THE INVESTIGATION INTO A COST EFFECTIVE METHOD FOR RETRIEVING BAREFOOT PRINT CONTROL SAMPLES FOR THE DEVELOPMENT OF A BAREFOOT PRINT DATABASE

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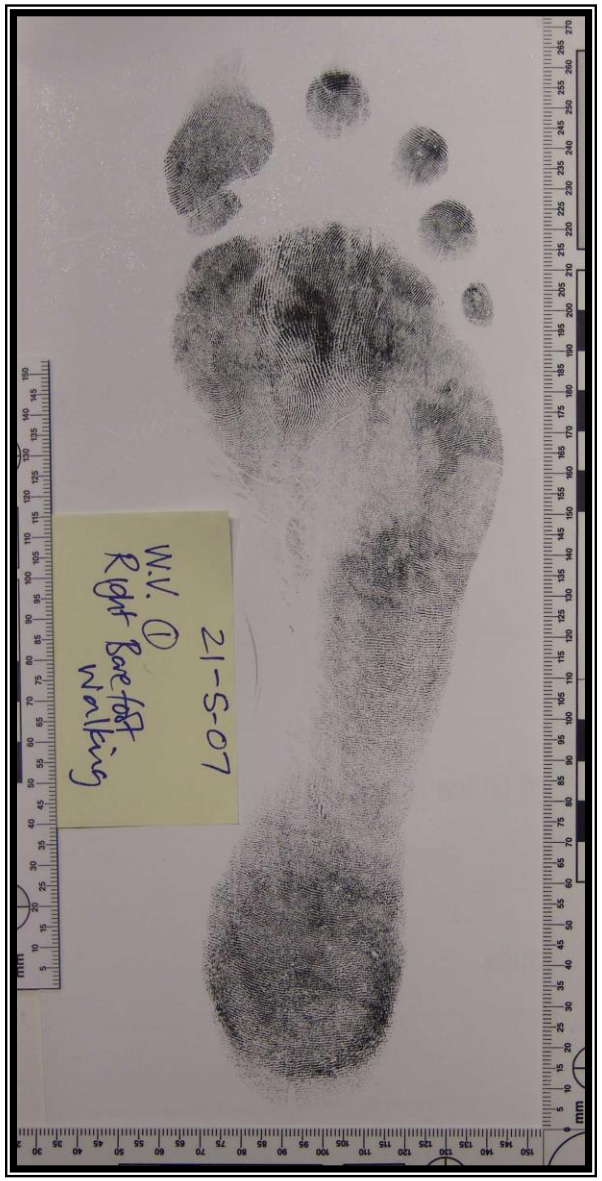


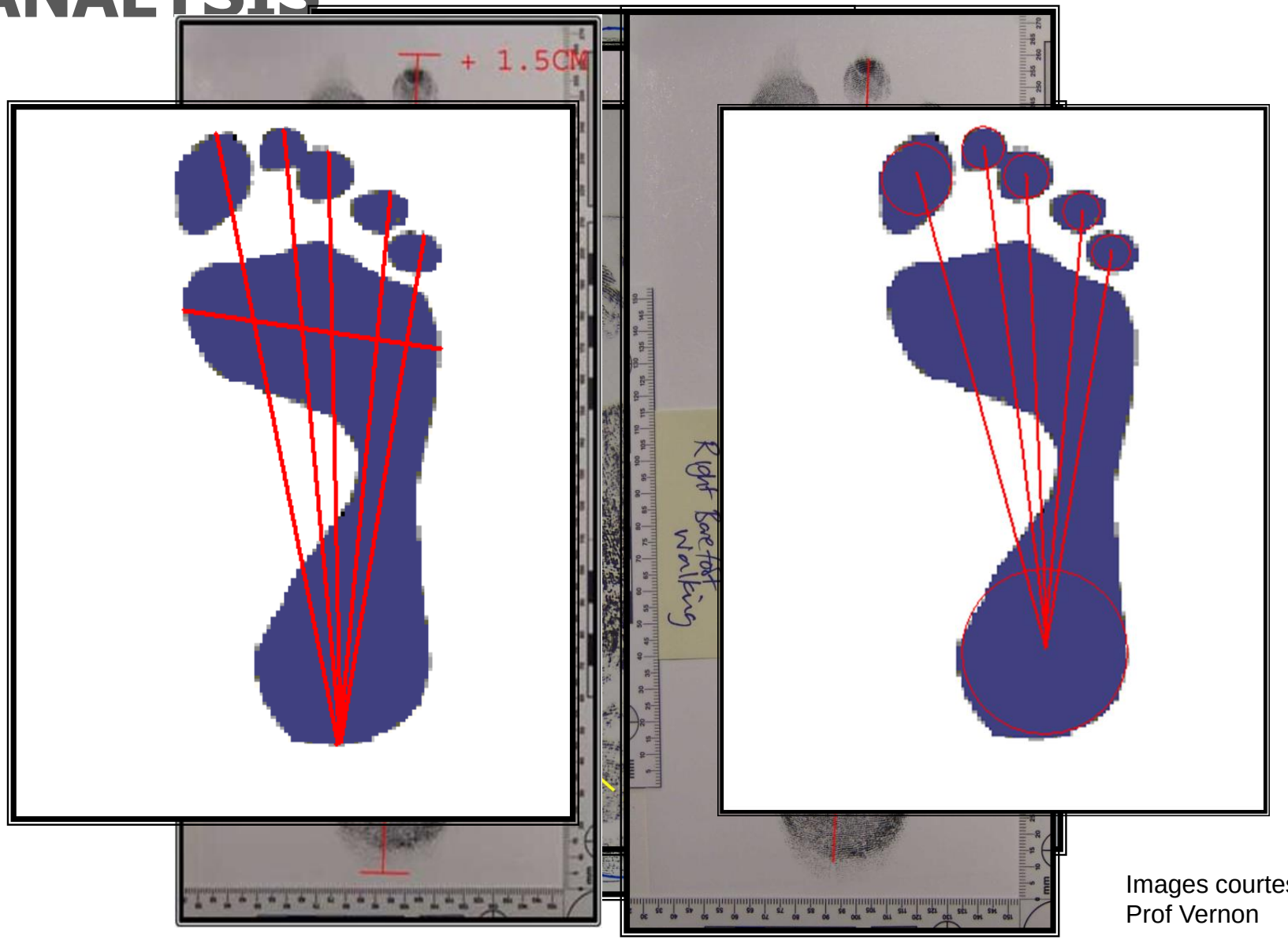
BARE FOOTPRINT IDENTIFICATION:

