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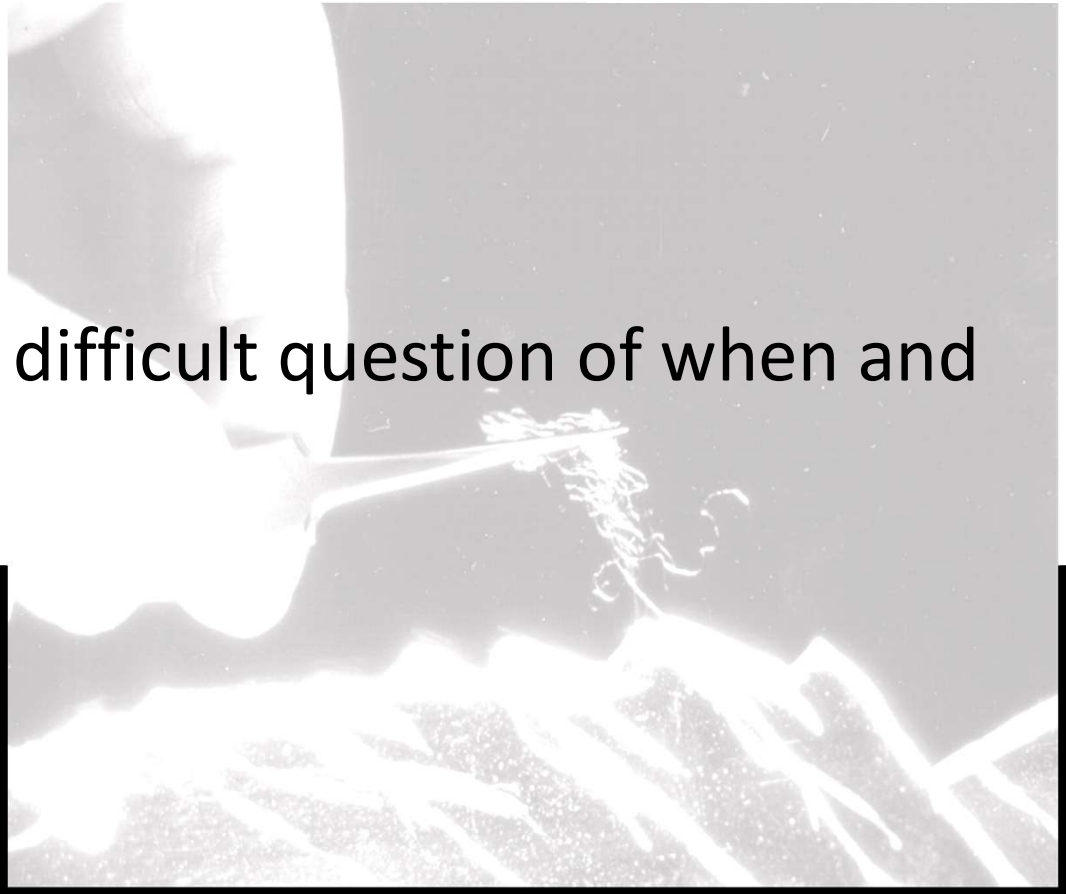

Fibre evidence – addressing the difficult question of when and how an incident occurred

Research Festival, Forensic Capability Network
6-10th September 2021

Dr. Kelly J. Sheridan

Overview

WHY FIBRES?

WHY NOT FIBRES?

HOW RESEARCH ASSISTS

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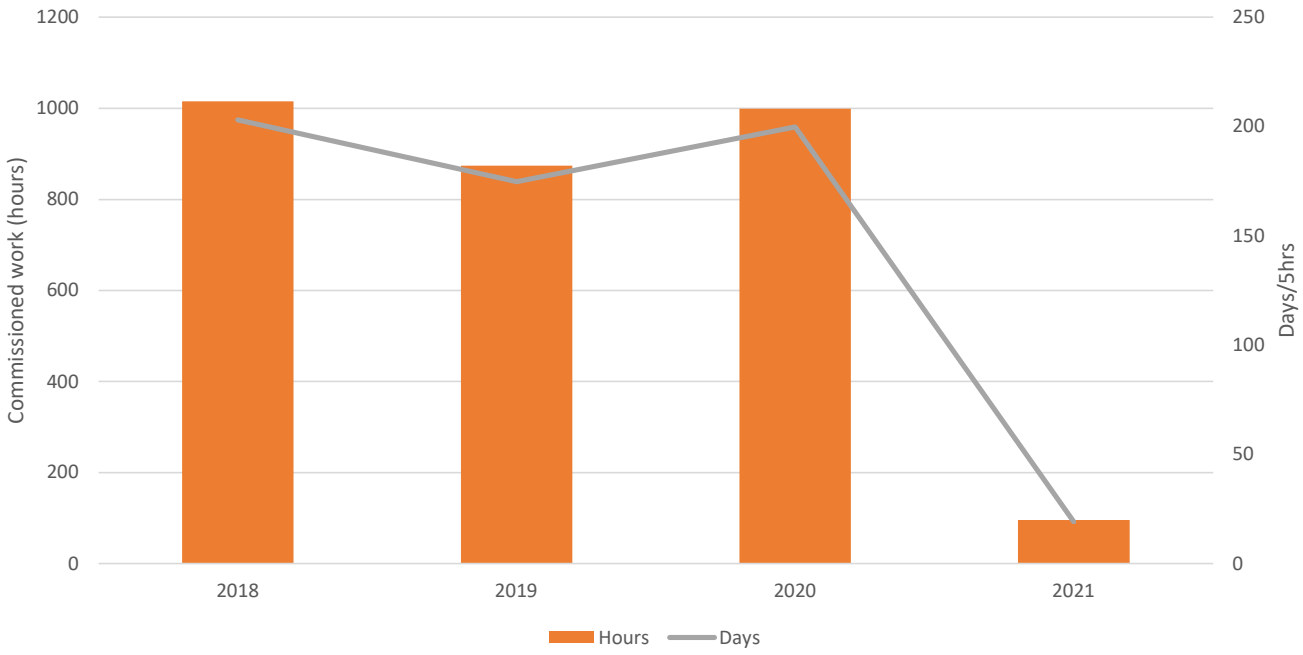
The sad reality



- FOI data from 31 of 43 police forces
- Breakdown re:product codes/bespoke (hourly) not entirely transparent
- Excludes biggest forces (e.g. MPS, Merseyside, GMP)
- One force (TVP) accounts for 24% of data 2018-2020

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*Data courtesy of Tiernan Coyle

Common concerns

- takes too long
- its too expensive
- “I’ve never had a positive case”
- poor evidential value
- garments are common
- no databases
- yeah, but, DNA ….! …..digital…..!

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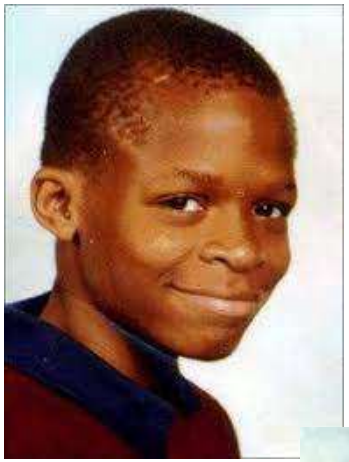
What did fibres ever do for us….



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What I see

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Features and benefits of fibres as evidence

- Ubiquitous
- Highly individual
- Easily transferred
- They are persistent
- Mute witness; criminals do not necessarily think about their evidential value
- Complimentary to other evidence types

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At the beginning…..

