COMPUTER-AIDED DATA HANDLING IN CASEWORK

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ABSTRACT: Since the beginning of the 1990's the fibre section of the Forensic Science Institute at the Bundeskriminalamt have had to deal almost exclusively with highly complex cases which are often linked to one another. In the majority of these, no fibre samples from known sources are available for comparison purposes, so adefined search for target fibres is not possible. The examinations are sometimes made even more complicated in that they have already been examined in another laboratory, where no useful result has been obtained. In this paper, the authors will describe how such cases are dealt with, including the use of computer supported documentation and evaluation of the extensive data resulting from the examinations. They also present their view on how this approach can bring benefits to fibre examinations in the future.

KEY WORDS: Fibres; Casework; Data evaluation; Spectral comparison.

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The type of cases which we have to examine in our Laboratory has changed substantially over the last 20 years. Whereas during the 1980's bank robberies, sex offences, common assaults, traffic accidents and drug related offences constituted our "bread and butter" work, since the beginning of the 90's we have become principally concerned with complex cases, for example those connected with terrorism.

In 1993 terrorists attempted to blow up part of a new high-security prison that was then under construction (Figure l). The complex of buildings was practically finished. Countless fibre tapings were submitted to the Laboratory for examination (Figure 2). These had been taken from the approach and escape routes used by the terrorists and from vehicles thought to have been involved in the get away. We were even required to examine tapes taken from warning signs ("Danger – Explosives") which had been erected by the terrorists. At the time of submission, no suspects had been developed and therefore the aim was to obtain as much helpful information as possible from the fibre traces. The entire fibre section, which then consisted of 7 people, was put to work on this case trying to filter out potentially useful fibre collectives from among thousands and thousands of fibres. At that time we did not have the support of computerised data searching facilities.

Fig. 1.

Fig. 2.

6 months later, a special police commando unit operating together with the Border Police arrested two persons suspected of being members of the "Red Army Faction" (RAF) terrorist group. It turned out that numerous fibres could indeed be matched to items of clothing secured from the two suspects. Seven years later, these items of clothing again form the centre point of an extensive series of highly complex examinations.

KT 33 was asked to try to clarify whether fibre traces left in connection with various hitherto unsolved assassination attempts on high ranking politicians or important public figures, could have originated from any of these items of clothing which had been secured 7 years before.

Another type of offence where we receive highly complex cases to examine are sexually related homicides. In June 1987 a suspect was developed in connection with such a case in north Germany. The scenes of crime team from the BKA took over all the recovered trace evidence from the body, which was found in the Netherlands. Numerous samples for comparison were then collected from the suspect's accommodation and environment. During the same time period there was a series of unsolved series of similar cases involving young girls in which the suspect could also have been involved. From the initial 35 cases, after an intensive investigation by a special commission, two cases remained in which the possibility of establishing a connection to the suspect had to be further investigated.

One of the cases took place in the Rhein-Main area of southern Germany. In 1994 the naked bodies of two teenagers were found (Figure 3). Both had been sexually assaulted and murdered. The only forensic evidence available from the victims was the trace evidence collected from the bodies.

The other case was from the Cologne-Bonn area of west Germany. In 1996 a walker found the naked body of a young girl (Figure 4). Again, she had been sexually assaulted before being killed. Once more, the only possible clues lay in the trace evidence on the body.

The evidence in both cases had already been examined by the regional state crime laboratories, responsible before it was submitted to us. The results from these examinations had not provided any insight into the possible identity of the suspect. The special commission believed that a re-examination might be the last chance to obtain information about a possible suspect and so the following procedure was agreed upon:

First, it would be established if among the fibre traces on the body useful fibre collectives existed which might provide a Leitspur (target fibre indicator) that could be sought in the environment of a suspect. If indeed such collectives existed, but no potential source for them could be found in the suspect's environment then further examinations should be made to see whether examples of fibres which came from textiles related to the suspect could

Fig. 3.

Fig.4.

be found on the bodies or on other items. You will all appreciate the enormous amount of work and time required to carry out such examinations.

In order to be able to deal with such requests, particulary within a foreseeable time limit, it was necessary to review and improve our analysis protocol without incurring any resultant loss of quality in the examination results. On the other hand it was clear that the amounts of data which are generated during such examinations can only be effectively dealt with using a computer equipped with the appropriate software. It was obviously a good opportunity to optimise the work place situation for routine fibres case work in our laboratory.