BACKGROUND TO PROJECT

PODIATRISTS' APPROACH TO BARE FOOTPRINT IDENTIFICATION

- Analysis: The independent assessment of questioned and reference bare footprints, looking to describe size, form and recognisable features
- Comparison: Of the size, form and recognisable features of questioned and reference bare footprints
- Evaluation: Of the comparisons made – what aspects of size form and feature matched, what mismatched and what was the significance of the matched and mismatched features in relation to commonality?
- Verification: Independent working through, checking and (hopefully) confirmation of the above conclusions

EXAMPLES OF BARE FOOTPRINT ANALYSIS



Images courtesy of Prof Vernon

INTERPRETATION OF BARE FOOTPRINTS

- In the UK, the likelihood ratio approach is then used to suggest the levels of individuality represented by these features
- Size, form and features considered need to be independent variables

- Published works,
- survey data,
- personal experience

used to inform/support the derived opinion

Cassidy (1987) - Observed 1:90

Bodziak (2000) - Distinguished 1:1,000

Freedman et. al. (1945) - Observed 1:6,700

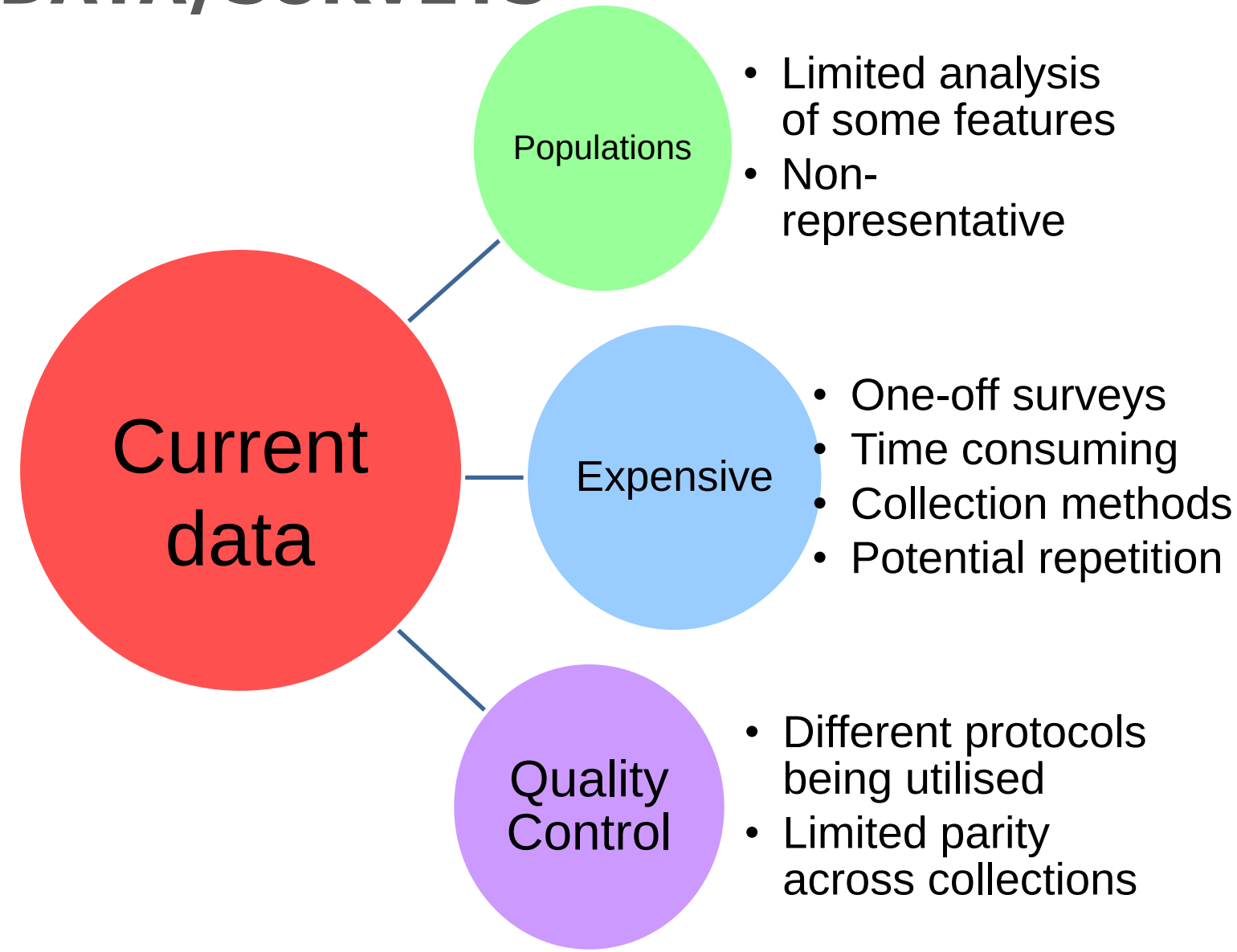
Rossi et. al. (1983) – Observed 1:6,800

Kennedy (2005) – Distinguished 1:24,000

Kennedy et. al. (2003) – Statistically suggested probability of a chance match >1:1.27 billion

SO HOW INDIVIDUAL IS THE HUMAN FOOT?

LIMITATIONS OF CURRENT DATA/SURVEYS



POPULATION QUESTION

In the absence of further information how do we know whether the sizes, forms and features we are interested in during casework relate to the person or the population type (i.e. whether they represent general features of the Caucasian, Afro-Caribbean, Asian, Germanic etc. populations?

COULD A BARE FOOTPRINT DATABASE AID INTERPRETATION?

RVT CASE [2010] EWCA CRIM 2439

- Court of Appeal for England and Wales rejected the testimony of an expert who had used likelihood ratios to assess the probative value of shoe-print evidence
- basis for the judgment was the reliance on an insufficiently large database, the FSS's Footwear Database.
- Reliability of such databases need identifying
- Data needs to be deemed as 'sufficient'

NEED FOR A BARE FOOTPRINT DATABASE

- Need for data collection for interpretation of bare footprint impressions in order to create a more robust interpretation

Subjective, Evaluative Opinion

Objective, transparent

- Need for extensive database of different populations to interpret particular case scenarios
- Not for identification purposes but could be used for intelligence

CURRENT CHALLENGES IN DATABASE PRODUCTION

Database Requirements

- Robust data
- Representative
- Able to be easily contributed to
- Inexpensive to populate and maintain
- Samples fit-for-purpose

Challenges

- Limited number of forensic podiatrists
- Expensive method for obtaining control prints
- Varied methods of collecting samples in custody

