Wednesday, 25th November 2009

(Afternoon session)

(1.57 pm)

PROFESSOR CRISTOPHE CHAMPOD, continued

THE CHAIRMAN: I am sorry, we had to interrupt you again but on you go, as soon as you are ready.

THE WITNESS: Thank you, my Lord.

The purpose of this slide is to explain that the identification process can be seen by analogy to a reduction process. So on the top of the triangle you have all the individuals among which the person potentially of interest. It will become of interest at the end, of course.

By practice, Fingerprint Examiners will conceive this whole population as the world population, will take the world population as a starting point. Now comes the scientific evidence here in the form of fingerprint evidence and this graph has its limits. I will focus only in cases where there is supporting information in favour of the identification. This graph is not adequate to reflect on the exclusion side of the balance.

The weight of evidence is shown here as this arrow of distinct length. The lengthier it is the stronger the evidence can be viewed in favour of the identity of

sources.

The little blue dot, blue segment here **(indicated)** reflects what I have called previously the leap of faith. The weight of evidence is huge in order to reduce from the world population up to the single individual in the bottom. So you need a large amount of weight of evidence to come to that position where the examiner may step towards the identification decision.

This outline here is the usual framework in which the Fingerprint Examiners will operate. So the expected weight of evidence to be produced in every fingerprint comparison cases, if we are talking towards identity, is of that magnitude, if I may use the length as an analogy to the weight of the evidence.

Of course there is two elements in this. One is the population and the second is the weight. Had the circumstances been different, for example, that we don't -- and when I say "we", I would think about the court, won't use the world population as a starting point but would use potentially the population of a city, the weight of the evidence which would be necessary to come to the same situation as before is reduced, but you come to the same conclusion.

So the argument I would like to make here is that we need to distinguish two things in interpreting forensic

evidence. There is weight and there is the putting the weight into the perspective of the case. The perspective is given by this reduction. Where do we start? If you start with the world population you need that weight to come to that point **(indicated)**. If the court had started with another more limited population then you need a different weight to come to the same ultimate decision in the end. So we cannot ask for the weight of the evidence to deal with the two elements. That is the argument which was made by the Court of Appeal in **Doheny and Adams**. As I read it, the court ruling was to invite the scientist to concentrate on the weight of the evidence only and express the weight of the evidence without putting in perspective to any sized population, unless he is invited to do so by the judge.

When we talk about weight of evidence, we try to remove it and treat it independently from the issue as to what is the contribution in the context of a case, putting this into a context of a case needs the fact-finder to establish the, what technically speaking we call the prior odds to establish the starting point as a function of the other element presented in the case.

So the identification process can be seen as a reduction process. It's a reduction process obtained by

a factor. The factor has the only effect to reduce the number of potential sources down to a limited set. It is probabilistic and there comes a point where we will claim -- and that's the jump -- that at the end of this reduction process only remain in the group one individual and that will be the individualisation.

I will talk about probabilistic models. There is more in my report. I will focus mainly on minutiae and I would like to discuss about the potential contribution of these models into the global discussion about fingerprint evidence.

These models and the ones I am going to concentrate on invite the consideration of two specific questions. The first is an assessment of the probability of observing the degree of similarity and/or dissimilarity between the two impressions should they come from the same source and this is the first question that the model invites you to assess, statistically speaking.

Again, we can view this as a balance. To balance this, we need to consider the alternative probability which is the probability of observing this degree of similarity and/or dissimilarity if the two impressions are originating from different sources.

Once both of these probabilities have been formed, then we have an element that describes the weight of

evidence and technically speaking we refer to this ratio, because we have a ratio between two probabilities, we refer to this ratio in our forensic jargon as the likelihood ratio. If, by hypothesis, the results of the examination are as likely if it is coming from that source that it is coming from a different source, in other words, that the probability associated to question 1 is the same as the probability associated to question 2, it simply means that the balance is even and the forensic element does not help to progress the case in one direction or the other.

Conversely, if the findings explain themselves much better under the proposition of a same source, than under the proposition that a different person produced the mark, in other words, that the first probability is high and the second is small, then in ratio the finding will provide support for the proposition that the mark has been produced by that person. We can make the same exercise reversely to support the exclusion.

So the likelihood ratio, its magnitude translate the reduction factor which I have shown before with length of the arrow. The likelihood ratio does not allow to say either by absolute terms or by degree whether the mark was left by that person. It just allows to say that regardless of the starting position it will make

you move into this triangle by a degree expressed by the weight of evidence.

The models which I am going to discuss all aim at assigning a likelihood ratio to features found in correspondence between a mark and a print. To answer the first question, the model will have to encapsulate knowledge about distortion because if we want to ask ourself what is the chance of observing these features if truly that person left the mark, we need to account for the possibility that the mark that has been deposited may be distorted, smudged, moved. So behind the scene, the model will account for distortion and it has been informed with data distorted finger-marks that have been acquired under different distortion conditions. That is what these images **(indicated)** are showing. All these images are coming from the same finger but, depending on how the surface was touched, we expect to observe distortion in the relative or in the positioning, global positioning of the ridges, their shape and the positioning of the minutiae.

The model has learned how fingerprints distort due to the application of a finger on a surface. It is what we call the within source variability, the model is informed for the first question about the variability we expect should that person truly have left the mark. So

by multiple repetition by simulation of distorted impression from that finger we can assess the chance of truly observing what we have under our eyes, given that it is the finger of interest which is at the source, which is the first half of the likelihood ratio.

The second question is when we postulate that a person of which we have kept the print for comparison is not the source of the mark. So in that case we ask ourselves what is the chance of finding someone else who by mere coincidence will display features which will not be distinguished from the features observed in correspondence between the mark and the print.

To answer the second question, we need a database of prints taken from different people and all these loops are from different people. I have used eight here but obviously the model is informed by more than eight loops behind the scene. It's from the statistical analysis of a distribution of minutiae on fingers coming from different sources then we can obtain a response, statistically speaking, to the second question. So what we do here is we invoke the concept of between sources variability of marks and print.

The main actors in the development of models who allow to compute likelihood ratios are to my knowledge three. The UK Forensic Science Service has developed a

model which I had the chance to be associated with in its early stages and the model is, in my opinion, by far the most extensively validated and is very close to casework deployment. The paper has been proposed to be read at the UK Royal Statistical Society.

The laboratory in the Netherlands, the National Forensic Laboratory (its acronym is NFI) has a research group who explore the very same issue. They are trying to assess likelihood ratio associated with partial fingerprint and our group has done extensive research in the past and still today on the very same subject.

All these three groups are aiming at the same objective: bringing a mechanism whereby we can assign a robust likelihood ratio to a comparison between two sets of features.

The reason why I didn't feel it was fundamental to go into the technical details about the estimation of these numbers is because the input, the prerequisite for obtaining a meaningful statistical value out of any of these models, the prerequisite is that we should have some sort of a consensus on the features which will fed somehow the system.

These system are not automatically extracting information from the mark or the print but they are processing information which have been put forward as a

question to the system by a Fingerprint Examiner. So the prerequisite to obtain any meaningful number out of a likelihood ratio calculator is that there is in consensus and agreement as to the features which are deemed to be relevant in the comparison at hand.

To illustrate this I will use this case which I have used also in my report. It is a mark which has been detected on the blade of a knife with a chemical technique called amido black and on the right you have the potential corresponding print. This is an enlargement of a -- sorry, I've moved straight to the comparison stage and evaluation stage. An examiner has indicated that he is able to annotate robustly all these features corresponding on the mark and on the print. The yellow ones are features that have been seen by the examiner only in the comparison stage. They were not features which he or she indicated during analysis. The reds are the ones which were annotated during analysis.

When you compute the likelihood ratio associated with this comparison, putting in correspondence these ten features with these ten features on the print, the computer will give you back a likelihood ratio in the order of 300,000. This is very powerful evidence to support the view that the mark has been left by the same person as the person who produced the print.

