SUPREME COURT OF NOVA SCOTIA
Citation: *R. v. Dechamp*, 2019 NSSC 367

Date: 20191210
Docket: CRH 482935 and 487728
Registry: Halifax

Between:

Her Majesty the Queen

v.

Tyrell Peter Dechamp

DECISION

RE: CYBERGENETICS REPORT ADMISSIBILITY

Judge:	The Honourable Justice Jamie Campbell
Heard:	October 9, 21, 22, 23, 24, 25, 30, 31, November 1 and 15, 2019, in Halifax, Nova Scotia
Written Decision:	December 10, 2019
Counsel:	Tanya Carter, Josie McKinney and Kim McOnie, for the Crown Anna Mancini, Brandon Rolle and Geoffrey Newton, for the Defence

By the Court (Orally):

[1] Tyrell Dechamp is facing two murder trials. The Crown wants to put scientific evidence before the jury. On one level the evidence is quite simple. It involves the analysis of a DNA sample from a shoe. The DNA sample was one from which the usual forms of DNA analysis used by forensic laboratories in Canada could not be used to reach any conclusion. When data from the DNA sample was sent to a company in the United States for analysis, they could form an opinion that would result in the shoe being inculpatory evidence. It is on that level that the evidence is quite simple.

[2] On another level the evidence is complicated. The process used to collect the DNA sample and to extract the data from it was unremarkable. It was done by the RCMP forensics laboratory. That data was then provided to the police who then sent the data for analysis, separate from the process used to collect the data. The analysis of the data involved the use of a computer program that applied advanced calculations of probability to the data obtained from DNA samples. As neither a scientist, nor a mathematician, I cannot pretend to have understood substantial portions of the technical information contained in all the 15 volumes of material filed by the Crown. Even acknowledging the limits of my appreciation of the complexities of probability calculations, I can assume that the chances of randomly selecting 12 people to serve on a jury who would all have the ability to meaningfully assess the strengths and weaknesses of the science would be rather low, perhaps approaching remote.

[3] I was assured that the jury does not get that level of detail when the information is presented at the trial. In other jurisdictions they have got, quite literally, a cartoon version. That simplifies the technical information, drops out the formulas with Greek symbols and instead uses PowerPoint slides. In this case the jury would of course hear Defence counsel cross-examine on the methods used and hear Defence experts provide opinions about why they believe that the information is unreliable. But it is unlikely that they would be asked to understand the details. Very few people could. And they are the people who will decide Mr. Dechamp's fate.

Two Stage Gatekeeping

[4] That is where the court's gatekeeper function comes in. Juries are called upon to deal with complicated scientific evidence and the jury system relies on jurors being able to understand it and assess it. There are often experts with

different opinions. Courts decide whether scientific evidence is reliable enough to go before the jury. The jury decides how much, if any, weight to give the evidence.

[5] The considerations for a court at that first stage relate to the science itself. Canadian courts have a second responsibility. In fulfilling that responsibility, the considerations relate to the science within the context of the specific trial. Even if expert evidence is reliable enough to go before the jury a judge must assess whether the prejudicial risks and the time involved with putting the information before the jury are greater than the probative value of the evidence itself.

[6] Evidence presented by an eminently qualified expert, in a field in which most non-experts can understand very little, will be given substantial weight by jury members who may not understand the technical intricacies of it. It will retain that elevated status despite instructions from the judge to assess and weigh it. When evidence of that kind is to be put before a jury it should be subject to a process by which that status is earned. Cross-examination and opposing experts appearing before a jury are not a substitute for rigorous and transparent examination by independent experts in a field that is specifically "forensic" in its nature.

Issues

[7] The Crown seeks to lead expert evidence from Dr. Mark Perlin, PhD, MD, PhD. The purpose of that evidence is to establish that a DNA sample contains the DNA of Mr. Dechamp. Dr. Perlin and his company Cybergenetics have developed a proprietary software known as TrueAllele®. The program uses a process known as probabilistic genotyping to identify matches in situations where a human interpreter of DNA data could not. TrueAllele operates on a set of instructions that a computer would read to execute the program.

[8] The issue is whether the Cybergenetics report and the science underlying it have been shown to be reliable enough to be put before a jury. Even if the science is sufficiently reliable, the question is whether the risks and costs of putting it before the jury outweigh the probative value of that evidence. The issue is whether the source code is likely relevant to ultimate reliability of the process used by Dr. Perlin. If the source code is likely relevant to ultimate reliability, it would have to be disclosed if the report is to be admitted as evidence.

Summary

[9] Expert evidence serves a valuable function in the adversarial system. Experts in Canadian courts are required to be impartial. They inform. The effect of their opinions may be persuasive, but they do not endeavor to persuade. They are called by parties, but their purpose is to assist the court. In their areas of expertise, they have knowledge well beyond that of the trier of fact. That status allows them to speak with an authority that is both helpful and at times troubling.

[10] DNA science, in the forensic context, has been referred to as the "gold standard". Forensic laboratories that extract data from DNA and analyze the results for use in Canadian courts are usually subject to rigorous standards of accreditation. Their work is audited. That is because their reports are often practically determinative in criminal matters. The validity of the science that underlies those reports and the reliability of methods used by the laboratories are broadly accepted. They have been independently tested. There is no legislation now in force that requires accreditation and auditing of the work of forensic laboratories in Canada but the RCMP and most other police services in the country use the RCMP forensic laboratories or other private laboratories that have been subject to accreditation and auditing when dealing with the analysis and reporting of DNA evidence.

[11] DNA evidence, because of its established reliability and frequent use, has come to be perceived as a highly reliable forensic science. That status has been preserved through the application of those rigorous standards of accreditation and auditing by independent bodies.

[12] Cybergenetics is not a forensics laboratory. It is not a laboratory at all. It is then not subject to any standards of accreditation as a laboratory by any independent body, whether in Canada or the United States. Those who provide reports from Cybergenetics are clearly highly educated people. They are not subject to any standards of accreditation in any country.

[13] Cybergenetics is a software company or a technology company. The company developed the TrueAllele software and is in the business of marketing that software in a competitive market. As a software company Cybergenetics is not governed by any standards. It may seek to voluntarily comply with those standards that the company accepts as being relevant to what it does, but there is no independent body that enforces compliance with any standards that relate to the development, the implementation or the ongoing maintenance of the software.

[14] Cybergenetics has developed a computer program to analyze data. The program is analogous to an instrument used to analyze breath samples in cases charging operation of a motor vehicle while impaired. An "approved instrument" must be operated by a "qualified technician".[1] Both the instrument and the person who operates the instrument must have gone through a process of formal approval. That is because of the use that is intended to be made of the instrument within the context of a criminal trial.

[15] Academic oversight through publication in peer reviewed journals helps to establish academic or scientific reliability. Voluntary adherence to some standards may help to establish reliability for some forensic applications. The test of truth is often in the open academic and scientific marketplace of ideas. The elevated status of DNA in the forensic context demands that caution be exercised before the admission of techniques used for the extraction of data and the analysis of those data, when those techniques have not been subject to independent oversight and accreditation. Here, the extraction of the data was done at an accredited RCMP laboratory. The analysis, which is an equally important aspect of the process, was performed by a technology company that is subject to no form of auditing or accreditation.

[16] Even if the expert report from Cybergenetics could be said to satisfy the test for threshold reliability the risks and costs of having it entered as evidence in this trial would outweigh its probative value.

[17] There are two identifiable risks. The first, that the DNA evidence would be given extraordinary weight by the jury. The second, that the evidence will distract from the central issue of the trial.

[18] The technical nature of the evidence on probabilistic genotyping would enhance the status of that evidence and serve to practically insulate it from effective challenge. Challenging that evidence would involve the presentation of volumes of materials to allow the jury to assess the reliability of the science. Juries are the judges of the facts. They weigh and assess evidence heard at a trial. The ability of members of any jury to make a technical assessment of scientific reliability, especially in the context of a murder trial, with the limitations imposed by the adversarial process would be limited. A jury is not expected to read volumes of materials on probabilistic genotyping and computer programming while in course of a criminal trial.

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[1] *Criminal Code*, s. 320.31(1)

[19] The trial time involved would be considerable, as it was here. The potential for distracting the jury from the ultimate question before them would be real. A substantial portion of the trial would be about the reliability of TrueAllele. A substantial body of evidence would come from both sides. It would not relate to this specific case. Most of it will have been rehearsed in numerous trials in the United States and some elsewhere. Volumes of materials prepared by either side and intended to show that there are indeed volumes of materials, would be offered. The jury members could not take them home to review them at night. Both sides of the academic, commercial or legal debate in the United States may have an eye to the result, as adding either to their win or loss column in another foreign jurisdiction. A criminal jury trial in which a person's liberty is at stake is not be a proxy for anything else.