Possible solutions

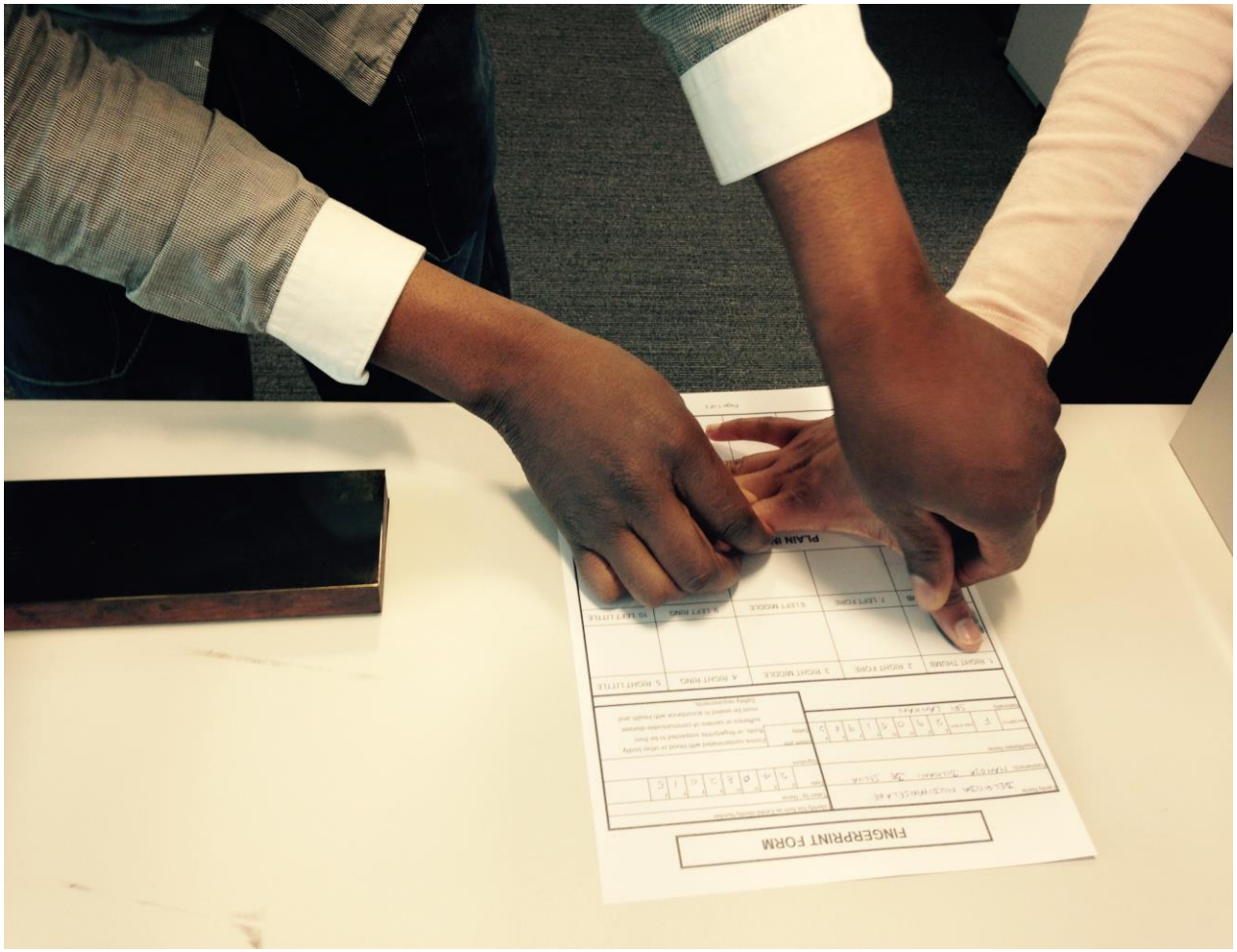
- Engage forensic science students/podiatrists
- Develop SOP's and proficiency test schemes
- Develop fit-for-purpose and inexpensive collection method

PROJECT AIMS

1. To identify a robust, reliable and cheap method for the continued collection of bare footprint impressions
2. To design a database that allows bare footprint impressions to be analysed and qualitative and quantitative measurements to be searched against.
3. To develop quality assurance procedures for people contributing data to the database
4. To query the collected data so as to determine intra and inter variability within different populations of bare footprints.

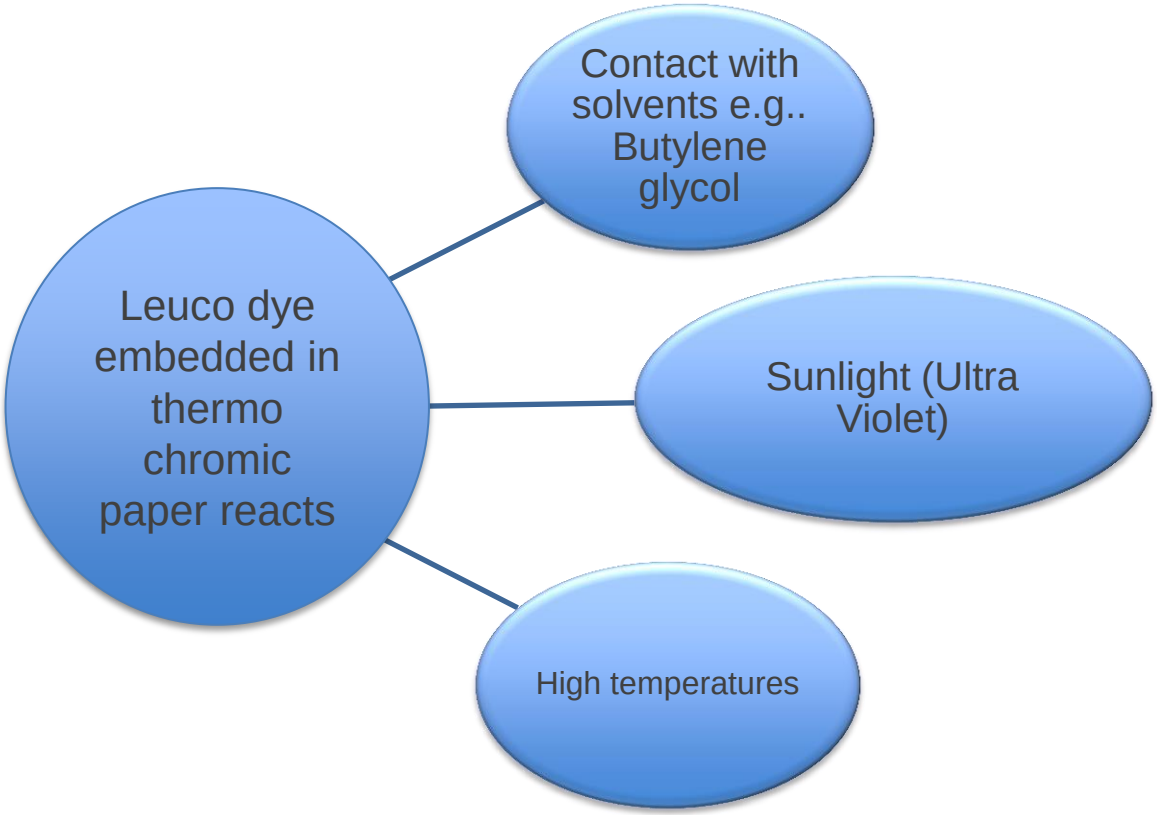
THE CURRENT PRACTICES FOR COLLECTING BARE-FOOTPRINT(S) SAMPLES

THE CRÈME AND THERMOCHROMIC PAPER (AKA FAX) IN FINGER-MARKS DEVELOPMENT



Bond, J.W., 2013. Capturing finger and palm impressions using a hand cream and thermo-chromatic paper. Journal of forensic sciences, 58(5), pp.1297–9.