Had a second examiner on the same case annotated five minutiae in correspondence instead of ten, of course the system computing the likelihood ratio on these five minutiae will get a likelihood ratio which will be much lower than the likelihood ratio you obtain for ten minutiae and here the likelihood ratio is estimated to be 5. That provides some evidence but to a degree, the size of the arrow of course is completely different between the previous case and this case, the same case but two examiners. Hence the argument which I suggest to the Inquiry is that the use of statistical modelling does not replace whatsoever the skill judgment of an examiner during analysis to agree on the sets of features which then may be used to obtain a statistical figure reflecting the strength of the evidence in the given association, if association is obtained.

The system is not here to replace examiners. The system may only offer help to guide their decision or to guide their informed judgment. It brings a layer of systematic study to their decision-making process. They can have some back-up data to suggest how rare or frequent a configuration of minutiae may be.

I would suggest that there is -- the use of statistical models should not be seen as the holy grail replacement of expert judgment in comparing

fingerprints. It provides a layer of objectivity and transparency but that has to work hand-in-hand within an examination process which remains unchanged and is still articulated along the steps of ACE-V, as we discussed.

So we are not talking about replacement. We may talk about calibration of informed judgments in the same way I have used some data previously to express why I felt that a bridge may contribute significantly into the comparison process.

Another benefit which I have always suggested for the use of these models is to tackle marks which fall within the inconclusive area and be able to guide judiciary as to the contribution of limited sets of features but still in agreement to how these features may help to support the proposition of common sources or otherwise.

I just have two chapters before closing. One is on Level 3 features and then I have some perspective to offer.

The Level 3 features are referring to the intrinsic small in terms of size details that either marks or prints may display when left on surfaces.

To prepare the report which I submitted to the Inquiry, I have benefited a lot from the work of one of my PhD students. His name is Alexande Anthonioz. He is

currently doing his PhD project on the statistical assessment of Level 3 features. Whereas we have done a lot of work in the community devoted to Level 2, there is a paucity of data when it comes to Level 3.

One of the publications I referred to in my report is a publication where we were interested to know if we ask examiners, what do you mean by Level 3 features? In a survey we conducted a few years ago, it became obvious that there is not a single definition about Level 3 and examiners may sometimes put things which we would classify as Level 2 as Level 3 and vice-versa. Also what we noticed is that the perceived contribution of Level 3 features, in other words, where an examiner were asked about the expected strength of a given set of Level 3 features should a comparison give a correspondence, we noticed that the responses in terms of their judgment as to the strength varies a lot from one examiner to the other.

The table you have on this slide shows you the four areas where there is commonality of agreement as to they represent Level 3 features. The ridge edges on the first column, they are the specific forms and shapes taken by the ridges as you follow them.

The pores, pores are the opening of the sweat canal where a secretion is secreted -- sorry for repetition --

as eccrine glands produce the fluids.

The shape, as we have seen this morning, shape and positioning is of interest. Then there is the shape of minutiae. By shape of minutiae we mean the form a ridge ending may take may be pointy, it may be bulky or also the shapes that the adjacent ridges will form coming close to the ridge ending here, we may have shapes in forms of bottle necks or a ridge may approach -- the right ridge may approach the ridge ending closely and form a specific shape. This is the shape of minutiae. The angles of bifurcation falls also into that category. The last one is the width of ridges and furrows.

To assess the strength of these features in the identification process one good starting point is to explore how these features are reproduced from one impression to the other. The reproducibility is one of the key components in the robustness of the features and when we conducted experiments as to the reproducibility of these features from mark to mark, we noted that the only features which have a good level of reproducibility -- by this term I mean that you can expect to find these features in correspondence should a corresponding print be made available -- the only features which are well reproduced from mark to mark are the relative pore positions and the specific shape of

minutiae. The form of the ridge edges, the specific forms of the pores are not well reproduced from one impression to the other.

It may happen in the process of production from mark from one person over and over again that mark 1 will find the same shape of the pore than mark 120, but although these events exist they are rare. Most of the time you won't see reproducibility. So the lack of reproducibility gave a good indication that these features are not reliable in the identification process for the decision-making. Their contribution, their weight in my balance, exists but they are quite limited in terms of weight.

It means also the converse. Observing differences on these features because of a lack of reproducibility the weight on the exclusion side will be limited as well. In fact, we could use a sort of guiding principle that if there is a feature which we will not consider for exclusion purposes it would be safe not to consider it for inclusion purposes.

One question which was put forward to us by the Inquiry was can we identify on Level 3 alone? We have taken the position, which is in the same line as the position of SWGFAST, we would not recommend to rely solely on third level details to individualise.

First, the exercise is a little bit of a theoretical exercise because most marks which will display Level 3 features, they will also display level 1 and Level 2 features and certainly Level 2 features. So it's quite difficult to envisage a situation where the only reliable information on the mark is composed of Level 3 features as I defined it. Quite often it walks hand in hand with level 1 and Level 2.

The paucity of research as to the selectivity and discriminative power of these features, the fact that the only research available supports or provides evidence that reproducibility is not well in place for many of these features, both together lead us to consider that although they may contribute with some weight in the decision-making process, we would not regard this as good practice to rely solely on Third Level Detail to individualise.

I will end my presentation with some perspectives. I've taken the liberty in discussion during the meeting last week just to highlight two or three elements which was a striking feature for me being involved in this Inquiry through the role you kindly allowed.

When I was faced with the task of trying to understand or identify areas of agreement and areas of disagreement, we aren't taking any position as to the

merit of the positions expressed. The absence of contemporaneous documentation and especially of the analysis made the task meaningless or impossible. So if there is a first perspective I would offer is that in case of disputed conclusions there is no way we can unfold the chain of evidence without having proper documentation of the analysis phase, otherwise everything is based on post hoc justification of conclusions that have been already taken and people have already signed up to them and there is no way to unfold the evidence to understand before making any evaluation, before making any comparison, what was the positioning as far as to the reliable features identified during analysis and how things developed from there.

It seems to me that the report following the Mayfield bombing, the mark which was mis-attributed to Brandon Mayfield -- sorry, it was the Madrid bombing, I apologise. The report was made possible because of the evidence available to the Inquiry team as to what was seen and searched through the AFIS before Brandon Mayfield was suggested as a potential source and when people went back to this information it was possible to understand and identify what was misread, if I may say so, during the analysis stage of that mark. In the case the Inquiry is focused on, we don't have this

information available.

That leads me to the next slide which I believe the two perspectives I am offering can be made regardless of the decision of this Inquiry in relation to the disputed marks.

There is a need to maintain and having adherence to standard operating procedures. These procedures should ensure a proper and separate undertaking and documentation of the ACE-V process and it should also include mechanism to handle conflicting results and errors.

I have been asked in the past to be a technical auditor for accreditation bodies under ISO17025 and I visited laboratories in Sweden and in Finland for their procedures in relation to fingerprint identification. These standards can be written in different ways but if the procedures are very clear about the separation between analysis and comparison, the level of documentation which are expected in both phases and how, if any conflicting opinion arise during that process, either in verification stages or through other QA mechanisms the laboratory has in place, if there is a clear understanding of a process that have to be followed by the laboratory to handle these events, then I think we will make a lot of progress.

The last one is I reinforce something I have said multiple times. The marks of very high quality do not require the same level of in-depth analysis -- and by in-depth analysis I certainly mean the documentation associated with it -- the same extensive and potentially blind verification that a complex mark would require.

So there is a need to design a process whereby we can distinguish the way simple marks are handled as opposed to complex cases.

Every mark has to be classified somehow. So if we view this as some sort of a triage at the end of an assessment before a formal analysis comes into play, the view that has been taken by some Swiss identification bureaux is to use the 12-point rule as a benchmark to make this distinction between complex cases and simple cases.

