

**The Significance of Fibre Transfer and Persistence –
A Case Study**

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Abstract

In April, 1995 the body of a young woman was found in a suburb of Sydney, Australia. The body was fully clothed and bore a number of injuries to the neck, face and fingers. There were no signs of sexual assault and she appeared to have been strangled.

The only physical evidence located at the scene was a number of dark, coarse fibres adhering to the soles of her shoes. These fibres consisted of 9 grey polypropylene, 12 blue polypropylene and 50 black polyester. The source of these fibres was found to be the carpet of a 1991 Honda CRX that belonged to the suspect. Almost all other possible sources of these fibres were eliminated.

At trial the source of the fibres was not disputed by the defence. Instead the issue became how long these fibres had persisted on the shoe soles. A number of experiments were conducted to investigate the factors influencing the transfer and persistence of carpet fibres to shoe soles and the results of these experiments became a critically important part of the prosecution.

Scene

On the 2 April, 1995 the body of a young woman was found at the bottom of an embankment at the side of a road. She was wearing a light blue long sleeve denim shirt, a dark blue short sleeve T-shirt, beige jeans, black leather belt, beige socks and a pair of beige and brown “Lipstick brand” lace up boots. There was a circular shaped laceration with jagged edges to her chin and throat and a small discolouration to the left side of her neck.



Figure 1: View looking north and the general area of the deceased

The victim was identified as a young woman who had been reported missing since the 29th March 1995. The pathologist in attendance was of the opinion that the victim had been strangled, suggested by the presence of bruising and abrasions on the left side of her neck and areas of haemorrhage within the eyes. He concluded that death occurred between the 29th March and the 2nd April, but most likely the 29th or 30th March 1995.

Questioned Fibres

At the scene, the crime scene examiner noticed that there were fibres on the soles of the boots the deceased was wearing. These fibres appeared to be adhering to the scuff marks on the soles and most of them were protruding from the surface. A total of 5 grey polypropylene, 5 blue polypropylene, 26 black polyester and 4 purple wool fibres were recovered from the

right shoe of the deceased and 4 grey polypropylene, 7 blue polypropylene and 24 black polyester from the left.



Figure 2: View of the soles of the victim's boots

Samples of carpets from the various sites that the victim had been the day she disappeared, as well as her home and family's vehicles was collected for comparison. All of these were excluded as potential sources for the fibres that had been found on her shoe soles.

Suspect

The victim had been in a violent relationship with a male for the previous two years. This degree of violence was such that the victim even took out an Apprehended Violence Order in late 1994, although the relationship resumed a few months later. However, in late February 1995 the deceased indicated to her mother that the relationship was over and on the 28th March, 1995 she agreed to meet this boyfriend the following day on her way home from University. The next day the deceased did not return home.

Co-workers of the suspect testified that he left work early on the 29th March 1995, although he denied doing so. There was also a witness who claimed that the suspect had asked him to kidnap and kill the deceased in late 1994. When the witness refused, the suspect made threats

that he would do so himself. When the suspect was questioned he stated that he had not seen the victim for six weeks prior to her disappearance.

At the time of her disappearance the suspect owned a 1991 Honda CRX. Samples from the carpets in this vehicle were collected and the interior carpet was found to consist of grey polypropylene, blue polypropylene and black polyester. The questioned fibres were indistinguishable from the fibres taken from the carpet of the Honda CRX using comparison microscopy, polarising microscopy and FTIR. As all the fibres were pigmented attempts at dye extractions were not successful.



