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Police Scientific Development Branch Crime Investigation Sector Fingerprint Development and Imaging Update

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The Fingerprint Research Programme

The main objectives of PSDB's fingerprint programme are to ensure that force fingerprint laboratories and crime scene examiners are equipped with the most effective and safe detection and imaging techniques. We are also concerned with effects on other types of evidence; some current work is therefore on the effects of processes on DNA profiling.

The programme is steered by a User Group of operational police fingerprint staff chaired by Tristram Elmhirst Forensic Services Director West Mercia Constabulary which reports to ACPO Crime.

This update summarises some of the outcomes of the work of the last eighteen months and provides some revised information particularly relevant to the effective operation of fingerprint development laboratories.

Work on developing latent fingerprints on adhesive tapes and enhancing fingerprints in blood is coming to a conclusion and operational trials will be proposed shortly.

The effectiveness of a range of powders and brushes has been assessed although there is still more to do. Some health and safety studies are currently underway measuring the concentration of aluminium powder in the air at scenes of crime. This work will be reported on as soon as results are available.

Fingerprints and DNA?

PSDB initiated a programme of work by the FSS to establish the effect of typical chemical and physical fingerprint development and enhancement techniques on subsequent DNA profiling using either SGM+ or Low Copy Number (LCN). There is more work to do but initial results are encouraging.



Swabbing for DNA on a sample from our trial

Recovery of SGM+ DNA profiles from blood contaminated fingerprints

Recent blood contaminated fingerprints enhanced with either the recommended aqueous or ethanolic formulations of amido black yielded full SGM+ profiles when processed soon after enhancement.

Four year old blood contaminated fingerprints yielded informative partial SGM+ DNA profiles after water-based amido black enhancement. Use of the methanol-based amido black on this age of blood, however, resulted in very poor partial profiles.

Recovery of LCN DNA profiles from latent fingerprints



Removal of non-DNA substances from extraction material

It has been found in recent trials that, when used individually the standard recommended chemical or physical methods of latent fingerprint development have relatively little effect on the subsequent recovery of DNA profiles. The following points should however be noted.

- i) If it is likely that DNA profiling will be needed on an exhibit after fingerprint treatment all relevant anti-contamination precautions should be taken and best practice used in the packaging and handling of the exhibit.

There is very little DNA within a latent fingerprint, although this varies from donor to donor. Every possible precaution should be taken to reduce cross-contamination from sample to sample and from those handling the exhibit.

- ii) DNA processing is best carried out as soon as possible after fingerprint development or

enhancement. This will optimise DNA recovery and help to limit the potential for cross-contamination.

- iii) LCN profiles are much more difficult to obtain from porous than non-porous surfaces. Full LCN profiles from porous surfaces are not always achieved even on untreated articles.
- iv) The use of a number of sequential fingerprint treatments is likely to reduce DNA recovery and increase the potential for DNA cross-contamination. If both DNA and fingerprint evidence are to be maximized it may be prudent to select the single most effective fingerprint development process appropriate for the surface and immediately submit samples for DNA analysis.

For a non-porous surface this is likely to mean choosing between aluminium powder, vacuum metal deposition or superglue followed by basic yellow 40 depending on surface and any environmental considerations.

For a porous surface it is likely that DFO would prove the most effective option, except where it has been wetted when physical developer should be used.

The Manual of Fingerprint Development Techniques should be consulted for further information.

- v) When aluminium powder is lifted some DNA remains on the surface and some is lifted with the powder. Informative partial LCN profiles have been obtained both from the surface after lifting and from the lift.
- vi) Use of Quaser 40 or 100 high-intensity light sources have so far proved non-destructive at all wavelengths for up to 30 minutes exposure.
- vii) Short wave UV is very destructive and should not be used.
- viii) You must inform your forensic provider which processes have been used so that the optimum method of DNA extraction may be selected accordingly.

On articles with large surface areas it is possible to use a suitable fingerprint process to better target where to swab for DNA.

Operationally LCN profiles have been recovered from articles that had been treated with superglue and DFO.

Luminol – Footprints in the Dark

Despite claims to the contrary the Luminol technique for developing blood stains is not a recent advance, and nor can it be claimed that it is among the more sensitive or specific techniques for the development of blood stains.

There are however circumstances where it appears to have value in enhancing traces of blood, footwear impressions, smears or faint blood spatter, on some surfaces at scenes.