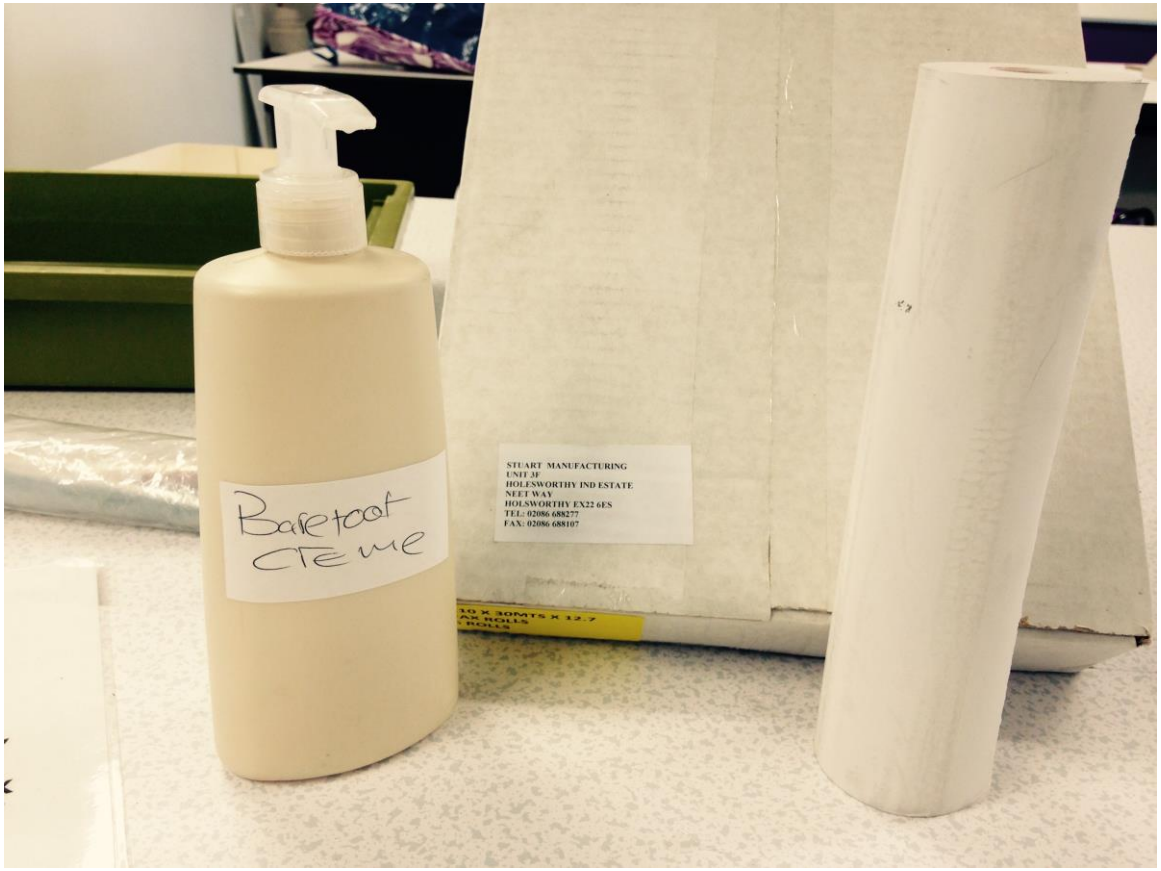
CRÈME AND THERMOCHROMIC PAPER



(Bond 2013)

AIMS OF CRÈME/FAX PAPER STUDY

- To identify whether the new crème and thermochromic paper method;
  - is easy to use
  - is comparable to extant methods
  - is more cost effective for large sample collection
- To identify optimum crème development and storage conditions
- To ascertain the extent of variation within sampling procedure and analyst measurement technique



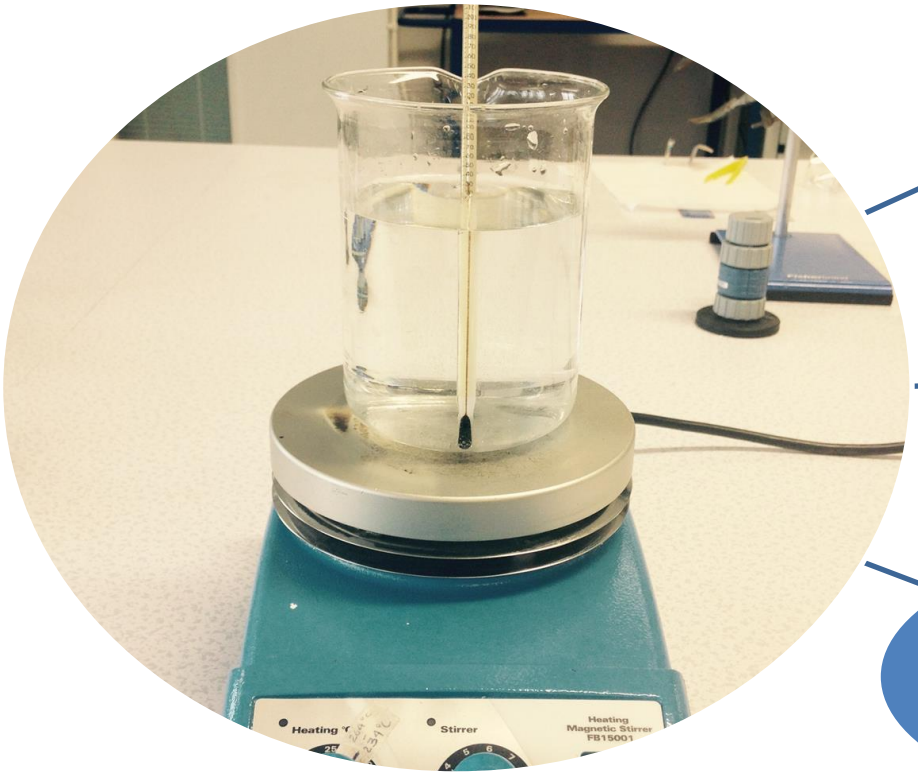
Creating the Optimum Crème and Thermo-chromic Paper System

