (Karl Mahall) 2003

- Trimboli, A.R., A.A. Wells, J.J. Yiu, H.M. Taylor, A.R. Stefan, B.L. Clelland, S.L. Morgan, "Forensic Studies of Dye and Fiber Degradation During Environmental Exposure by Microspectrophotometry and Capillary Electrophoresis/Mass Spectrometry," paper B5 at the American Academy of Forensic Sciences, 59th Annual Meeting, San Antonio, TX, 21 February 2007. This presentation showed that exposure to various environmental effects – sunlight, washing, etc did change the color and appearance of fabrics and fibers.

-Parker, J and M. Valadez "Environmental Effects on the Fluroescent Properties of Colorless Polyester Fibers" poster at 2009 TES
As environmental exposure time increased, the fibers from the fabric samples exhibited an overall decrease in fluorescence, both visually and spectroscopically. Several factors may give rise to a change in either the fluorescent intensity or color, including time of exposure, chemical composition of the fiber or additives, and the location of the fibers relative to the fabric.

Was-Gubala, J., Grzesiak, E. The kinetics of colour change in textiles and fibres treated with detergent solutions. Part II - Spectrophotometric measurements (2010) Science and Justice, 50 (2), pp. 55-58.

Was-Gubala, J. The kinetics of colour change in textiles and fibres treated with detergent solutions. Part I-Colour perception and fluorescence microscopy analysis (2009) Science and Justice, 49 (3), pp. 165-169.

Was-Gubała, J., Krauß, W. Damage caused to fibres by the action of two types of heat (2006) Forensic Science International, 159 (2-3), pp. 119-126

Was-Gubała, J., Krauß, W. Textile damage caused by vapour cloud explosions (2004) Science and Justice - Journal of the Forensic Science Society, 44 (4), pp. 209-215.

Was-Gubała, J., Krauß, W. Damage caused to fibres by vapour cloud explosions (2004) Forensic Science International, 141 (2-3), pp. 77-83.

Was-Gubala, J., Salerno-Kochan, R. The biodegradation of the fabric of soldiers' uniforms (2000) Science and Justice - Journal of the Forensic Science Society, 40 (1), pp. 15-20.

Salerno-Kochan, R., Was-Gubala, J. Assessing the degree of biodegradation of wool in fabrics for military uniforms (1999) Przeglad Wlokienniczy, (6), pp. 3-8.

Causin V., Marega C., Marigo A., Guzzini G. The effect of exposure to the elements on the forensic characterization by infrared spectroscopy of poly(ethylene terephthalate) fibers, JFS, July 26, 2005, 50/4 (887-893).

6. **What published databases of fibers, dyes, pigments, and manufacturers are available for fiber analysis and comparison?**

   - The Colour Index Third edition (print) online version http://www.colour-index.org/

   - Biermann-T-W; Grieve-M-C A Computerized Data Base of Mail Order Garments A Contribution Toward Estimating the Frequency of Fibre Types Found in Clothing. Part2 The Content of the Data Bank and Its Statistical Evaluation
   FORENSIC-SCI-INT; 1996; V77(1/2); January; P75-91

   - Biermann-T-W; Grieve-M-C A Computerized Data Base of Mail Order Garments A Contribution Toward Estimating the Frequency of Fibre Types Found in Clothing. Part 1 The System and its Operation
   FORENSIC-SCI-INT; 1996; V77(1/2); January; P65-73

7. **What published instrumental spectral databases are available for fiber analysis and comparison?**
   - Commercial databases for FTIR – FBI Fiber library (Ver. 4.1.)
   - Georgia State Crime Lab Sample Library
   - HR Aldrich Dyes, Indicators, Nitro and Azo Compounds
   - HR Polymer Additives and Plasticizers
   - Hummel Polymer Sample Library
   - Sprouse Fibers
   - Synthetic Fibers by Microscope

8. **What published databases exist that describe frequency statistics on various characteristics of given fiber types?**
   *It should be noted that the SWGMAT fiber subgroup does not feel the use of statistics in fiber analysis has been shown to be a reliable method of analysis based on the variation of fibers post-production and the lack of representative world production samples for comparison. (See SWGMAT guidelines). That being said, the following resources are available to aid in the determination of the significance of some fiber types:

   - -DMV databases of cars registered in an area (this can be used to determine a frequency statistic for automotive carpet fibers).
   - -Fiber Organon provides fiber production numbers and utilization rates– a publication of the Fiber Economics Bureau.