Figure 3: Comparison microscopy of a black polyester from the shoes (left) and the Honda CRX carpet (right)

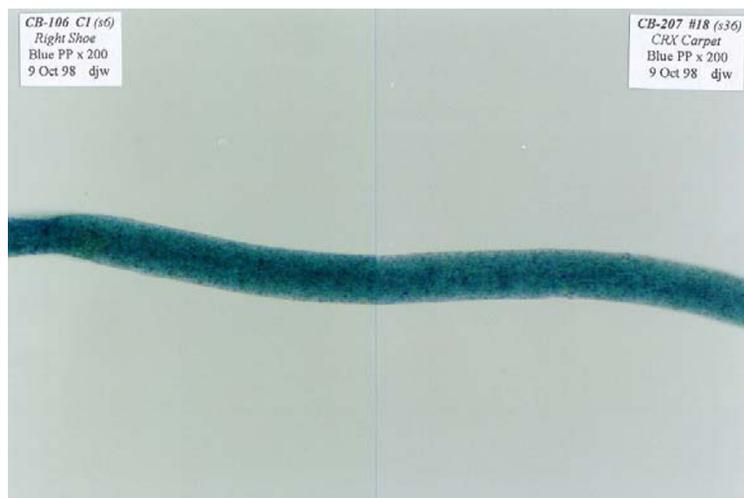


Figure 4: Comparison microscopy of a blue polypropylene from the shoes (left) and the Honda CRX carpet (right)

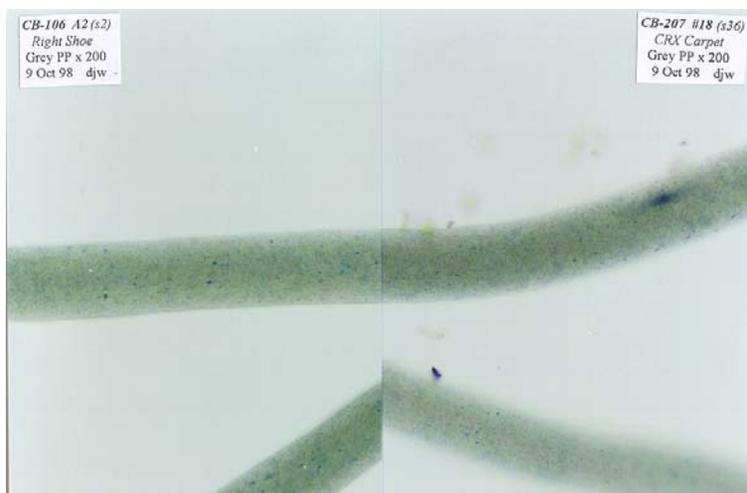


Figure 5: Comparison microscopy of a grey polypropylene from the shoes (left) and the Honda CRX carpet (right)

Enquires made to the manufacturer confirmed the composition of this carpet as 60% off black (grey) polypropylene, 15% blue polypropylene and 25% black polyester. This particular carpet was manufactured in Japan and was only used in 1990 and 1991 Honda CRX vehicles. 296 of these vehicles had been sold in Australia. Affidavits were obtained from the owners of 291 of these cars each claiming not to have been in the area the deceased was found from the 29 March to the 2 April 1995. Only 5 vehicles were unaccounted for, one of which was this particular vehicle.

Information obtained from the manufacturer also further categorised the 60% grey polypropylene as 15 denier (40%) and 7 denier (20%). During the fibre examination the analyst had not noted if there were two different deniers of grey polypropylene, but at the subsequent trial stated that thought the fibre he had examined were all 15 denier. During the trial much was also made of the fact that the proportions of the fibre types was different to those provided by the manufacturer. If calculated from the numbers of fibres found the percentages were 13% grey polypropylene, 17% blue polypropylene and 70% black polyester compared to 60% grey, 15% blue and 25% black from the manufacturer's data. This phenomena is known as differential shedding and can happen as the percentage compositions of textiles is often calculated from the weight of each component, while the proportions reported in the fibre examination are based on the individual fibres.

Transfer and Persistence

The transfer and persistence of car carpet fibres to shoe soles was investigated and the results of these studies published (Roux, Langdon, Waight and Robertson 1999). This study showed that fibres could be transferred from car carpets to shoe soles by normal activity in real life conditions. Other than this study, there has only been one other study of the transfer of carpet fibres to shoe soles (Robertson & de Gamboa 1984).