MATERIALS FOR CRÈME DEVELOPMENT

500mL Triple distilled water
200mL Glycerol
30g Glyceryl stearate
200mL Glycerol
30g Glyceryl stearate
35g Cetearyl alcohol
45mL Butylene glycol
Hot plates x2
Thermometers x2

(Bond 2013)

METHOD FOR CRÈME DEVELOPMENT



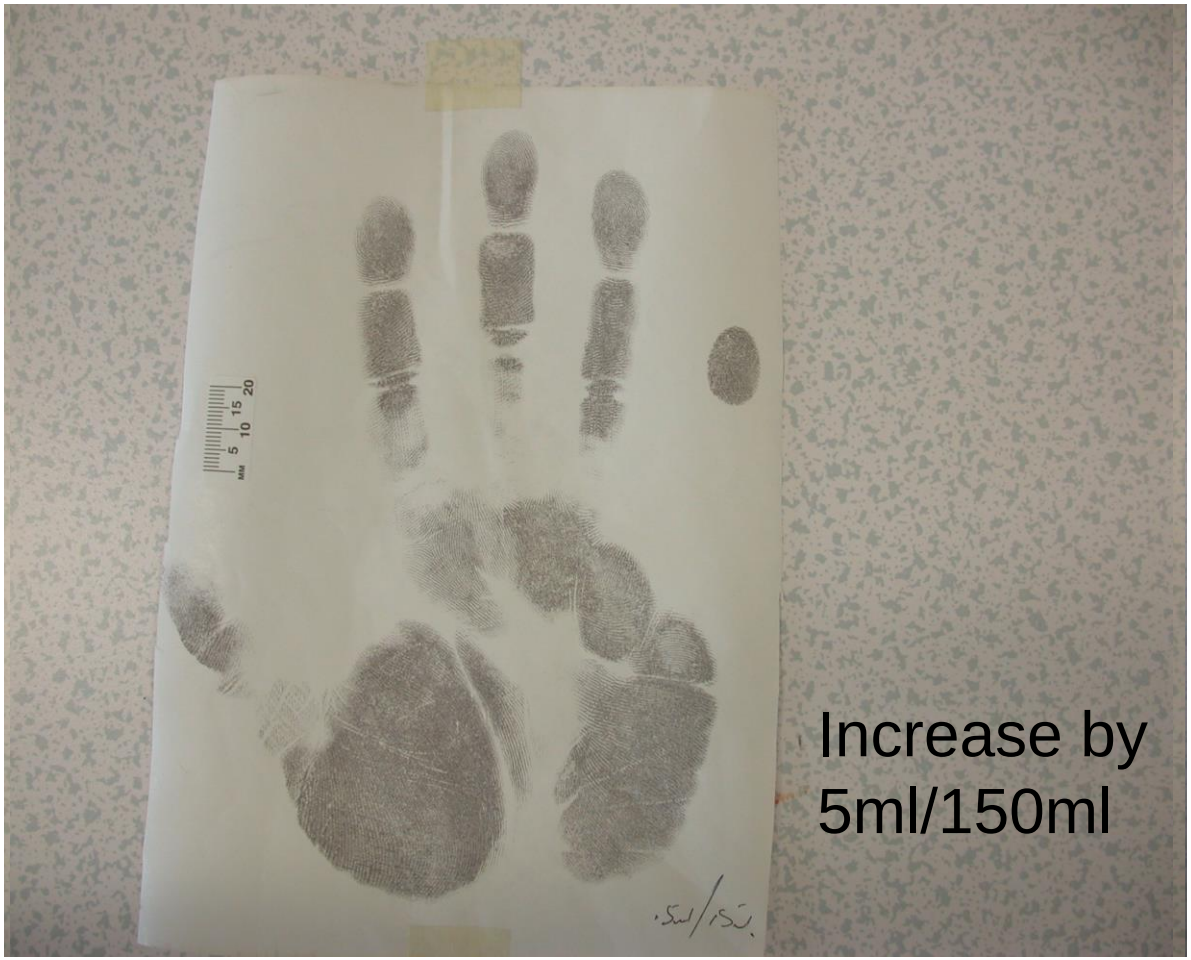
Temperature 80°C

Creating an emulsion of the water phase and oil phase

Incorporation of the desired quantity of the protic solvent (Butylene glycol)

(Bond 2013)

TESTING THE CRÈME ON THERMO-CHROMIC PAPER



(Bond 2013)