CASE ASSESSMENT

- Nature of contact
- Garments involved
- Post contact activity
- Potential evidential value

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Garment suitability for fibre transfer

- Propensity with which a textile will ‘shed’ it’s constituent fibres
- Used to inform our expectations of fibre transfer

QUICK ACTIVITY

– grab some Sellotape and a piece of white paper

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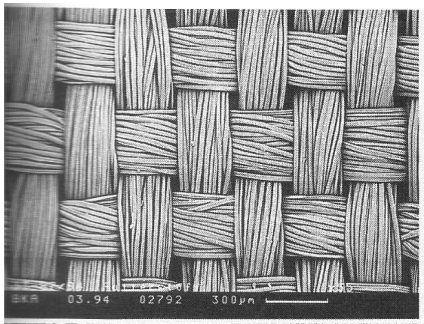
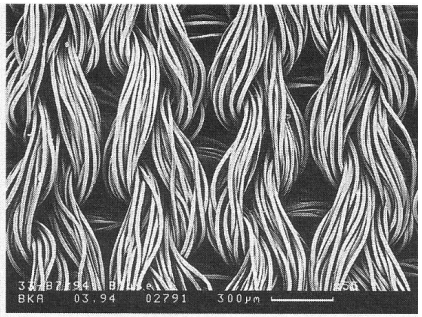
What garments are suitable for transfer?

(a)



(b)



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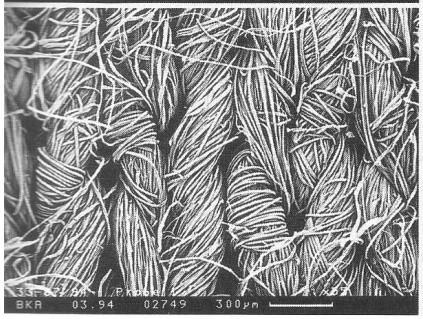

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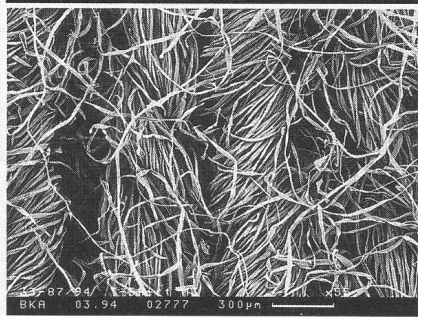

Source: Robertson J, Grieve M; Forensic Examination of Fibres, 2nd Ed, Taylor & Francis

- Construction of a garment is one of the key factors in whether or not a garment sheds its fibres
  - Knitted (b-d) v woven (a)
  - Staple fibres (c-d) v continuous filament fibres (a-b)

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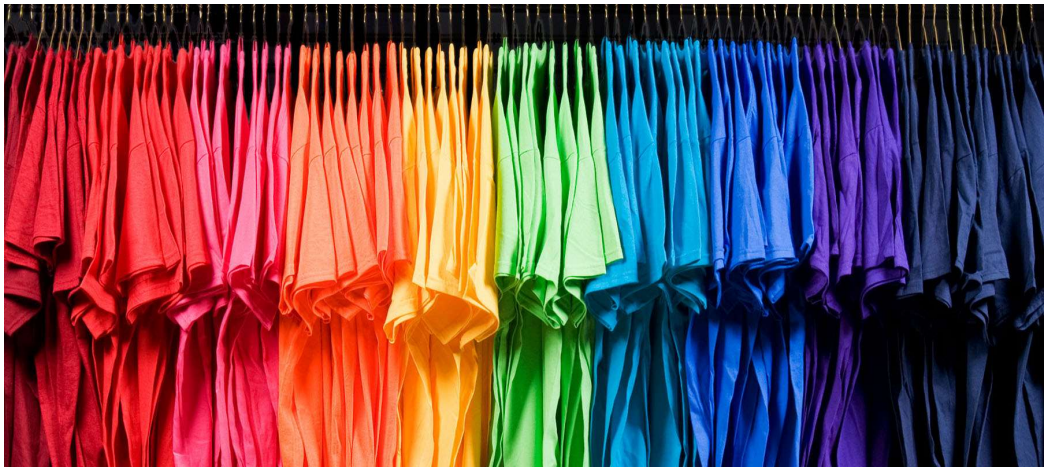
Mass production

- Garments are mass produced and so the ‘matching’ fibres could have originated from another matching garment, or any other source



….so what’s the point?

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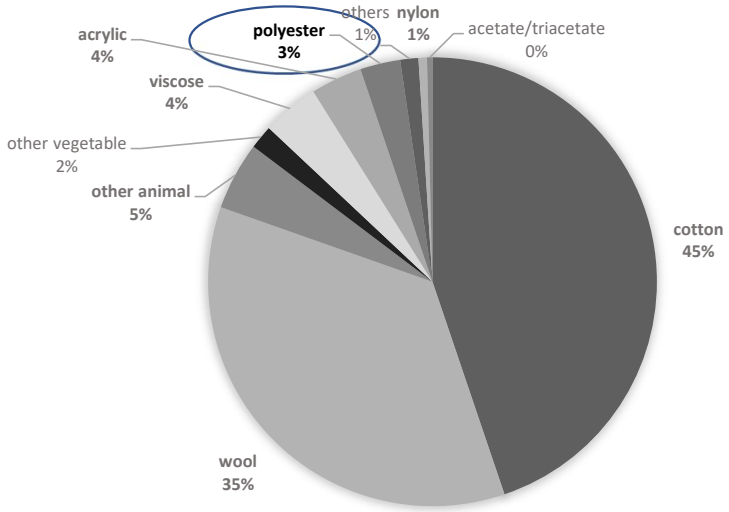
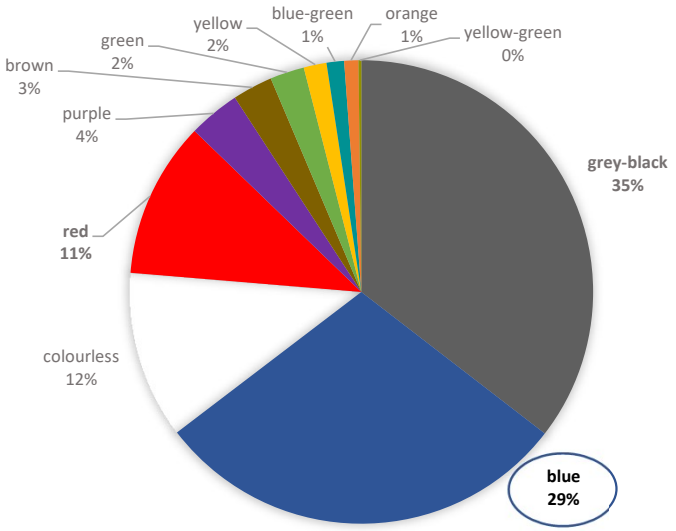
Fibre frequencies



Population (%) by fibre type



Population (%) by fibre colour

Blue polyesters are common?! Aren't they?

- 3% of fibres are polyester
- 29% of fibres are blue

So, blue polyester fibres equate to 0.87% of the population (i.e. 29/100*3)

