THE CHANGING FACE OF FIBRE EXAMINATIONS IN FORENSIC SCIENCE

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ABSTRACT: Most forensic scientists are well aware of the traditional situations in which fibres may be used to provide evidence in criminal cases. Increased emphasis on DNA analysis has meant that fibres examiners must consider new ways in which their service to the criminal justice system can be improved and extended. These changes can be divided into four areas-finding new applications where fibre or textile evidence may be useful making improvements in case management and analytical procedures; accumulating new information on fibre frequencies to facilitate the assessment of evidential value of case findings and striving to increase fibres intelligence work. These endeavours have been supported by increasing international co-operation and the introduction of Best Practice Guidelines.

KEY WORDS: Fibres examination; Development.

Z Zagadnień Nauk Sądowych, z. L, 2002, 155–165
Received 6 September 2002; accepted 17 September 2002

Many forensic scientists will be familiar with the more traditional uses of transferred fibres to provide evidence in criminal cases. Some examples are given here: the most frequent use is to provide evidence of possible contact between persons in crimes like murder, rape and sexual assault or aggravated assault. The next is in demonstrating contact between persons and other textile surfaces e.g. car seats or furnishings and usually concerns cases of armed robbery or terrorism. Fibres may be recovered from a point of illegal entry, or from weapons, knives, firearms, which may provide links to a suspect or victim. They can also be used to corroborate hit and run accidents, or to help in providing proof of having driven a stolen vehicle or having been driving whilst drunk or uninsured.

Increasing emphasis on use of DNA analysis – that is to say allocation of personnel, space and funding – has led to a real or perceived reduction in the importance of trace evidence, because of disadvantages associated with it's use. For example:

- case work is often very slow – especially for fibres, where the biggest problem lies in the recovery of potentially matching types rather than in the actual analysis and comparison;
- the results may be inconclusive;

– the source is usually not a unique item;
– fibres cannot be said to originate from one particular example of a mass produced textile.

In order to keep the subject area viable, fibre analysts have had to consider how they can make their work more effective. At the BKA our initial step was to change the approach to working cases. The first requirement was to improve the exchange of information with the case submitter so that the laboratory analysis can be concentrated on areas likely to provide the most helpful information. Laboratory requests for examination need to be more precisely formulated by the submitter. After discussion it is probable that agreement can then be reached on which items should be examined first, reducing the time before some information that may be of value to the investigation becomes available. When first stage results are complete these can be passed on to the "customer" and their value explained. Additional possibilities can be discussed and, if deemed necessary, more work can be carried out by the laboratory before a final report is issued.

In addition to creating better customer relations and taking steps to speed up examinations, the analytical results must be presented to the Court in such a way that their meaning is more comprehensible. For fibres evidence, this can best be done by referring to simple numerical examples which are easily understood. The figures which can be used in these examples have to be gleaned from increased research on fibre frequencies.

At the BKA, the underlying philosophy in fibres research during recent years has been to emphasize the individuality of fibres within common groups, to get away from the lay conception that all blue polyesters, red acrylics, green cottons etc. are, by definition, identical, and so widely used among textiles that they are effectively evidentially worthless.

Many fibres research projects initiated during the past 10–15 years have taken the form of collecting data on the frequency of occurence of morphological features and polymer sub-types and studies on "Blocks of Colour" in which spectral frequency within one generic type colour combination is examined. Naturally the analytical methods used have to be as discriminating as possible, as the ultimate aim of all trace evidence analysis is to strive for sample individualisation.

In addition, fibre frequency figures have been obtained from several population and target fibre studies. Unfortunately, although the results are of great value in evidence interpretation, this type of research is very labour intensive, however inter laboratory cooperation coordinated through the European Fibres Group has proved to be an effective way of reducing the work load.

An alternative way of collecting fibre frequency data is exemplified by the BKA Catalogue Data Base (CDB) which records information from mail order

catalogues. The CDB contains about 120 000 records but work has had to be suspended due to lack of resources. The CDB can be used to provide information on:

- the frequency of occurrence of different generic types of fibres in the general fibre population;
- the frequency of specific types/colours of fibres in over 90 types of garments;
- the frequency of fibre types/colours in a random population of garments.

The data can be used in conjunction with data about morphological characteristics from the Forensic Science Service in England. With the help of the combined data it is possible for example, to show that the chances of finding a particular garment of a certain colour containing a certain fibre type, among a population of random garments, may be as low as 1 in several hundred thousand. Subsequent studies have begun to look at the possible effects of geographic variation. The author's philosophy about the use of this type of data in case work interpretation is that it is perfectly acceptable provided any limitations are made completely clear.