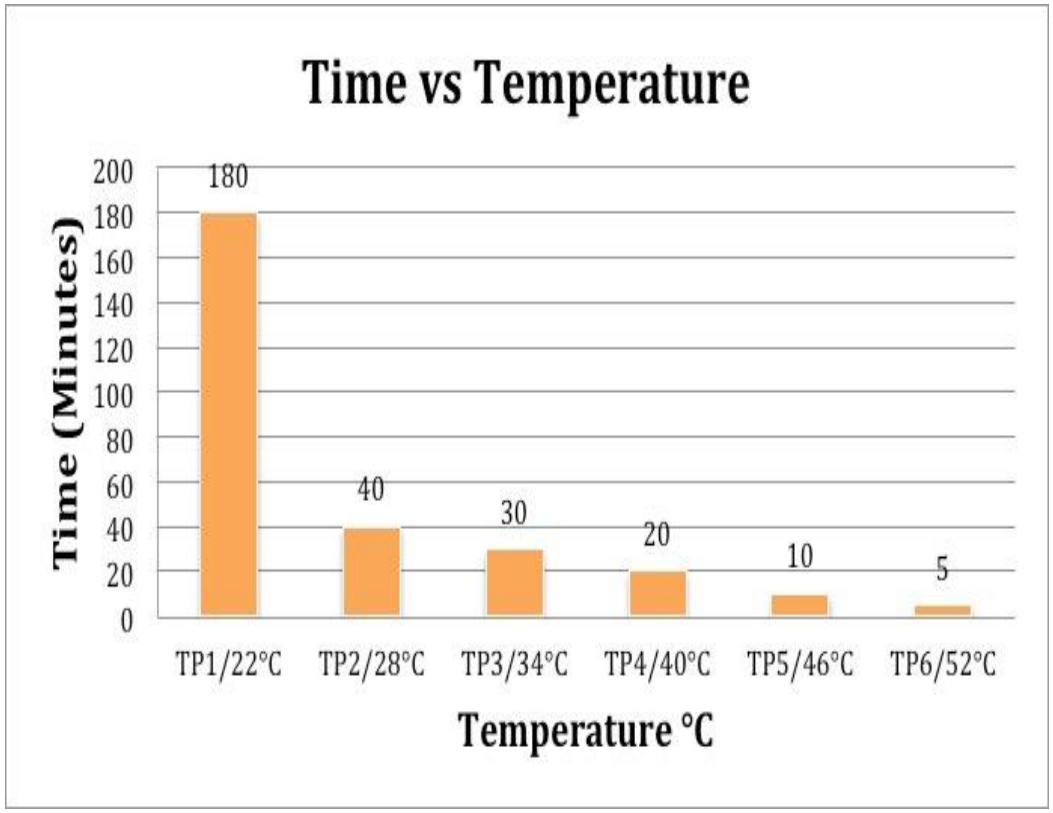
METHOD FOR TESTING OPTIMUM TEMPERATURES

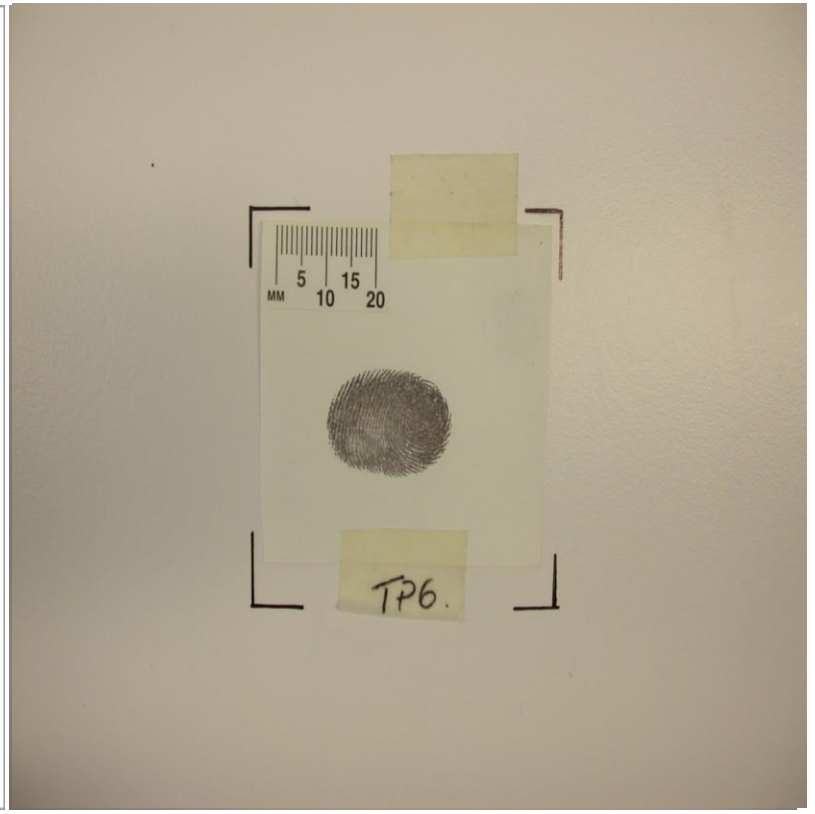
- 6x pieces of Roltech Fax paper measuring +/- 6 cm x 6cm:

Thermal Paper 1(TP1), Thermal Paper 2 (TP2) etc.

- Thermo Scientific Laboratory oven, equipped with a temperature regulator switch. Temperature is increased by 6ºC for each sample from 22ºC to 52ºC.
- Fingerprint sample created and placed immediately in the oven and observed at 5 minute intervals.

OPTIMUM TEMPERATURE RESULTS





STORAGE

7 days after contact of crème and thermo-chromic paper

90 days after contact of crème and thermo-chromic paper

CRÈME COLLECTION CONCLUSIONS

- Ratio of ingredients needs to be altered for use with bare-footprints
- Optimum temperature depends upon type of fax paper
- Will fade but this can be overcome by scanning asap after collection

COMPARING THE CRÈME SYSTEM TO EXTANT METHODS

Is it fit-for purpose?

QUANTITATIVE & QUALITATIVE ANALYSIS

Crème on thermo-chromic paper vs **Inkless ink on treated paper** vs **Fingerprint Ink on paper**

Bare-footprints → Static bare-footprints recorded on all conditions from one participant

(i) 1x Cream on Thermo-chromic paper
(ii) 1x Inkless ink on treated paper
(iii) 1x Fingerprint ink on paper

Qualitative observations

- Contrast
- Complete footprint outline
- Characteristics that include creases, humps, toe index, phalange marks etc.
- Presence of smudges or slippage that might affect quality

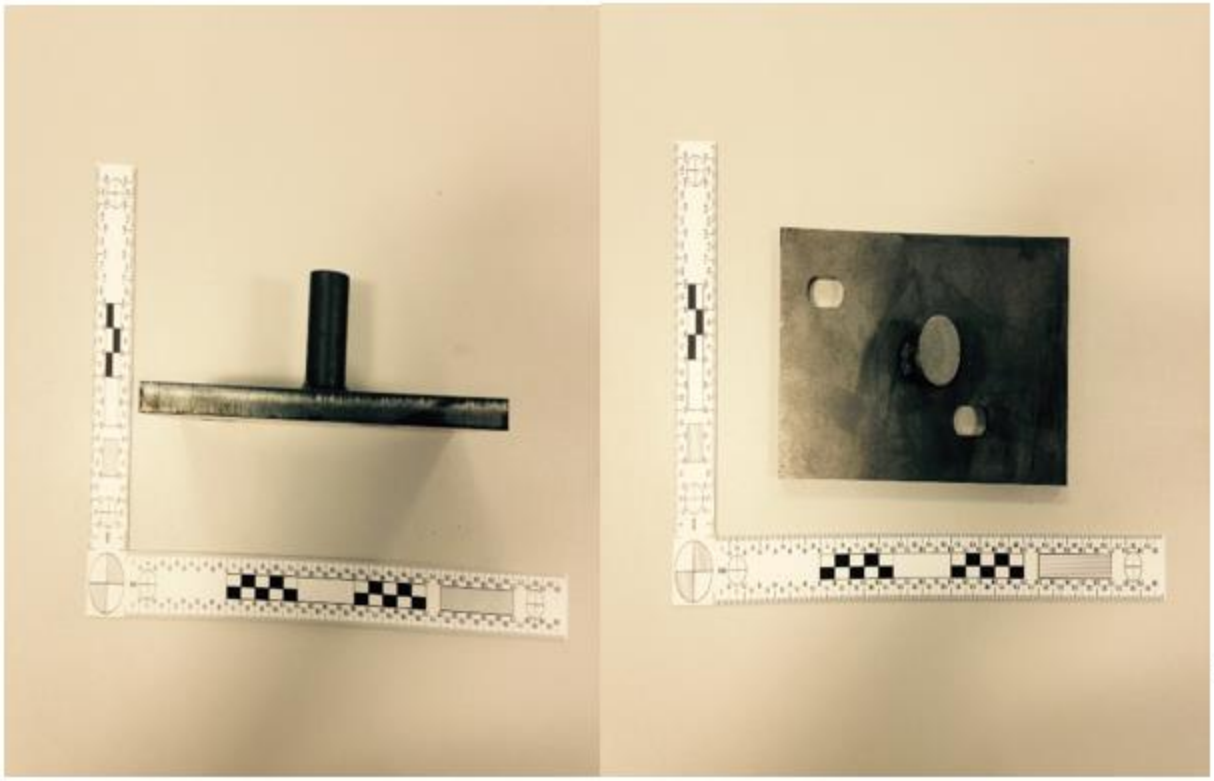
Controlled Sampler →

- Mild Steel flat plate
- Weight = 2.2 kg
- L= 195 mm W= 100mm T= 10mm

Quantitative Analysis

- Controlled repeated measures experiment on all conditions
  (i) 20x Crème on thermo-chromic paper
  (ii) 20x Inkless ink on treated paper
  (iii) 20x Fingerprint ink on paper