..or 8 in every 1000 fibres

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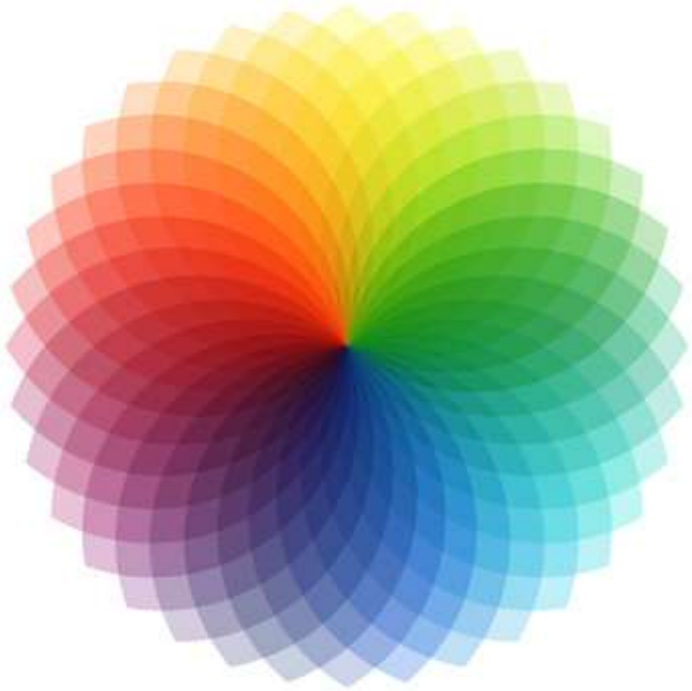
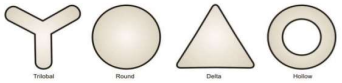
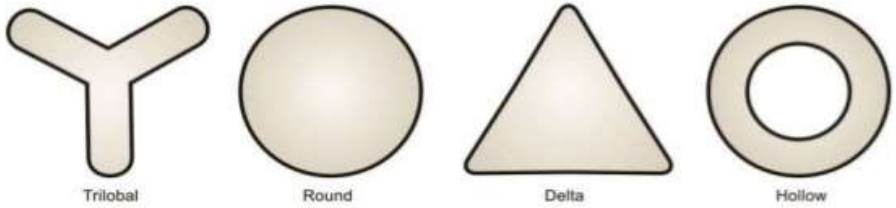
Roux and Margot, *The population of textile fibres on car seats*, Science & Justice (1997) 37(1): 25-30

But are blue polyesters all the same?







e.g. DuPont have over 70 different polyester fibres
>7000 fibre dyes in existence, which are mixed in countless different combinations

Therefore, the previous figure of 8 in 1000 is extremely conservative (and why relying on fibre frequency data only is misleading)

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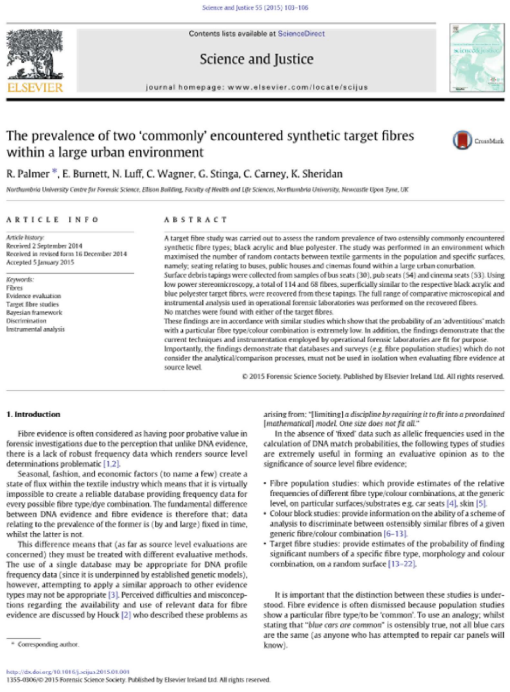
Grieve and Biermann, *The individuality of blue polyester fibers used to provide forensic evidence*, Forensic Science International (2003) 136: 121-122

What are the chances of a random match?

- Another way of looking at the issue, is to take a particular blue polyester fibre and fully characterise it.
- Take samples from random surfaces (garments, seats, tables etc) and search for blue polyester fibres that have exact same characteristics

–> TARGET FIBRE STUDIES



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The prevalence of two 'commonly' encountered synthetic target fibres within a large urban environment

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ABSTRACT

A target fibre study was carried out to assess the random prevalence of two ostensibly commonly encountered synthetic fibre types; black acrylic and blue polyester. The study was performed in an environment which maximised the number of random contacts between textile garments in the population and specific surfaces, namely; seating relating to buses, public houses and cinemas found within a large urban conurbation. Surface debris tapings were collected from samples of bus seats (30), pub seats (54) and cinema seats (53). Using low power stereomicroscopy, a total of 114 and 68 fibres, superficially similar to the respective black acrylic and blue polyester target fibres, were recovered from these tapings. The full range of comparative microscopical and instrumental analysis used in operational forensic laboratories was performed on the recovered fibres. No matches were found with either of the target fibres. These findings are in accordance with similar studies which show that the probability of an 'adventitious' match with a particular fibre type/colour combination is extremely low. In addition, the findings demonstrate that the current techniques and instrumentation employed by operational forensic laboratories are fit for purpose. Importantly, the findings demonstrate that databases and surveys (e.g. fibre population studies) which do not consider the analytical/comparison processes, must not be used in isolation when evaluating fibre evidence at source level.

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1. Introduction

Fibre evidence is often considered as having poor probative value in forensic investigations due to the perception that unlike DNA evidence, there is a lack of robust frequency data which renders source level determinations problematic [1,2].

Seasonal, fashion, and economic factors (to name a few) create a state of flux within the textile industry which means that it is virtually impossible to create a reliable database providing frequency data for every possible fibre type/dye combination. The fundamental difference between DNA evidence and fibre evidence is therefore that; data relating to the prevalence of the former is (by and large) fixed in time, whilst the latter is not.

This difference means that (as far as source level evaluations are concerned) they must be treated with different evaluative methods. The use of a single database may be appropriate for DNA profile frequency data (since it is underpinned by established genetic models), however, attempting to apply a similar approach to other evidence types may not be appropriate [3]. Perceived difficulties and misconceptions regarding the availability and use of relevant data for fibre evidence are discussed by Houck [2] who described these problems as arising from: "[limiting] *a discipline by requiring it to fit into a preordained [mathematical] model. One size does not fit all.*"

In the absence of 'fixed' data such as allelic frequencies used in the calculation of DNA match probabilities, the following types of studies are extremely useful in forming an evaluative opinion as to the significance of source level fibre evidence;

- Fibre population studies: which provide estimates of the relative frequencies of different fibre type/colour combinations, at the generic level, on particular surfaces/substrates e.g. car seats [4], skin [5].
- Colour block studies: provide information on the ability of a scheme of analysis to discriminate between ostensibly similar fibres of a given generic fibre/colour combination [6–13].
- Target fibre studies: provide estimates of the probability of finding significant numbers of a specific fibre type, morphology and colour combination, on a random surface [13–22].

It is important that the distinction between these studies is understood. Fibre evidence is often dismissed because population studies show a particular fibre type/to be 'common'. To use an analogy; whilst stating that "*blue cars are common*" is ostensibly true, not all blue cars are the same (as anyone who has attempted to repair car panels will know).

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Forensic Science International

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Inter-comparison of unrelated fiber evidence

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Received 10 December 2002; received in revised form 25 April 2003; accepted 6 May 2003

This paper is dedicated to the memory of Mike Grieve

Abstract

The foreign textile fibers recovered from one item of evidence from each of 20 unrelated crimes in three categories (bank robbery, kidnapping, and homicide) were cross-compared. The items of evidence were scraped to remove the trace evidence and a sample of the collected fibers was examined using a standard scheme of analysis. The fibers were examined with light microscopy (including polarized light microscopy), fluorescence microscopy, and microspectrophotometry. The fibers were divided into natural and manufactured groups and then categorized by color and generic (polymer) class. Cross-comparing all 2083 fibers resulted in 2,168,403 comparisons, after removing duplicate (same fiber) comparisons. Colorless and denim fibers were excluded from this study.

No two fibers were found to exhibit the same microscopic characteristics and analytical properties. Therefore, it is rare to find two unrelated items that have foreign fibers that are analytically indistinguishable. These results corroborate other population studies conducted in Europe and target fiber studies conducted both in the US and in Europe.

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Keywords: Trace evidence; Fibers; Significance

1. Introduction

The significance of trace evidence results is one of the most problematic topics in forensic science. Questions of proper populations, sampling, statistics, and interpretation schemes dot the literature and produce fervid discussions in court rooms, class rooms, laboratories, professional meetings, and various Internet chat rooms. Attempts to develop systems that characterize the significance of trace evidence have been explored but have yet to be universally embraced by the forensic scientific community. Until and unless a 'grand unified theory' of trace evidence interpretation is developed and accepted by the majority of the forensic science discipline, demonstrating significance by example is about the only method left to the trace analyst. To date, these examples have taken two forms: the population study and the target study.