   - Frequency of Occurrence Data for Textile Fibers – Hal Deadman presentation at 2004 AAFS – discussed variety of fibers found at GW Lisner auditorium from tapings collected from seats.

9. What references describe the quality review measures used in fiber analysis?

-Accredited forensic laboratories should all possess their own internal guidelines for quality review measures in their laboratories.

-ASTM E1492 - 05 Standard Practice for Receiving, Documenting, Storing, and Retrieving Evidence in a Forensic Science Laboratory

-SWGMAT Trace Evidence Quality Assurance Guidelines (January 1999 Revision)

-SWGMAT Trace Evidence Proficiency Testing Guidelines (July 2001)

-SWGMAT Expert Reporting Guidelines (January 2009)

Jones GR, President's Editorial -The Changing Practice of Forensic Science, Journal of Forensic Sciences, 47(3): 437-438 2002

The Manual of Best Practice for the Forensic Examination of Fibres, European Fibres Group, 2001. ENSFI

ISO17025
EFG QA group
ENSFI QCC (Quality and Competence Committee)
ANZFPAA-NIFS
SMANZFL
ANZFSS

10. What is the literature on the uncertainty or confidence of fiber analysis measurements?

-SWGMAT Fiber Guidelines: The fiber examiner is still limited to stating that the questioned fibers are consistent with originating from the evidence garment, with the understanding that all other garments listed under Item 11 (subsection 5.4.1.11) may or may not be distinguishable from the evidence garment by fiber analysis alone. This argument in no way intimates a positive match to the evidence garment to the exclusion of all other garments. Production numbers for textiles may be available for use in interpreting the significance of evidence in a crime, but the examiner must be careful to be conservative in all estimates in order to avoid false inclusions (8). Calculating exact probability statistics for this type of evidence is problematic at best, and professional statisticians must be consulted before any calculations are reported or testified.

-Houck, M “Statistics and the Tyranny of Numbers” Forensic Science Communications 1999 Vol 1, No.3 The public perception of science allies it closely with mathematics, and the application of statistics to forensic DNA analysis has reinforced this perception.

Numbers, however, are not required for the scientific process. All science, including forensic science, is a method of understanding the world around us, and quantitation is only one tool to assist that methodology. Yet, the public and the courts expect forensic scientists, including trace evidence examiners, to use mathematics and statistics regularly, based largely on the DNA model. Recent articles and court rulings have even suggested that without statistics, trace evidence may not be acceptably scientific.

This expectation is fraught with pitfalls that could adversely affect the accuracy of evidentiary reports presented in court. The foundational data upon which trace evidence statistics might be based differ radically from those used in DNA statistical calculations. If statistics are to be applied to trace evidence, they must be applied in a way appropriate to the discipline, unbiased in interpretation, and accessible to the trier of fact.

- Evett-I-W. The Theory of Interpreting Scientific Transfer Evidence (From 'Forensic Science Progress', Volume 4. Edited by A. Maehly and R.L. Williams, Published by Springer-Verlag) 1990; V4; P141-179

The history of forensic science has been characterised by dramatic advances in techniques which enable information to be gleaned from ever smaller quantities of material. Most of the literature is devoted to technical advances, with much less attention being paid to the procedures for interpreting the information objectively and efficiently. This is a review of the most important advances which have been made in the theory of interpreting scientific evidence in the context of the forensic transfer problem. Increasingly, the literature on interpretation employs what is known as Bayesian inference. The Bayesian approach to evaluating transfer evidence is explained and illustrates by simple examples. The problem of communicating a scientific assessment of evidence to a court is briefly discussed. Any attempts to move towards more objective methods demand background information in various forms and a number of attempts by forensic scientists to establish data collections and to study the nature of evidential transfer are reviewed. Interpretation is a difficult subject, which is the reason why progress has been slow, but this article attempts to explain some simple principles which should be helpful to any scientist in the field, whatever the discipline.

