



*PART 2:
EVALUATING
FORENSIC DNA
EVIDENCE*

*ESSENTIAL ELEMENTS
OF A COMPETENT
DEFENSE REVIEW*

*BREAKING OPEN
THE BLACK BOX:
HOW TO REVIEW THE
ELECTRONIC DATA*

Reviewing the electronic files produced by the ABI Prism 310 Genetic Analyzer™ (or similar equipment) has a number of additional benefits beyond revealing unreported low-level peaks. The software that controls these devices creates a complete record of all operations the device performs while typing samples in a particular case and records the results for each sample. These records can reveal a variety of problems in testing that a forensic laboratory may fail to notice or choose not to report, such as failure of experimental controls, multiple testing of samples with inconsistent results, re-labeling of samples (which can flag potential sample mix-ups or uncertainty about which sample is which), and failure to follow proper procedures. We know of several cases in which review of electronic data has revealed that the laboratory failed to run all of the necessary control samples needed to verify the reliability of the test results, or that the laboratory ran the control samples under different conditions than the analytical samples (a major breach of good scientific practice).

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The electronic files are also useful for producing trial exhibits. An expert with the right software can convert the files from their proprietary format into Adobe Acrobat™ files containing images that can easily be inserted into Powerpoint™ and Microsoft Word™ documents.

It is easy for crime laboratories to produce the electronic data that underlie their conclusions. All that is necessary is to copy the files produced in the case onto a CD-ROM or other storage medium. CD-ROMs are generally preferred because they create an unalterable record of the data produced by the laboratory. Copying files to a CD-ROM is a simple point and click operation that can be accomplished in fifteen minutes or less in most cases. CD-ROM burners compatible with any laboratory computer are available commercially for under \$200. There is no legitimate excuse for refusing to turn over electronic data for defense review. In a few instances laboratories have resisted producing electronic files, or have even destroyed the files, but the great majority of trial courts will not tolerate such obstructive behavior.

The electronic data produced by the ABI 310 Genetic Analyzer™ is in a proprietary format that can only be read and interpreted by ABI's Genescan™ and Genotyper™ software. Defense lawyers seeking a review of electronic data must find an expert who has access to this software. The review process typically takes a minimum of 3-4 hours, and may take much longer in an even moderately complicated case. The recent development of "expert system" software for analyzing Genescan™ and Genotyper™ data (see Sidebar) provides another option for analysis of electronic data.

Are there innocent explanations for the lab's findings?

In many cases, careful review of the underlying laboratory notes, electropherograms and electronic data will reveal no significant problems. Defense lawyers should never forget, however, that even clear-cut DNA test results may have innocent explanations.

Sample handling errors. Accidental mix-up or mislabeling of samples is a possibility that always must be considered. We have encountered a number of such errors while reviewing case work.¹ In most instances the mix-ups readily come to light (and are caught by the lab) because they produce unexpected results: Samples that are supposed to be from a man show a female DNA profile, two samples known to be from the same

person show different DNA profiles, and so on. The real danger arises when sample mix-ups produce plausible results. In these instances, forensic analysts may overlook subtle clues that something is amiss because they expected to find the very result produced by their error.

For example, after reviewing the laboratory notes in a Philadelphia rape case, one of the authors noticed some clues (later confirmed by additional testing) that the Philadelphia Police Crime Laboratory had mixed up the reference samples of the defendant and the rape victim. This mix up had falsely incriminated the defendant because the lab found what it thought was the defendant's DNA profile in a vaginal swab from the victim. In fact, it was the victim's own profile, and was mistakenly matched to the defendant due to the mix up.² Similar errors have come to light in other cases. Cellmark Diagnostics mistakenly mixed up the victim and defendant in a San Diego rape case, thereby mistakenly incriminating the defendant.³

The Las Vegas Crime Laboratory made the same error in a recent Las Vegas rape case.⁴ This error, which came to light in April 2002, sent the wrong man to jail for over a year. In both cases the error came to light only after a defense expert noticed inconsistencies in the laboratory records.