[20] The probative value of the evidence is not inconsequential. It is an important piece of evidence for the Crown's case, but it is not determinative. The Crown's case does not rely entirely on the DNA analysis.

[21] The risks and costs of admitting the report in the context of this case outweigh that probative value. TrueAllele, as a software program, is a commercial product used as an instrument in the analysis of data obtained from DNA. It is not a scientific theory the application of which can be demonstrated with respect to the evidence in this case. An expert cannot show each calculation performed to prove how or why a result was obtained. Data is entered and the program analyzes the data in much the same way that a scientific instrument would do. The product is only as reliable as the instrument that performed the analysis.

[22] The jury in this case would be asked to assess the ultimate reliability of TrueAllele in the context of a murder trial. TrueAllele has been tested and validated by scientists. When a computer program or instrument is intended for use in the forensic context, its reliability should be established through a rigorous process of third-party accreditation. The reservations about the use of DNA analysis from a company that is not subject to standards for accreditation, using software that is not subject to standards that are enforced by any independent body other than the academic community at large are not unreasonable. They justify questions being raised. Mr. Dechamp's criminal trial on murder charges is neither the time nor the place to resolve those issues.

[23] The time may and likely will come when probabilistic genotyping software will have been subjected to the kind of scrutiny appropriate in the Canadian

forensic context. The reliability of the program will by then have been established so that a jury can give it the weight earned by such scrutiny.

[24] The Cybergenetics report will not be admitted in evidence. There is no requirement then to make any finding about the disclosure of the source code.

Facts in this Case

[25] Tyler Richards was killed on April 17, 2016. Naricho Clayton was killed on April 19, 2016 and Ricardo Whynder was wounded on the same day. Mr. Dechamp is charged with the murder of Mr. Richards and Mr. Clayton and the attempted murder of Mr. Whynder.

[26] Investigators found a size 9.5 Adidas sneaker in a dumpster at the Clayton shooting site. The investigators believed that the sneaker had blood on the outside of it.

[27] Nine exhibits, including the sneaker, were sent to the RCMP National Forensic Laboratory Services in Vancouver. The report dated June 3, 2016 dealt with two areas of the sneaker. The interior top portion of the tongue of the shoe and the rear pull tab were examined. The DNA samples were found to be of mixed origin, each consistent with having originated from at least 3 individuals including at least one male. Because of the weakness of some components and the number of possible contributors, "no meaningful comparison" could be made to any samples.

[28] The Halifax Regional Police sought another report. The RCMP lab tested three different samples from the sneaker with the same result. That report was dated July 15, 2016. No meaningful comparison could be made.

[29] Another report was sought. This time the RCMP forensic laboratory tested four samples from the sneaker and again, the results were of mixed origin, each consistent with having originated from at least three individuals. Once again, no meaningful comparison could be made. That report was dated October 4, 2016.

[30] Over those three reports, 10 different samples from the sneaker were tested and no meaningful comparison could be made from any of them by the RCMP National Forensic Laboratory Services.

[31] Three samples from the sneaker were sent to a private lab in Guelph Ontario, then known as Maxxam Analytics, now Bureau Veritas. That is an accredited private laboratory that does forensic studies used in courts across Canada. The

Maxxam Analytics report dated December 22, 2016 concluded that the samples from the sneaker were from at least 4 individuals and were not suitable for comparison purposes.

[32] That might have ended things, but it did not.

[33] D/Cst. Nielsen of the Halifax Regional Police had heard about a company in the United States, Cybergenetics, that could take a mixed profile and generate potential contributor profiles. D/Cst. Nielsen wanted to submit the mixed profile from the sneaker to see if anything could be done with it. That was on October 25, 2016 a few weeks after the third report had been received from the RCMP laboratory.

[34] The RCMP had no policy about releasing raw data. What Cybergenetics required was the data for the profile, not the exhibit or the DNA sample itself. The RCMP forensics laboratory had already taken the DNA from the sneaker and generated the data from it. Cybergenetics does not take DNA samples. It analyzes data. Cybergenetics would assess for free whether the profile was amenable to their modelling. If it were, they would then start charging for their work.

[35] Christine Crossman was qualified as an expert. She is a reporting scientist with the RCMP National Forensics Laboratory. She had been dealing with D/Cst. Nielsen on the file. On November 1, 2016 she observed that Cybergenetics was a private company ultimately trying to sell a service. She said in her testimony that she had highlighted her concern to D/Cst. Nielsen that it would be more accurate if the DNA profile were run through Cybergenetics' own system to make sure that they were using the right parameters to account for the way the data is obtained. She was later told that the proprietary software used by Cybergenetics accounted for that internally.

[36] In accredited RCMP forensic laboratories analysts within the laboratory take the samples, extract the DNA, use a process known as polymerase chain reaction to amplify the DNA and obtain the data from that DNA. Reporting scientists within that same laboratory system then analyze the data to determine what if anything can be determined from it. That reporting scientist could show the data that was used, the calculations that were performed and the observations that could be made based on the data. What Cybergenetics was going to do would be to receive the data and have it analyzed by its program, TrueAllele.

[37] The RCMP did agree to release the data and Christine Crossman sent the 10 files of raw data to D/Cst. Nielsen on November 21, 2016. The RCMP did not release information directly to Cybergenetics. Ms. Crossman's email to D/Cst. Nielsen included the note that the information being sent contained genetic information and that further use of them "must adhere to existing federal DNA regulations and legislation". Dr. Mark Perlin is one of the owners of Cybergenetics and the expert whom the Crown proposes to have testify at trial. Dr. Perlin was not aware of the Canadian federal DNA regulations or legislation but he was confident that his company would keep information properly confidential.

[38] The information was received by Cybergenetics and on February 27, 2017 the company provided preliminary results after an initial TrueAllele computer analysis of the DNA mixture data. Comparison with the unknown person who left their DNA on the sneaker was expected to give a match statistic of over a million. A second report was sent on June 29, 2017. Cybergenetics had received the suspect reference, which was the information that pertained to Tyrell Dechamp. The informal summary was, "Suspect TD's DNA was found on the sneaker".

[39] Dr. Perlin was asked about that rather unreservedly conclusive statement. He explained that it is only an informal result and saves having to explain details to clients at this stage. The final report that is prepared of course does not purport to make a finding of that kind and is based on probabilities.

[40] A Cybergenetics report dated July 18, 2017 was sent to D/Cst. Nielsen. After comparing the profile of the suspect TD, which is Tyrell Dechamp, to the data from the sneaker it was determined that a match was 328 times more probable than a coincidental match to an unrelated British Columbia native person, 11.2 million times more probable than to a coincidental match to an unrelated Caucasian person, 41.9 billion times more probable than a coincidental match to an unrelated Northern Ontario Native person, and 400 million times more probable than a coincidental match to an unrelated Saskatchewan Native person. The population allele frequencies had been provided by the RCMP.

[41] A second report was sent by Cybergenetics on July 25, 2017. This time Cybergenetics used population statistics from the American Federal Bureau of Investigations, the FBI. A match between the sneaker and the sample form Tyrell Dechamp was 25.7 million times more probable than a coincidental match to an unrelated African American person. For a match strength of 25.7 million, "only 1 in 708 million people would match as strongly". Dr. Perlin said that he understood

the term African American to apply to the African Canadian population as well and that any difference would not result in a real difference in the result.

What is Cybergenetics?

[42] Cybergenetics is a company which has its headquarters in Pittsburgh Pennsylvania. It is not publicly traded. Dr. Mark Perlin is the Chief Executive Officer and Scientific Officer of Cybergenetics. Dr. Perlin has a remarkable CV. He holds a medical degree and doctorate degrees in each of mathematics and computer science. He has published his work extensively, both in popular journals and in peer reviewed literature. He has appeared as an expert in courts in various American states, in New South Wales and in Northern Ireland.

[43] Dr. Perlin testified in this matter for three and a half days. Through him, the Crown provided 15 volumes of materials. Dr. Perlin has appeared in courts many times to speak to the reliability of the results produced by Cybergenetics. His materials include background reading with reports about the use of TrueAllele in cases both for prosecution and Defence. There are validation papers written in peer reviewed journals. To most non-expert readers they would not be comprehensible at all. The Crown noted that the intent was not that I would understand the science and the mathematics involved. There was no need to try to read these materials. They are provided just to show that they are there and have been published.