- Morgan-S-L; Hall-S-H; Hendrix-J-E; Bartick-E-G Pattern Recognition Methods for the Classification of Trace Evidence Textile Fibres from UV/Visible and Fluorescence Spectra PROCEEDINGS-TRACE-EVIDENCE-SYMPOSIUM,-CLEARWATER-BEACH-FLORIDA; 2007; August; P1-10

Forensic chemists are often faced with having to identify patterns in analytical chemical data and interpreting observed differences. Likewise, a forensic fibre examiner might perform UV/visible microspectrophotometry on known and questioned fibres in order to evaluate possible associations between source and location. The use of multivariate statistics allows the confirmation of the statistical validity of discrimination between various polymer classes and dyed textile fibres, visualisation of significant differences between groups of spectra discrimination, and tracking of spectral changes with environmental changes. Fibres and associated spectra contained in the database,

combined with validated software, are useful for fibre comparisons in casework and for quality control and the training of analysts. This paper describes the application of linear discriminant analysis to a database containing more than 5,000 UV/visible absorbance and fluorescence spectra.

- Wakefield-J-C; Skene-A-M; Smith-A-F-M; Evett-I-W. The Evaluation of Fibre Transfer Evidence in Forensic Science: A Case Study in Statistical Modelling APPL-STAT; 1991; V40 (3); P461-476
Fibre evidence is often left at the scene of a crime. This paper considers the modelling aspects of assessing the evidential value of fibre evidence using Bayesian methodology. The likelihood ratio is used to draw inferences, derived from bivariate colour measurements. Details are also given of the modelling of the distribution of colour within a particular item of clothing. The use of a large database allows the incorporation of an empirical prior distribution, using kernel density estimation. Casework examples are used to illustrate these points.

Other articles include:

Bresee RR (1987), Evaluation of Textile Fiber Evidence: A Review, Journal of Forensic Sciences, 32(2): 510-521

Evett IW, Jackson G, Lindley DV, Meuwly D (2006), Logical evaluation of evidence when a person is suspected of committing two separate offences, Science & Justice 2006: 46; 25-31

Kokot S, Tuan NA, Rintoul L (1997) Discrimination of Reactive Dyes on Cotton Fabric by Raman Spectroscopy and Chemometrics, Applied Spectroscopy, 51(3): 387-395

Walsh KAJ, Buckleton JS, Triggs CM (1994), Assessing prior probabilities considering geography, Journal of the Forensic Science Society, 34(1): 47-51

Champod, C. and Taroni, F. Bayesian Framework for the Evaluation of Fiber Transfer Evidence. 1997. Science and Justice, 37, 75-83.

Champod, C. and Taroni F. Interpretation of fibres evidence – The Bayesian approach. 1999. In: Robertson, J. & Grieve M. (Eds.), Forensic examination of fibres. 2nd Edition. 1999. Taylor & Francis, London & Philadelphia, 379-398.

Aitken C. and Taroni F. Fibres. In: Aitken C. and Taroni F. (Eds.), Statistics and evaluation of evidence for forensic scientists. 2nd Edition. 2004. John Wiley & Sons, Chichester, 381-398.

Causin, V., Schiavone, S., Marigo, A., Carresi, P. Bayesian framework for the evaluation of fiber evidence. 2004. Forensic Science International, 141, 159-170

11. What is the literature on the potential and actual cognitive bias in fiber examination?

No known fiber specific studies on cognitive bias

-Bruce Budowle, Maureen C. Bottrell, Stephen G. Bunch, Robert Fram, Diana Harrison, Stephen Meagher, Cary T. Oien, Peter E. Peterson, Danielle P. Seiger, Michael B. Smith, Melissa A. Smrz, Greg L. Soltis, Robert B. Stacey. "A Perspective on Errors, Bias, and Interpretation in the Forensic Sciences and Direction for Continuing Advancement"

The forensic sciences are under review more so than ever before. Such review is necessary and healthy and should be a continuous process. It identifies areas for improvement in quality practices and services. The issues surrounding error, i.e., measurement error, human error, contextual bias, and confirmatory bias, and interpretation are discussed. Infrastructure is already in place to support reliability. However, more definition and clarity of terms and interpretation would facilitate communication and understanding. Material improvement across the disciplines should be sought through national programs in education and training, focused on science, the scientific method, statistics, and ethics. To provide direction for advancing the forensic sciences a list of recommendations ranging from further documentation to new research and validation to education and to accreditation is provided for consideration. The list is a starting point for discussion that could foster further thought and input in developing an overarching strategic plan for enhancing the forensic sciences.

-Dror, I.E., D Charlton, and A.E.Peron "Contextual information renders experts vulnerable to making erroneous identificiations" Forensic Science International 156 (2006) 74-78. The authors investigated whether experts can objectively focus on feature information in fingerprints without being misled by extraneous information, such as context.

