Historical development and evaluation of the „12 point rule" in fingerprint identification(*)

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PART I

Early in the history of the use of latent fingerprints in criminal identification. certain lower limits on the number of points of similarity that could be used for legal identification were set. These lower limits varied from expert to expert. from bureau to bureau and from country to country. The name "12 Point Rule". is used as a generalization of the existence of such lower limits. and is not meant to be restrictive to those where 12 is the significant figure.

The actual origins of these "rules" are somewhat obscure. There are two major ideas relative to the development of these lower limits. One is that they are a result of experience by police identification personnel. and the other is that they were arrived at from statistical considerations. Part I of this article will present a brief historical sketch and evaluation of the first of these ideas — that of police experience. The evaluation is directed at the bearing of the experience on the significance of partial prints showing the same of fewer characteristics than set by the lower limits.

Bertillon is a name that is often associated with fingerprints. Although he is among the first group of persons using fingerprints in criminal investigation. it is doubtful whether he ever really accepted fingerprints as a superior method of identification to his anthropometric method. Nevertheless he utilized fingerprints when they were found at the scene of a crime. realizing. it is assumed. that they were far superior to measurements when there is nobody to measure. On October 17. 1902. he was called to aid the investigation of the murder of Joseph Reibel. A glass panel from a nearby cabinet had been broken. and some bloody fingerprints were discovered on one of the broken pieces. These were dutifully photographed and preserved. After determining that they did not match the victim's prints. Bertillon began a search of his anthropometric cards. upon which. by that late date. he had added fingerprint impressions as a routine matter in addition to his measurements.

Eventually he found a card which contained fingerprint impressions that showed areas that matched the prints taken from the crime scene. The report of the case describes the isolation of three points of resemblance in the thumb-print. four in the index and middle finger. and six in the print from the ring finger. The murderer. Henri Lèon Scheffer. was caught and brought to justice (11). Two quotes from this same reference may be of interest.

"*It (the above case) is probably the most significant in the European history of fingerprints. On this evidence it is not possible to deprive Bertillon of the merit of being the first expert in Europe to effect the solution of a murder investigation upon fingerprint evidence alone.*

There is nothing to show that this spectacular success greatly increased Bertillon's confidence in fingerprint identification."

It is stated in one article that "*Bertillon found two fingerprints made by different men. having*

(*) This material was taken from the dissertation prepared by Charles R. Kingston for the degree of Doctor of Criminology in the School of Criminology at the University of California in Berkeley.

this as a basis, and figuring the inhabitants of the earth to be about one and a half billion, he figures that 17 points should agree for practical certainty of identification. That is, 4^{17} is about 17×10^{9}, and the number of people times the number of digits is about 15×10^{9}, which is less than the combinations of 17 points possible.

He goes on to say, that "In actual practice, it may not be necessary to find as many as 17 coincidences to make sure of identity. If the two finger prints that are being compared are known to have been made by Europeans, or by Americans.... the number of coincidences necessary . . . is much fewer." (1) He suggests that the number necessary in this case can be reduced to 12 or 11. Note that Balthazard's results give a much smaller probability of occurrence of an entire fingerprint than Galton's.

The above approach can be extracted into a relatively simple model. Consider a nest of 100 boxes arranged in a 10 by 10 array, and a container with four blocks in it, with one block numbered 1, another 2, another 3, and the last 4. There are also available 100 balls numbered with a 1, 100 numbered with a 2, and so on to 4, and the balls are of such a size that only one will fit into one of the boxes. Now the container with the blocks is shaken up, and a block withdrawn. A ball with the same number as the withdrawn block is placed into one of the boxes in the array. The block is returned to the container and the process repeated until all boxes in the array are full. Balthazard's calculations then give the probability of any particular arrangement of balls within the boxes.

If the actual distribution of characteristic points in a fingerprint can be approximated by this model, then the above calculations can be accepted. The essential ideas are the over-dispersed distribution (*), the occurrence of only one ball in each box, with the requirement that each box have a ball, and the implicit indistinguishability of the balls containing the same number. Also, the elements are restricted to the mentioned four, which is not a realistic restriction. This has been shown to be an inadequate model (4).

(*) Points spaced more evenly than would be expected in a random distribution.