In trying to offer an improved service to the criminal justice sytem in the area of fibre examinations it becomes obvious that managerial, analytical and interpretational aspects are closely linked. Much research and development work may be needed before analytical improvements can be successfully introduced into regular case work, but these may then eventually affect case management. Likewise, continuing research is necessary to provide data leading to better assessment of evidential value, but because of casework constraints, this time is often sadly lacking.

SPEEDING UP ANALYSIS

On the analytical front, the development which has made the greatest impact in fibre examination in recent years has been the introduction of the diodearray spectrophotometer for examining and comparing fibre colour. Because these new instruments record across the entire spectral range simultaneously, measurement only takes about 1 second, and thus it is possible to screen large numbers of suspect fibres for collectives very rapidly. A collective is a group of fibres of a particular generic type sharing the same colour (spectral pattern) and the same morphology.

The direct result of this at the BKA has been to incorporate visible range diodearray microspectrophotometers into work stations, where optical properties of the fibres can be observed under brightfield, polarised and fluorescence illumination and the colour spectra recorded, using only one micro-

scope. In addition these stations allow the possibility for photo documentation.

A further consequence was then the development of an on-line case protocol system, the information being input directly at the work station. All information concerning case analysis is networked to any one of a number of terminals located throughout the fibre section. It is not possible here to describe the protocol in detail, but I can provide an insight into it.

The title page is where all administrative details of the case are entered, and where the links are found which lead to the pages concerned with the fiber analysis and evaluation. Special forms are also included for recording notes on textile construction and damage if required.

All details of control and recovered fibres can be entered using drop-down menus – for example fibre type, delusterant, colour, fluoresence, cross section, melting point, optical properties etc. Additional information can also be added if desired.

At a later stage, by using a search routine it is possible to sort the recovered fibres into groups showing the same characteristics (for example blue, delustred, peanut shaped acrylic fibres that fluoresce purple, yellow and orange under different filter combinations). At this stage the spectra have not been taken into account.

Finally, spectra recorded from potential matches between control and recovered fibres can also be stored and compared in the networked system. The software allows a choice of criteria which can be used as search parameters. It is possible to create spectral libraries and to search them for examples of a particular spectrum. For example, the hits are listed in a window on the right of the screen, with the best fit to the spectral match being sought being at the top. The correlations coefficient is shown in a second column. A value of 1 would represent an exact match. As the values fall, the degree of coincidence with the desired spectrum becomes less and less.

The advantages of this system can be summarised:

- all workers in the section can quickly access the same data;
- it is possible to rapidly store and recover information on very large numbers of recovered fibres in extensive cases;
- it offers the possibility of recognising similar fibres recovered in connection with different serial offences;
- as a by-product it allows the simultaneous establishment of data banks e.g. on morphological characters, without additional work;
- it facilitates Quality Control procedures.

FIBRE RECOVERY

Another recent development in case work concerns retrieval of fibre traces. It is generally known that the most widely practiced method of recovering transferred fibres is the use of adhesive tape. The use of so called "1:1 serial taping", where the area of one piece of tape represents exactly the same area on the object being taped, was pioneered in Germany. It has the advantage that when dealing with a corpse, it is possible to show that any transferred fibres found have been recovered from a very specific location. If these fibres can be shown not to originate from the victim or anything in his/her environment then there is a strong possibility that they were deposited by the suspect.

Such a finding may have two advantages:

– it may provide an "investigative lead" which can narrow the choice of suspects;
– the pattern of fibre distribution may help to reconstruct events during the crime e.g strangling, attack from the rear, or kneeling over the victim.

However, because so many tape lifts are created, their evaluation becomes something of a logistical problem. In addition, for the theory to work properly, a number of conditions must be met, and even an experienced evaluator must take care to avoid providing information leading in in the wrong direction. It has been suggested that a compromise in taping may provide the best answer, where the body area is still subdivided into small areas, but the total number of tapings would be limited to about 34. This would speed up the complete process considerably, while still providing more detailed information than is available with regular taping.

Most of you probably think that the work of a Fibre Section is solely concerned with examination of transferred fibres. Examination of textiles, threads, ropes, string, laces, wicks and textile tapes may also be involved – indeed, any textile product. Very often information about the construction, finishing and possible origin of an item is requested. Such examinations require extensive knowledge of textile finishing and production processes, but can lead to a wider range of applications for fibre analysis.

EXAMPLES OF OTHER APPLICATIONS OF FIBRES EXAMINATION

Some case examples are provided to illustrate a few of the more unconventional ways in which textile/fibre evidence may be used to aid the judicial process – some you may be aware of, others may be new to you.