Luminol (3-Aminophthalhydrazide) differs from all the other blood reagents in respect that it is chemiluminescent, using the peroxidase-like activity of the h  m group (the iron containing complex) in h  moglobin to catalyse the production of light. The chemiluminescence produced is transitory, fading quite quickly and is only visible in virtually total darkness. It does not produce a daylight visible trace.

Luminol also reacts with other transition metal ions (copper, cobalt, nickel, zinc etc), some plant extracts including potato, onion and apple, strong oxidizers *eg.* bleach, and some other body fluids. Therefore other tests must be carried out to confirm the presence of blood.

Walter Specht of Jena first carried out the use of luminol to test for the presence of blood by this method in 1937.

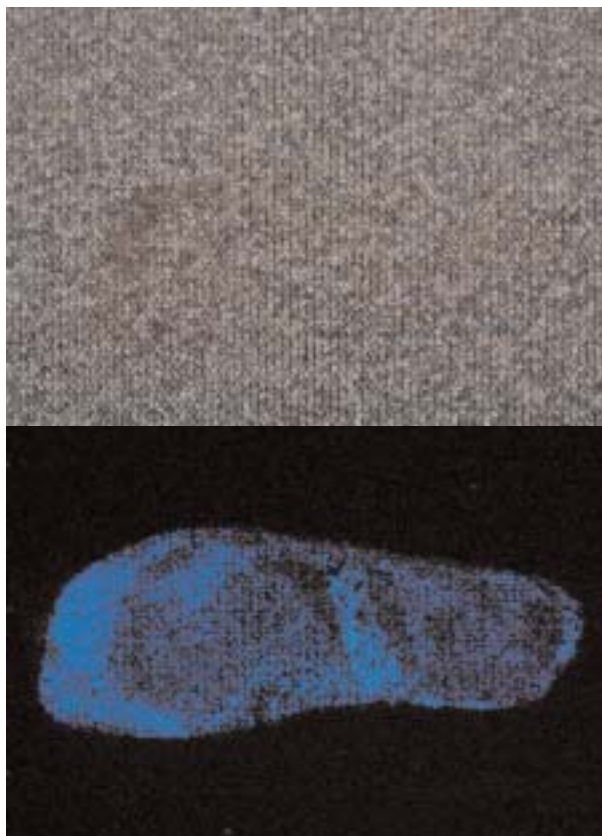
The raw sensitivity of this and other methods was investigated by Olsen in 1985 by placing diluted blood on glass and white paper. He found that luminol was not as inherently sensitive as many other techniques on these surfaces.

In recent years PSDB has carried out an extensive evaluation of the sensitivity of blood reagents specifically for the development of fingerprints. We have found that luminol is amongst the poorest performing techniques. Generally the effectiveness of techniques was found to be dependent on the proportion of material in blood with which they react, so that protein dyes and reagents were more effective than those that were specific for h  m were.

When using luminol it proved very easy to diffuse and damage deposits of blood to the detriment of fine detail making fingerprint identification impossible and footwear

identification extremely difficult. Also the amount of light produced was low and faded quickly making recording more problematic.

The chemiluminescent property of luminol can however prove valuable for visualising footwear impressions, smears and splash patterns in blood on dark and patterned carpets, floor coverings and wallpapers where fine detail is not required.



Bloodstain on a carpet treated with luminol

Health and safety studies carried out in Japan in the late 1980's and until 1990 have shown that Luminol is a mutagen (*Chromosoma* V99, p360, 1990) and it is listed as such in the Registry of Toxic Effects of Chemical Substances (RTECS). The stability of luminol is however unknown and the oxidized product is not suspected of being as hazardous.

Currently we are unable to recommend the use of luminol until a definitive safety study has been carried out and either it is shown not to present a health risk, or a way of neutralising it at the scene is confirmed.

We have no data on how long luminol will remain on typical substrates at crime scenes, but may look further into the safety and application of luminol.

Changes to Chemical Specification and Suppliers Information

Please note the following changes, all of which relate to recommended methods in the PSDB Manual of Fingerprint Development Techniques (MOFDT).

5-Sulphosalicylic acid anhydrous (Amido Black)

Anhydrous 5-Sulphosalicylic acid used for fixing blood is no longer generally available from suppliers. The alternative is to use the dihydrate but 23g must be used instead of the 20g in the formulation given in the Manual.