-M.J. Saks, D.M. Risinger, R. Rosenthal and W.C. Thompson "Context effects in forensic science: A review and application of the science of science to crime laboratory practice in the United States" Science and Justice Vol 43, Issue 2 2003, p77-90.

Taroni, F., Aitken CGG., Garbolino P. (2001) De Finetti's subjectivism, the assessment of probabilities and the evaluation of evidence: a commentary for forensic scientists. Science & Justice; 41(3): 145-150.

12. What is the literature on contamination and control thereof in forensic fiber examinations?

-SWGMAT Trace Evidence Recovery Guidelines and SWGMAT Forensic Fiber Examination Guidelines
- Individual laboratory evidence handling protocols

- Sano-T; Hrynchuk-R; Sandercock-M; Greenlay-W; Cassista-A. The Movement of Acrylic and Cotton Fibres Between Examination Benches Resulting From the Routine Examination of Garments (EFG 7th Meeting, Zurich, June)
PROC-EUROPEAN-FIBRES-GROUP; 1999; P65-75
A recent, Canadian government-appointed report cited incidents of contamination of exhibits in a forensic laboratory regarding fibres evidence that was being examined and compared. The report made specific recommendations concerning the prevention and documentation of possible contamination in fibre examinations, therefore a research project was carried out to respond, in part, to the recommendations by studying the movement, from bench to bench, of fibres shed from a garment under examination for trace evidence. The garments used in this case were composed of either acrylic or cotton. This study showed that there was no movement of these fibres between examination benches in different rooms when routine contamination prevention measures were implemented. However, significant numbers of fibres may accumulate on work surfaces if they are not regularly cleaned. Also, the opening and handling of a packaged garment may result in the transfer of fibres from that garment to the exterior of any other packages handled in the same room. The importance of routine contamination prevention measures is highlighted.

Roux C., Huttunen J., Rampling K., Robertson J., Factors Affecting the Potential for Fibre Contamination in Purpose Designed Forensic Search Rooms, Science and Justice, 41(3), 2001, 135-144.

13. What references describe guidelines for reporting and interpretation of fiber related findings?

-SWGMAT reporting guidelines
-SWGMAT Forensic Fiber Examination Guidelines
-SWGMAT Forensic Fiber Training document

- Grieve-M-C. A Survey on the Evidential Value of Fibres and the Interpretation of the Findings in Fibre Transfer Cases. Part 2 - Interpretation and Reporting
SCI-JUST; 2000; V40 (3); P201-209
As the first part of this series of papers considered the effect of fibre frequencies on evidential value, the second part considers the evaluation and reporting of fibre evidence.

Responses to casework scenarios are studied, and the degree of variation in assessing the strength of the evidence in such cases are assessed using a verbal probability scale. Opinions were sought regarding the extent of the information which should be included in fibre casework reports. Bearing in mind the survey results, together with ideas advocating the use of a Bayesian approach to the evaluation of fibre evidence, proposals are put forward regarding improvements in the reporting of fibre evidence.

The Manual of Best Practice for the Forensic Examination of Fibres, European Fibres Group, 2001.

Forensic Fiber Examiner Training Program, Scientific Working Group for Materials Analysis (SWGMAT) Fiber Subgroup, 2005, Forensic Science Communications, 7(2)

Arnold J. (2004) The Bayesian Approach: Curse or Blessing in Evidence Evaluation. Proceeding of the Young Scientists Workshop (European Fibres Group), Prague, CZ.

Bennett S, Roux CP, Robertson J. (2009) The significance of fibre transfer and persistence - a case study. Australian Journal of Forensic Science; 42(3): 221-228.

Bresee RR. (1987) Evaluation of Textile Fiber Evidence: A Review. Journal of Forensic Sciences; 32(2): 510-521.

Buckleton J, Evett IW. (1989) Aspects of the Bayesian Interpretation of Fibre Evidence. CRSE Report No. 684

Causin V, Schiavone S, Marigo A, Carresi P. (2004) Bayesian framework for the evaluation of fiber evidence in a double murder-a case report. Forensic Science International; 141(2-3): 159-170.

Chabli S. (2001) Scene of Crime Evidence Fibres A Review: 1998 to 2001. 13th INTERPOL Forensic Science Symposium; D1- 107-119.

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Cwiklik C. (1999) An Evaluation of the Significance of Transfers of Debris: Criteria for Association and Exclusion. Journal of Forensic Sciences; 44(6): 1136-1150.