Examination of textiles can often be helpful in reconstructing events that have occurred during a crime, the first two cases provide examples of this.

The first example, a case involving the explosion of a handgranade in a VW bus, provided a testing challenge on the examination of damage and the morhological effects resulting from it.

The VW van failed to start, the driver was tinkering with the motor at the rear of the vehicle and asked his wife to activate the starter. Due to the subsequent explosion the woman in the passenger seat lost her life. The question was whether she was the victim of an attack intended to kill her husband, who was a (former) Yugoslavian arms dealer, or whether he had placed the grenade in the bus in an attempt to kill her – the issue was whether it was possible to determine the exact positioning of the grenade at the moment of explosion.

The rest of the driver's and passengers' seats were submitted as were the remains of a wool blanket. By careful unravelling and examination of the damage to the driver's seat and it could clearly be seen from the pattern of cuts and tears in the seat back that the grenade fragments had originated from the centre of the explosion which lay to the left of the middle of the seat cushion.

Extensive examination of damage to the items available with projections of flight path taken by the exploding fragments, together with examination of the black powder residues enabled us to conclude that the grenade was placed above the back of the seat cushion, covered by the blanket. A test explosion was carried out by our explosives examiners using comparable parts and the same type of hand grenade, which resulted in an identical damage pattern being produced. The grenade was probably triggered by the women leaning over and supporting herself on the driver's seat, thus dislodging the grenade pin as she turned the ignition key. This theory was supported by her injury pattern.

The next case involves an accident in which two young men were standing on top of a railway wagon (they were grafitti sprayers) and one of them came too close to the electric cables, receiving a shock which severely injured him. We received clothing from both persons and were asked to try to reconstruct what had happened. It was postulated that the injured man had been abandoned by his colleague. His clothing was just a crumpled and badly damaged mess.

The injured mans clothes – his sweatshirt and polyester trousers, which were almost totally melted by the heat and those of his colleague could be painstakingingly reconstructed and fitted together with the aid of tailor's dummies. It appeared from our findings that his colleague was standing with his back to him (and may not have realised the extent of his friends injuries) as the back of his jeans were decolourized due to the heat and were

covered in molten blobs of polyester which had apparently sprayed through the air during the destruction of the injured mans jogging pants. The back of the vest of the second man, not only showed discolouration and some blobs of molten polyester but also charred cotton fragments could be recovered and identified as coming from the sweat shirt of the injured man.

If recovered from a crime scene or body in large numbers, transferred fibres can often be used for intelligence work, particularly if they are of an unusual colour or variety, have limited production (like microfibres) or have unusual and specific uses (like flock fibres). The success of fibres intelligence work is heavily dependent on having a network of contacts within the textile industry.

Recently, a pair of shorts were the only clothing found on the mutilated body of a child found floating in the River Thames in London. In order to try to help identify the victim the BKA was asked whether we could confirm that the shorts had been sold in Germany (they bore a label marked "Kids Company"/"100% Baumwolle"). We contacted the Deutsche Patent and Markenamt in Berlin who found the Trade name in their register. The chain who had sold the item had a branch in Frankfurt who were able to provide detailed information about how many of these items of this particular colour had been sold during a specific time period.

Two other case examples involve determination of product individuality. In the first, a T-shirt provided the wick for an incendiary device used by animal rights activists to firebomb a fur farm. This one particular device failed to ignite. The T-shirt was submitted to see if it would yield useful information concerning it's origin.

Thinking in terms of a manufacturers enquiry, we noticed that the shirt bore a very faint print design. Using image enhancement technology it was possible to reveal the slogan "Don't be shy, come a little closer" and the image of a man with his head buried in the breasts of a long haired girl wearing a mini-shirt. By taking measurements of the T-shirt and using tailoring tables it was possible to determine the approximate size of the garment.

In addition the shirt bore a laundry tag on which it was possible to decipher the name of the owner. In addition the letters Do were embroidered in the neck of the shirt. The offence took place near Berlin. You can imagine our delight as an internet search of the local telephone directory revealed one of the entrants living in the vicinity of the crime scene to have the same surname, with christian name "Doreen".

In another case the examination of garment labels was helpful in establishing time of death. Late in 2001 a female body was recovered from a marshy area near the Rhein river. The issue was whether she had been dumped there during 1999 or 2000. The deceased was wearing the remains of a pair of underpants with a brand name "Linda Clifford". This brand is

sold by the German chain store Aldi, who told us that they are manufactured by the German company Huber Masche in Asia.