Detergent solution (PD)

The supplier for n-dodecylamine acetate given in the Manual has stopped selling this material. Police forces in the UK using physical developer should contact Lesley Fitzgerald at PSDB who will supply made up detergent solution. We do not recommend purchase of any of the 'ready made' PD solutions from SOC suppliers.

Ammonium Iron(II) sulphate hexahydrate (PD)

It has been reported that this product is sometimes difficult to obtain from some suppliers. All the companies listed in the Manual continue to list this product in their catalogues, although under slightly different names. Sigma-Aldrich - Ammonium Iron(II) sulfate hexahydrate. VWR (Merck, BDH) – di-Ammonium iron(II) sulphate 6-hydrate. Fisher - Ammonium Iron(II) sulfate. In all cases the CAS Number is 7783-85-9.

Basic Yellow 40 (for superglue dye staining)

W S Simpson, the suppliers of Basic Yellow 40 listed in the Manual, have ceased trading. However an equivalent product may now be purchased from Keystone Europe Ltd, Tel 01484 341 1466 under the product name Keyazine Brilliant Yellow 10 GF.

Superglue

PSDB have tested Cyanobloom cyanoacrylate glues manufactured by Vortex Industrial Products Ltd and also sold by Mason Vactron for use in the superglue process.

Three products are available – low, medium and high viscosity cyanoacrylate. The low viscosity product performed as well as previously recommended superglues; the medium and high viscosity products were not as effective and are not recommended. In general it has been found that unthickened, ethyl cyanoacrylates perform best in this process.

Ethanol – Absolute and 96%

Significant savings on the cost of all types of ethanol can be made by purchasing from a specialist spirit manufacturer such as Hayman Ltd, 01376 517 517 or contact Lesley Fitzgerald at PSDB for a local supplier.

New HFE supplier (DFO, Ninhydrin)

Supplies of 3M HFE 7100 and HFE 71DE are now available from Severn Biotech Ltd, Tel 01562 825 286.

Packaging of Adhesive Tapes

Adhesive tape removed from surfaces may be placed onto glassine paper, a smooth, low adhesion surface to protect the adhesive coating during storage, transportation or processing of the non-adhesive surface. It may be then readily removed when required. In some cases it may be desirable to treat the back of the tape for fingerprints whilst on the glassine paper. The tape may then be easily removed prior to treatment with other techniques on the adhesive side. Standard Honey Glassine 65gsm is available in A4 sheets from Sheet & Roll Converters, Tel 01753 523 238. Precautions must however be taken to ensure that there are no fingerprints on the paper that could be transferred to the adhesive surface. If other forensic evidence is required it is important to ensure that the glassine paper does not contaminate the surface by transferring dust, fibres hair etc.



Adhesive tape being placed onto glassine paper

Thermal Papers – No More Problems!

The acetic acid in both the DFO and ninhydrin formulations reacts with the surface coating of thermal papers resulting in them turning black.

If such articles are left in the working solution the dark colouration will usually disappear. Sometimes colouration is particularly difficult to remove and leaving in the normal working solution may not be effective.

If batches of thermal papers only are to be treated the following modified DFO and Ninhydrin solutions may be used and will be quicker at removing the staining.

These formulations should not be used for other documents because of the potential diffusion of handwriting.

DFO Formulation for Thermal Papers Only

0.25g DFO

60ml Methanol

20ml Acetic Acid

275ml HFE71DE

725ml HFE7100

Ninhydrin Formulation for Thermal Papers Only

5g Ninhydrin

90ml Ethanol

5ml Acetic acid

2ml Ethyl Acetate

1litre HFE7100

In each case the amount of alcohol in the formulation is twice that of the normal recommended formulation as this removes the colouration.



Thermally printed receipts

When only a small number of articles with a thermal coating are to be treated an alternative way of producing the same solution is to take 200ml of normal ninhydrin working solution and add 9ml of Ethanol or 200ml of DFO normal working solution and add 6ml of Methanol.

Articles may still need to be soaked for 10-30 seconds before all the dark colouration is removed.

If dark coloured droplets form on the surface of the treatment solution it should be discarded and

a new batch of solution used in a clean trough.

If dark colouration returns on drying or heating articles may be re-treated.

Any relevant document details should be recorded, or in the case of handwriting, photographed, as the higher alcohol content of the formulation will often diffuse handwriting and transaction details will disappear.



Ninhydrin developed fingerprints on a thermal receipt.