The above 12 clear identifiable features in analysis phase the mark will be declared to be simple and simple doesn't mean simplistic. If below 12 or with signs of disturbance and difficulties or what practitioners term often red flags in analysis stage the mark will be considered as complex and will go through a different route.

The level of training of the examiners who will be allowed to verify a complex case is different in

Switzerland compared to the level of training an examiner is required in order to be allowed to verify a complex case.

The 12-point rule has been kept not as a decision threshold after the evaluation but it has been kept as a quality assurance mechanism with potential it's drawback as well but offering a way to cope with the number of marks submitted to a service and allow distinct pathways handling easy cases in an economical manner without running the risk of a misattribution and running cases which are complex in a way which ensure that people appropriately trained to verify these cases are involved.

Sir, that concludes my presentation.

THE CHAIRMAN: Thank you very much indeed.

Mr Moynihan if you would like to continue.

Examination by MR MOYNIHAN (continued)

Q. I'm very grateful to you, Professor.

Needless to say, because the slides you prepared reflect the conversation we had at the end of last week, I don't have too many questions because you have incorporated much of the conversation in the presentation. There are, however, some points I would like to discuss with you. I can maybe begin by using the ACE-V methodology just as a starting point.

First of all, I noted in an article you wrote in particular with Mr Chamberlain -- but it may not have been precisely that one -- that you do observe ACE-V as an acronym is a fairly recent addition but as far as you are concerned the ACE-V methodology is itself not new and what you have written is that it would be wrong to think of a pre-ACE-V fingerprint world and a post ACE-V fingerprint world. Is that fair?

A. Yes. ACE-V is an acronym that has been suggested would translate good practice and good practice has been around before ACE-V. A good practice would say concentrate on the unknown, study the unknown first and then move to the comparison from general to particular, assess your findings only when you have finished with all of the comparison exercise and ask a second opinion, if needs be. That, in essence, are the steps of ACE-V under this acronym, which are, to me, just reflect good forensic practice that had been around before the acronym itself.

Q. Also what I have observed that you have written is that though ACE-V is, as you describe it, a protocol for working, this acronym does not in fact tell us of the standards that individual practitioners actually apply in arriving at a decision of identity. Again, is that fair?

A. That's fair, yes.

Q. In that case, what I want to do it just step back from the protocol and look at the practices which result in a conclusion.

First of all, you have told us about events and event seems to be the generic term which is used by fingerprint practitioners. Looking to paragraph 59, ultimately, of your own paper for the Inquiry, which is ED0003, paragraph 59, page 18, you had been looking at statistical data and you said:

"These data are important to Fingerprint Examiners when they want to weigh different types of minutiae. Results from these surveys help to calibrate expert's judgment on the relative frequency of a given minutiae. The above data show also that a simple additive rule with equal weight for each minutiae -- up to 12 points for example as a numerical standard -- is an inadequate model from a statistical perspective."

I want to look at that in a more simplistic way. An event, as I understand it, a fingerprint practitioner could ultimately decide an event could simply be a coincidental feature on the underlying substrate and, therefore, in fact be irrelevant to identity of the mark. That's possible?

A. I just may need to clarify what we mean by event. In

the presentation I did I have restricted the concept of event to stops of ridges or stops in a bifurcation which end into one ridge. Then we may have uncertainty as to the nature of the event being it a ridge ending or a bifurcation but when I say I can see an event, in the presentation of this morning I would qualify it as being an interruption or stop for a bifurcation or the ridge and not other features from the substrate which might be confused with an event.

Q. I am grateful because, as you say, the invitation to clarify the terminology is exactly what I am coming to.

By an event I am meaning something broader than what you were discussing yourself in the presentation. By an event, what I mean is that there is an appearance in the image from the mark, so simply the broadest collective term, there is an appearance. A fingerprint practitioner will have to, first of all, take a judgment whether that appearance is extrinsic to the mark, part of the background substrate or intrinsic. That's the first?

A. Yes, and that would be, in the little scale I showed, it would be the passage from in all likelihood there is an event or you think it might be something but it might be something else, meaning it has nothing to do with the mark of interest.

Q. I am grateful because I wasn't actually myself going to discuss that but what I wanted to do was to concentrate on the intrinsic features and that would then bring me to the same definition of event that you have been using.

An intrinsic feature of the mark which is ambiguous, it could be either a ridge ending or a bifurcation and that is what you have been discussing just now today?

A. Yes.

Q. We have heard some evidence to suggest that in some situations a practitioner might say what matters is that there is some event, either a ridge ending or a bifurcation, what matters is there is some event coincident between the mark and the print but the precise nature of that event is of secondary importance.

Taking what you said in paragraph 59, would that form of reasoning be unduly simplistic because the precise nature of the event as either a ridge ending or a bifurcation, the distinction could be statistically very important, namely that a particular feature, a ridge ending or a bifurcation, might be either rare or common?

A. It may depend on -- when examiner will say it's not important it depends important for what? If it is something they will consider to be important to qualify

this as a significant difference or important to exclude when the mark is of low quality of course the ability to distinguish between a ridge ending and bifurcation is so weak than a difference between a mark where you move towards a ridge ending and a print towards bifurcation, that difference might not be important in a sense. That difference alone will not dictate a conclusion of exclusion. So in a sense if that is what was meant by important I would tend to agree.

If by important we mean once we have identified corresponding features of clarity, so in terms of the reliability of the observation are in place and on one side we have, in a case we have a set of bifurcation and in another case we have a set of ridge ending, the strength of the information is different if we are talking about ridge ending or if we are talking about bifurcation. So if by importance we mean the importance in contribution in my scale side of the balance towards identification, if the mark allows an assessment, an analysis, as to the nature of features that will have an impact on the weight that will be assigned if correspondence is found during the comparison stage. That is done in analysis. Did I say analysis first?

Q. So if I understand it correctly, what you are indicating is a correct characterisation of the event as a

bifurcation on the one hand or a ridge ending on the other could have a material bearing on the true weight to be applied to that event?

A. Yes.

Q. The second aspect of this that interests me, I think it is covered by your answer but in a slightly different angle, if an examiner is not sufficiently careful in defining his event, he could in fact eliminate a difference simply because he is not properly attuned to the fact that truly it's a bifurcation in the mark, for example, and a ridge ending in the print.

A. Yes, I think that's correct.

Q. I want, in following that through, to discuss with you then this question of tolerances. If I understand it correctly, and this is the paradox for me in listening to what you have said, where the clarity of the mark is clear the tolerances that the examiner will set will be narrow and, therefore, before declaring an identity he will look for a very, very close correspondence between mark and print. Is that correct?

A. That's correct.

Q. The paradox for me is that where the clarity is poor, the examiner at the analysis stage may set a wide tolerance, yes?

A. Yes.

Q. So that when he comes then to a comparison, he is again applying wide tolerances to mark and print?
A. Yes, absolutely.
Q. That must run the risk that the chance of an advantageous match between mark and print is increased precisely because, the phrase you used is the window for a match is wider?
A. Yes, that's absolutely true.
Q. How then ought a practitioner to guard against that problem in a sense that, if I can put it at its most extreme, the chances of finding a match in a complex mark are greater simply because the margin or window set for a match is wide to compensate for the lack of clarity, how do we restore that to a balance?
A. I think that's where the analysis is essential. There is a translation in the documentation during analysis about the size of the windows: which are the features which are robust and which are the features with higher tolerances?

Of course if all the features in analysis are essentially of less reliability, so with large tolerances, then you would need more of that information in order to come to the same degree of weight compared to a case where the tolerances will be smaller. So, yes, indeed there is a very -- the only way to guard is

to apply a strict distinct analysis from the comparison in order that the features are declared to have large tolerances upfront and not then a reduced tolerances once you have found them in agreement on the print.

Q. So it really very much depends on training practitioners to be alert to the fact at the analysis stage they have set themselves fairly broad tolerances they must be conscious of when they come to the evaluation and they weigh up the coincident features?