Balthazard's calculations were referred to in the appeal decision of State v. Kuhl, 42 Nev 185 (1918). The concern in this case was primarily on the applicability of fingerprint evidence in general, rather than the problem of identification with only a few points of comparison.

The next calculation to be discussed is the one found in a publication by Cummins and Midlo (2). It is an example of how errors can occur in trying to determine all compound probabilities by using the multiplication rule, e.g. $P(A) \times P(B) = P(AB)$.

The authors first discuss the probabilities involved in tossing coins. If a fair penny is tossed, the probability of it landing with heads up is $\frac{1}{2}$. If two pennies are tossed, the probability of both landing heads up is correctly given as $\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$. If 25 pennies were tossed, the probability of any single configuration is shown to be $(\frac{1}{2})^{25}$. Now they further specify the floor to be laid out with 25 squares, each square bearing a different letter from identification. The coins are likewise marked, so that one square corresponds to one coin. The situation is restricted now, so that only one coin can land in one square. They say, "The chance of one coin lying head up within its proper square is the product of the chances of these two independent events, namely, $\frac{1}{2} \times \frac{1}{25} = \frac{1}{50}$. The chance that all 25 coins satisfy this requirement is $\frac{1}{50}$ raised to the 25th power, or . . ." There follows the figure written completely out. The authors overlook the fact that they have established conditions that insure that the tosses are not independent, and have incorrectly applied the multiplication rule anyway. The correct probability is $(\frac{1}{2})^{25} \times \frac{1}{25!}$ (*)

They go on to say:

". . . the concatenation of 25 specific ridge details existing in the finger-print example chosen may be likened to a successful result in the tossing of the 25 coins . . . The occurrence of a particular ridge detail in a particular place is not a strictly random event, but that the element of randomness plays the chief role in producing it is evidenced by the differences

(*) $25! = 25 \times 24 \times \ldots\ldots \times 1$.

Galton (3). He first wanted to determine whether or not the minutiae, or groups of them, could be treated as independent variables. His approach to this was to cut small squares of paper and drop them upon enlarged photographs of fingerprints. He then traced the ridges around the square on an overlaid tracing paper, making an outline of the square. Then he would remove the tracing paper and fill in the void where the square was: he would guess at what the covered area might look like on the basis of the surrounding ridge formation and fill it in accordingly. Then, by comparing his tracing with the original, the number of times that he was right and wrong in his guess were tabulated. The size of square which resulted in as many right guesses as wrong ones, which turned out to be squares of approximately five or six ridge intervals on a side, was what he was looking for. He says of this:

"*These six-ridge-interval squares may thus be regarded as independent units, each of which is equally liable to fall into one or other of two alternative classes, when the surrounding conditions are alone known. The inevitable consequence from this datum is that the chance of an exact correspondence between two different finger prints, in each of the six-ridge-interval squares into which they may be divided, and which are about 24 in number, is at least as 1 to 2 multiplied into itself 24 times (usually written 2^{24}), that is as 1 to about ten thousand millions. But we must not forget that the six-ridge-interval square was taken in order to ensure under-estimation, a five-ridge square would have been preferable, so the adverse chances would in reality be enormously greater still.*"

He then continues to include the calculations of the chances of not guessing correctly the surrounding ridges, etc. His final figure for a single fingerprint (a complete one) is a probability of 1 in 2^{36} of a particular pattern occurring.

"*The result is, that the chance of lineations, constructed by the imagination according to strictly natural forms, which shall be found to resemble those of a single finger print in all their minutiae, is less than . . . 1 to about sixty-four thousand millions. The inference is, that as the number of the human race is reckoned at about sixteen thousand millions, it is a smaller chance than 1 to 4 that the print of a single finger of any given person would be exactly like that of the same finger of any other member of the human race. (Italics are the authors'.)*"

The reference to the population is too high, the actual figure being somewhere around one to one and one-half billion. This passage is quoted in most later publications as having stated that the chance of *duplication* of a single finger is one to 64 billion, which is clearly not what was written.