Contact with this company enable us to obtain specimen labels from the ranges of this product that were marketed in the two respective years, but examples with the correct garment size were not available. By scanning the images of the case label (and the washing instruction symbols on the reverse side) and overlaying them with the images of the labels sent to us, it was possible to see that those for the year 1999 did not match in positioning at all, but that an almost exact fit was obtained for the 2000 label. The slight difference in the positioning of the size could be accounted for as due during label printing there will be variation in the positioning for different sizes, and we had not been able to obtain a label from the correct size. Nevertheless it was possible to say with certainty that the pants she was wearing had not been produced in 1999.

A final example illustrates that the possibilities connected with textile examination are limitless – you never know what you may be called upon to examine. Again the theme is product individuality. A small boy disappeared from a childrens home and was later found murdered. He was known to have a "Pikachu" cuddly toy, but it was alleged by witnesses that he had given it away to his little girlfriend as a present. However on the evening before he disappeared he was photographed by his teacher with such a Pikachu toy. The question was, was this his own original one, or was it another one that might have been given to him by a suspect as an enticement. To decide whether it was possible to individualise these toys a number of them were purchased from a local store much to the amusement of the sales person.

Variations could be seen in the shape of the head, the black tips of the ears and the angle of the ears, the arms, the positioning of the eyes and red cheek spots, the angle of the mouth and the length and intensity of the seams and folds. We were able to determine that the characters of the one in the photo corresponded exactly with those of his own toy.

A new type of case, being encountered with increasing frequency, involves the comparison of video surveillance pictures – with textiles recovered from a suspect to see whether a match can be established. The most common example of this type of case is bank robberies. All possible characteristics of the clothing, including masks, and shoes will be taken into account during the comparison e.g. the cut and hang of the clothing, folds, seams and stitching. If the resolution of the photo is good enough it may be possible to recognise specifically characteristic seams or accessories, logos or patterns and the type of shoes.

I mentioned at the beginning that fibres are often connected with cars. In addition to the possibility of transfer of fibres, paint and glass to the outside of the vehicle during a hit and run accident, another possibility is the exami-

nation of fibre-plastic fusions formed inside the vehicle. The frictional heat generated by abrupt contact between clothing and the vehicle interior, as the result of (forward) motion of the occupants during a collision, will cause fibre fragments to become embedded in plastic parts of the vehicle trim and plastic smears to be transferred to clothing. Examination of these traces often allows reconstruction of the seating plan within the vehicle and may be of value in establishing who was the driver.

In future it may become worthwhile that such cases are examined in a regional centre where special expertise is available. The Forensic Science Service in the UK have used fibres very successfully to deal with volume crime (car theft) by issuing local police forces with a very simple car seat fibre taping kit and pre-printed information form. These are returned to the laboratory and can be examined very rapidly for fibres likely to have originated from a suspects clothing, providing the police with a quick and satisfactory outcome in approx. 70% of submissions. Although not a new idea in itself, this is an innovative way of putting fibre evidence to good use.

To recap, the following represent some examples of how textile fibres can play a useful role in a wider variety of cases than the conventional ones which spring to mind:

– crime reconstruction by 1:1 taping;
– from damage 1. physical, 2. thermal;
– fibre/textile sourcing (fibres "intelligence");
– combatting volume crime (e.g. car theft);
– automobile accidents – plastic/fibre fusions; fabric imprssions;
– identification of video images;
– contradiction of false allegations;
– fraud – evasion of taxes on "designer-label" textiles.

The old adage that the only limit to fibre examinations is the limitations of the investigators' imagination has never been more apt. Of course at the same time fibre experts must be careful not to exceed their area of competence. Forensic scientists need to consider how fibres can often be used in conjunction with other types of evidence.

A noticeable by product of the close cooperation within the European Fibres Group and connections with the SWGMAT group in America has been the recent increase in requests for assistance in case work. During the past year the BKA fibres section has assisted both the Forensic Science Service and Forensic Alliance in Great Britain, the National Forensic Institutes in Rijswjk, and Oslo, and the Guardia Civil in Spain. In addition we have provided case relevant information to the States of California, Wisconsin, Texas and Virginia and been of assistance to ESR in Auckland, New Zealand.

I see a continuation of this situation as highly desirable and if the increasing possiblities for exchange visits between personnel employed in various laboratory systems can be realised, then at least in the fibres area, international cooperation will have proved truly beneficial.

The author apologises that for logistical reasons it is not possible to supply the illustrations which originally accompanied this presentation and acknowledges the help of everyone in KT 33 for the work that has made the presentation possible.

Suggestions for further reading:

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