The result of our efforts is shown in this overhead. The heart of the individual workplace remains a high quality light microscope equipped for examinations in brightfield and polarised light together with the facility to make qualitative fluorescence observations using three filter blocks. To speed up the analysis, the microscope is coupled to a diode array spectrometer with which it is possible not only to measure the visible spectrum from the fibre dye within seconds, but also if the emission is sufficient to measure the fluorescence spectrum. To complete easy and rapid documentation of the sample being examined, the work station includes a video camera and monitor (Figure 5).

Fig. 5.

When the fibre is observed under the microscope, all relevant information such as the cross sectional shape, the delusterant and other morphological characteristics, the elongation and birefringence, the dye spectrum and the fluorescence under UV, blue and green excitation can be observed and measured. The possibility of screening at this early stage by spectral search drastically reduces the number of fibres which must be measured in the UV range and the burden of the preparative work associated with this.

You will see that a computer is also part of our standard work place set up. On the one hand the networking of the terminals in the fibre section by the EDV department, meant that everyone in the section would be able to pool data and have direct access to it from their own terminal. The development of a suitable case data bank with the appropriate software to record the fibre data was on the other hand a step into unknown territory. We set out with the intention of recording and managing all the notes which had previously been collected on paper – online. This would include the exhibit descriptions and the fibre data and allow computer supported evaluation of the analytical results.

Our section had already had experience with creating data banks since the 1980's, so we did not need to rely on the help of the specialists in the EDV department. This turned out to be a great advantage as it meant that no problems arose between the software developer and the user. Rectification of mistakes in the software and the incorporation of new ideas could both be carried out immediately. This helps to establish acceptance on the part of the users.

The data bank was created using MS Access. This software offers numerous possibilities for the object oriented programming of data banks and applications software.

This overhead shows the most important part of the case protocol – the Regiecentrum (Figure 5). On the one hand this form contains all of the administrative information about the case which includes:

- the case number,
- the submitter and their reference number,
- when necessary, the person requesting the examination, and their reference number,
- date of receipt at the BKA,
- date of receipt in the fibre section,
- the reporting officer and the analyst,
- the reason for the examination,
- details of what examinations are specifically requested.

At the moment, this page also offers the register cards for exhibits, analysis, evaluation, textile construction, damage and further administrative functions. Using these, other form pages can be called up, for example for the exhibits listing, description, and chain of custody.

In addition to recording who brought the exhibits, and who received them in which room and on what day, other details about the exhibits can be recorded (Figure 6):

– the exhibit number,
– description,
– the packaging,
– who examined the exhibit,
– in which evidence collecting room it was dealt with special observations.

Fig. 6.

The form for recording fibre data (Figure 7) can also be called up from the register cards.

During the analysis all of the following parameters can be recorded online (Figure 8):

– cross sectional shape,
– information about the delusterant,
– elongation and birefringence,

Fig. 7.

Fig. 8.

- generic type,
- colour,
- whether the fibre is printed,
- whether a visible or UV-Vis spectrum has been measured,
- melting point,
- the two refractive indices,
- if recovered and control fibres have been examined by comparison microscopy,
- fluorescence behaviour under Uv, blue and green excitation,
- whether control and recovered fibres match.

The same information is also recorded from the “Known fibre material”.

The following additional information is recorded:

- an unambiguous identification – the fibre number,
- from which taping the fibre originates – taping number,
- from which exhibit the taping has been made – description and exhibit number.

In order for the information about the recovered fibres to be researchable, only acceptable definitions can be used for the entry in certain descriptive categories like “Cross section”, “Generic type” and “Colour” (shown in this overhead). These can be selected by mouse click from drop down lists (Figure

Fig. 9.

Fig. 10.

Fig. 11.

9) and entered into the form. When all the fibres have been analysed and their data recorded, we return to the Regiecentrum (Figure l0).

The register card fibre evaluation allows the choice of various routines which for example permit groups of natural or man made fibres to be sorted from all of the stored data. It is also possible that records from different case complexes can be integrated, making it possible to recognise possible connections between different offences. An example of the results from such a search are shown in the next overhead (Figure 11).