Galton then continues to extend the argument to a full set of ten prints per person. What the calculations of Galton seem to represent is an estimation of the chances that some particular person's first finger (or any other particularly chosen finger) would show a pattern which was the same as a freehand pattern drawn by Galton from his *imagination*. In other words, the basis of the calculation is his ability to create a fingerprint pattern. Because he found a size square which he could duplicate fifty percent of the time correctly, given a particular print beforehand, does not seem to indicate what the variation of actual fingerprint patterns in a similar size square would be. If, given the surrounding pattern, a six-ridge interval square could only result in two different configurations, the fundamental basis of the above calculations might have some merit, and it would be worthwhile to examine the extensions in more detail. But there is nothing in Galton's work or anywhere else to support this, and thus, his calculations must be questioned.

The next probability estimate of *importance* is that made by Balthazard, sometime around 1910 (1, 6). His method is to estimate how many characteristic points a fingerprint is likely to contain, and then construct a grid over the print with the same number of squares as the estimated number of points. His estimate is about 100 points, and he therefore uses a grid of 100 small squares. He considers four basic types of points: fork directed above, fork directed below, superior interruption and inferior interruption. Each point is considered equally likely to occur, and it is apparently assumed that one point occurring in each of the squares is the typical situation. Then, the argument goes, there are four ways for a characteristic point to occur in the first square, and so on. Thus the probability in all 100 squares is $1/4^{100}$. Using

It is internationally recognized by specialists that probabilities are excluded in the field of identifying a crime scene print. Either the proof of identity is possible with absolute certainty, or the print is insufficient and considered as unusable. (17)

Unfortunately, there is no international agreement about the minimum number of check points or characteristics demanded for an identification. The number required varies as shown in this list of countries:

Spain		10—12
Switzerland		12—14
Austria,	at least	12
England,	at least	16
France,	at least	17
Germany		8—12 (17)

"The number of characteristics which must correspond in order that two finger prints may be judged as originating from the same finger is a problem which was posed about twenty-five years ago by a number of finger print experts who reached varying conclusions, some contending that at least nine were necessary, others that fifteen should occur, and so forth . . . I have always maintained that it is an unscientific problem and clashed with the concept of relative identity *inasmuch as it is not possible to establish* a priori *the number of signs or marks which are necessary for any decision."* (16)

One author states that some experts in India are satisfied with six identical points. He points out that some "learned authors" say that a blurred impression can be identified satisfactorily with three points, although he apparently does not go along with this.(9)

These quotations would give a fairly good idea of the trend of thinking about partial fingerprint identification up to the present time.

Some search was made to find any cases that had gone to the appeal courts in which some reference was made to the identification of a partial print with less than twelve points, and where some discussion of the justification was made. There was one case in Ohio (*) where a F.B.I. agent was testifying for the prosecution. A latent fingerprint had been found at a crime scene on a drinking glass, which was identified as having been used by the defendant just before the victim was shot. Part of the appeal decision follows.

"..testimony of state witness Latona, who explained that the rules laid down therein (1937 F.B.I. Bulletin on Finger Prints) nine years ago by Dr. Locard, an early French finger print authority, that twelve identical points were necessary in the comparison of latent and ink prints was no longer followed by the F.B.I.; and testified, "today there's no rule or policy in the F.B.I. to the effect that it takes twelve points or any specific number of points to make an identification, as the science of fingerprinting and comparison had developed during that period, and other factors had become of dominant importance."

...and on cross examination testified that "there were seven points of comparison" on the smaller glass which were a sufficient number for identification . . ."

In 1959, the F.B.I. policy was essentially the same. In a letter to M. K. Mehta (10), J. Edgar Hoover said:

"We know of no absolute number of points of identity which could be technically justified as a requisite applicable to all identifications. Each case has to be individually observed.

It has been proved through long experience, however, that twelve points of similarity are sufficient to establish an identification. Any two prints possessing this number of ridge similarities will not have any dissimilar ridge formations."

PART II.

In Part I of this article, brief consideration was given to the role of police experience in the development and evaluation of the "12 Point Rule". It was concluded that such experience as is reported in the literature is inadequate to evaluate the evidential value of a latent print with fewer points of comparison than the lower limits that may be established. In part II some consideration will be given to the attempts to evaluate partial prints by probabilistic arguments.