Population studies survey a delimited locale and describe the demographics of a particular type of trace evidence sampled from it. Examples of such studies are the textile fibers found in head hair [1] or the population of textile fibers on car seats [2]. Target fiber studies are similar except that a specific trace evidence sample type is chosen and then items are searched for examples of that type that are analytically indistinguishable from the target material. A target fiber study using movie theatre and car seats [3] or the occurrence of a specific fiber type on a variety of clothing items [4] are examples of this type of research. The majority of both kinds of studies have been conducted in Europe, although some have occasionally been conducted in the US [5].

Population and target studies provide useful information to the trace evidence analyst. Target studies answer specific, often case-related, questions of transfer, persistence, and significance of evidence associated with a particular item, locale, or situation. Population studies provide feedback in the form of either confirming or altering an analyst's expectations of the number and kind of materials that may be transferred and that persist on an item or in a locale. Feedback is the key to these research-by-example investigations: without any information coming back to the analyst about

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doi:10.1016/S0379-0738(03)00195-6

Studies consistently show that coincidental matches are VERY UNLIKELY; exceptions when very low no's (<5) or very common fibre type

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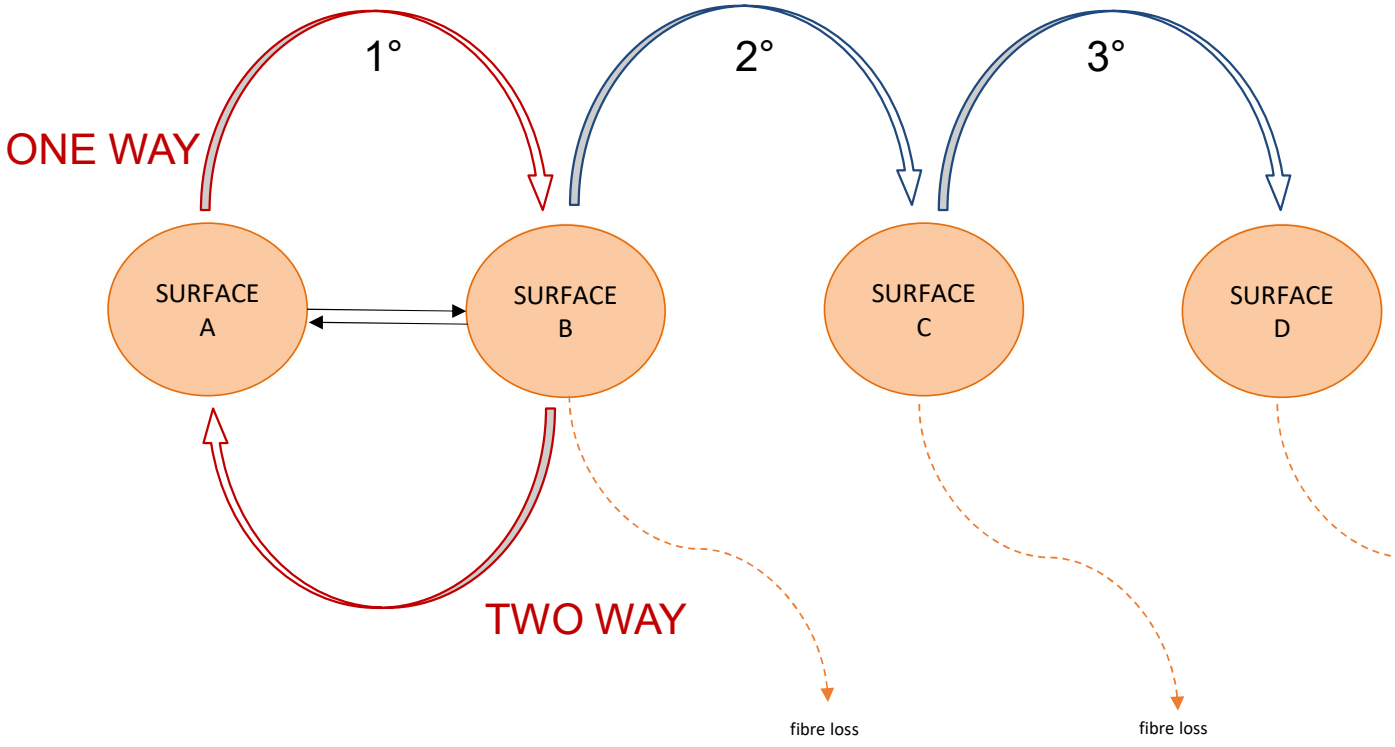
Fibre transfer



- **In addition to how likely it is that your matching fibres came from a particular source we can also consider fibre quantities and their distribution.**
- **This is where fibres can help with the 'how' and sometimes the 'when'**

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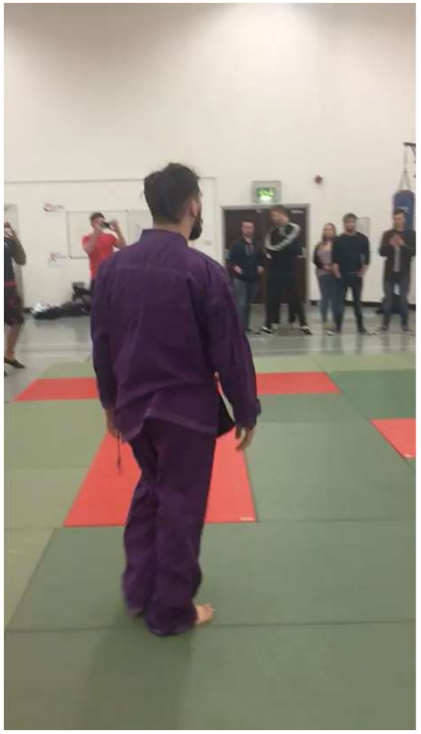
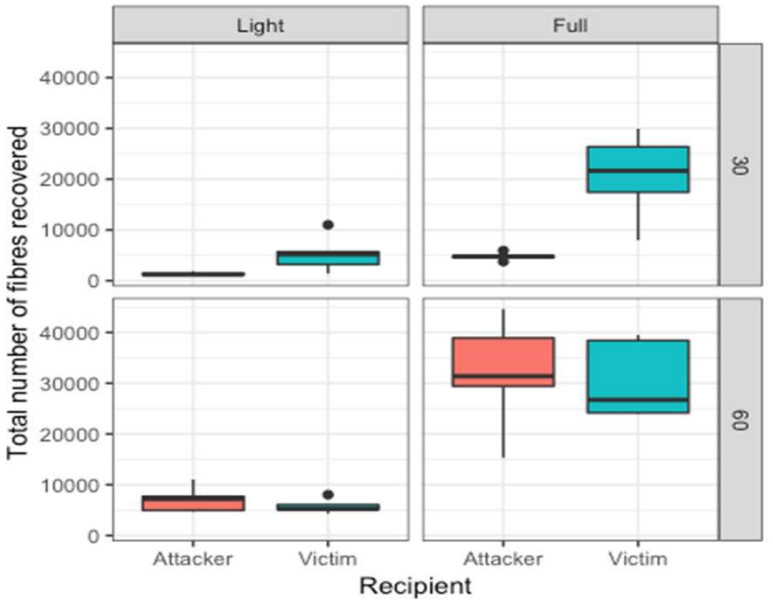
What kind of numbers are we talking?