A. Yes, and to me the verification stage should take advantage of the documentation prepared during the examination of these two individual or three, if necessary, and the verification of complex marks should, in my view, not only be concerned with the agreement on the conclusion, but also having a technical review on the features used by these examiners both in analysis as in comparison.

So it may highlight that in fact there are so many differences between the three people involved on the level of tolerances and reliability of the features that will trigger a discussion as to the robustness of the conclusion.

Q. So, in fact, if you find across a range of practitioners, where wide margins are being allowed, inconsistencies in relation to the detail then you might

begin to wonder about the robustness of the overall conclusion?

A. To me that should trigger some quality assurance mechanisms to see what is going on if these examiners have been presented with the same information and there is complete disagreement on the features that have been used and their weighing in the mechanisms to come to their conclusion. Here of course we are talking about a complex mark and if I may just add it's different if we have a mark which is of such extent that one examiner may use the upper part to come to the conclusion and the other examiner may use the bottom part to come to the conclusion, then just for sake of efficiency of course they haven't used the same sections to come to their conclusion but that's because of the richness of the mark as a starting point but the case I think we were referring to is a case where the mark is of such limited quality that it has to be assessed completely.

Q. The final significance that has occurred to me listening to you talking about tolerances is reinforcing the need for blind verification. If one is looking at a complex mark with examiners setting wide tolerances, wide windows, there therefore must be a correspondingly greater risk that they would be influenced in their judgment by knowing the conclusion formed by others.

Is that fair comment?

A. Yes, I think so.

Q. If I then move on to a slightly different angle in relation to tolerances, I understand from what you said so far in that the tolerances are themselves at present a subjective judgment by practitioners?

A. Yes.

Q. You are yourself aware of the American Academy of Science's report earlier on this year and of what it recommended, it said very little specific in relation to fingerprints but I did observe that it recommends that research be done in relation to the potential distortion of movement and the likes.

Is that with a view to it setting parameters for tolerances?

A. The parameters for tolerances indeed derive from knowledge about how a mark will appear when left by a person and it is the knowledge about the various instances a given mark from a same source may appear, that allows you to set the tolerances. So the National Academy of Science report may have advised to have more research on distortion and tolerances.

Q. Do you think that that is a subject that requires more study?

A. I would say that all subject in relation to the

interpretation of fingerprints would require some study. If you look at the number of structured research in this area, there is quite a paucity of research so distortion is certainly a subject that would need further research.

Q. Perhaps to try to understand how we've arrived at a situation where, as you say, there's a relative paucity of research, if I understand it correctly, the literature might suggest that because such a high standard was set historically, the 16-point standard, in the United Kingdom, it was understood that if you found 16 points in sequence and agreement there was a very high probability of a match and, therefore, the use of such an extraordinarily high standard had, in fact, removed the need for detailed research, that there was, in a sense, a rule of thumb that was found to be reliable, removing or reducing the need for research. Is that fair?

A. I'm not sure it is the 16-point standard that led to the paucity of research. As soon as you develop this scientific endeavour allowing only conclusion of certainty, either using a point standard or otherwise, then the consequence of this is that research dealing with uncertainty is not at the fore of the priorities because in a world which is dominated by clear-cut answers talking about reliability or visibility of

features and features which are more reliable than others it means, like I did this morning, it means that there is grey levels in what we see and assess. Tolerances is also a concept which is probabilistic in nature and then the end result of how we make the decision of individualisation is also probabilistic.

So as soon as we decide that it will be a profession ruled by certainty then the impact is that the research arm is cut immediately because it has to be probabilistic. To me that's the reason why we have so few statistical research in this area. I'm not sure it is directly related to the 16-point standard.

Q. If I move then from the question of tolerances to evaluation under a non-numeric system, I looked with Mr Chamberlain, with whom you wrote a chapter for Professor Fraser's book, at something where you and Mr Chamberlain attempted to define the manner in which the individual practitioner would declare a match, the threshold they would set when they were looking for sufficiency of minutiae in agreement, so the question is we always ask how do you determine sufficiency? What was written at page 69 of that article was this:

"In a nutshell, the individualisation will be reached when the examiner observes a level of agreement across the three levels of legible features that exceeds

the highest level of correspondence he observed through his/her training and experience in comparisons involving non-matching entities."

Read literally, what I myself was thinking from that is that that would mean that any one particular practitioner, if in the witness box, I would say, "What is your personal standard", and he or she would be able to give me one because they would be able to say, "The highest number of points I have observed in sequence and agreement in non-matching entities is X", whatever X may be, "and therefore I personally look for X plus one before I would declare an identity".

In fact, there has been a consistency in approach of all the practitioners asked this question, on whichever side of the debate they are in relation to our fingerprints, and they all say they have no personal threshold. It seems that the judgment is one that is dictated by the particular print in front of them.

Can you explain why it is that they have no consistent personal threshold applied to all matches?

A. A key component of the paragraph you mentioned is that I think we said something across all levels of features. The information is not restricted to and only to minutiae. So when we say across all levels of features it encapsulates the concept that depending on the

quality you may require less Level 2 features to come to the same level of confidence or sufficiency that if you don't have the quality in terms of clarity of image you would need more. So because of this qualitative and quantitative assessment it's very difficult to define the fixed(?) number required.

That being said, the argument which we suggested in that paper is an argument I believe was suggested to me both by David Ashbaugh in discussions we had together and it is also through the same line of reasoning that firearm examiners will testify to the level of agreement in terms of striation between a questioned bullet and a reference bullet.

There is an accountability when the examiners say this is the highest or I never have seen such level of agreement between two, a mark and a print coming from a different source. By accountability I would expect that examiner to keep a record of the best non-known non-matches he has experienced in his career and being in a position to say, "Here is the case I am talking about today where I had that amount of feature which I can present and show and this is, in terms of agreement, much higher to the best known matches I have a chance to see in my career", and then he could even -- of course it never happened that way but I just projecting myself

in a state where we are not at the moment but we can even think that this collection of close non-matching can be put forward and say these are the best relationship we managed to have.

Now, by relationship I would see not only counting points, all the points are important, but across all the spectrum of features which may be used in the identification process. So in the case at hand during analysis the examiner had said, "I cannot see any Level 3 features. There is a lot of uncertainty as to the clarity of the ridges and the shapes, et cetera, at the end of the day everything boils down to the minutiae", then I would expect that report for you that will be structured according to this will be cases where, in similar situation, in terms of quality, what would be the maximum observed level of agreement obtained on the known non-matches. That's the essence of the sentence we proposed with Paul Chamberlain to project ourselves in a state where it's not only an opinion, it's an opinion which is based on systematic acquisition of cases of known origin in that case, difference of origin which can be proposed and put forward.

Q. Just to be clear about this, in an ideal world one would like to have some objective standard for evidence but, if I understand you correctly, you accept, subject to

the statistical cross-check, you accept that identification of fingerprints is, in fact, an inherently subjective exercise?

A. If by subjective exercise we mean that it is -- it implies skilled knowledge and informed judgment by examiners which have been trained to do this work I think, yes, it is subjective exercise.

If by subjective exercise we mean arbitrary exercise I think, no, it's not it's not arbitrary even though it is, there is an element of subjective judgment while looking at a mark there also I would expect some transparency by the expert to be able to explain why a feature is more robust and why other features are less robust. So it's not subjective in the sense of being completely arbitrary. It is within a framework of training, competency and protocol that this subjective activity is undertaken.

Q. Two follow-on points really from that. First of all, given the subjective element to it, is that in fact where the necessity comes in relation to verification, namely it's the fact of the consistent conclusion from a number of different practitioners that the reliability of the conclusion emerges and is reinforced?

A. Yes, I think the consensus is the key to the process.

Q. Just while I go on in this same theme, so far as all

your work is concerned, are you yourself satisfied that on the whole the conventional fingerprint evidence does indeed produce reliable results?