One of the earliest (if not the earliest) known calculations based on probabilities of the occurrence of particular patterns were those of

(*) State v. Viola 51 Ohio LAbs 577 (1947 -- appeal decision).

of Balthazard, which was apparently first presented around 1910 or 1911. Since this is three years before the initial publication of Locard's, no solid conclusion can be drawn as to whether experience showed that less than 12 points or so had been duplicated by chance, whether the figures were first brought to mind by the results of the mentioned or other calculations, or whether they originated from other considerations. The phrase, "experience has shown", really seems to mean that nothing has backfired on fingerprint evidence when the minimal number of coincidence required is 12, or whatever the figure might be for a particular country or laboratory. Perhaps if the limit were dropped to 7, experience might show that *this* was the minimal correspondence necessary. In short, it appears that *the discussed experience is worthless as a criterion to judge the value of only a few coincidences.*

The writings of Locard are probably the origin of most of the later statements relative to the accepted minimal number of points necessary. This is not unexpected, since his work was the first that became widely known and which spelled out a set of "rules" on the subject. It appears then, that Locard's writings, and the probability calculations of about the same time form the major source of present day thinking on partial fingerprint identification. Some of the comments in the various publications are quoted below.

"The demand for twelve similar details is the result of the opinion of bygone days, founded on the belief of scientists such as Galton, Remus, Balthazard, and others. All recent scientists working in the field of dactyloscopy, as, for instance, Locard, De Rechter and others share the opinion that the number of characteristic points which can be noted at the edge of an enlargement is a matter of little importance. A rare detail is an identification sign one hundred times more important than a whole series of forks: four to five details in the core of an unusual pattern have more value as evidence than twelve to fifteen forks in the periphery. Some ridges with unsusually grouped pores have more weight than the classical twelve points. (*) (15)"

..No rule of evidence covering this point (exists) (i.e. 12 points in fingerprint evidence) . . . (It is) a matter of proving beyond a reasonalble doubt. Also it is a common practice in presenting fingerprint evidence in court . . . Prints may be proven with less, but twelve are considered sufficient in any situation. As a matter of practice, most experts . . . constantly satisfy themselves as to identity with eight or even six points of identity." (14)

The reader will naturally ask, what constitutes an identification after all the different combinations have been considered, and the answer must be, that it depends upon the number and position of the points of identity, although the calculations based on the researches of Galton, Féré, Balthazard, Oloriz and others appear to show that *certain* identity can scarcely be claimed without at least 12 homologous points of comparison. The above is the generally accepted rule, with the exceptions noted, yet the authors and some others feel that six or eight points well grouped, defining a centre of exceptional form, constitutes such a perfect proof of identity as to give no grounds for argument, while double the number of forks disseminated in the outer zone of some confused trace, may leave the way open for reasonable doubt. (18)

(*) Editor's note: In this context, it seems relevant to recall the method recommended by a Spanish authority in this field (now retired) — Mr. Santamaria, who devoted all the energies and the skill of his career to problems of fingerprint identification.

This method, which was set out in 1942 in the pages of the Spanish police reviews "INVESTIGACIONES" and "POLICIA", starts with the proposition that certain characteristic points should be assigned a greater importance than others Certain rare points should have an added value. Mr. Santamaria suggested that these be multiplied by a coefficient from 1 to 3, depending on the rarity of the point in question. With this system, the investigator finds a quantitative figure indicating the *number* of points common to two fingerprints, and also a *qualitative* figure, based on the rareness of these common points. By studying a group of one thousand fingerprints, Mr. Santamaria had showed that these points occur with varying frequency, from 534 in 1000 (broken lines) to 0.2 in 1000 (turns). (Bridge-players make the same sort of calculation in evaluating their cards before bidding.) But that is not all. Mr. Santamaria also proposed assigning to certain peculiarities *other than the characteristic points* (rarity of points, scars, high degree of porousness) a value of 1 (which is the value assigned the most frequent common points). The result is two sets of figures, for two groups of characteristics, and Mr. Santamaria proposed that identity be taken as established when these figures, their values reckoned and totaled, can be added to amount to at least 10. In other words, taking the figure 10 as the threshold for positive identification, that figure could be arrived at in the case of two not unusual fingerprints in two ways: either by adding 10 common points, each counting as one, or by adding, say, 5 "classic" common points, each counting as one, and two rare points, counting as 2 and 3 respectively.

as many as thirty coincidences" (1). This was explained by the fact that the two men were twin brothers. If these coincidences were of characteristic elements or points, the fact that the men were twin brothers is not a reasonable explanation of such a coincidence. It is generally accepted today that the distribution of the elements or characteristic points in a fingerprint pattern is not dependent upon heredity. This of course does not preclude the possibility that the overall type of pattern may be dependent upon heredity.