By using a search routine which looks for identical records, fibres with the same data will be separated (the lowest unit would be 2 fibres). These fibres can then be sorted according to colour and shown in lists which are easily overseeable. With each change between the groups that are on hand the number of fibres in each will be shown as a summary.

An exemplified result (Figure 11) might be:

– 4 blue, printed cotton fibres that fluoresce blue, green and orange under the three filter combinations, followed by a group of
– blue dyed wool fibres that also fluoresce blue, green and orange.

Among the manmade fibres the following example might occur (Figure 12):

– 3 blue, peanut section, delustered acrylics that fluoresce purple, orange and orange,

Fig. 12.

– 2 blue, peanut section, bright acrylics that fluoresce red under all filters,
– a group of blue, round, heavily delustered polyester fibres that fluoresce blue, green and orange respectively.

With these search routines it is possible to sift through thousands of fibres for identical groups within seconds and to display them on the monitor or to produce a printed list. This situation is ideal when information which might be useful to an investigation is required at short notice.

In the examples presented here the dye spectra of the fibres concerned have not yet been taken into account. The preselections researched are therefore only provisional and it is quite possible that further differentiation will be achieved when the visible spectra are also taken into account. However, today it is also possible to do this with the help of computerised spectral comparison.

All of the VIS and UV/VIS spectra measured during a case examination can be centrally stored in the online case protocol. This is made possible by using Spectralys software (Figure 13) used in conjunction with both the Tidas DAD-Spectrometer and the MPM 800 microspectrophotometer. This provides the great advantages of having a unified operating system and an identical format for the VIS and UV/VIS spectra. The software operates under Win 3.11, Win 95/98 and also under Win-NT. The use of the latter also allows the spectrometer to be used in a network system. In addition to providing comprehensive routines for spectral evaluation and presentation Spectralys also offers the possibility of creating spectral libraries and then being able to search them for examples of a particular spectrum.

There is considerable variety in the choice of criteria used as search parameters for spectral comparison (Figure 14). Under the heading "Similarity", the following choices exist:
– DIFFERENCE – spectral subtraction of absolute values,
– DERIVATIVE – spectral subtraction of first derivative,
– (DIFFERENCE 2) – the least squares fit,
– (DERIVATIVE 2) – least squares fit of first derivatives,
– EUCLIDEAN – Euclidean difference,
– PEARSON – Pearson's correlation coefficient.

In the "Peak" section there is the following choice:
– MATCH – number of coinciding peaks,
– FORWARD % – percentual coincidence of library spectrum with peaks of unknown spectra,
– WEIGHT – sum of coincident peaks weighted by the deviation,
– REVERSE % – percentual coincidence of unknown spectrum with peaks of library spectrum,
– COMBINE 1 – 1 : 1 forward and reverse search,

Fig. 13.

Fig. 14.

– COMBINE 2 – 1 : 2 forward and reverse search.

Under “Operation” the choice can be made between:

– similarity search,
– peak search,
– text search,
– retention time search.

At present we are in the process of gaining experience about which parameters are most useful in preselecting spectra from a library before a dye comparison is made.

Fig. 15.

The next overhead shows the result of a spectral search using spectral difference as the search parameter (Figure 15).

Comparison is carried out using normalised spectra. In the right hand window the “hits” are listed with the best fit to the spectral match sought being at the top, the rest in decreasing order. In the second column the correlations coefficient is shown. A value of 1 means that the spectra are an absolute match. As the values fall the degree of coincidence with the spectrum sought becomes less and less. By viewing the marked spectral curve that will then appear in the left window it can immediately be seen whether it matches that of the desired spectrum, or deviates from it.

We are on the verge of a development that in the future will not only allow us to store and evaluate the amounts of data, but also in the future spectral comparisons will be carried out digitally on the monitor. The stored fibre data can be used to build up spectral libraries and also to establish databanks on the frequency of occurrence of morphological parameters. For the first time we have a tool at our disposal that will enable us to quickly and efficiently recognise possible similarities between fibres recovered in connection with various crimes.

To sum up, we can say that not only has the online collection of analytical data completely changed the standard work place for fibre analysis, but has also revolutionised the way of documenting and evaluating cases. This not only brings benefits to the case submitter, but also serves the cause of Quality Management.