A. Again, this is my personal belief. Although we don't know what is the black number associated with this area of expertise, it is my strong belief that the comparison between the mark and the print can provide, provided the quality is present, extremely powerful evidence to guide towards identity of sources. So I think the black number, which we don't know, I believe that number is very small.

Q. Indeed, would it follow that your own belief would be that if procedures are properly followed the rate of error ought to be quite small?

A. Yes. I mean, the rate of error is extremely small. Absolutely.

Q. Accordingly, while one can see in your writings that you say that fingerprint practitioners should not claim 100 per cent certainty, you are not as a result inferring at all that the conclusions that they arrive at are unreliable?

A. I hope that I managed to show the little subtlety between claiming 100 certainty and claiming extremely strong evidence. There is a subtle difference. If by claiming individualisation the expert is providing

extremely strong evidence towards identity of sources as opposed to different sources, then I would agree. I have no disagreement with that judgment.

Q. So in fact what it really comes to is what you are advocating is that the expert should more accurately represent the statistical significance of their conclusion rather than claiming something that seems to be, in fact, unjustifiable 100 per cent certainty?

A. I think it's probably something for the judiciary to consider what are the best ways to present such a difference in court without overstating its power. The difficulty I have with the 100 per cent certainty is that it gives or it may give, contrary to what the Court of Appeal said, a jury the impression that the evidence alone is sufficient to balance the case in one direction regardless of the other evidence at hand. Whereas I would rather see forensic science contribute significantly in the judicial process but not having cases being where the forensic evidence had such a weight that no other evidence available may move the case in the other direction. The 100 per cent certainty gives me this flavour of factual finding which I always find may mislead the jury; whereas a concept of providing extremely strong evidence is very powerful, but allows for contradictory evidence to potentially

point in another direction. So that's why I have difficulties with absolutes presented that way in court.

But again I would invite, especially because of the long tradition of presenting fingerprint evidence in court that way, I think it should invite discussion with judiciary about the proper ways and mechanisms to present this to a jury.

Q. Again, to use a word I have used earlier on, the paradox here is you are not suggesting that fingerprint evidence is prone to error. Rather, what you are suggesting is that its true potential weight should be properly presented to the jury to weigh up against all other sources of evidence in a case.

A. Yes, I think that's fair.

Q. If I can then use an article, another article that I used earlier on this week, an article written by an American author Mnookin, who seems to be somewhat of a critic of fingerprint evidence, poses the question if 100 per cent certainty is unobtainable what actually replaces it? Because, in particular with the IAI forbidding degrees of probability one would rather fear that one would leave a Fingerprint Expert without what Mr Pugh described yesterday as an explanatory model, one in other words leaves him without a toolkit to explain to the jury how persuasive the identification might be.

Do you see that as a risk?

A. I think -- I don't know exactly what the position of the Standardisation 2 Committee will be on the 1980 resolution. But I have taken publicly the position that claiming 100 per cent certainty or individualisation in the face of the earth population was a claim which was difficult to substantiate through a scientific process. Hence, I would rather to see the evidence expressed differently by conveying the strength of support the comparative features provide in favour of a view of a common source.

This level of support does not alleviate the contribution of the element. Stepping back from the 100 per cent certainty does not leave me in the middle of nowhere because the evidence, provided there is associated elements which are strong, will still guide very strongly in favour of the right source hence being perfectly useful, I believe, in court proceedings exactly in the same way DNA evidence is used nowadays.

Of course I can see the argument from Professor Mnookin that if you look at today's status of the IAI 1980 resolution and if all of a sudden courts potentially in the United States tend to refuse testimony as to 100 per cent certainty I can see the argument saying where you lie now with this situation?

But as far as the strength of the evidence is concerned I don't think it is changing anything. A strong case will remain a strong case. The difference is I'm expressing it differently than using the term 100 per cent certainty.

Q. Again, to use a phrase that Mr Pugh used yesterday, if Fingerprint Examiners today don't have a scale by which to measure their conclusion, because, as you say, they have not been accustomed to thinking in terms of probability, how can they demonstrate to a jury the strength of the particular judgment in a particular case?

A. I think the difficulties we may envisage here are no different from the difficulties an expert has to justify an individualisation conclusion today. The fact that we are talking about a different manner of expressing the weight of the evidence does not change anything and, indeed, explaining how an individualisation was reached or explaining how I would conclude to extremely strong support in favour of the view that the mark is coming from that person it has to rely on the same mechanisms. So I do not see any major -- although there is training issue but I do not see any major scientific changes while we are talking about the scale, where there is more than one point on the scale or if we are talking

about a scale where there is only one point on the scale, if we have to argue about the scale that's the same difficulty anyway.

Q. If I follow it through -- sir, I am just noticing the time -- if I follow this through you have pointed to some statistical work on the incidence of minutiae so that will assist to enable Fingerprint Examiners to calibrate their conclusion. That is one approach, yes?

A. The numbers associated with each different types of minutiae are good to calibrate their judgment not on the overall case but with bits and pieces in the comparison.

The likelihood ratio models are much better to assess the contribution of the whole configuration because they will take account for distortion and they will take account for all of the features at once so they are much better guidance as to the contribution compared to the single values associated with each types of minutiae because we cannot really combine them easily. So it's good to calibrate our judgment, how rare is that type of minutiae compared to the other but to get the overall story they are not ideal and I would rather use statistical models with likelihood ratios.

MR MOYNIHAN: Sir, I have actually noticed the time. I'm sorry, I've overstepped it.

THE CHAIRMAN: No, what I thought, we obviously want to

complete this witness' evidence today, so we will maybe take a break when you reach your conclusion.

MR MOYNIHAN: I shouldn't be too much longer, Professor.

What I, in fact, wanted to do was ask you one other point in relation to the likelihood ratio and then to look at two points in relation to documentation, so I shouldn't have too long.

So far as the likelihood ratio is concerned, I understand what you said earlier was that you primarily see the likelihood ratio as complementing the traditional fingerprint evidence given by fingerprint practitioners and not something that would displace it?

A. Yes.

Q. That has two dimensions to it. Firstly, the likelihood ratio is itself entirely dependent on the accuracy of observation of the fingerprint practitioner?

A. Absolutely.

Q. The second point that I wanted to ask you about, there has been some limited discussion of an alternative use of probabilities, which is to deal with very low incidence of minutiae, for example, small portions of fingerprint where traditionally a fingerprint practitioner would not see enough reliable characteristics to express an opinion.

Do you see the probability ratios or likelihood

ratios having a function there or not?
A. Yes, I do. I think the likelihood ratio may help to guide as to the strength of this comparison which now will be declared to be inconclusive.
Q. How do you respond then to the proposition that if one is dealing with a very small portion of a print there may be a coincidental high incidence of match of features there where if one went just slightly off screen to the part of the print that is not deposited one would find a significant number of differences?
A. I'm sorry that was a little bit too quick for me. Can you repeat the question, please?
Q. I will start again. How do you deal with the proposition -- let us take a mark that if one had, say, 50 per cent of the mark one would see in the inner part, near the core, a number of points of identity come slightly out from the core to the rest of the 50 per cent one would see some killer points of difference. Then by chance what is deposited at the crime scene is a very small portion, namely the part that is nearest the core with the similarities and the suspect, unfortunately for him, has just not left the part with the differences, the likelihood ratio might correspond, it might give potentially on this view a misleading likelihood of a match between the suspect print and the

mark; whereas a larger portion would, in fact, show an inconsistency.

How do you respond to that potential source of, in fact, misleading evidence?

A. Well, the likelihood ration itself capture that there is a possibility for coincidental match, if I may say so. So the number itself captured that there is a possibility, quite small, potentially, depending on the magnitude of the ratio, that someone else will display the features in the same positions.