- Time: 30 sec; 60 sec
- Intensity: low (light); high (full)
- Role: attacker; victim

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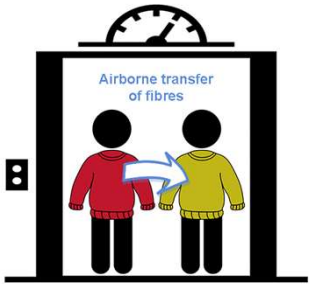
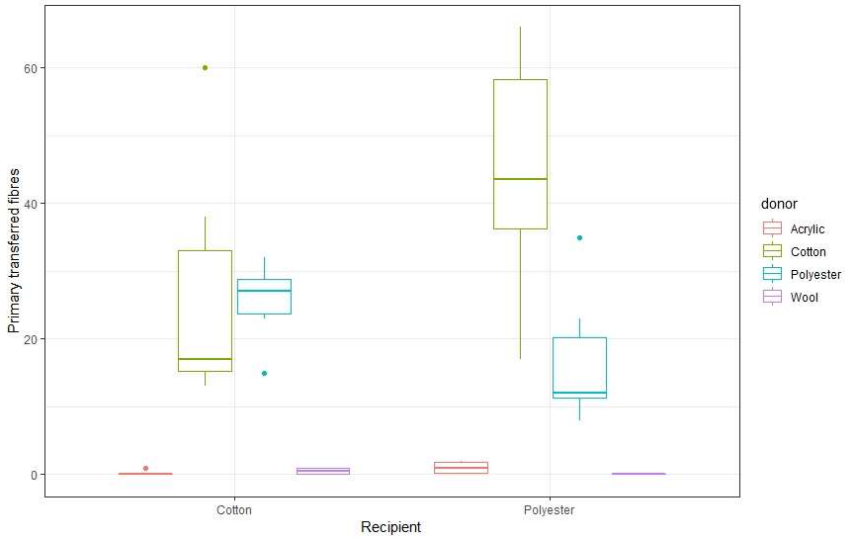
Sheridan et al, *in preparation*

Contactless transfer?

- Two people stood opposite each other in a lift (no contact) for 10 minutes
- Determined if fibres were transferred from one to the other

- Yes, but….
  - Space
- Fibre type/donor has greatest effect on number of transferred fibres





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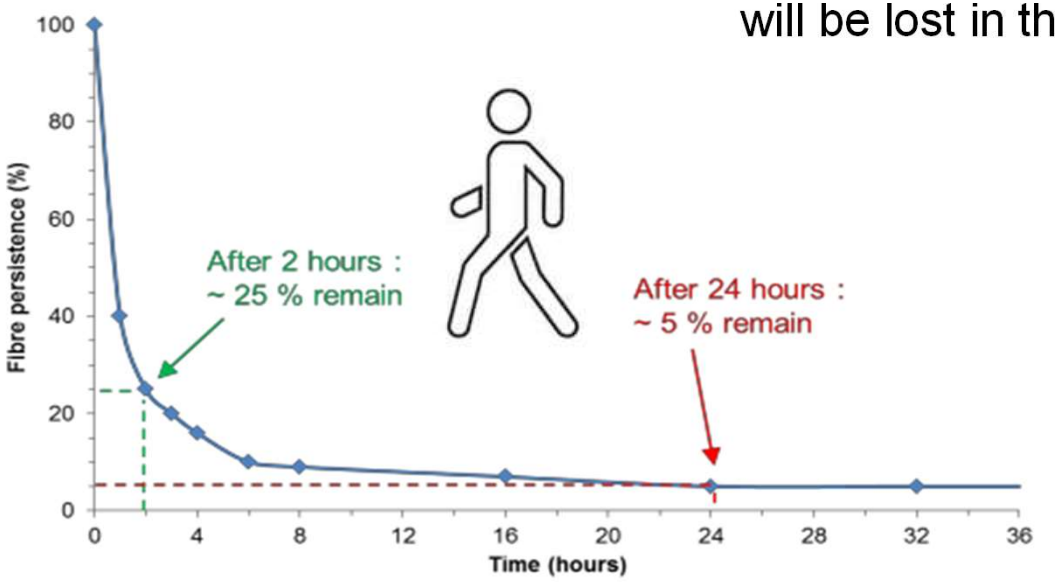
Sheridan et al, *A study on contactless airborne transfer of textile fibres between different garments in small compact semi-enclosed spaces*, For. Sci. Int. (2020), 315, 110432

Fibre persistence

In general, the majority of transferred fibres will be lost in the first few hours.



- Rate of loss dependent upon the **nature of the recipient item** and **post-contact activity**
- Beware of assumptions!

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Pounds & Smalldon, *Journal of the Forensic Science Society*,15(1), 1975, 29-37

Fibre persistence

Skin (living)

- lost after 24 hours post shower/bathing (Palmer 2009)
- can readily persist on hands (Hong 2014)

Bodies (deceased)

- up to 6 weeks (Krauss 2009), dependent on fibre type and length
- most lost after 2 days, but persist up to 12 (Palmer 2011)
- wind/rain accelerates loss
- depsite wind/rain fibres recovered from naked bodies of 3 women 2-7 days after deposition (Ipswich killings)

Submerged bodies

- victims Ipswich killings - 2-7 days despite heavy rainfall/wind

Garments in water

- standing water - little effect on persistence (Lepot 2015a)
- flowing water – greater loss, varys depending on fibre type, rate of flow etc (Lepot, 2015b)

Hair

- masks!
- persist up to 6 days if hair not washed, 3 if washed
- shorter hair retain fibres for longer
- have persisted for weeks when body submerged in water (Ipswich killings)

Footwear

- lost v quickly on soles (Roux 1999, Sheridan, unpublished)
- persist longer on uppers, particularly laces (up to 3 days) (Sheridan, unpublished)

Post laundering

- they do persist!
- usually in small numbers (<10%) (Szewcoa and Robertson, 2011)

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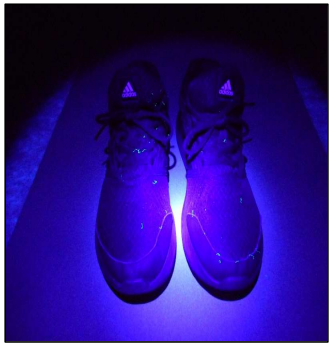
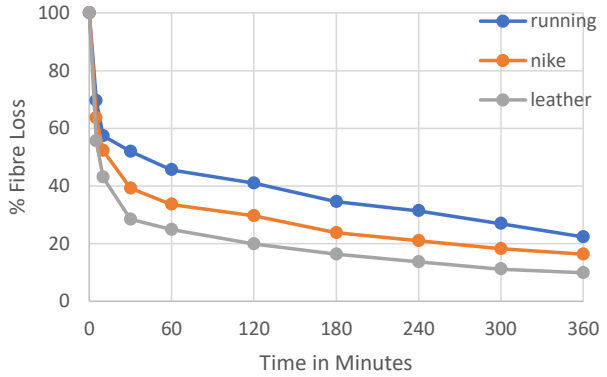
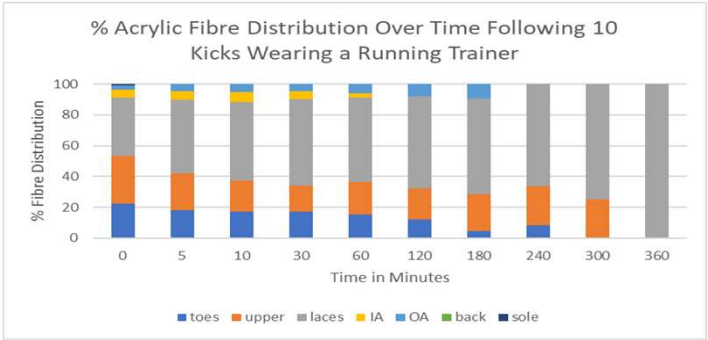
Fibre persistence – Footwear



- Fibres transferred via kicking
- Variables – shoe type, fibre type, number of kicks, kicks v stamps



- Shoe type and fibre type important
- Fibres generally lost from soles v quickly, but persist longer on uppers – especially laces (up to 3 days)
- Consider esp. if fabric trainers