Cook R, Evett IW, Jackson G, Jones PJ, Lambert JA. (1998) A model for case assessment and interpretation. Science & Justice; 38(3): 151-156.

Cook R, Evett IW, Jackson G, Jones PJ, Lambert JA. (1999) Case pre-assessment and review in a two-way transfer case. Science & Justice; 39(2): 103-111.

Cook R, Evett IW, Jackson G, Jones PJ, Lambert JA. (1998) A hierarchy of propositions: deciding which level to address in casework. Science & Justice; 38(4): 231-239.

Cook R, Evett IW, Jackson G, Rogers M. (1993) A workshop approach to improving the understanding of the significance of fibres evidence. Journal of the Forensic Science Society; 33(3): 149-152.

Cook R, Evett IW, Jackson G, Rogers M. (1992) A Workshop Approach to Improving the Understanding of the Significance of Fibres Evidence. CRSE Report No. 745.

Deadman HA. (1984) Fiber Evidence and the Wayne Williams Trial (Part I). FBI Law Enforcement Bulletin, March, 13-20.

Deadman HA. (1984) Fiber Evidence and the Wayne Williams Trial (Conclusion). FBI Law Enforcement Bulletin, March, 10-19.

Deedrick D. (1998) Searching For The Source - Car Carpet Fibres In The OJ Simpson Case. FSS: Contact, 26: 14-16.

Dillinger S (2008) Investigation Approaches Based on Textile Labels. Global Forensic Science Today; January (4): 6-7

European Fibres Group, Proceeding of the 6th Meeting of the EFG, Dundee, Scotland, 1998

European Fibres Group, Proceedings of the 4th EFG Meeting, London, England, 1996

European Fibres Group, Proceedings of the 11th EFG Meeting, Istanbul, 2003

Evett IW, Jackson G, Lambert JA. (2000) More on the hierarchy of propositions: exploring the distinction between explanations and propositions. Science & Justice; 40(1): 3-10.

Evett IW, Jackson G, Lindley DV, Meuwly D. (2006) Logical evaluation of evidence when a person is suspected of committing two separate offences. Science & Justice; 46: 25-31.

Fong W, Inami SH. (1986) Results of a Study to Determine the Probability of Chance Match Occurrences Between Fibers Known to be from Different Sources. Journal of Forensic Sciences; 31(1): 65-72.

Garbolino P, Franco T. (2002) Evaluation of scientific evidence using Bayesian networks. Forensic Science International; 125(2-3): 149-155.

Grieve MC. (2000) A survey on the evidential value of fibres and on the interpretation of the findings in fibre transfre cases. Part 1 - fibre frequencies. Science & Justice; 40(3): 189-200.

Grieve MC. (2000) A survey on the evidential value of fibres and the interpretation of the findings in fibre transfer cases. Part 2 - interpretation and reporting. Science & Justice; 40(3): 201-209.

Grieve MC. (1993) Fibers and Forensic Science - New Ideas, Developments, and Techniques. Forensic Science Review; 6(1): 59-79.

Grieve MC. (1983) The Role of Fibers in Forensic Science Examinations. Journal of Forensic Sciences; 28(4): 877-887.

Grieve MC, Dunlop J. (1992) A practical aspect of the Bayesian interpretation of fibre evidence. Journal of the Forensic Science Society; 32(2): 169-175.

Houck MM. (2003) Inter-comparison of unrelated fiber evidence. Forensic Science International; 135(2): 146-149.

Houck MM. (1999) Statistics and Trace Evidence: The Tyranny of Numbers. Forensic Science Communications; 1 (3).

Jones J, Coyle T. (2010) Automotive flock and its significance in forensic examinations. Science and Justice; 50: 77-85.

Kaufman F. (2005) Report of the Kaufman Commission on Proceedings Involving Guy Paul Morin. Commission Report.

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Kubic TA, King JE, Kovar S. (1987) Microscopical Similarities and Differences in a "Random" Collection of Forty Red Textile Exhibits. Canadian Society of Forensic Science Journal; 20(3): 145.

Palmer R. (2000) Fibers: Identification and Comparison. Encyclopedia of Forensic Sciences; 815-823.

Palmer R. (2000) Fibers: Recovery. Encyclopedia of Forensic Sciences; 823-829.

Palmer R. Examination of Fibres and Textiles. 16th International Forensic Science Symposium Interpol, Lyon, 5th-8th October 2010, Review Papers.

Patterson D. (1976) The Development of Colour Science. Rev. Prog. Colouration; 7: 46-54.