[44] In addition to the validation papers there are 30 validation studies. A number of those papers deal with the validation of TrueAllele for use by police forces and crime laboratories. It is important to note that TrueAllele as a program can be purchased for use by a crime laboratory. The purchasers of the software obtain a user interface by which they can input data. It is then sent to the TrueAllele server. The server runs the program that provides the probabilistic genotyping analysis. Users of the program validate it for use within their systems. The Halifax Regional Police did not buy the TrueAllele program. They sent data to Cybergenetics which ran the program at their facility in Pittsburgh. Neither the Halifax Regional Police nor the RCMP did any validation of the TrueAllele program because it was not being integrated with their systems.

[45] There are materials on other forensic applications of the TrueAllele technology. Those include materials on the work at the Word Trade Center in New York after the 9/11 attacks and on various cases in which wrongfully convicted people have been exonerated using the technology.

[46] One volume is entitled "Regulatory Approval". Dr. Perlin noted in his testimony that Cybergenetics in not a laboratory. It does not look like a laboratory. It is an office with people and computers. Because it is not a laboratory it is not governed by the regulations that govern laboratories. Its clients who obtain data from DNA using laboratory work would be bound to comply with those kinds of guidelines. Laboratories may be accredited and audited, so that the RCMP forensic laboratories for example, would be subject to that auditing and accreditation by outside authorities. Cybergenetics provides a service that does not involve laboratory work, so it is not required to be either audited or accredited.

[47] Cybergenetics uses its proprietary software TrueAllele to analyze data. It reports results. It is not subject to either accreditation or auditing with respect to the development or maintenance of that software. Dr. Perlin says that TrueAllele has instead been subject to extensive validation, testing and peer review. The mathematics that underlie the program have been disclosed and subject to rigorous evaluation. The source code that operationalizes the mathematics and DNA science, has been seen in its entirety only by Dr. Perlin. That source code and the program that the source code runs are not subject to any kind of regulation, auditing or accreditation.

[48] Another volume includes Cybergenetics' Standard Operating Procedures. One of the purposes of the software is to replace human analysis with computer analysis. A user of the TrueAllele program receives training by reading materials and taking an online course. It does not begin to approach the level of training of a reporting scientist in an RCMP forensics laboratory. But the user is not required to make the kinds of judgements or perform the kind of analysis that would be performed by a reporting scientist. Where judgements are made, they seem to involve parameters that do not affect the ultimate results, but which affect the amount of time the computer program will be required to run to generate an answer.

[49] Another volume of materials provides information about the general acceptance of TrueAllele and probabilistic genotyping around the world. Another volume deals with related systems. TrueAllele is not the only software that purports to do probabilistic genotyping. A substantial amount of information has been provided about admissibility rulings for TrueAllele ranging from the first reported case in 2012, *Commonwealth v. Foley*[2] to cases in 2019. The technology

[2] 47 A. 3d 882 (Pa. Super. 2012)

is widely accepted in the courts of the United States. Legal commentary was provided that both approved and disapproved of the use of probabilistic genotyping software.

[50] A volume entitled Scientific Development included technical papers. The first, for example, is entitled, "Toward Fully Automated Genotyping: Genotyping Microsatellite Markers by Deconvolution".[3] This was another filed document that was not intended to be read much less understood. It adds to the physical weight and volume of materials that show this indeed to be a very complicated subject matter. The volume containing "Other Papers" contains information about Bayesian methods in statistics and economics, the evolution of the Markov chain Monte Carlo analytic methods, MATLAB programming language and developing allelic and stutter peak height models for a continuous method of DNA interpretation. The purpose of providing these papers is again the show that such papers exist and are broadly available.

[51] A volume entitled source code includes a series of American cases that discuss why Defence counsel do not require the disclosure of the computer source code. Another volume contains cases from the United States, Australia and Northern Ireland in which TrueAllele has been accepted. It is information that would usually be entered as part of legal argument, but it is difficult not to reach the conclusion that Dr. Perlin and his materials come as a "ready to present" package. During his direct examination he was quite ready to tell Crown counsel that the court had heard enough on a topic and it was time to move on or that "we'd get to" something later.

[52] Finally, a volume includes the CVs of Cybergenetics' employees and another provides the materials that pertain to this case.

[53] All in all, it is a ponderous stack of materials. Some of it is written in accessible language and some is entirely impenetrable. The more accessible the material to a general non-scientific readership, the more it approaches marketing in its content. It leaves the impression that Dr. Perlin is a brilliant man who has worked for many years to combine areas of science and technology that are themselves complex into a computer program that most people could never hope to understand, assess, challenge or question. We can only marvel at it and operate in the trust that other competent experts and academics have understood, assessed, challenged and questioned it.

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[3] *Am. J. Hum. Genet.* 57: 1199-1210, 1995, Mark Perlin, Giuseppe Lancia and See-Kiong Ng

[54] Cybergenetics' main competitor appears to be STRmix™. That software was developed by the Environmental Science and Research Limited, which is a New Zealand crown research institute. It is a commercially available software that, like TrueAllele uses a continuous interpretation model with Markov chain Monte Carlo modelling to calculate likelihood ratios. Dr. Perlin asserts that STRmix is based on TrueAllele, although TrueAllele is a more sophisticated technology. He is suing the developers of the STRmix software. He says that STRmix is doing very well marketing TrueAllele technology. TrueAllele is used by 10 "crime labs" in the United States while STRmix is used by 50 or so. Dr. Perlin estimated that there are about 250 crime labs in the United States.

[55] TrueAllele has not been validated by any forensic laboratories in Canada. Dr. Perlin trenchantly observed that DNA behaves the same way in Canada as it does in the United States. The RCMP is considering purchasing probabilistic genotyping software and is reviewing STRmix. In order to be used in the RCMP forensic laboratories the software would have to go through a process of validation in which it is tested within that laboratory system to ensure that the interaction of the RCMP systems and the STRmix software produce reliable results.

[56] TrueAllele has successfully gone through that process with several American crime labs. Some American crime labs that started using TrueAllele have stopped. The New York State crime lab is one of those. Dr. Perlin said that this was not a result of any problems associated with TrueAllele. A management change within the organization resulted in the contract being opened for competition from which Cybergenetics was excluded because of issues that did not relate to the software.

[57] The California Department of Justice contracted with Cybergenetics for casework. They sent employees for training on the TrueAllele software and they dropped out of the course before it was finished. Dr. Perlin said that the problem was not with the software but with the fact that the employees were using TrueAllele in a flawed manner.

[58] When asked about others who had stopped using TrueAllele Dr. Perlin could recall "maybe 3 to 5". The Massachusetts State Police and the Allegheny County crime lab in Pennsylvania both had management changes. Suffolk County on Long Island in New York changed because the New York State Police were using STRmix.

[59] None of that is to suggest that there have been problems identified with TrueAllele. It does demonstrate that it operates in a competitive environment in which there is some level competitive tension between STRmix and Cybergenetics.

[60] That is not the only point of friction. Dr. Perlin and Cybergenetics also take issue with the findings made by the President's Council of Advisors on Science and Technology (PCAST). In September 2016 that body, created by President Obama but no longer in existence, issued a report entitled, "Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature - Comparison Methods". It is a source of contention. The PCAST report says, at page 79, that while probabilistic genotyping software represents a major improvement over purely subjective interpretation the software requires "careful scrutiny". That scrutiny is with respect to the validity and limitations of the scientific methods and whether the software correctly implements the methods. The PCAST report said that the programs employ different algorithms and can yield different results for the same mixture profile. The report goes on to state that the range in which foundational validity for probabilistic genotyping of complex DNA mixtures is likely to grow as adequate evidence for more complex mixtures is obtained and published.

[61] Dr. Perlin was highly dissatisfied with the process used by PCAST. One of the people involved was from STRmix and the limitations observed by PCAST were limitations with STRmix and not with his more sophisticated TrueAllele software. Dr. Perlin said that there was no foundation validity to the PCAST assertions about foundational validity. He said that scientists and prosecutors had one view and Defence attorneys had a different view. The PCAST report has been considered not for the truth of its contents, but as an example of the disputatious nature of the debate surrounding this important development in forensic science.

[62] Cybergenetics exists within a competitive commercial environment. It is a commercial entity. Dr. Perlin says that he is not motivated by profit and is quite happy to run the business as a break-even proposition. At the same time, he is concerned about the investment of $5 to $10 million in the creation of the TrueAllele software. He does not want to disclose without a robust confidentiality agreement, much less share, his trade secret. He has been prepared to take legal action to protect TrueAllele from STRmix. Dr. Perlin cares about his company and would clearly prefer if it were to prosper in that competitive environment. There is nothing wrong with that. TrueAllele and STRmix are in competition and both have a commercial interest in establishing the reliability of the results that they provide and the product they market.