QUANTITATIVE & QUALITATIVE ANALYSIS



Metal plate control sampler

Control Sampler measurements

COMPUTER HARDWARE REQUIREMENTS FOR DATA STORAGE & SOFTWARE FOR ANALYSIS

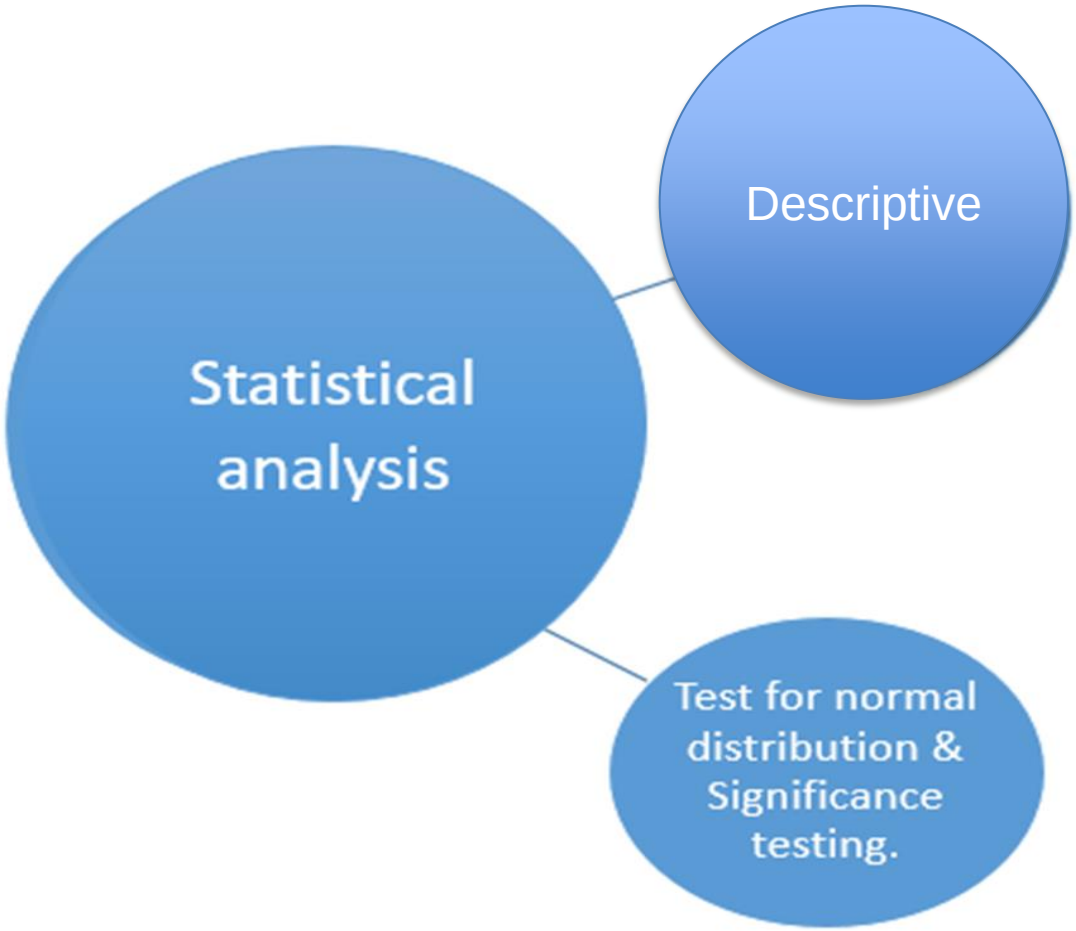
Hardware

- Laptop or computer with new generation processors
- Flatbed Scanner with optical resolution 150dpi (Set default to RAW or TIFF format to prevent image alteration)
- Camera equipped with a 50mm lens (DiMaggio & Vernon. 2011)
- At least 2gb camera memory card
- At least 250gb storage to cope with large image files or to start with.

Computer Software

- Gimp GNU Image manipulator (open source software), (Reel 2012).
- Adobe Photoshop.
- Clic Morphometrics software (Borstler 2014).
- TPS dig, Geometric Morphometrics software (Domjanic et al 2013).

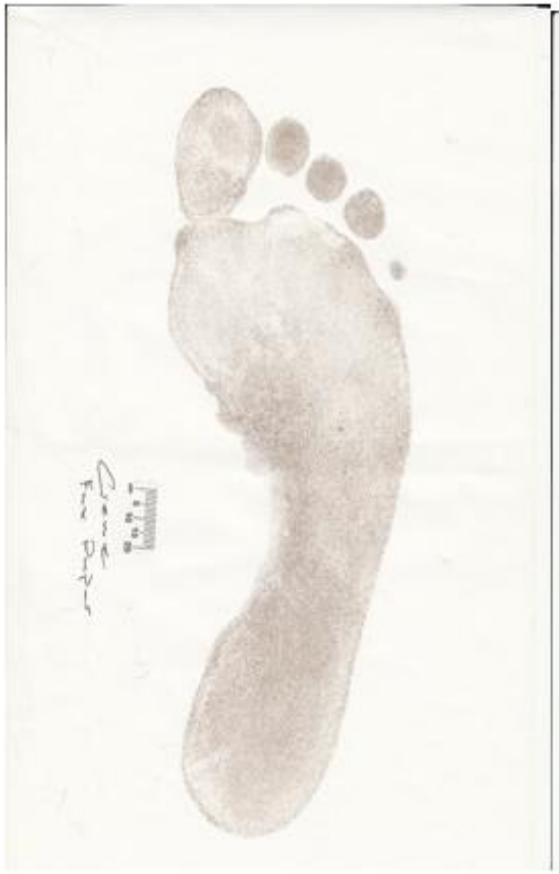
STATISTICAL ANALYSIS OF QUANTITATIVE MEASUREMENTS



- Mean
- Mode
- Minimum and maximum
- Range
- Standard deviation

- Kolmogorov – Smirnov Test
- Histograms for observing skew and distribution
- Significance testing (Wilcoxon sign rank test, Paired T-test)