The Robertson and de Gamboa study looked at the transfer of fibres from five different domestic home carpets onto four types of shoe soles. Overall, this study found that the number of fibres that transferred depended on the fibre composition of the carpet and, to a lesser extent, carpet construction as well as the composition and pattern of the shoe sole. This study found that rubber soles retained more fibres than leather soles and unworn soles retained more fibres than worn soles, although the differences were not always significant. The persistence studies found that the transferred fibres were rapidly lost, sometimes within minutes.

The transfer and persistence studies conducted in relation to this case also found similar results for automotive carpets. For this study four types of shoe soles were used, one of which were of the same type as worn by the deceased. Five vehicles were used for the carpets, one of which was the actual Honda CRX involved. This study found that fibres were transferred from the carpets to the shoe soles with the number depending on the individual car carpet and on the profile of the shoe (i.e. shallow or deep tread pattern). In almost all trials, the greatest number of fibres was transferred onto the soles with the deepest profile pattern (which were the soles similar to the victim's shoes).

Of particular interest to this case were the results of the persistence studies. In all the persistence trials, very few of the fibres transferred to the shoe soles remained after only 5 minutes of walking over any type of surface. In fact, in many cases **no** fibres remained. The persistence was poorest after walking over grass, which was of great interest because of the location where the victim was found. This study also found that the persistence of fibres on worn soles was less than on new, unworn soles. The fibres that did persist after 5 minutes were also found to be either physically caught in the edges of the sole pattern or were in a recessed area of the sole that did not come into direct contact with the ground. It is interesting to note that the fibres that were recovered from the victim's shoe soles were found mainly on

the surfaces that would come into contact with the ground (see Figure 6). After 30 minutes **no** fibres were found on the shoe soles at all.



Figure 6: Location of questioned fibres on the right and left heels

Frequency of the Fibre Types

Carpet samples were obtained from 175 vehicles, including 29 manufactured by Honda. The majority of these carpets were grey in colour. However, there was a large variation in the colours and cross-sectional shapes. The only vehicle that potentially had similar carpet was a 1991 Honda Civic that also had carpet consisting of grey, blue and black fibres. However, when these fibres were examined it was found that the black fibres were polypropylene, not polyester like the carpet in the 1991 CRX.

Of the carpet samples examined, 53.1% contained only one fibre type, 32.0% contained two, 12.0% contained three types and only 2.8% had four or more different fibre types.

Trials were also conducted to assess the differential shedding characteristics of the actual carpet from the suspect vehicle. A sample of carpet was removed and soles similar to those used in the manufacture of the boots the victim was wearing were also obtained. An abrasion tester was used to simulate the contact in a reproducible way. After a number of trials at

different pressures and number of revolutions it was found that there were no significant factors influencing the relative proportions of fibres transferred and in fact appeared to be random.

Expert Testimony

For the trial, Dr James Robertson was called by the Prosecution to testify about the significance of the fibre evidence, particularly his opinion in respect of the transfer and persistence of automotive fibres to shoe soles. Based on his qualifications, experience and the results of the two transfer and persistence studies his opinion was

“What I am able to conclude, on the basis of the substantial experimental data available to me, is that [the victim] did not walk for any substantial time after contact with the source of the fibres found on her boots. By a substantial time, I mean a matter of minutes and not hours or longer. Given the number of fibres said to have been recovered from the boots, it is probable that the time or distance walked would have been less than that covered in five minutes.”

A podiatrist was also called by the Crown, who had examined the wear pattern on the deceased's shoes and said that the fibres were located on areas which would come into direct contact with the ground during normal walking and therefore would expect that normal walking would have removed the fibres from the shoes.

The Manager of the Testing services Division of the Melbourne Institute of Textiles testified that there would have been virtually no polyester carpets in Australia in 1995. He was of the opinion that polyester was not used in Australian carpets, particularly in the commercial field and he had not come across a blend of polypropylene and polyester fibres in a carpet. He also expressed the opinion that it is unlikely that the blend of fibres lost from a carpet is identical to the blend in the carpet.