Now, when you say by chance the defendant in your case had left only a surface which shows the matching features and not the area which shows the discrepancies, this probability in itself is very small. So, yes, indeed, any matching element expressed with a strength of evidence expressed probabilistically imply almost by definition that we may face the coincident -- a random coincidence but with magnitude over ratio we'll express how often that may occur and if it is a rare occurrence then the likelihood ratio would be much higher than it is in everyday occurrence that you can see this level of coincidence by pure chance. So you'd capture this. In essence, the likelihood ratio just gives you the strength of evidence pointing in one direction without telling it that that is the truth. It guides you by

degree in favour of one proposition versus another.

Q. If I come then to documentation, I have just a number of points to ask you about documentation. First of all, principally what you are saying is that you favour the need for documentation of reasoning both at the assessment and verification stage for complex marks. You have mentioned in Switzerland that a standard of 12 is used and also that consideration is given to rotation and distortion.

Would you have in mind suggesting as a recommendation a fixed definition of complexity or is that something that itself requires more careful study?

A. At the moment, the concept of what is a complex mark is not sorted in the specialised literature. The Swiss attitude to this has been -- was not driven by a fundamental research project but was driven by the willingness also to move towards a change keeping some old practice in place which was driven by 12 and we felt that was a good transition scheme so that is why 12 had been retained as this selection or triage measure. But certainly there is room for research to define what is a complex mark as opposed to a simple case.

Q. I've asked you earlier on today, we have heard some evidence of some statistical work having been done by Pincante and Jane(?) to suggest that the 12 points that

one might trace back to Locard might by coincidence in fact on modern statistics be a reliable indicator as to the identity.

Do you have a comment on the reliability of the statistics that would point in favour of 12 as being the key number here?

A. I do not recall the publication completely. If my memory serves me well, they showed through a statistical model that the chance of finding on another person a set of features when you have 12 minutiae in correspondence, that probability is a very, very small number, something like 10 to the power of 16, 17 or 18 minus, hence the argument that 12 is safe.

The view I have on this is that it is not because a model is able to calculate teeny-teeny numbers but these numbers have a realistic meaning and I like the approach what was adopted with DNA evidence in this country where at some point it has been suggested that even though you have a full DNA profile the match probability that will be quoted associated with that will be in the order of 1 in a billion. Even though the mathematics of computing the (inaudible) frequencies together by multiplication leads you to 10 to a power of minus 15 or 16, the argument was that if you want to be reliable in these teeny-teeny-teeny numbers, the constraint on the

experiments you need to set up in terms of peer-wise comparison is enormous. With DNA, the argument was made that at the current stage of knowledge we cannot substantiate match probabilities below the order of magnitude of 1 in a billion and I quite like the approach and adopting exactly the same approach for fingerprint evidence.

So even though by multiplying factors together like the paper you referred to, you can obtain extremely small figures which might lead to the impression that there is no need to discuss any more when we talk about ten to minus 20. These numbers has to be -- we have to ask ourselves how robust they are and I don't think these numbers, when they are so small, are robust so I would be tempted to fall back into a position of order of magnitude.

Now, the paper of course demonstrates that the more minutiae, the more information you have, the larger the likelihood ratio will be which, in a sense, is absolutely correct and logical but I don't see the paper as demonstrating that 12 points is safe for individualisation.

Q. If I try to understand that in a lay way, are you indicating there is a problem about reliability of mathematical modelling when it comes down to relatively

low samples of data?

A. Yes.

Q. If I then carry on and ask you two other questions in relation to documentation, first of all, I observed in one of your slides -- you may want to bring up again slide 32 from your presentation today -- it just happens to be one of a number -- I don't have too long to go. This is the penultimate question.

I observe that what you have done is not just marked the feature by the codes you have indicated by triangles, circles and squares you have also taken the trouble to trace in what you understand to be the underlying ridge flow. Is that tracing of ridge flow something you personally do as a matter of routine?

A. When documentation is required due to the quality like this one, I think tracing the ridges and sometimes even the valleys is extremely useful to understand the configuration.

A mark left by friction ridge skin is a series of ridges and the ridges can be traced, so to me that's, in fact, in the case like this one I start with ridge tracing and overlaying then the minutiae afterwards. So the minutiae are just positioned as a logical consequence of ending or opening of ridges so, yes, I believe it is critical.

Q. Is that what you teach?
A. Yes.
Q. In a sense, I think you have probably just answered my conclusion question to this.

Do you find that it is in fact the tracing of the ridges as much as anything that you attach weight to rather than simply, as we have seen in some of the tracings we have here, where practitioners just put a dot on a precise point in an image?

A. Yes, to me the information from the mark is expressed by ridges in sequence and not expressed by points, like dots on the surface.
Q. The final question -- and I do promise it is the final question -- is a concept I have used with a number of witnesses called demonstrability, by which I mean plainly it requires skill, training and expertise to be able to observe features in a mark and to interpret them but when once an expert has arrived at a conclusion, has observed features and has interpreted them, should that expert be able to demonstrate the existence of the feature to a lay person such as me rather than the expert being able to say that my eye can see things that no lay person can see?
A. As long as we both have eyes with decent aptitude I think that if I guide you to my observation you should

be able to see what I see. The difference between a lay person and someone with some knowledge in this area is how they will interpret the findings but observing the features themselves I think that, provided the technology is available, that the demonstration should be possible to a lay person.

MR MOYNIHAN: Thank you, Professor. I must say thank you to everyone else for their patience this afternoon. That concludes my questions.

THE CHAIRMAN: What I suggest is if we start again at 3.40 and then if we cannot finish by 4.30 then I think we may have to make new travel arrangements but I hope that it will be possible to finish if we can but I don't want anybody to feel kept out. So we will sit again at 3.40.

(3.34 pm)

(A short break)

(3.40 pm)

THE CHAIRMAN: We will begin at the back for a change.

Ms Jones, you have an application, have you?

MS JONES: Yes, sir, I have questions about the differences between complex and simple marks really and how they relate to documentation in particular.

THE CHAIRMAN: Yes.

Cross-examined by MS JONES

Q. Professor Champod, you spoke about what you thought were

the different requirements for documentation depending upon whether something was a simple or a complex mark and I think you recognised that it is not clear how to differentiate the two. You mentioned the 12 points example from I think was it Switzerland.

Can I ask you first are there any other examples or guidelines so far as you're aware that are of assistance in any other jurisdiction?

A. No, I'm not aware of any other guideline of that nature.

Q. Can you tell me -- I don't know if you know -- does Switzerland work on the basis of the non-numeric system or the numeric system?

A. No, Switzerland since 2007 has adopted a holistic approach without any numerical standard.

Q. I wondered if you had a view as to how a numeric approach to one aspect of the process sat with a non-numeric approach to the holistic process. I don't know if you have a view on that.

A. Yes, the pragmatic position taken by the Swiss identification bureaux is to use the 12-point as a quality measure which can be then audited. In other words, during the audit of a bureau you may revisit decisions that have been made according to this 12-point rule to see if truly what has been classified as complex needed to be treated as complex and what has been

classified as simple needed to be treated as simple.

This number is used as a quality assurance measure as a yardstick in the processes, not in the decision-making when it comes to evaluate the corresponding features.

Q. I appreciated that point but one matter that I wondered about was that during the course of the Inquiry there has been some discussion about the problems or issues with the numeric system, whereby there appears to be at least a suggestion that a numeric system may encourage examiners to tease out points and I wondered whether that was something that had been analysed in the Swiss situation?

A. The 12-point rule I referred to applies to the analysis stage without any reference to the print. The concept of teasing out points has been always referred to in relation to the addition the print may provide in terms of information when you suddenly can increase the number of minutiae seen on the mark because of the benefit of the print.

Here the 12-point rule is used in analysis only without any reference to the known print as a decision-making process and has to be documented accordingly in the case file.

Q. I wondered, though, whether it could be applied to the

12-point rule on the basis that examiners may be encouraged or perhaps somehow persuaded to find 12 points where if, say, they count 11 and if they found one point or event, then it means a more simple and straightforward process will be followed.

