Upsides and Downsides of Successive New DNA Technologies for Operational Forensics

ESRC Seminar, Durham University

Dr Angela Gallop
Chief Executive, Axiom International

16 March 2016

Contents

AXIOM INTERNATIONAL

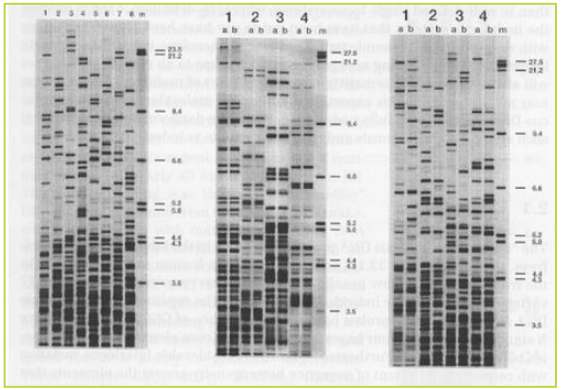
- My Background
- Successive Technical Advances
  - Benefits and Challenges
- Summary of Upsides and Downsides
- Looking Forward
- Future Challenges

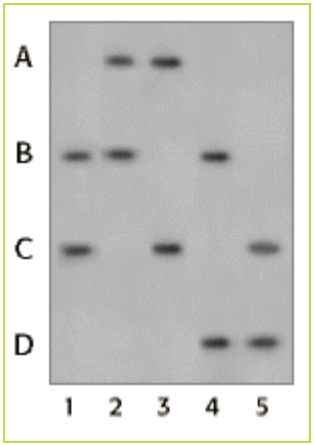
My Background

- Traditional forensic biologist
- HOFSS, Forensic Access, Forensic Alliance, LGC Forensics, and Axiom International Ltd
- Increasingly specialising in complex cases
- Using DNA
- Setting up and running forensic laboratories
- Including DNA
- But not a DNA expert *per se*
- Reviewing and advising about laboratories and individual cases

Early Analytical Techniques

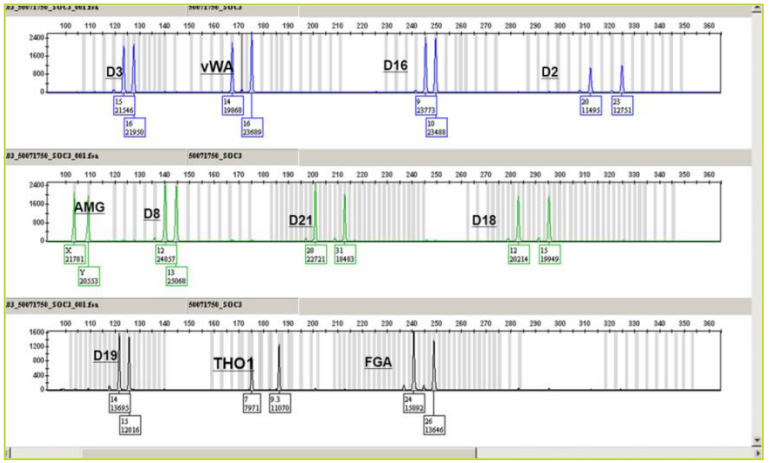
- **Multi Locus Probes (MLP): (1985)**
  - Massively more discriminating than blood grouping
  - But still needed a lot of starting material
- **DQα: (1991/3)**
  - Needed much less starting material
  - But much less discriminating than MLP
- **Single Locus Probes (SLP): (1990/7)**
  - Like DQα, needed much less starting material
  - But substantially more discriminating





Short Tandem Repeats

- **STR Quad (1994/5), SGM (1995/6), SGM+ (1999)**
  - Increasingly more discriminating and requiring successively smaller amounts of starting material
  - But no competition on price of kits, and risk of being blinded by statistics eg. Bolton burglary