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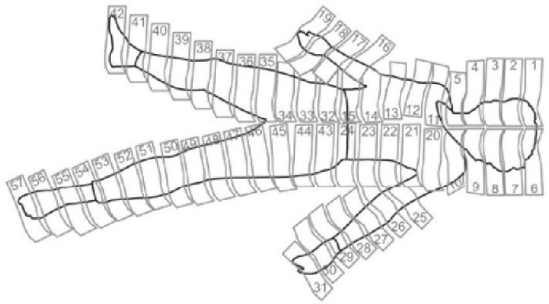
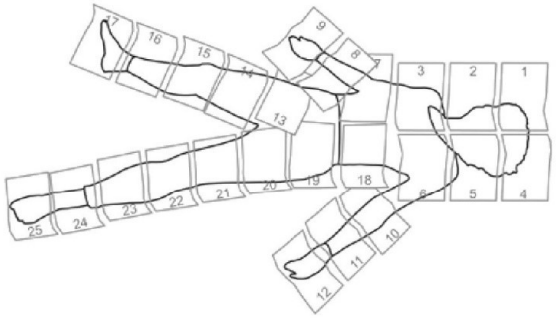
Sheridan KJ. et al, *in preparation*

Fibre distribution

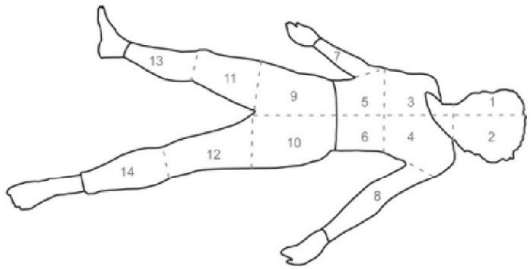
- Violent murder involving strong physical contact
- Crime scene has been well preserved
- Not a deposition site, nor should the body have been moved
- Best conditions - dry



1:1 taping



semi 1:1 taping



zonal taping

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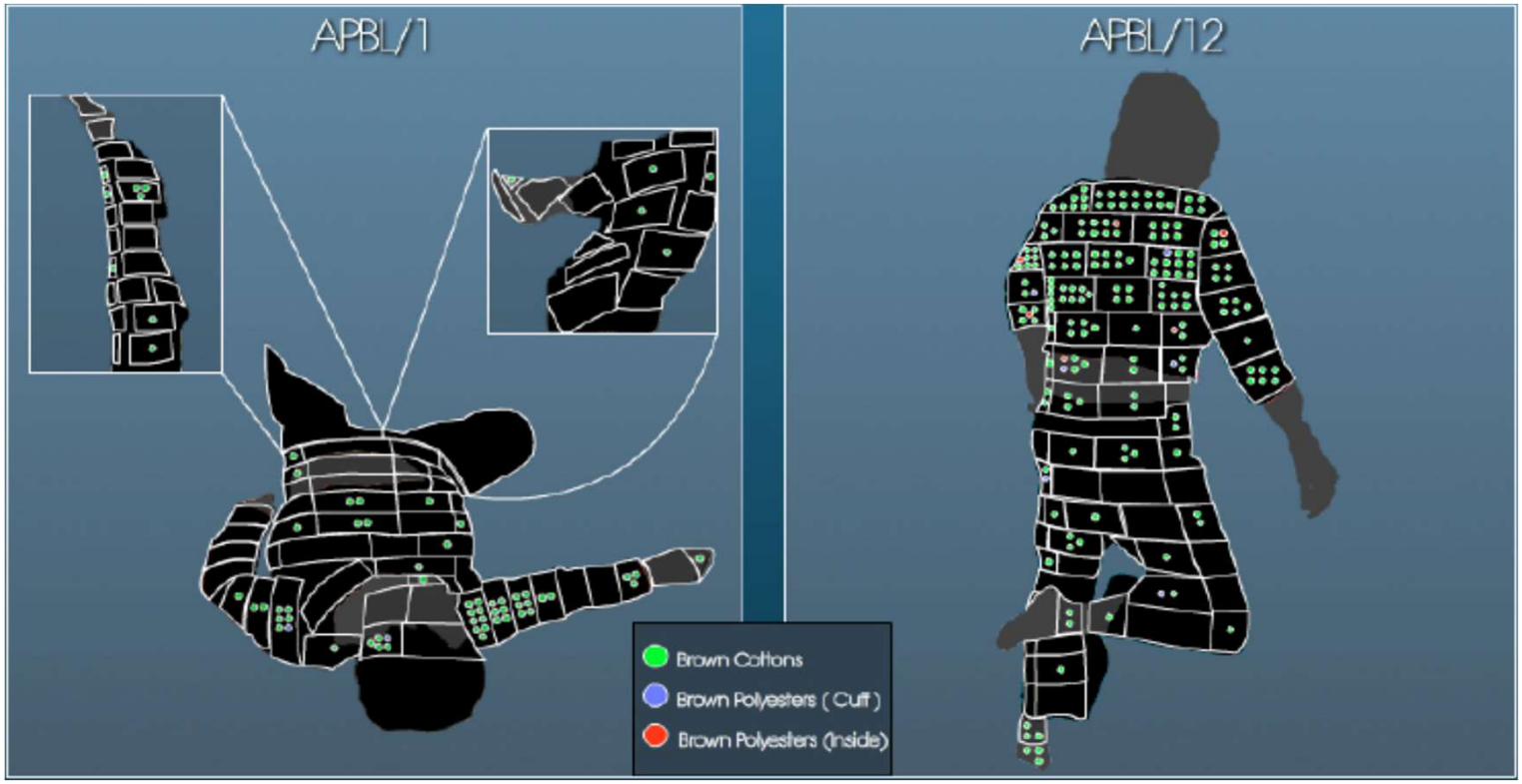
Fibre distribution – case example



The ‘how’ becomes fairly obvious!

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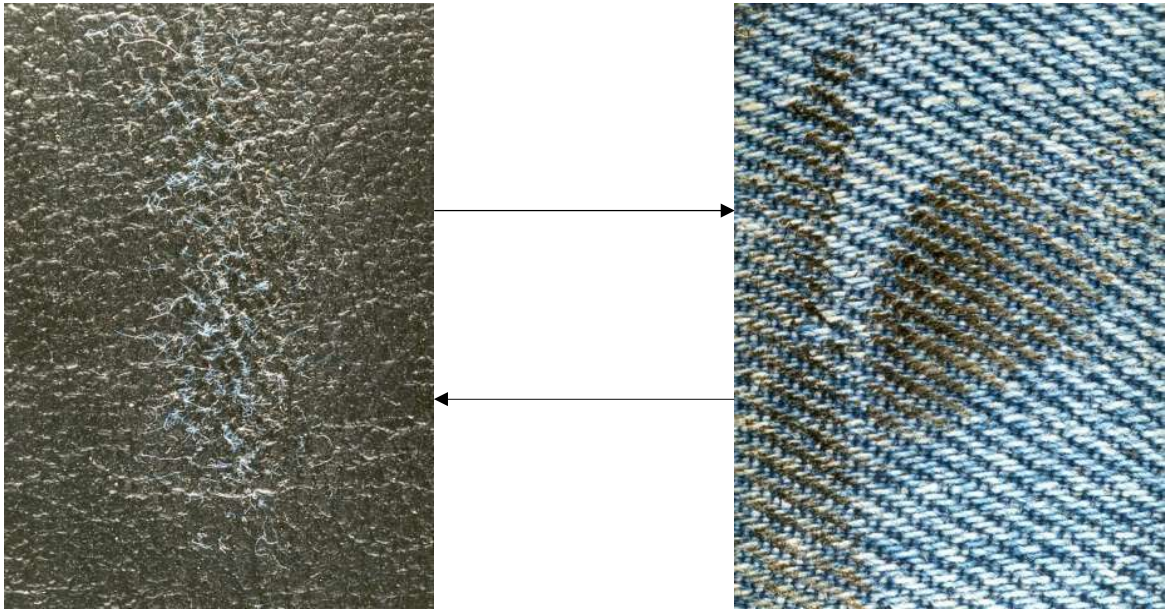
Fibre plastic fusions (FPF's)