I wonder whether that was something that there had been any analysis of?

A. Not that I'm aware of. I think that's part of the quality system to ensure there are mechanisms to avoid the situation where, in other words, to make your life easier that you push things up to 12. I think the fact that life is complex should not force us to shy away from complexity and the management system of the laboratory should find ways to reconcile this.

Q. I wonder then whether that perhaps brings us on to another point I wanted to ask you about, whether there had been any research or analysis of the resource implications of the differing requirements for documentation because, I think, all of that perhaps could be said to link up but it may be a very hard-pressed and overworked examiner may be more concerned to deal with simple marks rather than complex marks because of the workload and I wonder whether there had been any studies or research into the actual resource implications for notes.

A. I'm not aware of any research that has been published on that subject.

Q. In your own investigations, I think you said that you had been to a number of different bureaux. Was that something you were interested in looking at when you were looking at the processes of different bureaux?

A. Excuse me, could you repeat the question?

Q. Sure. I think you said particularly -- perhaps if I link this into another matter that I was going to ask you about. You said in relation to blind verification that that wouldn't be appropriate in all circumstances because of the cost implications relating to that and I wondered whether that was based on some kind of empirical evidence or was that really more of a commonsense approach to the issue?

A. No, that was based on a commonsense approach.

Q. Thank you. I wonder then if you are able -- it may be you are not able -- to elaborate on a more practical basis on what type of documentation it is that you think may be appropriate either in simple or complex cases what level of documentation or recording is it that you have in mind.

A. If we take the simple case, the key element to documentation is having a legible image of a marked image of the mark of interest which of course stays in

the case file and constitutes the primary documentation of the case. Some laboratories have developed **pro forma** sheets for analysis which invite the examiner to assess the various questions which I raised during my presentations as far as the substrate is concerned, identification of red flags, identification of issues with distortion and that sheet can be quite limited with check boxes to identify if there is issues recognised. If none of the red flags are flagged up I think a good indication about the amount of information available, and again this is the screening process, would be to indicate the minutiae which have been observed on the mark.

We may debate, if we have a 50 -- and I'm using 50 as an example -- if we have a palm mark with 50 minutiae is there any need on the legible image to indicate point by point the minutiae of interest? I think having written information at the time of examination by the examiner just saying, "I'm assessing this mark as having roughly 50 minutiae worth of pursuing for comparison and hence this is a simple case", if I may put it that way, I would have no problem with that personally.

The complex side of the house, the PiAnoS I showed you with the annotation of ridge flow and minutiae with degrees of reliability during this annotation process,

we designed it with a view of applying this to complex cases and I think it's quite a good compromise if the tool can be made, can be user-friendly. It's quite quick to annotate convincingly marks of limited quality that way.

MS JONES: Thank you very much.

THE CHAIRMAN: Miss Grahame?

MISS GRAHAME: No, thank you.

THE CHAIRMAN: Mr Holmes?

MR HOLMES: No, thank you, sir.

THE CHAIRMAN: Mr Smith?

MR SMITH: Thank you, sir, there are just two matters I would like to ask about. One relates to the question of probabilities. I hope to be fairly brief on that -- largely because I don't understand it myself -- and the second question relates to the issue of distortion. I hope I can deal with that fairly briefly too.

THE CHAIRMAN: Two pretty broad subjects but --

MR SMITH: They are indeed.

THE CHAIRMAN: -- if you can deal with them promptly and shortly, as I am sure you will, please do.

Cross-examined by MR SMITH

Q. Professor, I wonder if you can try and help me with something. You described earlier in your evidence the issue of I think it was the Baysian Theory on questions

of probabilities and how that had been largely criticised, I think, in at least one court case. I wonder if we can just stand back and give me some help with the way that probability sometimes operates.

I think in simple terms -- and I do want to keep it very simple -- is the Baysian theory a theory that tries to introduce some degree of almost subjectivity into the question of probabilities? Is that a fair way of summarising.

A. Bayes Theorum is a standard theorem applied to probability theory, probability as being either subjective or objective. So it's not restricted to a Baysian or a subjective view of probabilities.

That being said, the school of thought in terms of the philosophy of statistics called the Baysian view is indeed related to the concept of subjective probabilities. The probability is expressed as a degree of belief which has been proposed in the literature in the fifties to complement what we know from either modelling or the frequentist approach to statistics which is looking at occurrence of events in the long run. There are some events in life which occur only once also or some events which cannot be put into the context of repeated experiments. Hence, in the fifties the development of a school of thought using a measure

of uncertainty called subjective probabilities which measured the degree of belief and it has been associated with the Baysian Theory of probability theory.

When I have used the term Bayes Theorum, when I have used likelihood ratio, it is in relation to the classic definition of Bayes Theorum as in the theory of probability without exposing the subjective probability definition for all probabilities I discussed.

Q. Just really by way of example to try and talk through a real example and maybe you can confirm to me or correct me if I get it wrong, if I was to ask a statistician, "What's the probability of me living for the next year?" then the statistician could then look at life tables and say, "Out of the entire population, X per cent of them will die within the next year" and that gives you your probability.

Then if I say, "Well, actually I am aged 90" then that increases the probability of me dying over the next year. So you have further information about the position and I think you can work out a formula pitching these two factors against one another and come up with a probability of my death in the next year based on that information.

Can I apply this to the facts, as I understand them, of the Shirley McKie case. If you take it from me, when

I refer to the "crime", I'm not talking of the crime of murder, I'm talking about the crime of allegedly leaving a fingerprint at a particular place where the individual should not be.

In trying to assess the probability, just without looking at the fingerprint, the probability of that fingerprint being left by Shirley McKie, one of the factors that would be relevant is there was no independent evidence of, as it were, another crime. The crime was leaving the fingerprint. Do you follow the distinction?

A. I think so.

Q. One of the factors is a lack of independent evidence that Shirley McKie was in the **locus**. Do you follow? There's not someone who says, "I saw her there, I saw her near that area." So there's nothing of that kind. Another factor would be there's no or there is in evidence that there was a limited number of people who were actually in the area.

Would you agree, just generally speaking, all of these factors when you're just asking the question of probability markedly reduces the probability just of a random fingerprint being left by someone else on another occasion, would you agree that tends to point to a reduction of probability if one looks it as simply a

probability exercise?

A. If I may just try to put my own analogy to your suggestion, if by the specific circumstances you described you're telling me that instead of starting from the earth population we are starting from a limited set of individual, then yes, that's absolutely right and indeed this is a probabilistic judgment.

Q. Because just to say looking at probability in simplistic terms you would have to proceed on an assumption almost that any person in the world could have been in that house at that particular time which clearly is a ridiculous starting point, isn't it, in real terms? It may be statistically correct but in reality it's not?

A. Well, it's a matter for the court to assess what is the reasonable size of the initial population given the circumstances at hand; so I cannot say it's ridiculous. It depends on the position of the court.

Q. Now can I turn on to the other matter that I wanted to ask you about. It is the question of distortion and movement. I think you touched on this in your presentation earlier, which I may say for myself I found very helpful to identify the method of analysis under ACE-V.

I am not sure how closely you have been following the evidence before this Inquiry, but one of the regular

themes that has been coming up when apparent differences between an inked mark and an unknown print have been pointed out is the response by those who say it is a match is to say, "Well, this is due to distortion or movement of some kind: full stop". No greater explanation as to whether it was twisting, smudging, double tap, overlay, anything of that kind.

Do you have any comment about just saying, well, there is a difference but it must be due to movement or distortion? Can you comment on that in general terms, if you can, as to a realistic explanation for differences between an inked mark and an unknown print?

A. Well, when an expert invokes physical movement of a finger to explain a difference, perceived difference, between a mark and a print, I would rather see some empirical evidence that what is suggested is a possibility. The mere fact of invoking an explanation to me is not sufficient to make that explanation right and when I say "right" with a probability of 1: it happened that way.