Reducing the Consumption of HFE

A large metropolitan police force recently reported that after introducing the PSDB yellow processing trays for routine ninhydrin and DFO their consumption of HFE was much reduced.

PSDB still has a limited number of small and medium sized yellow processing trays available. Contact Lesley Fitzgerald at PSDB.

Freezer Spray for Adhesive Tape Removal

Cooling of most types of adhesives used on tapes below a critical 'glass transition temperature' results in solidifying of the adhesive. This may enable it to be 'fractured' from surfaces to which it is adhering. In the past some authors have advocated putting exhibits in freezers and we

have had operational successes with a liquid nitrogen cooled plate. An alternative easier method may be the use of freezer sprays such as RS Freezer spray (cat. no. 846-682) which is designed for printed circuit board testing. We have used it successfully for the removal of adhesive tapes from problematic surfaces such as thin plastic bags and bubble wrap.



Freezer spray in use

The freezer spray is as effective as liquid nitrogen but easier to use, safer, and can be applied on small areas. Other freezer sprays are widely available and may prove similarly effective. It is essential to localise the application and freeze a small section of tape at a time and gradually peel it off. Goggles and strong impervious gloves must be used and care taken not to expose the skin to the intense cold produced.

The condensation caused when using the spray or any other method to freeze the adhesive will damage fingerprints on the back of tapes with respect to development by superglue. It will therefore normally be advisable to process the back of the tape prior to attempted removal.

Labcaire Superglue Cabinet

A Labcaire benchtop superglue cabinet, was submitted to PSDB for testing early last year. Whilst we found that the general design and construction of the cabinet was of high quality a report was submitted to the manufacturers recommending some minor but important changes. We will not be recommending that police forces purchase this system unless these changes are made.

SUPERfume – An Initial Evaluation

Since the late 1980s many organisations have carried out superglue treatment of vehicles and room interiors using combinations of heaters

and humidifiers. Mason Vactron are however now marketing a system called SUPERfume and we have carried out an evaluation. This portable superglue fuming system is intended for use at scenes of crime, or to treat vehicles or other large objects in a room or tent, not necessarily at the crime scene.

The SUPERfume kit comprises of a humidifier, two glue heaters and a fume scrubbing system, the latter is of low capacity and in practice we understand natural or forced ventilation is utilised to dispel most of the fumes.

A trial was conducted in a 40m³ room at PSDB. Many surfaces, fingerprint donors and ages of print were used, resulting in an experiment with approximately 6000 fingerprints. We believe this to be the first substantial comparison of the effectiveness of crime scene superglue treatment with the alternatives of powdering, or removal of exhibits where possible, for processing in a superglue cabinet.



SUPERfume field kit

22 surfaces covering a range of materials and textures typically found at scenes of crime or on vehicles were used. For most of these surfaces 3 sets of 6 donors were used. Each set consisted of 3 panels with fingerprints 1 day, 1 week or 1 month old.

A Crime Scene Investigator from Hertfordshire Constabulary powdered one set of surfaces. we did not influence the choice of brush, powder or lifting tape for each surface. Another set of removable samples was processed in a Mason Vactron MVC5000 superglue cabinet and dyed with ethanol-based BY40 prior to photography. The final set was processed with SUPERfume and dyed with water-based BY40 prior to photography.

Overall, on smooth surfaces fingerprint powders were at least as effective as SUPERfume and on several surfaces produced more useable fingerprints. On some textured surfaces SUPERfume showed significantly better results although for each of these the results were better when treated in the cabinet.



SUPERfume system set up in a small laboratory at PSDB Sandridge

It is well known that operating conditions are very important for the superglue reaction in maximising fingerprint recovery, and a well maintained superglue cabinet will give much better results than one poorly maintained. The set of surfaces treated in a MVC5000 superglue cabinet in ALL cases produced better results than those treated in situ with SUPERfume.

There are likely to be two principal reasons for this. Firstly, it is difficult to obtain uniform temperature and therefore constant humidity within a room or tent with problems of varying surface temperatures on outside walls, windows etc. Secondly, there are currently limitations on the types of dye solution that may be safely used at a crime scene. Ethanol based BY40 dye formulation is highly flammable and would not be recommended for use at scenes of crime. The water based BY40 formulation was therefore used to dye the articles treated with SUPERfume.