- Usually fatal car accidents
- Fused/fixed fibres to plastic surfaces of car interiors
- Can place people in specific seats
- Only occurs during high speed impact
- Very compelling evidence

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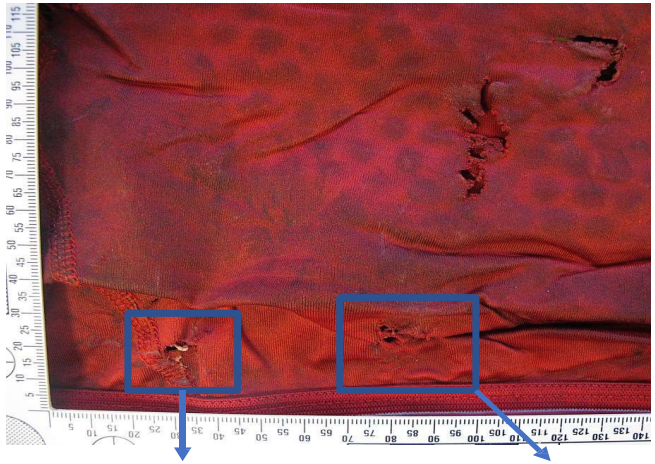
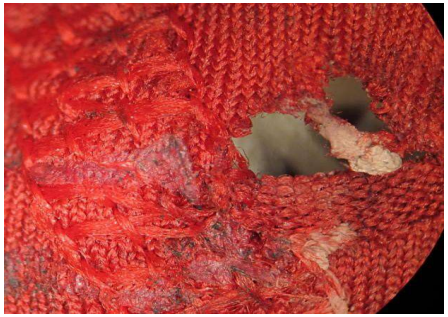
Fibre plastic fusions (FPF's) – case example



DAMAGED AREAS AMONGST A BLACK CIRCULAR TRANSFER PATTERN

CYCLIST'S DAMAGED RED TOP



ABRASION HOLES & MOLTEN MATERIAL (SOME LAYERS HAVE ALSO FUSED TOGETHER)

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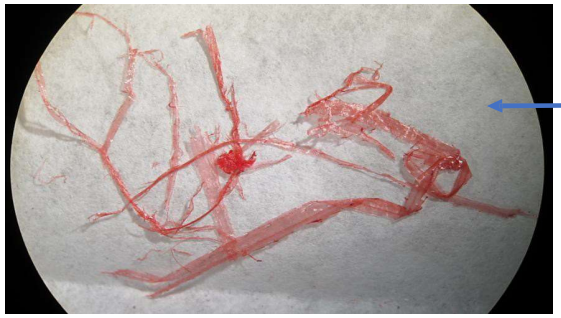
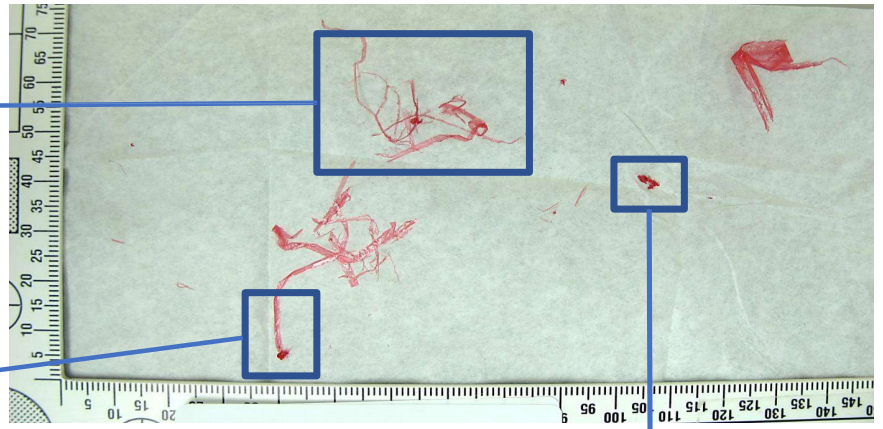
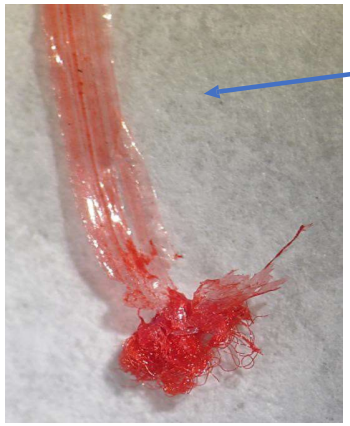
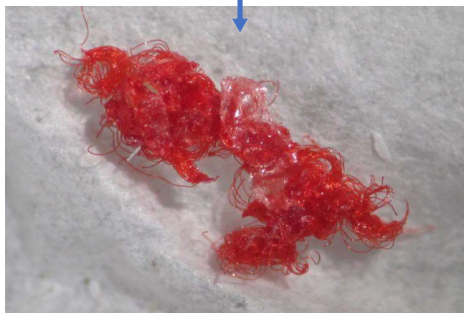
Fibre plastic fusions (FPF's) – case example









"RED TRANSFER" – TOP VS VAN BONNET

- FIBRE PILLS (WITH MOLTEN AREAS)
- ASSOCIATED MOLTEN FIBRE FILM
- ***NYLON FIBRES MATCH THE RED JACKET***

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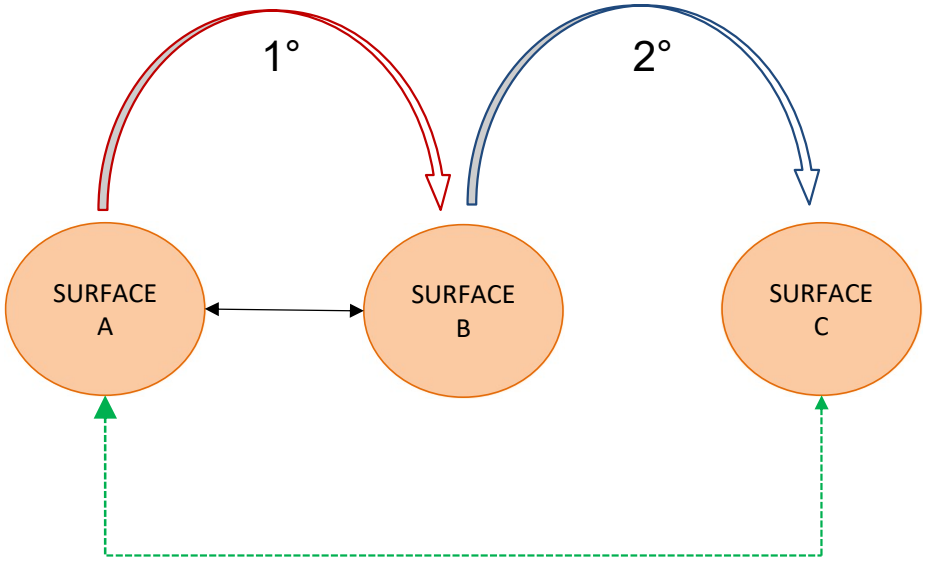
Absence of a source?