[63] Engineers may provide differing expert opinions in which subjective judgements are made based on objective calculations. Those calculations can be fully disclosed and explained, and the expert does not have a direct commercial interest in whether those calculations are recognized as valid science by the court. In this case, while Dr. Perlin has been qualified as an expert, and he is eminently qualified, he also has a commercial interest in the success of TrueAllele as a product. That does not serve to disqualify him or his opinion. The commercial dispute with STRmix and the commercialization of the science, serves to set this apart from an entity like the RCMP National Forensics Laboratory. There is of course nothing wrong with "private" science. It does need to be assessed in the knowledge that it is private and for profit and that it is being proposed for use in the forensic context in which it may be practically determinative of the outcome of some cases.

What is probabilistic genotyping?

[64] TrueAllele and STRmix are both probabilistic genotyping tools.

[65] The science of DNA is complicated. That is not to say that I understand it, in all its complexity but that I just cannot explain it in a way that would be understandable. As a non-scientist I can at best get a basic understanding of the science. Similarly, the mathematics of probability are complicated. I cannot hope to understand them. Those fields come together in probabilistic genotyping.

[66] From that, as the judge in this matter, I must exercise the gatekeeper function with respect to reliability of expert evidence on that subject. As a non-scientist I am in somewhat the same position as the trier of fact in this case, the jury. I have had the benefit of having the time over the course of weeks, to read or try to read the materials provided. Jurors would not have that opportunity. Juries are called upon to make assessments based on the evidence before them. Their assessments are based on evidence not on faith in an eminently qualified scientist. I am required to assess the reliability of scientific evidence with a view to the reality that ultimately a jury will be called upon to do the very same but in different circumstances.

[67] DNA testing is done by examining specific locations on the genome where there are short tandem repeats or STRs. Those STRs are short repeated sequences of DNA base pairs that are identified by one of four letters. The number of times that a sequence is repeated at a *locus* (location) is called an allele. A person inherits one allele from each parent at each locus. A genotype at a locus is a pair of alleles.

[68] Some *loci* encode for observable traits. Others are non-coding. They are the ones that are of interest in forensic identification. Because they have no known function, they can evolve into a diversity of possible repeat lengths. When a number of *loci* are examined the number of possible combinations is far greater than the size of the human population. The STR genotype then provides a way in which individuals can be potentially identified.

[69] DNA is tested by having a laboratory technician isolate the DNA and produce a result for interpretation. The process involves extracting the DNA from the sample and amplifying it. Amplification is done through a process using a polymerase chain reaction (PCR). The PCR process harnesses the power of an exponential chain reaction so that a few gene copies are amplified into virtually unlimited quantities for easy detection. With the amplification the STR locus can be identified.

[70] The material is then put through a capillary electrophoresis instrument. That instrument separates the DNA fragments by size so that alleles can be identified. That generates a chart called an electropherogram. That chart shows a series of peaks. The peaks are proportionate to the amount of DNA present or the length of the STR in the allele. Some peaks are not used. If the peak falls below a certain threshold it is considered to be not present at all. Some peaks are interpreted as "stutter". Stutter peaks arise from imperfect DNA copying during the PCR process. Some peaks are interpreted as artefactual. An artefactual peak is one that has arisen from the manner in which the data was obtained.

[71] The peaks are measured in fluorescent units because of the dye that is used to identify the four lettered proteins that make up the sequence.

[72] When the DNA has been isolated it is compared to a sample from a known source. That is usually done by a person using statistical assumptions. In RCMP laboratories, that function is performed by a reporting scientist. In a single DNA profile, the reporting scientist would expect to see one or two peaks at each locus. When there are three or more peaks at a locus, that tells the reporting scientist that there is more than one contributor, or a mixed sample.

[73] That is where probabilistic genotyping becomes involved.

[74] Laboratories that use human analysis of DNA follow an all or nothing approach. With the improvement of technology for the extraction and amplification of DNA more and more profiles are available in which the DNA contribution is

low or there is a combination of contributors. There can be a number of peaks at a single *locus*.

[75] Probabilistic genotyping uses computer software and algorithms to apply DNA data, statistical theory and probability distributions. The program infers the probability of a single profile even when there have been mixed contributors. It uses all the information, even that which would be counted out by a human analyst. It does not replace the DNA collection process or the process for isolating the DNA itself. The process is the same until it reaches the point of the statistical analysis. In human analysis a person manually examines the peaks of the alleles. Probabilistic genotyping programs operate by having a person input the isolated DNA information into the computer program. The program does the analysis.

[76] In the case of TrueAllele the program models for background noise which allows it to account for much shorter allele peaks that would otherwise be dropped out of the analysis. It models for the characteristics of individual systems used to collect the data which might affect the data that have been collected.

[77] The program compares statistical models to the data and weighs the probability of a match. The algorithms used by TrueAllele are derived from a Bayesian statistical analysis called Markov chain Monte Carlo modelling. The program takes the quantitative information from the DNA profile and calculates the probability of the peak heights given all the possible genotype combinations for individual contributors. The program makes assumptions about the underlying behaviour of peak heights to evaluate the probability of a set of peak heights. That statistical approach has been used in other situations in which complex data sets are modelled.

[78] The TrueAllele software can be run for days or weeks to analyze the data from a sample. The data in this case were analyzed by the software for a total of 46.5 days. It is a feat of calculation that would take many years for human analysts to undertake.

[79] The algorithms and complex mathematics that form the basis of TrueAllele have been reviewed and disclosed publicly in journals. Dr. Perlin makes no secret at all about them. Other companies like STRmix also make use of Markov chain Monte Carlo modelling in their probabilistic genotyping software. The mathematics are not a secret. How they are operationalized in the software is very much a secret.

Validation and Standards

[80] Valerie Blackmore is the Technical Leader with Wyndham Forensic Group in Guelph Ontario. Wyndham is an accredited DNA laboratory that does forensic biological testing for police, Crown and Defence clients. It also serves as an advisor to parties in cases and does project-based work. Ms. Blackmore has worked with Global Affairs Canada and the United Nations on building accredited forensic testing capacity outside Canada. Accreditation is third-party assurance and oversight that standards have been met.

[81] Ms. Blackmore was qualified as an expert. She worked on the Forensics Advisory Working Group for the Solicitor General of Ontario. That group provided support with the new Ontario legislation, the *Forensic Laboratories Act*.[4] The *Act* has passed but is not yet in force. It would require anyone providing a forensic science report to a court in Ontario to have third-party accreditation.

[82] As the situation stands now, accreditation in Canada is voluntary. Like Wyndham, the RCMP Forensics Services Laboratory is accredited by the Standards Council of Canada. The SCC has standards that apply to the calibration of instruments used in laboratories, technical specifications, management systems and the introduction of new methods. Those standards also apply to proficiency testing, education and professional development of staff within laboratories. Each year laboratories are assessed against those standards and any others with which the laboratory claims to be compliant.

[83] There are standards that apply to the way in which forensic information is presented in court. Standards do not only apply to the work of so called "wet labs". They are applicable for the entire process from the generation of DNA data in the laboratory, to its analysis and reporting. Ms. Blackmore noted that the forensic DNA process is a continuous one. It goes from the extraction of DNA from the sample, to determining whether there is enough DNA to be subject to meaningful analysis, the PCR process of copying specific areas of DNA, electrophoresis, the preparation of the electropherogram, the analysis and interpretation of the data, the preparation of a formal report, and eventual testimony in court. The interpretation of data may be undertaken with the assistance of a software program such as probabilistic genotyping software, but it is all part of the same process.

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[4] S.O. 2018, c. 3

[84] If an accredited laboratory were to use probabilistic genotyping software the laboratory would have to internally validate it. The software would be tested within that laboratory to determine whether it is fit for the purpose and what limitations there should be on its use. If a part of that process is outsourced, the accredited laboratory would have to demonstrate that the other party performing the work was itself accredited and that the collaboration had been validated.

[85] In this case, the report is not an RCMP Forensic Services report. It is a Cybergenetics report. The RCMP Forensic Services did not outsource work to a non-accredited body. The RCMP did not release data directly to Cybergenetics. The RCMP generated data was released to the Halifax Regional Police. Had the RCMP sought to outsource analysis of the data to Cybergenetics, a process would have to have been undertaken to determine whether Cybergenetics had been accredited and whether the collaboration between the RCMP and Cybergenetics had been validated.

[86] The Standards Council of Canada "Guidelines for the Accreditation of Forensic Testing Laboratories"[5] applies to the RCMP laboratories, to Maxxam Analytics now known as Bureau Veritas, to Wyndham and various other Canadian forensic laboratories. It does not apply to Cybergenetics. Cybergenetics is of course an American company but more importantly it is not a laboratory. Appendix 3 of the Guidelines deals with biology, and in its scope, it describes the quality assurance requirements that laboratories performing forensic DNA testing must follow to ensure the quality and integrity of the data generated by the laboratory. Cybergenetics analyzes data. It does not generate data.