Robertson J. (1987) Unique Evidence of Association Through Fibre Transfer? A Case History. Canadian Society of Forensic Science Journal; 20(3): 139.

Robertson J, Grieve M. (eds.) ‘Interpretation of Fibres Evidence’ in Forensic Examination of Fibres 2nd Edition; Taylor & Francis; London; 1999.

Robertson J, Lloyd AK. (1984) Observations on Redistribution of Textile Fibres. Journal of the Forensic Science Society; 24: 3-7.

Robertson J, Roux C. (2000). Fibers: Transfer and Persistence. Encyclopedia of Forensic Sciences; 834-838.

Robertson J, Roux C. (2010) Trace evidence: Here today, gone tomorrow? Science and Justice; 50 (1): 18-22.

Rothe M. Examination of Foreign Fibre Populations. Proceedings of the 5th Meeting of the European Fibres Group, Berlin, Germany, 1997, p 119-120.

Roux C, Robertson J. (2000) Fibers: Significance. Encyclopedia of Forensic Sciences; 829-834.

Roux C, Robertson J. (2000) Fibres: Types. Encycolpedia of Forensic Sciences; 838-854.
Taroni F, Aitken CGG. (2000) Fibres evidence, probabilistic evaluation and collaborative test. Forensic Science International; 114(1): 45-47.

Taroni F, Aitken CGG. (1998) Probabilistic reasoning in the law. Part 2: assessment of probabilities and explanation of the value of trace evidence other than DNA. Science & Justice; 38(3): 179-188.

Taroni F, Aitken CGG, Garbolino P. (2001) De Finetti's subjectivism, the assessment of probabilities and the evaluation of evidence: a commentary for forensic scientists. Science & Justice; 41(3): 145-150.

Taroni F, Biedermann A, Garbolino P, Aitken CGG. (2001) A general approach to Bayesian networks for the interpretation of evidence. Forensic Science International; 139(1): 5-16.

Walsh KAJ, Buckleton JS, Triggs CM. (1994) Assessing prior probabilities considering geography. Journal of the Forensic Science Society; 34(1): 47-51.

Wiggins KG. (2003) The European Fibres Group 1993-2002: "Understanding and improving the evidential value of fibres". Analytical & Bioanalytical Chemistry; 376: 1172-1177.

While fiber examiners from the US generally do not advocate use of Bayesian statistics for determining evidential value the following studies are useful:

Target fiber studies

1940 Plaa	Evaluation of Textile Fibers as Evidence, Jour of Criminal Law and Criminology, 1940, pp 382
1942 Burd/Kirk	Clothing Fibers as Evidence, Jour of Criminal Law and Criminology, 1942, pp 353
1986 Jackson	The significance of fibres found on car seats. FSI, 32(1986) page 275
1986 Cook	The significance of finding extraneous fibres in contact cases, FSI 32(1986) page 267, see also Wilson 1987
1988 Grieve	An Assessment of the Value of Blue, Red and Black Cotton Fibres as Target Fibers in Forensic Science Investigations, JFS, 1988, 1332-1244
1996 Palmer	A Target Fiber Study Using Cinema and Car Seats as Recipient Items, JFS, 1996, 802
1996 Bruschweiler	A study on the random distribution of a red acrylic target fibre, Sci and Justice, 32(2) 1997 page 85
1997 Cook	Target fiber study head hair, FSI, 1997, pp. 155-160
1997 Siegel	Review article summarized target fiber studies, Forensic Science Reviews December 1997
1998 Kelly	Target fiber study public houses, Science and Justice (S&J) 1998, pp 39-44
2004 Wiggins	A Study in Relation to the Random Distribution of Four Fiber Types on Clothing, S&J 44(3) page 141
2005 Grieve	The Individuality of Fibers … to Provide Forensic Evidence (actually a block of color study), S & J, 2007, pp 68-87

Population studies

1992 Grieve	A practical aspect of the Bayesian interpretation of fibre evidence, JFSS, 1992, 32(2) page 169, study of underwear
1995 Biermann	Population study catalogs, FSI, 1996, pp 65-91 (parts 1 and 2)
1996 Roux	The population of textile fibers on car seats, S&J 1997 37 page 25