QUALITATIVE RESULTS



Cream on Thermo-chromic paper

Inkless ink and Treated paper

Fingerprint Ink and Paper

QUANTITATIVE RESULTS

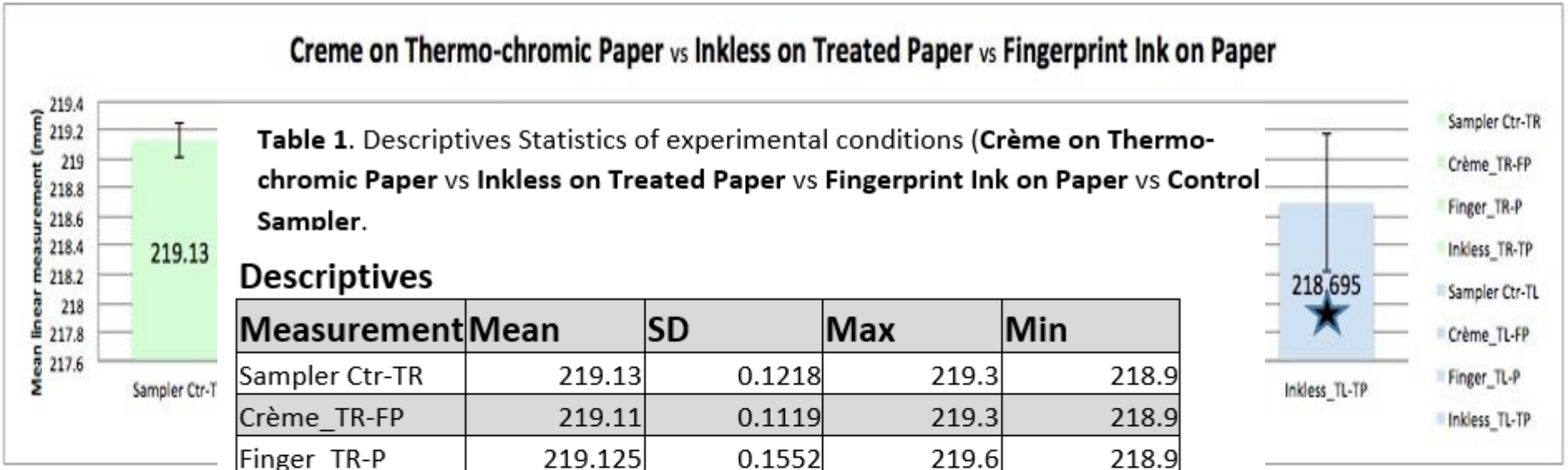


Table 1. Descriptives Statistics of experimental conditions (**Crème on Thermo-chromic Paper** vs **Inkless on Treated Paper** vs **Fingerprint Ink on Paper** vs **Control Sampler**.

Descriptives

Measurement	Mean	SD	Max	Min
Sampler Ctr-TR	219.13	0.1218	219.3	218.9
Crème_TR-FP	219.11	0.1119	219.3	218.9
Finger_TR-P	219.125	0.1552	219.6	218.9
Inkless_TR-TP	218.575	0.2613	219	217.9
Sampler Ctr-TL	219.045	0.0999	219.2	218.9
Crème_TL-FP	219.06	0.0883	219.2	218.9
Finger_TL-P	219.03	0.175	219.2	218.4
Inkless_TL-TP	218.695	0.474	219.7	218

★ Indicates significa

TL

n=20

INVESTIGATING VARIATION IN ANALYST MEASUREMENTS

- 3 x static bare footprints from one donor obtained using crème – each of varying quality; low, medium, high

- Each scanned image measured 25x by same analyst across different periods of the day using GIMP

High Medium Low

TESTING THE PRECISION OF MEASUREMENT METHOD

Table 2. Descriptive Statistics of the Precision of Measurement Method **(High, Medium and Low Quality of Static Bare-footprints Measurements)**

Descriptives

Quality	Mean	SD	Max	Min
High_TL1	251.44	0.2566	252	251
Medium_TL1	256.464	0.4405	257.2	255.4
Low_TL1	252.62	0.3	253.1	252
High_TL2	247.292	0.2272	247.9	246.9
Medium_TL2	248.196	0.3984	248.8	247
Low_TL2	247.08	0.2255	247.6	246.6
High_TL3	237.732	0.2376	238.3	237.4
Medium_TL3	238.652	0.3137	239.2	238.2
Low_TL3	236.532	0.2561	237.2	236
High_TL4	228.86	0.255	229.5	228.5
Medium_TL4	230.052	0.2417	230.5	229.6
Low_TL4	228.472	0.2475	229.1	228
High_TL5	209.604	0.2336	210	209
Medium_TL5	212.008	0.2957	212.7	211.4
Low_TL5	211.704	0.3553	212.9	211.3
High_WB	106.788	0.5585	107.7	106.1
Medium_WB	105.456	0.9111	107.2	103.4
High_HB	56.32	0.2021	56.7	56
Medium_HB	54.968	0.5483	55.9	54.3

n=25

CAN WE USE THE CRÈME AND THERMAL PAPER?

- Results indicate that;
  - Qualitatively the crème/thermal paper are comparable to extant methods and deemed better than ink-less paper/pencil paper
  - Quantitatively all of the methods show slight differences to the sampler
    - analysts method of measurement – some variability seen
    - Reproducibility of sampler

If creation of impressions is comparable to extant methods, what other factors should be considered before choosing which method?

COST BENEFITS

Ink/Paper

- 7.9p/sample, $0.12/sample, € 0.11/sample
- Approx £1.58/$2.48/€2.24 per individual
- Unlimited shelf life, no storage issues.

Treated paper/Inkless Pad

- 70p/sample, $1.10/sample, € 0.99/sample
- Approx £14/$22/€20 per individual
- 1 year shelf life

Crème/Thermal Paper

- 7.4p/sample, $0.12/sample, € 0.11/sample
- Approx £1.48/$2.32/€ 2.10 per individual
- Unlimited shelf life but careful storage

Exchange rate as of 19/8/15

THE MESS!

NEXT STEP FOR BARE-FOOTPRINT DATABASE PRODUCTION & PROJECT

- Crème system to be utilised
- Create an SOP for the use of the crème that is fit-for-purpose for obtaining controls from suspects/participants.
  - Survey of current international practices
- Initially, 6 population groups (minimum of 25 participants/group
- Investigate data for correlations in features within and between groups
- Creation of a sustainable database

THANK YOU FOR LISTENING

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