It is not always possible to tell from the laboratory records whether samples *actually* were mixed up or cross-contaminated. However, careful review of the laboratory records will usually provide important information about whether such errors *could have happened*. For example, evidence that a reference sample from the defendant was handled or processed in close proximity to samples from the crime scene can support the theory that a sample handling error explains incriminating results. In one case, review of a criminalist's notes showed that the defendant's trousers, collected at his home, were transported to the laboratory in the same box that contained a number of items from the crime scene that were saturated with the victim's blood. This fact cast important new light on a seemingly incriminating result: blood from victim was detected on the defendant's trousers.

We suggest that defense lawyers obtain and review complete copies of all records related to evidentiary samples collected in the case (see Appendix for a model discovery request). It should be possible to document the complete his-

tory of every sample from the time it was initially collected through its ultimate disposition.

Inadvertent transfer of DNA

One of the most striking developments in forensic DNA testing in recent years is the testing of ever smaller biological samples. Whereas the original DNA tests required a fairly large amount (*i.e.* a blood stain the size of a dime) of biological material to get a result, current DNA tests are so sensitive that they can type the DNA found in samples containing only a few cells. There is likely to be enough of your DNA on the magazine you are reading right now for your DNA profile to be determined by a crime lab.

The increasing sensitivity of DNA tests has affected the nature of criminal investigations and has created a new class of DNA evidence. Analysts talk of detecting "trace DNA," such as the minute quantities of DNA transferred through skin contact. DNA typing is currently being applied, with varying degrees of success, to samples such as doorbells pressed in home invasion cases, eyeglasses found at a crime scene, handles of knives and other weapons, soda straws, and even single fingerprints.

These developments will bring more DNA evidence to court in a wider variety of cases and may well open new lines of defense. A key issue will be the potential for inadvertent transfer of small amounts of DNA from one item to another, a process that could easily incriminate an innocent person. Studies have documented the presence of typeable quantities of human DNA on doorknobs, coffee cups and other common items.⁵

Studies have also documented the inadvertent transfer of human DNA from one item to another.⁶ *Primary transfer* occurs when DNA transferred from a person to an item. *Secondary transfer* is when the DNA deposited on one item is transferred to a second item. *Tertiary transfer* is when the DNA on the second item is, in turn, transferred to a third. There are published studies that document secondary transfer of DNA (in quantities that can be detected by STR tests) from items that people simply touched to other items.

A recent study commissioned by a wealthy defendant was used to show that tertiary transfer of DNA could have occurred in a manner that falsely incriminated the defendant. Dr. Dirk Greineder, a prominent physician and adjunct Harvard professor, was accused



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NACDL members with an oral argument scheduled in a federal court of appeal can hone their skills before a panel of mock judges consisting of attorneys, professionals, and law students. At least six weeks prior to oral argument, members wishing to use this service should submit a one-page "bench memo" to the coordinator(s) listed below in the circuit where the case will be heard. Coordinators will screen cases and arrange for a panel of mock judges. The panel will attempt to accommodate every request, but given the volume of federal appeals, the coordinators will have the discretion to prioritize cases, favoring those that raise significant appellate issues.

CIRCUIT COORDINATORS

Please contact the coordinator in the circuit where the case will be heard.

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of killing his wife. A DNA profile similar to Greineder's was found, mixed with his wife's profile, on gloves and a knife found near the crime scene. Greineder denied touching these items, which appeared to have been used by the killer. But how did his DNA get on them?

Greineder offered a two-pronged defense.

First, he challenged the conclusion that his DNA matched that on the gloves, noting inconsistencies between his profile and the profile on the gloves. The crime laboratory had shifted its threshold for scoring alleles in a manner that allowed it to count alleles that matched with Greineder, while ignoring some that did not. And the lab had to evoke the theory of "allelic drop out" to explain why some of Greineder's alleles were not found.

Greineder's second line of defense is our focus here. He argued that his DNA could have gotten onto the glove through tertiary transfer. He and his wife had shared a towel the morning of the murder — perhaps his DNA was transferred from his face to the towel, and from the towel to his wife's face. His wife was later attacked by a glove-wearing stranger who struck her on the face, strangled her, and stabbed her, in the

process transferring Greineder's DNA from his wife's face to the gloves and the knife. According to this theory, the tell-tale extra alleles on the gloves and knife that matched neither Greineder nor his wife were those of the killer.