[87] The Standards Council of Canada defines a DNA analyst as an employee who has completed the laboratory's training requirements for casework sample analysis, passed a competency test and entered into a proficiency testing program. "This individual conducts and/or directs the analysis of forensic samples, interprets data and reaches conclusions." Cybergenetics employees interpret data and reach conclusions but they do not do so in the context of a forensic laboratory.

[88] The Scientific Working Group on DNA Analysis Methods (SWGDAM) is a group of about 50 scientists representing American federal, state and local forensic DNA laboratories. It invites guests from Canada when appropriate. SWGDAM discusses topics of interest to the forensic DNA community. In 2012 it produced Validation Guidelines for DNA Analysis Methods. Cybergenetics has provided

[5] CAN-P 1578 May 2009

information to show that it complies with the SWGDAM Guidelines with regard to the validation of TrueAllele but once again, the Guidelines do not apply to Cybergenetics. It is not a forensic laboratory. It is not what is in the United States called a "crime lab".

[89] The 2016 President's Council of Advisors on Science and Technology (PCAST) does apply to probabilistic genotyping software programs. As noted, Dr. Perlin does not accept the foundational validity of the report. It addresses the weaknesses in the STRmix program, but it would not apply to his more sophisticated software.

[90] There are no standards for forensic laboratories that apply to Cybergenetics because it is not a forensic laboratory. It has developed software that analyzes data.

[91] Nathaniel Adams is a Systems Engineer at Forensic Bioinformatics Services Inc. in Fairborn Ohio. He analyzes electronic data generated during the course of forensic DNA testing, reviews case materials, laboratory protocols, and performs calculations of statistical weights including custom simulations for casework and research projects. Mr. Adams has reviewed software development materials, including the source code, for probabilistic genotyping systems, STRmix and FST (Forensic Statistical Tool). Because of non-disclosure agreements and protective orders, Mr. Adams was not permitted to discuss the findings of several of his reviews.

[92] Mr. Adams was qualified as an expert in software engineering, software standards and bioinformatics as they apply to probabilistic genotyping. He is not an expert in probabilistic genotyping, and he acknowledged Dr. Perlin as one of the pre-eminent experts in that field. Having noted that, however, it must be observed once again, that the issue of use in courts of probabilistic genotyping software is a contentious one. Dr. Perlin and Mr. Adams have very different views and they have expressed those views in court before.

[93] The question then is what, if any, standards are applied in the development and use of probabilistic genotyping software. Those standards do exist. The International Organization for Standardization (ISO), the US National Institute of Standards and Technology (NIST), and the Institute of Electrical and Electronics Engineers (IEEE) have all developed standards documents. Mr. Adams noted that the software developers must consider the degree of confidence required and the relative value of that confidence in terms of potential life-safety, financial and social consequences. A program that runs a gaming system may have defects that

could have financial implications for those who market the software. Those implications are not of the same magnitude as those that would arise from a failure of the software operating a passenger aircraft for example. A departure from the intended behaviours of a probabilistic genotyping system could be very significant. But there are no formal guidelines on the validation methods for probabilistic genotyping software that address the concept of integrity levels.

[94] Mr. Adams noted that verification involves reviewing software development materials. That is done to determine whether the software conforms to requirements for correctness, completeness, consistency and accuracy for all activities. If the requirements and specifications are not formally declared in documents shared by the designer and developers of the software system, to serve as an objective reference, they are replaced by subjective decisions and assumptions. When there are no formal requirements the quality of the testing process is limited. As Mr. Adams states, at page 7 of his report, "Testing against requirements requires that requirements be defined."

[95] There has been no public release of the formalized requirements and specifications for TrueAllele.

[96] There is no common standard for the development of probabilistic genotyping software. There is no independent body that assesses software used in forensic applications. There is no requirement that the source code that operationalizes the underlying complex algorithms that calculate probabilities be reviewed by any accrediting body. There is no independent authority that is responsible for the testing of that software.

[97] The central dispute in this case lies here. On one side there is a claim that there should be a high system integrity requirement for probabilistic genotyping software used in a forensic context. Until standards are applied and compliance is enforced through independent third-party auditing the risks of using the software are too high. On the other side there is the assertion that both the science and software have been validated and verified to a high scientific standard through testing and peer review.

[98] The validation and testing of the TrueAllele software by Cybergenetics have involved the publication of peer reviewed journal articles and studies. Three large volumes of validation papers and validation studies were provided. There are 8 validation papers, with 5 under the heading "Laboratory", and 3 under the heading "Casework". There are 30 validation studies. There can be no doubt that

TrueAllele has been subject to peer review. Scientists and experts in the field have studied it comprehensively and given it their approval. That has happened over several years. It is not simply a matter of Cybergenetics testing its own product and declaring it fit for the purpose. Members of the forensic scientific community have given TrueAllele their approval.

[99] Peer review is a rigorous scientific standard. It means that other experts in the field have reviewed the subject matter of the paper that has been published. That review is limited to the subject matter of the paper and the reviewers are not necessarily members of any regulatory body. They do not have to be. Science is assessed by other scientists not by a central government authority.

[100] Cybergenetics is not a forensic laboratory. It is not an accredited anything. The development and maintenance of its software has not been subject to oversight by any independent authority. TrueAllele has been validated through peer reviewed publications and testing. And that brings the issue back to the central dispute.

Canadian Legal Caution

[101] DNA evidence has been called the gold standard. The "CSI Effect" can refer to the demand the jurors make for forensic scientific evidence and an increasing reluctance to rely on circumstantial evidence. It might also be said that when jurors do hear and see scientific evidence, particularly DNA evidence, it can be perceived as having an almost conclusive weight. While in the United States comments may be made about what jurors do or do not demand based on interviews with jurors, the law in Canada is different. Jurors cannot discuss with anyone what happened during their deliberations. No one knows what jurors expect.

[102] Courts are called upon to be vigilant with respect to assessing evidence that is proposed to be entered as scientific. A scientific opinion given by an expert carries weight because it addresses issues that are outside the scope of knowledge of the trier of fact. An expert who purports to give evidence on DNA can make efforts to explain the science in terms that are understandable, but the trier of fact is fully aware that the expert knows more. Despite jury instructions that are intended to tell jurors that the expert opinion is an opinion, there remains a level of trust that is a function of the expert's scope of knowledge in a subject matter.

[103] Judges are gatekeepers of evidence. That is a particularly important role when dealing with expert evidence. The purpose is not to replace trial by jury with trial by motions judge. It is to prevent evidence from being put before a jury

through an expert that has not been shown to be sufficiently reliable to have that designation. It is not to assess whether the expert opinion should be accepted or the weight to be given to it, but whether it passes the test of threshold reliability.

[104] Junk science is a dangerous thing. It masquerades as science and sometimes does it very effectively. It can lead to miscarriages of justice. The term itself is problematic. It suggests quackery or absurdity or a kind of fake scientific authority that would either be apparent on its face or that would cause a reasonable person to become suspicious. More troubling is the kind of information that has the hallmarks of reliable science, presented by credible scientists and adopted as authoritative. Yet it can still be wrong. And it can lead to miscarriages of justice.

[105] Canadian judges and criminal lawyers are familiar with the finding of Kaufman Commission which studied the wrongful conviction of Guy Paul Morin for the murder of Christine Jessop in 1984.The Kaufman Report was issued in 1998.[6] The report considered the role played by the Centre for Forensic Sciences in Toronto. The CFS was the laboratory where forensic examinations were conducted for criminal investigations in Ontario. It was publicly funded and accountable to the Attorney General of Ontario. Investigators relied on the comparisons of hair and fiber samples done to refute Mr. Morin's evidence that he had no contact with Christine Jessop. The experts from the CFS failed to accurately and adequately explain the limited relevance of the evidence they provided. The conclusions with respect to the hair samples were subsequently disproven by DNA analysis. A number of things went horribly wrong in the conviction of Guy Paul Morin but one of them was the reliance on overstated expert evidence.

[106] In 2008 the Honourable Stephen Goudge issued a report on the *Inquiry into Pediatric Forensic Pathology in Ontario*.[7] That inquiry examined the work of a leading forensic pathologist, Dr. Charles Smith, who made errors that resulted in many wrongful convictions. He concluded that children had been murdered when their deaths had been accidental. His opinions were considered reliable by investigators, lawyers and judges. The Goudge Report made it clear that a lack of vigilance in scrutinizing whether expert evidence meets a minimum threshold of reliability could result in wrongful convictions.