1997 Roux	An attempt to assess the relevance of textile fibers recovered from car seats, S&J 1997 37(4) page 225
1997 Grieve	The Population of Coloured Textile Fibers on Outdoor Surfaces, S&J, 1997, pp 231-239
2001 Cantrell	A Textile Fiber Survey as an Aid to the Interpretation of Fibre Evidence in the Sydney Region, FSI, 2001, pp 48-53
2002 Akulova	Outdoor surfaces, population study, S&J, 2002, pp.165-171
2003 Houck	Inter-comparison of Unrelated Fiber Evidence (not really a population study FSI 2003 (135) page 146
2005 Palmer	Population study human hair, S&J 2005 44(2) page 83
2005 Watt	Population study washing machines, S&J 2005 45(1)
2006 Marnane	A pilot study to determine the background population of foreign fibre groups on cotton/polyester T shirt, S&J, 2006 page 215
2009 Palmer	The Population, Transfer, and Persistence of Fibers on the Skin of Living Subjects Science & Justice; 49(4) 259-264

Blocks of Color studies (these are also population studies looking at the variety within a particular color class combination)

1997 Cassista	Survey of red, green and blue cotton fibres, J Can. Soc. For. Sci., 1997 volume 30, (4)
2001 Grieve	The evidential value of black cotton fibres, S&J, 2001 41(4) page 245
2002 Parent	Airport clothing fibers (also a population study) presented at the AAFS meeting in 2002
2003 Grieve	Orange and green cotton fibers, S&J 2003 43 (1) page 5
2005 Grieve	The individuality of fibres used to provide forensic evidence, not all blue polyesters are the same, S&J 2005 45(1) page 13
2007 Biermann	Blocks of colour IV, the evidential value of blue & red cotton fibers, S&J, 2007, pp. 68-87
2009 Palmer	The discrimination of (non-denim) blue cotton, S&J, 2009, pp. 12-18

14. What literature describes empiric evaluations of error rates in fiber examination?

SWGMAT does not believe that an actual error rate can be calculated for forensic fiber examinations – fiber examiners qualify their statements of association by stating in their report or testifying that a fiber can not be associated to a single item to the exclusion of all other textiles of similar type, color and manufacture. As textiles are mostly mass produced, there is an acceptance that coincidental associations are possible.

- Kevin Roberts, Matthew King, Edward G. Bartick, Stephen L. Morgan and John Goodpaster "Evaluation of Statistical Measures for Fiber Comparisons: Interlaboratory Studies and Forensic Databases" (current NIJ grant)

15. What literature exists describing the instrumental analysis of fibers and the significance of the information obtained there from?

-SWGMAT Forensic Fiber Examination Guidelines, SWGMAT Forensic Fiber Examiner Training Guide

-- Tungol, Bartick, Montaser. Practical Guide to Infrared Microspectroscopy, Humecki ed. Ch. 7 – Forensic Examination of Synthetic Textile Fibers by Microscopic Infrared Spectrometery. New York: Marcel Dekker Inc. 1995.

Subsections on Experimental Considerations (including sample preparation), Infrared Spectral Databases, the Value of IR Analysis in Fiber Casework, Peak Area Ratio analysis of Acrylic Copolymer Fibers, Dichroism Studies of Single Fibers, and Future Directions.

- Ziba-Palus, J and J. Was-Gubala "An investigation into the use of micro-Raman spectroscopy for the analysis of car paints and single textile fibres" Journal of Molecular Structure, Vol 993, Issues 1-3, 2011, Pages 127-133

Micro-Raman spectroscopy was applied to identification and differentiation between criminalistic traces such as micropaint chips and single fibres. The aim was to determine the degree of discrimination between fibres coloured by defined chemical dye classes and to differentiate between paint samples on the basis of pigment/dye content. Samples of coloured cotton fibres and samples of green car paints were examined. It was found that the majority of the obtained Raman spectra provided information about the main dyes present in the sample. However, in some cases fluorescence of the samples made dye identification impossible. Spectral libraries for examined paint samples and single fibres were created in order to facilitate quick recognition of similar forensic traces using this analytical method.

- De Wael, K and T. Vanden Driessche "Dichroism measurements in forensic fibre examination. Part 1 - Dyed polyester fibres. 2010 Forensic Science International

One hundred and twenty dyed polyester samples were examined with plane polarized light on their dichroic behaviour by optical light microscopy (OLM) and microspectrophotometry in the visible range (MSP Vis). It was found that most of these disperse dyed polyester fibres possess a strong dichroism, which fall into two broad categories. Either a decrease of intensity (hypochromic effect) or a change of hue (hypsochromic or bathochromic shift of absorption bands) is noted. These dichroic effects are related to the orientation of the dye structure with respect to the polymer chains.