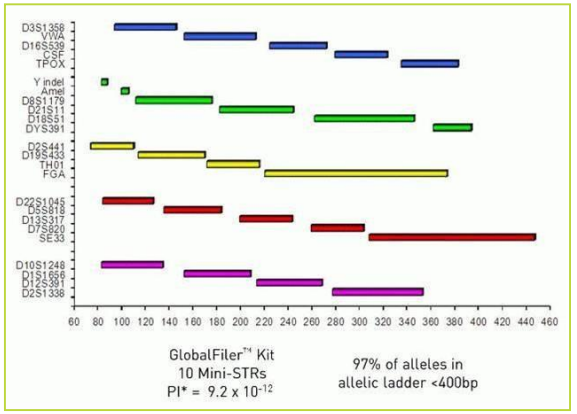
- **LCN (2001)/Enhancement (2004)/DNA SenCE (2006)**
  - Needed much less starting material and just as discriminating
  - But greater risk of contamination contributing to results eg. Omagh bombing

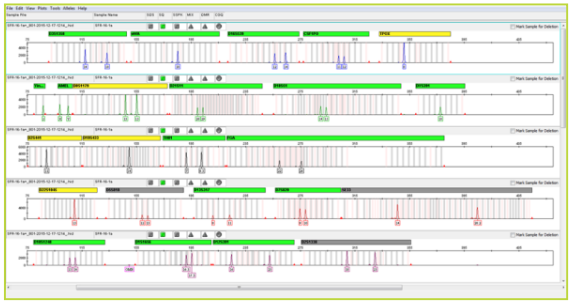
Optional Extras

- **Mt DNA, Identifiler, Minifiler, Y-Filer**
- Variously enabled eg:
  - analysis of wider range of samples
  - greater discrimination
  - better understanding of relative contributions in mixed samples
  - better results from degraded samples

Current Analytical Techniques

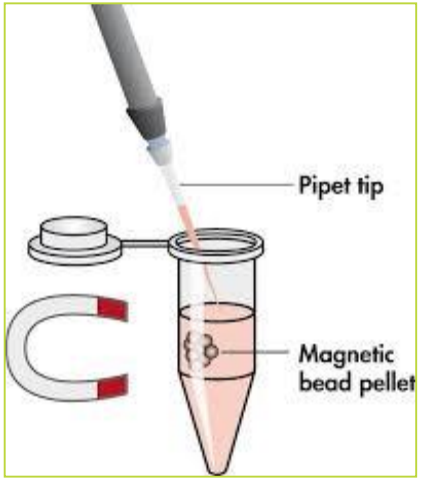
- DNA17 (2014), Globalfiler, Powerplex Fusion
- Incorporating some of optional extras
- All extremely discriminating and requiring extremely little starting material
- Producing many more results - with advanced software programmes for mixture deconvolution
- But increased risk of contributing contamination and difficulty with interpretation, eg. Laboratory staff contamination
- Especially in absence of up-to-date transfer and persistence studies and increasing ignorance of individual case contexts eg. fragmentation selection and streamlined reporting (SFR)





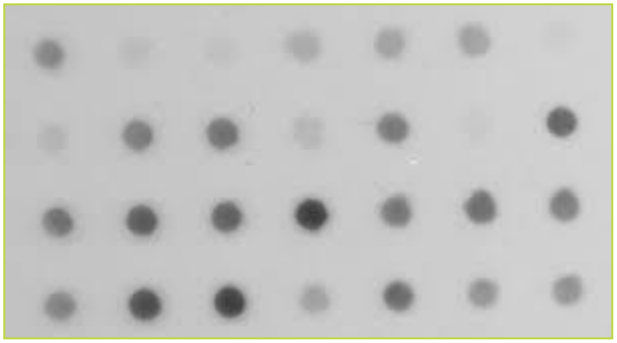
Extraction of DNA

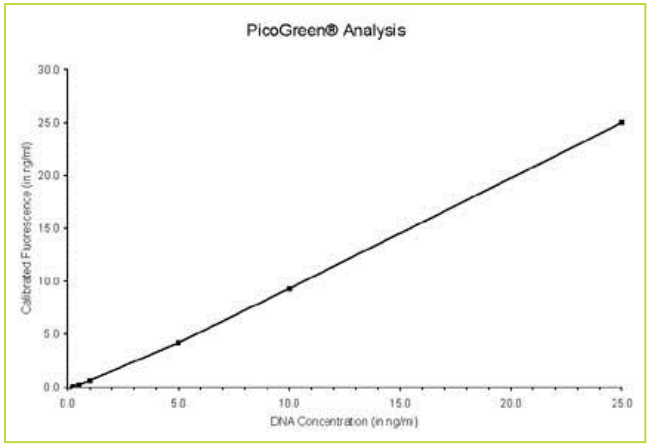
- Innovation also in extraction and quantifying DNA
- Chemical extraction to bead technologies to automation
- Enabling better extraction, faster extraction and extraction of high volumes of samples
- But can still give rise to problems even in the best labs eg. GMP case involving contaminated consumables