I think as a matter of transparency I would advise that if specific movement is invoked and there is evidence that indeed through in controlled experiments we can reproduce that that indeed is a possible explanation, which might be quite rare but it's

something we've managed to demonstrate. Otherwise I have difficulties because we can always invoke explanations.

Q. Can I ask you, professor, just on a slightly different point but related if you perhaps haven't worked this out, I'm a lawyer and I'm imagining being in a court situation. A Fingerprint Expert comes in under the non-numeric standard and I have to cross-examine that expert and I say to him, "Why are you sure that this is a match between the two?" He will no doubt explain, "Well, with my experience, I can see sufficient points of similarities, the detail is clear enough and my understanding and experience dictate that these two marks, the latent print and unknown mark, have common authorship".

Now I would be right, I think, in saying that the exercise of that analysis is still based upon minutiae, ridge endings, et cetera, et cetera. I am right so far about that, aren't I?

A. It may not be solely restricted to minutiae in terms of the features that the examiner has used.

Q. So it may depend on, for example, the quality of Third Level Detail, for example. Is that what you mean?

A. If they are legible on the mark, yes.

Q. Nonetheless, if I am re-examining and saying, "Well,

let's go one stage deeper than that rather than just your experience. What is it about these two fingerprints that lead you to the conclusion that they are of common authorship?" and from your evidence I think you say he should be able to demonstrate that, he should be able to say, "Well, look, there are a number of ridge endings, a number of bifurcations, that to me indicate this comes from the same author but it's a futile exercise to count them up .I'm not going to say there's 10, 11, 16, 18. That doesn't matter" but he must still be able to demonstrate them under the non-numeric standard.

Is that your evidence?

A. Yes.

Q. I take it when you make reference to the fact that the type of minutiae may be important because I suppose, and I am not sure if there are any statistics on this, but one particular feature with another may be much more improbable than another set of features. So, for example, if you have an upward opening bifurcation immediately adjacent to a downward opening bifurcation that is probably a very unusual feature.

Without asking you if there are studies on it, is that something you would agree broadly might be unusual?

A. Absolutely, yes.

Q. Whereas if you have two upward opening bifurcations with one straight ridge in between, that's relatively common and it wouldn't give any great cause for excitement but you have a difference in the positioning between two features just because one is very different to the other and that would be fair, wouldn't it?

A. Yes. Different types of minutiae may bear -- depending where they are on the ridge pattern, they would provide different weights indeed.

Q. But I suppose to make that an important difference between the two sets of data, an up and a down bifurcation as compared to two upward bifurcations, one would really need to have some kind of research, or at least experience, to say an upward and a downward adjacent to each other are unusual. Again, is that not a valid observation?

A. The way you can approach the problem is either having access to some empirical data -- counted how many times I have that sort of configuration to two bifurcation downwards, for example -- and that will calibrate your judgment as to the rarity of that event. That's one way.

Another way -- and that's the way most examiners have been trained to do -- would be to say that through the years of experience and the number of fingerprints

they have looked at in their career, they built up some sort of a mental database about the rarity of these features.

I would not say that one is better than the other but certainly the systematic acquisition of data is more transparent than the invoking experience.

Q. Give me just one moment, please. **(Pause)**

Finally, I wonder if you could help me with this. I'm interested in the question of error rates in science and, indeed, in fingerprinting. As far as science is concerned, generally speaking again, taking your particular area, what is the perceived wisdom about error rates? Is science supposed to be error-free, if I can put it that way?

A. If we talk about a scientific approach to the search for identity of sources in forensic science, to put it that way, there is of course, and by definition, an error rate in that operation and it will be foolish to claim that because it's scientific, it's error-free.

Q. Can I compare that to where fingerprints fit in, in your view, with regards to science as pure science or whether it's largely a question of opinion. Where do you fit in into the spectrum?

A. You mean with regard to fingerprint evidence?

Q. Yes.

A. I think we cannot make such a clear-cut distinction between pure science versus art. I consider fingerprint examination as a scientific process. The protocol is typical of a scientific process. The mechanisms that are put in place for quality assurance are the same kind of mechanisms you put in place in scientific research. Indeed, at some point in the process there is informed judgment that comes into play, but I would not value less this judgment than the judgment of a scientist to make decisions when he is doing some chemistry experiments. That's part of the intelligent approach to any experiment to build up on the scientist's experience to guide in the development of his approach.

I won't see the world be divided between pure science approach to fingerprints versus blackheart(?) approach to fingerprints. If you ask me to position myself on the spectrum as I think fingerprint comparison is part of forensic science and the term science is not usurped .so yes, it is a scientific process.

MR SMITH: Thank you very much, professor.

MR MOYNIHAN: I think to everyone's relief I have no further questions. Thank you.

THE CHAIRMAN: I have only two matters which I am sure it is my fault for not getting it right. On slide 34 there was a reference to length and terms of ridge unit and I

think I read orientation and length in terms of ridge unit. I wasn't quite clear what that means.

A. My Lord, indeed, I haven't defined it at all. The concept of ridge unit is something that was introduced by Dave Ashbaugh as trying to describe the smallest element along the ridge we can define. So if you view ridges as a sequence of units, each unit having a pore on the top, you could view a long ridge as being a series of ridge units attached one after the other. Of course, that tells the distance -- if these ridge units aren't connected by two ridge endings, this distance is fixed because you expect -- the blueprint is fixed on the dermis. So if you have eight pores from two ridge endings, you expect that distance to remain permanent and do not change.

The length of the ridges are something that needs to be accounted for in the comparison process, hence my reply to previous questions when it comes to following the ridges. Following the ridges allows us to assess the length of the ridges involved and to check that the number of ridge units are compatible between the mark and the print.

THE CHAIRMAN: Thank you. The other point I wanted to ask you about we have heard reference before to a bridge but what is your definition of a bridge?

A. The bridge I presented in my presentation is when you have two bifurcations connected by their branches. So the form it takes, it is either a Z if you follow it or an S if it is the other way round. This connection by two bifurcations is often described as a bridge.

THE CHAIRMAN: It is just to be sure we are talking about the same thing. Than you very much for a very comprehensive presentation. I apologise for you having to do it twice but it was important that what I heard should be heard in public and I think that has been covered now. Thank you for the really large amount of assistance that you have given to the Inquiry. We can release you, I hope.

(The witness withdrew)

So far as tomorrow is concerned, I understand, Ms Jones, you will begin tomorrow morning.

MS JONES: I think either myself or Mr McPherson were going to go first depending on what time we started at.

THE CHAIRMAN: At 10.00.

MS JONES: I think both of us are going to be very short.

THE CHAIRMAN: 10.00 or as soon thereafter as you are available we will begin. Then I gather that you can agree between yourselves as to what order you wish to go in.

That, I think, concludes the evidence.

MR MOYNIHAN: Sir, that concludes the evidence. What I propose to do is to circulate tomorrow morning a table which is being prepared which will list all of the witnesses. It will specify those who have provided a statement only and also those who have provided both oral testimony and a statement. That will be made available because I have attempted over time to sweep up but I may have made some omissions. Tomorrow I hope to be able to issue to all concerned a comprehensive list of the witnesses, the evidence from whom is available to you in arriving at your conclusion.

Yes, that is all the evidence, bar I suppose to be absolutely clear I have not yet had a definitive statement from Mr Russell in connection with the e-mail that we received some weeks ago about Mr Swann. We have put a summary of what we understand Mr Swann's evidence to be and, absent any contradiction from Mr Russell, I am not myself proposing to recall Mr Swann, but I can't yet be definitive about that.

THE CHAIRMAN: We will see what transpires then. The only other thing I want to say is that I would not feel it any discourtesy if anyone, having made their submission, wants to leave and was not anxious to listen to other submissions but I would be very pleased of course to see you if you decide otherwise.

Tomorrow morning at 10.00.

(4.15 pm)

(Adjourned until 10.00 am the following morning)