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[6] F. Kaufman, *The Commission on Proceedings Involving Guy Paul Morin: Report* (Toronto: Ontario Ministry of the Attorney General, 1998)

[7] S.T. Goudge (Toronto: Ministry of the Attorney General, 2008)

[107] For 15 years the Motherisk Drug Laboratory at the Toronto Hospital for Sick Children was a leader in hair strand drug and alcohol testing. Courts routinely accepted those test results. They were widely regarded as accurate. But they were frequently wrong. And the consequences were devastating. The Motherisk Drug Laboratory was at the Toronto Hospital for Sick Children. Nothing about it raised an intuitive concern.[8]

[108] It is now widely recognized that invalid forensic science is present in a large percentage of wrongful convictions.[9] Canadian law recognizes the value of expert opinion in assisting the trier of fact but is also alert to its limitations and its failings. When assessing expert evidence Canadian judges do so in the context of a system that has the experience of the failures in the Guy Paul Morin case, and the tragic consequences of the reliance on the opinions of Dr. Charles Smith and the Motherisk Laboratory. To borrow a phrase from software development, the "integrity level" for forensic science, where the risk is the admission of inculpatory evidence that could lead to a criminal conviction, should be high.

Legal Test for Admissibility in Canada

[109] The test for the admissibility is of course informed by the role of the expert in a Canadian court.

> An expert's function is precisely this: to provide the judge and jury with a ready-made inference which the judge and jury, due to the technical nature of the facts, are unable to formulate.[10]

[110] The process for admitting expert opinion evidence involves two steps. The first is to determine whether the opinion satisfies the threshold requirements for admissibility. The second is to determine whether the value of the expert evidence is outweighed by the risks or costs associated with it. Both steps involve a consideration of the reliability of the science underlying the expert evidence.

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[8] *Report of the Motherisk Hair Analysis Independent Review* (December 15, 2015) Susan Lang, Ontario Ministry of Attorney General

[9] B. MacFarlane, "Convicting the Innocent: A Triple Failure of the Justice System" (2006), 31 Man. L.J. 403, B.L. Garrett, "Judging Innocence" (2008), 108 Colum. L. Rev. 55, B.L. Garrett and P.J. Neufeld, "Invalid Forensic Science Testimony and Wrongful Convictions", (2009) 95 Va. L. Rev. 1

[10] *R. v. Abbey*, [1982] 2 S.C.R. 24, at p. 42

[111] The first step relies on four criteria set out in *R. v. Mohan*[11] and, if the opinion is based on novel or contested science, whether the science underlying the opinion is reliable.[12] The *Mohan* criteria are whether the evidence is relevant, whether it is necessary in assisting the trier of fact, whether there is an exclusionary rule that would otherwise make the evidence inadmissible, and whether the expert has been properly qualified. In *Mohan*, Justice Sopinka explained that relevance involves not only whether the evidence has a logical bearing on the matter in issue but also the "legal relevance". That is a consideration of the value of the expert evidence and the distorting impact that it would have on the trial process. Expert evidence is not admitted if its prejudicial effect outweighs its probative value, if it would consume an unwarranted amount of court time or if its effect on the jury would be excessive in light of its limited reliability. Justice Sopinka noted:

> There is a danger that expert evidence will be misused and will distort the fact-finding process. Dressed up in scientific language which the jury does not easily understand and submitted through a witness of impressive antecedents, this evidence is apt to be accepted by the jury as being virtually infallible and as having more weight than it deserves.[13]

[112] Justice Sopinka quoted from the decision of Justice Flanigan in *R. v. Bourguignon*.[14] In that case DNA evidence was admitted but not the specific evidence of statistical probability.

> This Court does not think that the criminal jurisdiction of Canada is yet ready to put such an additional pressure on a jury, by making them overcome such fantastic odds and asking them to weigh it as just one piece of evidence to be considered in the overall picture of all the evidence presented. There is a real danger that the jury will use the evidence as a measure of the probability of the accused's guilt or innocence and thereby undermine the presumption of innocence and erode the value served by the reasonable doubt standard. As said in the *Schwartz* case: "dehumanize our justice system".
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> I would therefore, rule admissible the DNA testing evidence but not the statistic probabilities. This restriction can be easily overcome by evidence that "such matches are rare" or "extremely rare" or words to the same effect, which will put

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[11] [1994] 2 S.C.R. 9
[12] *R. v. J.-L.J.*, [2000] 2 S.C.R. 600
[13] *Mohan*, at para. 19
[14] [1991] O.J. No. 2670 (Q.L.)

> the jury in a better position to assess such evidence and protect the right of the accused to a fair trial.[15]

[113] Justice Sopinka did not necessarily accept the reasoning and added that other courts had admitted evidence of statistical probability. The case was cited to show the approach that was taken with regard to the concern that a jury is not overwhelmed with technical information at the risk of losing the focus on the ultimate question.

[114] The weighing of costs and risks is a part of assessing relevance.

[115] The second *Mohan* criterion is whether the evidence is necessary to the trier of fact. The evidence meets that criterion if it likely lies beyond the scope of the judge or jury's knowledge or experience or the facts involve technical issues than cannot be understood without expert assistance. Necessity must be judged in light of the danger that expert evidence might distort the trial process by usurping the jury's fact-finding function or turning the trial into "a contest of experts".[16]

[116] The third *Mohan* criterion is whether there is any exclusionary rule that would make the evidence inadmissible. The fourth criterion is that the expert be properly qualified. Of those four criteria the first two implicate the balancing of risks and costs.

[117] In *Mohan* the court held that novel science should be subject to "special scrutiny".[17] In *R. v. J.-L.J.*[18] the Defence sought to call an expert witness who used a technique known as penile plethysmography in which a subject was monitored for physical signs of arousal on exposure to sexual images. The purpose of the evidence was to show that the accused did not have the disposition of a likely perpetrator. The technique was an established one for monitoring progress during treatment, but it had not been used before in a forensic context. Justice Binnie set out four factors that would assist the court in assessing novel science.

[118] The first factor is whether the theory or technique had been tested. The second is whether the theory or technique had been subject to peer review and publication. The third is whether there is a known or potential rate of error or

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[15] *Mohan*, at para. 20
[16] *Mohan*, at p. 24
[17] *Mohan*, at p. 25
[18] [2000] 2 S.C.R. 600

standards. The fourth is whether the theory or technique has been generally accepted. Those factors are taken from the American case, *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[19] There is an abundance of American case law dealing with the "*Daubert* test" and dealing with probabilistic genotyping software considered under that test. Those factors have been imported into Canadian law, but they do not represent the only Canadian law that has to be considered and applied in this context.

[119] Those factors were considered in *R. v. Trochym*[20] in which a Crown witness had recovered part of her memory through hypnosis. Hypnosis as a technique had been established and the subject of scientific research. But recent research had cast doubt upon the reliability of the technique. Justice Deschamps noted that a judge must scrutinize novel scientific evidence and admissibility will be circumscribed when evidence may distort the fact-finding process. In the case of hypnosis there was a controversy surrounding its forensic use and there would have to be an explanation of its shortcomings if it were to be used.

[120] The Ontario Court of Appeal in *R. v. Abbey*[21] set out an approach that uses the *Mohan* criteria but orders them somewhat differently. The first phase of the analysis uses the *Mohan* criteria as a checklist, of a rules-based analysis yielding yes or no answers. The second "gatekeeper" phase requires the exercise of judicial discretion weighing the costs and benefits of admitting expert evidence in the context of the case. The benefits of the evidence are measured by its probative potential including its reliability and the extent to which it is necessary to assist the trier of fact. The costs include overreliance by the jury and the unwarranted use of court time. Justice Doherty of the Ontario Court of Appeal said that the most important risk is the danger that the jury "will be unable to make an effective and critical assessment of the evidence".[22]

[121] Canadian law governing the admissibility of expert evidence has adopted that two-stage approach. The first "rules based" stage requires the consideration of the *Mohan* criteria and the special scrutiny that should apply to novel science. The second discretionary stage involves the weighing of the benefits of the evidence against the potential costs of its admission. For established scientific techniques, the criteria are relevance, necessity, the absence of an exclusionary rule and proper

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[19] 509 U.S. 579, 113 S. Ct. 2786, 125 L. Ed. 469 (1993)
[20] [2007] 1 S.C.R. 239
[21] 2017 ONCA 640
[22] *Abbey*, at para. 90

qualification of the expert. For novel science the court has to consider whether the technique can be or has been tested, whether it has been subjected to peer review and publication, whether there is a known or potential rate of error and the existence of standards for them, and whether the theory or technique has been generally accepted. If those criteria are met, the judge is required to undertake the balancing of the benefits, costs and risks within the context of the specific trial.