Amount of DNA

- Dot blot to picogreen to realtime PCR
- Increasingly more reliable estimates of how much DNA, and how much human, how much male, and presence of degraded or inhibited DNA
- To focus analysis, save money and avoid mistakes
  eg. Rachel Nickell and Operation Cube





Upsides

- Incredibly powerful tool for identifying source of body fluids and tissues/traces and providing evidential links
- Applicable to wide range of samples/items in all types of criminal activity/cases
- Ideal for investigating historic cases - lasts a long time and detected and analysed in tiny quantities
- National DNA Database routinely provides identifications from cold
- Can now interface effectively with other DNA databases to fight international serious and organised crime

Downsides

- Successive technologies providing increasingly mind numbing statistics
- No common agreement on application of statistics, or clear understanding of statistics by end users
- Insufficient attention paid to transfer and persistence studies using newer techniques, and contextual understanding
- Compounded by eg:
  - Increasingly narrow selection of items to test
  - Summary reports, not always compiled by DNA experts

Forensic Science Regulator
Overseeing Quality

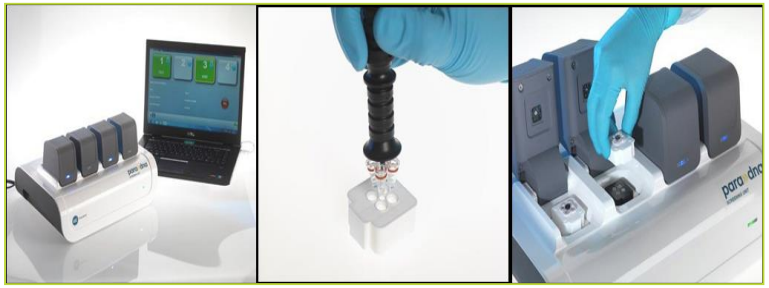
Report

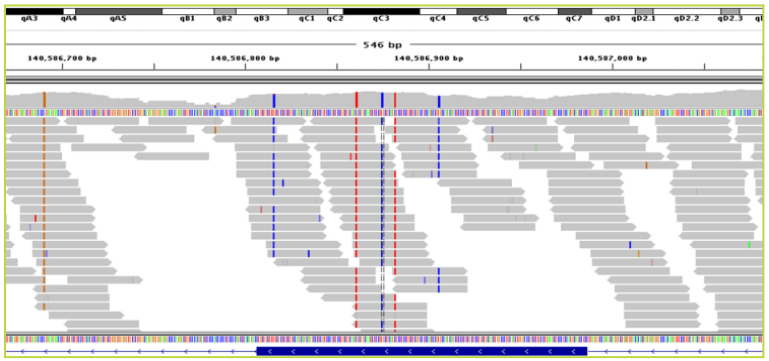
Report into the circumstances of a complaint received from the Greater Manchester Police on 7 March 2012 regarding DNA evidence provided by LGC Forensics.

Mr Andrew Rennison MSc
17 September 2012
FSR-R-618

Looking Forward

- Next Generation Sequencing for: ‘Ultimate’ identification
  - Information about physical appearance
  - Indication of ancestry/ethnicity
- Rapid, more-or-less portable analytical processes for ‘real time’ information





Future Challenges

- Addressing some old chestnuts eg:
  - How was the DNA deposited?
  - In what was it deposited?
  - When was it deposited?
- Addressing new chestnuts eg:
  - Ethics and data protection
  - Forensics increasingly provided by police
- And always
  - What does the DNA mean in specific case contexts

Upsides and Downsides of Successive New DNA Technologies for Operational Forensics

ESRC Seminar, Durham University

Dr Angela Gallop
Chief Executive, Axiom International

16 March 2016