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Grieve MC, Dunlop J, Haddock P. 1990. An Investigation of Known Red, Blue, and Black Dyes Used in the Coloration of Cotton Fibers. Journal of Forensic Science. 34(2):301-315.

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Hartshorne AW, Laing DK. 1988. Color Matching Within a Fiber Data Collection. Journal of Forensic Science. 33(6):1345-1354.

Fong W, Inami SH. 1986. Results of a Study to Determine the Probability of a Chance Match Occurrence between Fibers Known to be from Different Sources. Journal of Forensic Science. 31(1): 65-72.

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Houck M. 1999. Forensic Fiber Examination Guidelines. Forensic Science Communications. 1(1)

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Grieve MC, & Wiggins K. G. 2001. Fibers under fire: Suggestions for improving their use to provide forensic evidence. *Journal of Forensic Science, 46(4),* 835-843.

Grieve M; Biermann T.; Wiggins K.G Fibre comparison using microspectrophotometry [1], Science and Justice, Oct 27, 1999, 39/4 (273).

White P. (1992). Chromatographic analysis of fiber dyes. In J. Robertson & E. Horwood (Eds.), *Forensic examination of fibers.* 143-179

Wiggins K.G.; Holness J.-A; March B.M. // Wiggins K.G. The importance of thin layer chromatography and UV microspectrophotometry in the analysis of reactive dyes released from wool and cotton fibers, JFS, March 1, 2005, 50/2 (364-368).

16. What literature exists describing the various methods for the recognition, collection, and storage of fibers and how those processes affect the examination?

-SWGMAT Trace Evidence Recovery Guidelines, SWGMAT Forensic Fiber Examination Guidelines, SWGMAT Forensic Fiber Examiner Training Guide

- Chewning-D-D; Deaver-K-L; Christensen-A-M. Persistence of Fibres on Ski Masks During Transit and Processing FORENSIC-SCI-COMMUN; 2008; V10 (3); July
A study was undertaken in order to examine the persistence of fibres on the interior and exterior surfaces of ski masks during transportation to the FBI Laboratory and during evidence processing in order to assess the case for separate examinations of the interior and exterior of a mask. To this end, ski masks (n = 20) were each seeded with 50 test fibres on either the interior or exterior only. The masks were subsequently packaged, shipped, and processed according to standard procedures before the final recovery locations of the fibres were documented. The results obtained suggested that 11 (55%) of the ski masks showed evidence of test-fibre transfer at some point during the study, although the number of fibres transferred only ranged from one to three. The probability that a fibre will be recovered from the same side on which it was deposited is higher than the probability that it will be recovered from the opposite side, but an examiner cannot conclude with certainty that fibres recovered in the laboratory from the interior or exterior of an item of evidence were originally deposited on that side. In many cases, processing of all the surfaces together may be acceptable.

-Pounds. The Recovery of Fibres from the Surface of Clothing for Forensic Examinations. JFSS 1975: 15, 127-132.

17. What databases are most needed in the field of fiber analysis?

-An up to date, comprehensive automotive carpet fiber database would be very useful along the lines of PDQ – searchable for investigative leads.

-a fiber population database is NOT recommended for statistical use at this time due to the ever changing colors of fibers and textiles due to style and season as well as post-manufacture changes from exposure to sun, laundering, etc. The wide range of countries that manufacture fibers would also make it almost impossible to get a truly representative sample – it would not be advisable to reference a fiber found in a case against a database that may be limited by fiber manufacturer and that may not take into account the fact that fibers can change over time due to exposure to light, washing etc.

18. What new technologies and areas of research should be pursued with regard to fiber examination and analysis?

-Instrumental analysis of dyed single fibers (LC-MS, CE, etc.) following the generally accepted analytical scheme that utilizes stereomicroscopy and comparison microscopy to differentiate the majority of fibers prior to any instrumental analysis. This may include an assessment of each technique individually and then in comparison to one another.

-Analysis of finishing products and laundry products

-Elemental analysis of fibers and dyes

-Methods to distinguish individual automotive from interior carpet fibers

-A tape grid search instrument which can screen tape lifts with discrimination equal to or better than human stereo exams relating to color, cross-section, fiber type, diameter, etc.

-Analysis of surface contaminants on fiber surfaces for investigative and comparative purposes

-in situ/non-destructive dye analysis