[122] Reliability is the factor that has emerged as the central criterion for admissibility. It is an essential component of admissibility.[23] It informs the *Mohan* test. Reliability at this stage means "threshold reliability" or whether the evidence is trustworthy enough to be admitted for the jury's consideration. Ultimate reliability is whether the evidence will be relied upon as true in deciding the outcome of the case. Professor Lisa Dufraimont has noted some of the factors used to assess threshold reliability, stressing rigor and sensitivity to context.

> But while no uniform test applies across all types of expert evidence, both the Goudge Report and *Abbey* catalogue numerous factors that can be helpful in assessing threshold reliability. For example, both these authorities emphasize the questions whether the expert's field employs quality assurance processes, whether the particular theory or method relied on by the expert has been accepted within the field and subjected to independent review, and whether the expert evidence will permit critical examination and independent judgement by a jury. These are among the factors that should guide judges in assessing the reliability of expert evidence; clearly judges cannot be content with a mechanical application of tests. The law now demands that gatekeeper judges analyze threshold reliability in a way that is at once rigorous and sensitive to context.[24]

[123] A scientific theory or a new technology can gain a foothold on acceptability in one jurisdiction and leverage it for acceptance in the next. The consensus builds court by court until it becomes widely accepted. Science does not progress by faithful reliance on previous work. It is never final. It is always open to skepticism. That does not mean that every piece of new technology or every forensic scientific advance must be tested each time. It does mean that scientists and the courts who receive their opinions must be conscious of the potential for creeping reliability.

[124] In the past Canadian courts tended to admit expert evidence and allow the jury to assess the weight to be given it. That approach was not accepted by the

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[23] *Trochym*, at para. 27

[24] Dufraimont, L. "New Challenges for the Gatekeeper: The Evolving Law on Expert Evidence in Criminal Cases" (2012) *58 Crim. L.Q.* 531, 547

Supreme Court of Canada in *J.-L.J.* Trial judges must scrutinize expert evidence at the admissibility stage.

> The admissibility of the expert evidence should be scrutinized at the time it is proffered, and not allowed too easy and entry on the basis that all of the frailties could go at the end of the day to weight rather than admissibility.[25]

[125] Reliability is in fact so important that it is considered twice. It is considered in the first stage of the analysis, when dealing with novel or contested science or for established science when there has been issue about its reliability. It is also considered in the second or gatekeeping stage. Reliability is factored into the costs and benefits of the admission of the expert opinion.[26]

[126] While Canadian law has adopted the "*Daubert* test" as part of a much larger scope of inquiry, the judicial attitude toward the gatekeeping function in Canada and the United States is not the same. Canadian courts are required to scrutinize expert evidence at the time it is proffered while American courts appear to be more inclined to let the jury sort it out. In *Rock v. Arkansas*[27] the Supreme Court of the United States explained that cross-examination of an expert witness and cautionary instructions to the jury are effective tools for attacking "shaky" but admissible evidence. In *Ohio v. Shaw*[28] the court applied *Daubert* to TrueAllele and considered whether the theory or technique had been tested. The judge concluded that both the internal validation studies and the peer review articles supported the position that the system had been tested. Given the admission of TrueAllele in other jurisdictions and its use in three laboratories, the technology satisfied the general acceptance factor.

[127] The court noted that the issue was whether the probative value of the evidence is "substantially outweighed by the danger of unfair prejudice, of confusion of the issues, or of misleading the jury".[29] The court noted the liberal standard of admission under *Daubert* and cited with approval *United States v. McCluskey*[30] where the court acknowledged the general presumption in favour of admission of "shaky evidence" with the danger of undue weight being countered by vigorous cross-examination, presentation of contrary expert evidence and the

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[25] *J.-L.J.*, para. 28
[26] *R. v. Abbey* 2009 ONCA 624
[27] 483 U.S. 44, 61, 107 S. Ct. 2704, 97 L. Ed. 37 (1987)
[28] 2014 Court of Common Pleas, Cuyahoga County, Ohio Case No. CR-13-575691
[29] *Ohio v. Shaw*, p. 24
[30] 954 F. Supp. 2d 1224

possibility of jury instructions to explain the issues. The court was satisfied that the parties would educate the jury on statistical issues and DNA testing and methodologies. If the court were to conclude that jurors were confused by the evidence presented the court may deliver carefully crafted instructions to ensure that it is understood.

[128] It is not entirely surprising then that American courts have found that TrueAllele passes the threshold test in American law for the admission of expert evidence. It can be well argued to pass the *Daubert* test for admission as that test has come to be interpreted and applied in the United States.

[129] Canadian law is somewhat more circumspect regarding the admission of expert evidence. The history of wrongful convictions in this country, and the fear of tragic miscarriages of justice has not created a new standard of proof that goes beyond reasonable doubt. It has not made Canadian courts cynical about science. It has made Canadian courts more skeptical that even the most vigorous cross-examination can contest "shaky evidence" when that evidence is wrapped in the mystique of scientific expertise. It may also have made Canadian courts less confident in their abilities to craft instructions that will guard against the entirely natural inclination to consider the evidence of highly regarded experts as being virtually infallible.

TrueAllele is Novel Science

[130] TrueAllele passes the four *Mohan* criteria. The evidence is relevant. It is necessary. It does not offend against any exclusionary rule. It comes from a person who would be qualified as an expert.

[131] It is also novel or contested science. While there may be no precise definition of what constitutes novel science in the Canadian context, the absence of routine acceptance in Canadian courts is an indicator of that. When a form of scientific evidence is being considered in a Canadian court for the first time it is novel. It may have been accepted by courts in other jurisdictions but unless it has been subjected to the scrutiny of Canadian law informed as it is by our history and values, it remains "novel".

[132] While probabilistic genotyping software may have been used in other cases in Canada, there has been no case provided in which it was considered by a Canadian court. While the technology may be gaining acceptance in other jurisdictions, some courts have not accepted it. It is novel science.

Testing of TrueAllele

[133] TrueAllele has been subjected to testing and validation by a number of laboratories that have purchased the software for their use, and it has been extensively tested by Cybergenetics itself. The use of probabilistic genotyping for interpreting DNA mixtures has been tested. Thirty-three studies determining the reliability of TrueAllele have been conducted for both laboratory generated samples and DNA samples from court cases. The validation studies repeatedly show that TrueAllele has met the requirements of sensitivity, specificity and reproducibility. The studies also show that TrueAllele has a knowable error rate.

[134] Testing must be considered having regard to what is being tested and by whom. Cybergenetics' TrueAllele software has been tested by Cybergenetics and other scientists for use in their applications. That provides an indicator of the reliability of the science.

[135] TrueAllele has not been validated in Canadian laboratories. Accredited Canadian forensic laboratories adhere to standards from the Standards Council of Canada, and SWGDAM, as well as the FBI Quality Assurance Guidelines. They indicate that any procedure used by a forensic laboratory must be internally validated before being used to do casework. Each laboratory has its own set of independent variables so that any new product has to be tested within those variables to make sure that the product performs as expected within that laboratory's specific conditions. The laboratory then sets limits and parameters for the use of any product or instrument brought into the laboratory. Those are distinct from the manufacturer's developmental validation. That process involves testing the instrument or the technology in isolation to understand its limitations and the conditions under which it can be used.

[136] The Standards Council of Canada Guidelines for the Accreditation of Forensic Testing Laboratories require that the reliability of a new product must be established in-house and must be fully validated before being used in casework.

[137] Dr. Perlin and Cybergenetics maintain that the TrueAllele program has been developed to account for any independent variables within a specific laboratory. There is no need to calibrate the software to take into account the manner in which data were collected in the laboratory.

[138] The concern here is that Cybergenetics is not a forensics laboratory or to use the American term a "crime lab". In this case part of the work involving the

collection of data was performed at an accredited forensics laboratory, and that data was returned to the Halifax Regional Police. The data was then sent to Cybergenetics which is an uncredited software company. This key component of the forensic casework process, including the reporting function, was removed from the accredited laboratory system that is normally accepted in Canada.

[139] As a scientific theory probabilistic genotyping has been tested. As a software program, TrueAllele has been tested. It has not been subjected to and is not subject to the rigorous standards that apply to accredited Canadian forensic laboratories. But it has been "tested" as science.

Peer Review

[140] TrueAllele has been subjected to peer review and publication. Extensive volumes of materials show that probabilistic genotyping as used in the TrueAllele software has been the subject of numerous peer reviewed articles in scientific journals. When a paper is peer-reviewed, the editor has at least two independent scientists in the field read the paper, assess its merits and advise the editor regarding whether the draft article is suitable for publication.