To support the theory that his DNA could have been transferred innocently to the instruments of murder, Greineder commissioned a study. Forensic scientists Marc Taylor and Elizabeth Johnson, of Technical Associates (an independent laboratory in Ventura, California) simulated the sequence of events posited by the defense theory: A man wiped his face with a towel, then a woman wiped her face with the towel, then gloves and a knife like those used in the murder were rubbed against the woman's face. DNA tests on the gloves and knife revealed a mixture of DNA from the man and woman — exactly what was found in the Greineder case.⁷ Taylor was allowed to present his findings to the jury. Although the jury ultimately convicted Greineder (there was other incriminating evidence besides the DNA) the case is a good example of how the amazing sensitivity of contemporary DNA profiling methods facilitate a plausible explanation for what might at first seem to be a damning DNA test result.

Finding experts

The complexity of short tandem repeat (STR) testing makes it difficult if not impossible for a lawyer to evaluate the evidence without expert assistance. Defense lawyers generally need expert assistance to look behind the laboratory report and evaluate whether its conclusions are fully supported by the underlying data. Defense lawyers may also need expert assistance to develop and assess alternative theories of the evidence. Experts can also be helpful, and often are necessary, to assess whether laboratory error or inadvertent transfer of DNA might plausibly account for the incriminating results.

In our experience, the best experts for evaluating whether the lab's finding are supported by the underlying data are academic scientists in the fields of molecular biology, biochemistry, bioinformatics, molecular evolution, genetics (particularly human and population genetics), and related fields. It is not essential that the expert have had experience analyzing forensic samples. In fact, we find that forensic scientists often (but not always) make poor defense experts because they tend to accept too readily the goal-directed subjective judgments and circular reasoning of their crime lab

Ethics Hotline

Need advice
on ethical
questions arising
in your practice?



Contact the NACDL Ethics Advisory Committee. All requests are handled in confidence, covered within the attorney-client privilege. Ethics Hotline available for emergency situations. Formal written opinions available upon request.

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Whenever possible, requests for assistance should be in writing, setting forth all relevant facts and circumstances. In urgent situations, oral requests will be accepted.

colleagues.

Academic scientists generally have much stronger training in scientific methods and, as a result, demand that test results be interpreted in a scientifically rigorous and unbiased manner. They often are appalled at the willingness of some forensic scientists to rely on subjective judgment and guesswork to resolve ambiguities in scientific data and their unwillingness to utilize blind procedures when making such judgments.

Having the electronic data analyzed by a company like Forensic Bioinformatics Services can make it easier to work with an expert. The FBS analysis eliminates the need for the expert to do several hours of tedious work that requires specialized software, making it possible for the expert to get to the heart of the matter more quickly. The FBS reports also highlight potential issues and problems that the attorney can use to get the interest of an expert.

Conclusions

Careful review of DNA evidence can reveal a variety of potential weaknesses, making it possible in some cases to challenge the government's conclusions and offer alternative interpretations. In order to provide effective representation to a client incriminated by DNA evidence, the defense attorney must do more than simply read the laboratory's conclusions. It is important to obtain and review the underlying scientific records, including electronic data, in order to determine whether the laboratory's conclusions are fully supported by the test results. It is also important to evaluate alternative explanations for the test results, to determine whether there are plausible innocent explanations. Promoters of DNA testing have effectively used the media to convince most people, including potential jurors, that the tests are virtually infallible. As DNA testing becomes more common in the justice system, it is vital that defense lawyers give it careful scrutiny in order to detect and expose those cases where genetic evidence deserves less weight than it is otherwise likely to receive.

Notes

1. See, William C. Thompson, Franco Taroni, and Colin G. Aitken, *How the probability of a false positive affects the value of DNA evidence*, J. FORENSIC SCI. (January 2003, in press).

2. See *Id.* for further discussion of this case. Copies of the laboratory reports may be obtained from William C. Thompson.