A Chartered Textile Technologist testified that the fibres in the carpet installed in the 1991 Honda CRX have never appeared in any carpet installed in any Australian made car; such carpet had never been manufactured in Australia and was a very unusual blend of fibres.

The defence accepted that there were fibres on the deceased's boots that could have come from the Honda CRX. The dispute at trial mainly revolved around whether the black fibres came only from the CRX and the length of time the transferred fibres would persist on the soles.

The first issue arose from the differential shedding of the car carpet. As previously mentioned, the black polyester fibres accounted for approximately 70% of the fibres recovered from the shoe soles compared to a composition of 25% black polyester from the manufacturer. The analyst that conducted the fibre examination also assessed the relative fibre composition by cutting a small sample from a section that had been removed from the actual carpet and then sorting and counting the three fibre types/colours. Using this method he found the composition to be 55.3% grey polypropylene, 18.3% blue polypropylene and 26.4% black polyester. This composition was confirmed and accepted by the defence witness.

Defence experts argued that the difference in the proportion of the black polyester fibres found on the shoes when compared to the composition of the carpet was evidence that the black polyester fibres did not come from the one source. However, the differential shedding studies discussed earlier discounted this as they found that the relative proportions of the fibres transferred to be highly variable. In fact, when the defence expert was questioned further about his own shedding experiments he had also found this to be the case.

The second dispute was the length of time the fibres had persisted on the shoe soles. A second defence expert, an engineer, was of the opinion that the fibres could have adhered to the shoe soles for weeks or months, as opposed to the matter of minutes found in the published studies. He criticised the police and laboratory staff for removing the fibres from the shoe soles without any "tests" to determine how the fibres were retained on the shoe soles. From examining the photographs he believed that there may have been a sticky substance which may have caused the fibres to remain for some time. He also believed that the fibres had gotten into the sole prior to the striations and could have been there for a considerable time.

The opinions of the defence experts were discounted by the research studies that had been conducted. The criticism of the scene examiner's decision to remove most of the fibres at the scene was also unfounded. The fibres were all photographed before removal, and some that

appeared to be more securely attached were left adhering. If these fibres had not been collected appropriately, as they had been, then they would very likely have been lost or at least dislodged during transit of the exhibits.

Outcome

When this case first went to trial the accused was found guilty and sentenced to 20 years with a minimum non-parole period of 13 years. The defence appealed this decision on a number of legal grounds, including that the prosecution in the original trial had presented two alternatives to the jury, one that the accused had killed the victim himself, or that he had arranged for someone else to while using his car. This appeal was upheld and the conviction set aside. However, as there was evidence on which it would be open to a jury acting reasonably to convict, a new trial was ordered.

The prosecution appealed the decision of this appeal in High Court of Australia. This application was refused and retrial upheld. There was then a second trial and the accused was found guilty again. He was sentenced to 20 years with a non parole of 14 years.

The second conviction was again appealed by the defence in the NSW Court of Criminal Appeal and then in the High Court of Australia, both of which were unsuccessful.

This has exhausted all avenues of appeal for this case and the person concerned is currently serving his sentence. He will be eligible for release in May 2012.

Final conclusion

This may not be a unique fibre case but is certainly rare and illustrates several important aspects of trace evidence. It is rare because to all intents both prosecution and defence accepted that the combination of fibres recovered from the shoes of the deceased came from the Honda CRX belonging to the defendant. The critical question then became when the fibres had been deposited on the shoes and how long these would be retained.

The interpretation of the retained fibres was possible because of the excellent work of the crime scene examiner who was alert not only to the possibility of trace evidence being present but who also recorded their location in situ and protected the evidence against loss.

The eventual interpretation was greatly facilitated by the number of recovered fibres and their location.

This case also illustrates the value of industry enquiries to the interpretation of the individuality of the fibre combination seen. The research study was essential to provide a solid basis for interpreting fibre persistence which proved vital in countering the defence expert.

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