Although it may appear more convenient to superglue an entire room or vehicle and contents, fingerprint recovery will be compromised. Most smooth non-porous

surfaces will yield as many, or more, fingerprints with careful powdering. Grained or matt plastic surfaces will in most cases give better results with superglue but wherever possible such articles should be removed and treated in a superglue chamber.

PSDB recommended superglue cabinets ensure that the operator is not exposed to superglue vapour above the Occupational Exposure Standard of 0.3ppm for a 15-minute reference period. Since every crime scene is likely to be different in terms of volume, surfaces and ventilation it is very difficult to predict what levels of ethyl cyanoacrylate vapour may be encountered. We would therefore urge extreme caution in the use of such systems. During the trials at PSDB we had the unusual advantage of a room with a fume cupboard which was used to extract the fumes. Even then we did not return the room to normal use for over a week.

In summary, results from this trial indicate that the use of SUPERfume should be restricted to surfaces where fingerprint development is known to be poor if powdered. If used in this way it will increase the potential number of usable fingerprints for some crime scenes. Any surface more suitable for powdering should be powdered first and portable items more suitable for superglue should whenever possible be taken to a laboratory for treatment in a cabinet.

Treatment with superglue can reduce the effectiveness of blood enhancement dyes; it is not known whether superglue would reduce the performance of other processes that might be used at serious crimes, such as ninhydrin.

IRIS – Update and the Link to NAFIS

Production of the most advanced fingerprint imaging systems anywhere in the world is now well underway and several have been delivered. The rapid 'live image capture' and high sensitivity of the large pixels CCD array makes capture of almost any type of developed fingerprint quick and simple. Further details are available and demonstrations may be arranged by contacting anyone in the fingerprint team.

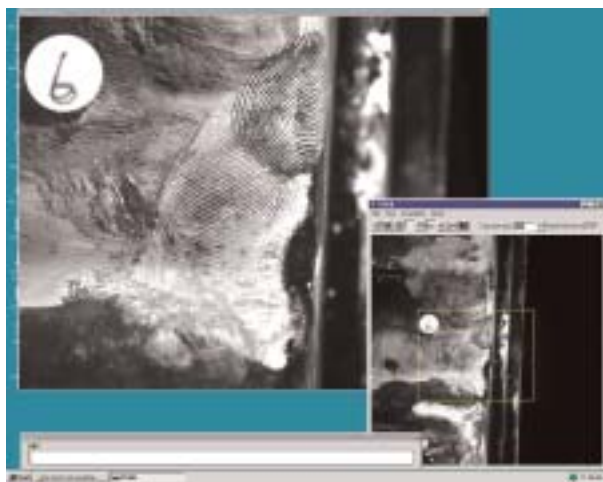
Rewriting of the IRIS software onto an industry standard image processing platform will facilitate the provision of a range of additional functionality and support an increasing number of camera and capture board combinations ensuring long term support for the system.



Production IRIS Workstation

Software development continues with a range of new functions including various print options being made available to users free of charge.

The first live link to NAFIS has now been established at Essex Police Headquarters enabling fingerprints to be captured on any article treated in the laboratory in seconds and made available immediately to the fingerprint bureau. An image can then have a NAFIS number assigned and then be forwarded to the NAFIS server to be called up at any workstation.



Full field of view(FOV) Enlarged Region of Interest(ROI) and NAFIS Data Entry Screen

A PC in the bureau allows fingerprint experts to have the same image processing functions as the staff in the laboratory.

Most forces are outputting hardcopy to Fuji Frontiers or Pictographys but PSDB will assist with interfacing to any high quality print system. An IRIS benchtop demonstrator system will be available shortly for loan this may incorporate a larger format, but less expensive camera.

International Fingerprint Research Group Meeting

In May 2003 PSDB will be hosting an International Fingerprint Research Group meeting at Sandridge. This group has been meeting biennially over the last 12 years and consists of representatives from most of the organisations around the world with active fingerprint research programmes.

There will be representatives from the UK FSS, Canada (RCMP), the US (FBI and US Secret Service) , France (Gendarmerie Nationale) Germany (BKA) the Netherlands (National Forensic Science Laboratory), Switzerland (University of Lausanne, Israel (National Police and Hebrew University) and Australia (Australian Federal Police).

It will be an opportunity to exchange results and discuss research programmes. This gives us the benefit of results and ideas from other programmes and the opportunity minimise overlap and duplication of work.

Outcomes from the meeting will be fed back to the User group and disseminated by future editions of this newsletter.

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