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3. *Id.*

4. Glen Puit, *DNA Evidence: Officials admit error, dismiss case. LV lab put wrong name on sample*, LAS VEGAS REVIEW-JOURNAL, April 18, 2002.

5. See, van Oorschot *DNA fingerprints from fingerprints*, NATURE, June 19, 1997, 767; Findlay, *et al.*, *DNA fingerprinting from single cells*, NATURE, October 9, 1997, 555-556; Ladd, *et al.*, *A systematic analysis of secondary DNA transfer*, 1999 J. FORENSIC SCI. 44(6): 1270.

6. Ladd, *et al.*, *supra* note 5.

7. An unpublished report on this study may be obtained from William C. Thompson. ■

Travis Doom, Ph.D., is an assistant professor in the Department of Computer Science and Engineering at Wright State University in Dayton, Ohio. He played a key role in development of Genophiler™, the automated system for re-analysis of STR data discussed in this article.



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APPENDIX:

MODEL DISCOVERY REQUEST FOR STR TEST RESULTS

DISCOVERY REQUEST

This is a request for disclosure of scientific materials pertaining to DNA testing performed in the case of [case name] ([County, Case Number]). This request applies to all DNA testing that has been, is currently being, or will be performed in the instant case. The request is ongoing. In the event that new materials responsive to this request are produced, discovered, or otherwise come into the possession of the prosecution or its agents, said materials should be provided to the defendant without delay.

In the event that there is a charge for reproducing any of these materials please include an itemized list indicating the number of items (for example number of pages of documents, number of photographs, X-ray films, number of CD-ROMs, etc.) and the cost of copying per item.

1. **Case file:** Please provide a complete copy of the case file including all records made by the laboratory in connection with this case. If the file includes photographs, please include photographic quality copies.
2. **Laboratory Protocols:** Please provide a copy of all standard operating protocols (SOPs) used in connection with the testing in this case. To minimize any burden of duplicating these items, we invite you to provide them in electronic form.
3. **Chain of custody and current disposition of evidence:** Please provide copies of all records that document the treatment and handling of biological evidence in this case, from the initial point of collection up to the current disposition. This information should include documentation which indicates where and how the materials were stored (temperature and type of container), the amount of evidence material which was consumed in testing, the amount of material which remains, and where and how the remaining evidence is stored (temperature and type of container).
4. **Software:** Please provide a list of all commercial software programs used in the DNA testing in this case, including name of software program, manufacturer and version used in this case.
5. **Macros:** If the results produced by the software are dependent on the instructions contained in macros, please provide copies of any macros used. (For analyses performed with GeneScan and Genotyper, these macros are contained in Genotyper output files in order to allow analysts to interpret the results. Simply

providing a copy of the Genotyper output files in response to request 6 will satisfy this request as well).

6. **Data files:** Please provide copies of all data files used and created in the course of performing the testing and analyzing the data in this case. These files should include all data necessary to, (i) independently reanalyze the raw data and (ii) reconstruct the analysis performed in this case. For analyses performed with GeneScan and Genotyper, these materials should include
 - (6.1) All collection files (such as injection lists and log files for an ABI 310 analysis).
 - (6.2) All Genescan files, including sample files and project files.

All Genotyper files, including templates/macros (see Request 5).

7. **STR frequency tables:** Please provide copies of any allelic frequency tables relied upon in making statistical estimates in this case. If the laboratory relied upon published or publicly available data, this request can be satisfied by providing a specific reference to the source.
8. **Instances of Unintended DNA Transfer or Sample Contamination:** Please provide copies of all records maintained by the laboratory that document instances of unintended transfer of DNA or sample contamination, such as any instances of negative controls that demonstrated the presence of DNA or the detection of unexpected extra alleles in control or reference samples, and any corrective measures taken.
9. **Accreditation:** Please provide copies of all licenses or other certificates of accreditation held by the DNA testing laboratory.
10. **Laboratory personnel:** Please provide background information about each person involved in conducting or reviewing the DNA testing performed in this case, including:
 - Current resume
 - Job description
 - A summary of proficiency test results