- Take advantage of fibre transfer processes
- Link surface C with surface A
  - to establish an indirect link
  - to provide a further line of enquiry to identify Surface A (aka the source)

→ look for fibre 'populations' or 'collectives'
i.e. groups of fibres that are from a source other than they one you've collected them from

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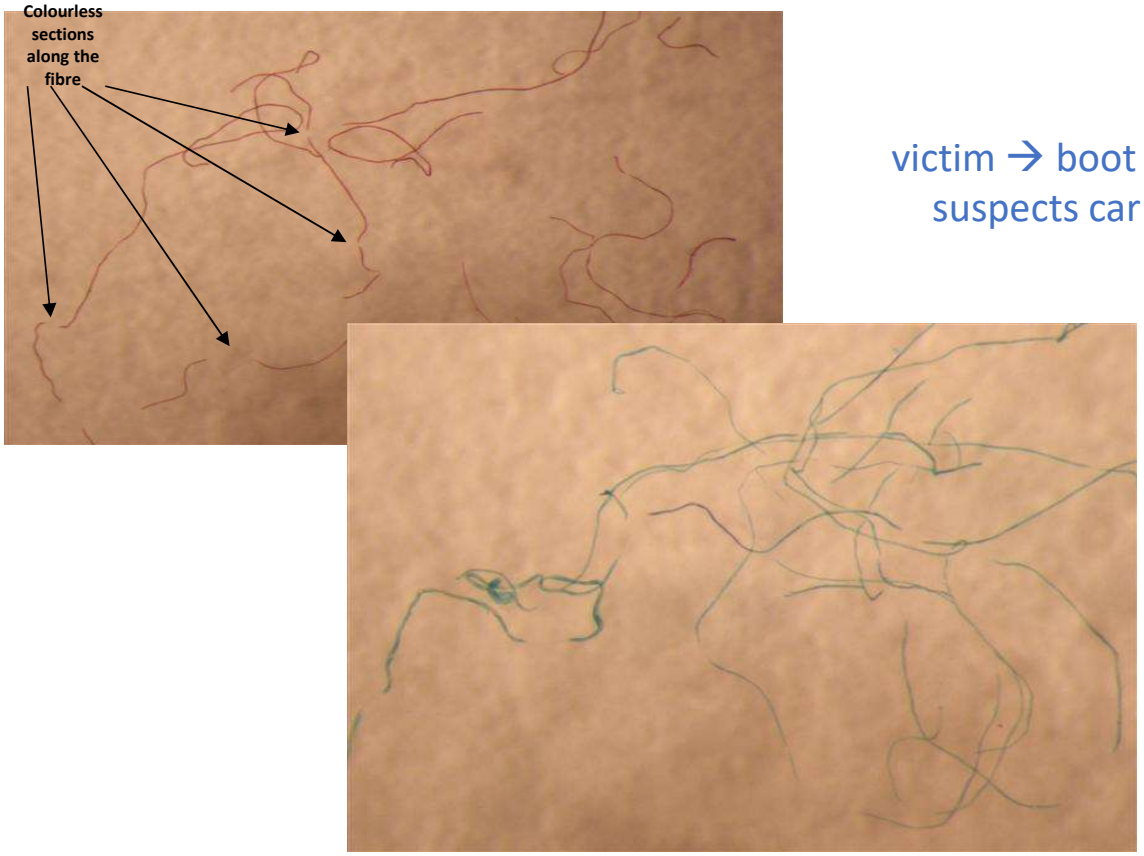
Fibre intelligence – case example



victim → boot of suspects car

- In **regular** and/or **recent** contact with the source
- Source item is multi-coloured with a propensity towards dark red/purple, along with greens and blues
- It is made of cotton and sheds very well

Source – bedding

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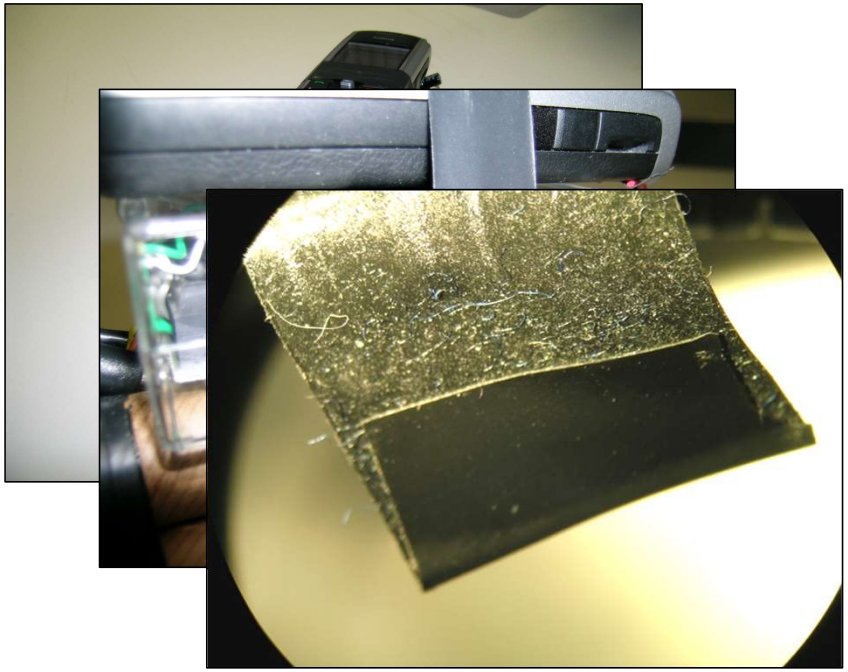
Fibre intelligence



Examples of fibre types or combinations used frequently in specific products:

- Acrylic – knitted garments (those usually described as ‘wool’)
- Microfibres (polyester) - sports clothing/fake satin (‘peach skin’ texture)
- Flock – fake suede/velvet
- Modacrylic – synthetic fur/wigs
- Polypropylene/acrylic/nylon/wool – carpets/rugs

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Fibre intelligence – what could the source be?

Examples of fibre types or combinations used frequently in specific products:

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….plus colour, their shape, potential mixtures

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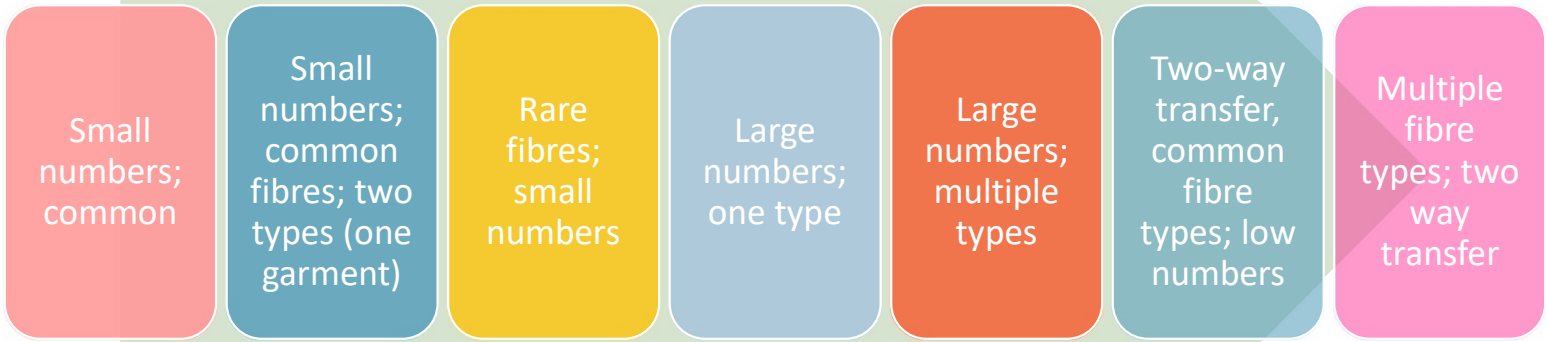
Assessing the significance of fibre evidence



NB The specific circumstances of the case, the pros and def claims must be considered within any evaluation

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Summary

- Fibres are everywhere and so can be used in volume, serious and major crime
- Highly individual – finding them means something!
- Intelligence – identify potential sources, link unconnected cases, provide an investigative steer
- Transfer & persistence studies mean in addition to common/rarity and an evidential link to the source they can also **be used to assess the alleged activity**
- Not always time consuming or expensive – staged approach
- DNA often provides the ‘who’, fibre evidence can assist with ‘how’ and ‘when’
- Only get one opportunity

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References (persistence)

Palmer R. and Burch H., *The population, transfer and persistence of fibres on the skin of living subjects, Sci & Justice (2009) 49: 249-264*
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Ashcroft CM., Evans S. and Tebbit IR., *The persistence of fibres in head hair*, J. of the Forensic Science Society, (1988) 28: 289-293
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Thank you for your time!

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