[141] In most cases involving TrueAllele the articles themselves have been written by Dr. Perlin or an employee of Cybergenetics. That does not make them any less "peer reviewed". Anonymous reviewers have read the articles and provided commentary to the editors of the publications involved about whether the articles were suitable for publication. While there is no indication as to whether they attempted to replicate the work done or what, if any, testing was performed to test the accuracy of what was stated, the peer review in this case would pass as "peer review".

Error Rate

[142] The TrueAllele system has a known error rate. It provides an error rate for every case.

Standards

[143] Dr. Perlin noted that TrueAllele complied with a number of standards that Cybergenetics identified as being potentially applicable. It is not a laboratory so of course the standards that apply to laboratories, or specifically forensic laboratories do not apply.

[144] At Cybergenetics the Standard Operating Procedures are provided to operators or users to encourage them to think about the data and to think about the questions that the computer has answered, rather than simply running a computer program without thought. Cybergenetics is of course not subject to the same kind of independent auditing as an accredited forensic laboratory and its Standard Operating Procedures are a very different document to what is used by forensic laboratories. Those procedures set out specific instructions and procedures for clearly defined scenarios.

[145] The FBI Quality Assurance Standards used by accredited Canadian forensics laboratories require analysts to have at least 6 months of forensic human DNA laboratory experience before conducting casework. Analysts must successfully complete competency testing before conducting independent DNA analysis. They are required to undergo ongoing proficiency testing. The Standards Council of Canada sets out the minimum requirements for a DNA analyst. Those requirements include a university degree in a relevant science, course work in biochemistry, genetics, molecular biology and course work or training in statistics and population genetics as it applies to DNA analysis. There are numerous training requirements that must be satisfied before a person can perform the function of interpretation and reporting of data in the forensic context.

[146] Cybergenetics has several self-paced courses developed by Dr. Perlin and the company's IT coordinator. They involve reading materials related to TrueAllele and writing an exam. They are not verbally taught to students. The courses vary in length and the time depends on the pace at which one wishes to proceed. At the completion of each course the person receives a certificate from Cybergenetics. While a background in forensic sciences is helpful it is not required.

[147] Reporting by accredited forensic laboratories is governed by standards and is in a standardized format. Scientists provide reports based on what they did. They do not infer facts from conclusions.

[148] Ms. Blackmore noted that the scientific method involves attempting to disprove a hypothesis. Conclusions are framed as "cannot be excluded" rather than as a "match", which is the term used in the Cybergenetics report. Dr. Perlin explained that because all information was disclosed in the case packet, he was less concerned about the specific wording of the report itself. In his view reporting

information to non-scientists required using informal language like "match", even though that term would be inaccurate in probabilistic genotyping.

[149] In accredited Canadian forensics laboratories ethical training is required for staff. Ms. Blackmore noted that given the implication of the reporting evidence in the justice system ethics training is particularly relevant. Cybergenetics does not have ethical training for its employees. It is subject to no requirement to have any.

[150] Accredited Canadian forensics laboratories are regularly audited to maintain accredited status. Those audits are conducted by independent parties, that make sure the laboratories are complying with external standards and the laboratories own standard operating procedures. Cybergenetics is not subject to any external oversight of auditing. There is no legal or other requirement that it be subject to audit of its work.

[151] Cybergenetics is not subject to the accreditation standards that apply to forensic laboratories. It is a software company. It is not clear what, if any, standards apply to the development of software or whether Cybergenetics has complied with any standards. There is no auditing of the software development process and the software itself is a proprietary trade secret.

[152] There is nothing to suggest that Cybergenetics has failed to comply with any standards or laws that apply to it. That, however, is the very concern.

General Acceptance

[153] Probabilistic genotyping has been accepted by many as a valuable enhancement to the ability to interpret complex DNA mixtures. It reduces human error, saves time and helps to eliminate bias. TrueAllele is used by a number of American "crime labs" and has been used in 800 cases. Expert evidence has been given in 100 trials. Dr. Perlin has testified as an expert in more than 20 trials in courts in the United States, Northern Ireland and Australia.

[154] It has not yet been considered by a court in Canada. The use of probabilistic genotyping software is still the subject of litigation. Some American courts have not accepted it as being reliable.

[155] The requirement is "general acceptance" not universal acceptance much less universal acclaim. The issue is not legal acceptance but scientific acceptance.

The Gatekeeper Function

[156] As "science" probabilistic genotyping and the software program TrueAllele may meet the *Daubert* test. That is perhaps a less than full-throated endorsement. TrueAllele has been tested and subject to peer review. It has an identified error rate. Cybergenetics voluntarily complies with those standards that Dr. Perlin believes are relevant to its work. It has achieved a level of acceptance within the scientific community that has satisfied more than a few foreign courts.

[157] Context is important. Rigor, and sensitivity to context mean that the kind of science that forms the basis of the scientific opinion must be considered. So does the kind of report that it is and the purpose for which it is to be used. In this case, the nature of the evidence is relevant. This is not evidence of one scientific theory that is being contested by the other party with a competing or opposing theory. It is a computer program that produces a result, without showing in each case how it got that result. It is a computer program that analyzes data from DNA - the forensic "gold standard". It is primarily a forensic tool. It is tested by the factors that are used to assess the reliability of science, but it is science developed and implemented for a forensic purpose.

[158] TrueAllele, as software, is an instrument. The instrument has been tested and validated but it has not been subject to formal approval or accreditation for use in the forensic context in Canada.

[159] In Canada forensic science is undertaken by accredited forensic laboratories. Other science is used routinely in Canadian courts. Reports are received from engineers, doctors, psychologists, actuaries, and many others. Forensic science and particularly the science of DNA used for identification in the forensic context is a field that is subject to another level of accreditation and regulation. That is because of the implications that the evidence may have on the outcome of criminal cases.

[160] TrueAllele has been tested. The testing that has taken place is testing by academics and "crime laboratories" seeking to use TrueAllele as part of their work. It is not only a technology or a theory. It is an instrument that is to be used in the context of forensic DNA. Other aspects of forensic DNA evidence in Canada are widely subject to scrutiny by independent accrediting bodies. Cybergenetics is not. And TrueAllele is not. The report is not a report from an accredited Canadian forensic laboratory that has validated the use of TrueAllele within its system. It is the report of an unaccredited private company that has used data obtained from an

accredited laboratory. It may be tested for scientific or academic purposes. It has not been tested by an accredited body for forensic purposes.

[161] TrueAllele has been peer reviewed in the academic context. It has been reviewed by anonymous scientists chosen by the journals that published the articles. The reviews are with respect to the contents of the articles. They are performed by anonymous reviewers who themselves have not be accredited. TrueAllele has not been subjected to review by any accrediting body in the way that every other part of the DNA collection and analysis process is widely accredited or audited in Canada.

[162] Cybergenetics is not subject to any of the standards that apply to accredited forensic laboratories in Canada including the standards that apply to reporting and ethical and other training. There are no standards that apply to TrueAllele or Cybergenetics that apply to the development of the software and therefore there is no ongoing monitoring to ensure that any standards are maintained.

[163] Probabilistic genotyping itself has received wide acceptance in the scientific community. The technology provided through the proprietary software program TrueAllele is offered for sale in a competitive market. The commercial dispute between STRmix and TrueAllele simmers in the background of any discussion about the reliability of this software.

[164] The opinion offered by Cybergenetics is wrapped in the double mystique of genetics and analytics. Regardless of what instructions were given to a jury there would remain the real likelihood that the jury would perceive the opinion as being infallible. The effort to undermine the expert opinion would require Defence counsel to engage experts once again. That effort would be time consuming and complicated. The trial could potentially devolve into the trial of the reliability of TrueAllele. The ability to make that assessment would tax the abilities of any jury. That would result in the focus of the trial, for a jury, being diverted from the ultimate question to the efficacy of probabilistic genotyping. Though that would happen in the context of a strong judicial caution attempting to alert the jury to their obligation to fully and properly assess the science, that would not be enough. The process would not only be time consuming, but it would be distracting. There are commercial, academic and scientific interests at stake in the determination of whether TrueAllele or probabilistic software should be permitted to be used in one more jurisdiction. The interest in preserving a fair and efficient trial involving murder charges in this case is more important.

[165] The use of the evidence in the context of a criminal trial could mean that it would be given far more weight than would be justified given the absence of any formal external monitoring of its processes.

[166] The Cybergenetics report will not be admitted as evidence. The risks and costs of its admission outweigh its probative value. The matter of the disclosure of the TrueAllele source code was argued but in light of that ruling there is no need to make any finding.

Campbell, J.