A better explanation of this surprising coincidence can be found in the book referred to above.

"In 1912, two years before his (Bertillon's) death, he published an article in the Archives of Lacassagne *which purported to show that the points of resemblance upon two fingerprints of different origin might in certain circumstances show an apparent correspondence. The article was illustrated with the excellent photographs he knew so well how to take. They were ingeniously reproduced to indicate how, if certain portions of the pattern were not shown, what remained might suggest correspondences which would produce an appearance of identity in different fingerprints. It did not explain how the artifical conditions he created to produce these fragmentary designs could have occurred in practice. Advocates of the fingerprint system, which was now well established, also declared that his "points of resemblance" were not points of resemblance at all, since they showed only the same general form. (12)"*

A student of Bertillon, Dr. Edmond Locard, who became director of the laboratory at Lyon, made further studies of fingerprints as a means of identification. He published a paper on some legal aspects of fingerprint identification in 1914 (7), in which certain rules were presented which told just what was needed for various degrees of identification. Since these rules seem to have had a strong influence on the minimal number of points required in practice, they are reproduced here as they appeared in one of Dr. Locard's later books.

"En résumé, trois ordres de cas peuvent se présenter:

1. Il y a plus de 12 points évidents: l'empreinte est nette: certitude indiscutable.

2. Il y a 8 à 12 points: cas limités. La certitude est fonction: a) de la netteté de l'empreinte: b) de la rareté de son type: c) de la présence du centre de figure ou du triangle dans la partie déchiffrable: d) de la présence des pores: e) de la parfaite et évidente identité de longueur des crêtes et des sillons, de direction des lignes et de valeur angulaire des bifurcations. Dans ces cas, la certitude ne s'impose qu'après discussion par un ou plusieurs spécialistes compétents et expérimentés.

3. Il y a très peu de points. Dans ce cas, l'empreinte ne fournit plus de certitude, mais seulement une présomption, proportionnelle au nombre de points et à leur netteté. (5) (*)"

In leading up to the summation rules above, Locard discusses one of the major probability calculations (to be discussed in Part II), which concludes that about 12 points are sufficient for an identification under certain conditions. He then says that:

"C'est à des conclusions analogues que l'empirisme avait déjà conduit. Les dactyloscopes, les chefs des divers laboratoires de police, ont toujour conclu qu'avec 12, 14 ou 15 points de repère correspondants, l'identification est formelle." (**) (8)

There is no indication of why these conclusions were actually made. The above statement would seem to infer that the calculations were only significant as support of the conclusions rather than as a basis of the conclusions. However, the work referred to was that

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(*) "In summary, three orders of cases can occur:
"1st. Where there are more than 12 evident points: the imprint is clear: indisputable certainty.
"2nd. Where there are 8 to 12 points: limited cases. The certainty is a function: a) of the clarity of the imprint: b) of the rarity of its type: c) of the presence of the center of the figure or of the triangle (delta) in the discernable part: d) of the presence of pores: e) of the perfect and evident identity of the length of crests and furrows, of the direction of the lines and of the angular value of the bifurcations. In these cases, certainty is established only after discussion by one or several competent and experienced specialists.
"3rd. Where there are very few points. In this case, the imprint no longer furnishes certainty, but only a presumption, proportional to the number of points and to their clarity."

(**) "It is to analogous conclusions that empiricism has already led. The dactyloscopes, the chiefs of various police laboratories have always concluded that with 12, 14 or 15 corresponding points of comparison, the identification is formal."

which occur in "identical" twins . . . For treatment of chance in reference to fingerprint details it seems safe to apply the usual computation for the concurrence of random events . . ."

The use of the term *random* is also somewhat confused here. Although it may be correct to speak of the occurrence of a particular type of characteristic element at a given point to be random, that is, each of the types of elements has an equal chance of occurring, it is not correct to say that the elements are randomly distributed over the area when they must occur in particular squares, and only one element can occupy any one square. This is an overdispersed distribution.

The last offering on this subject to be examined is found in a book by Wilder and Wentworth (19). They go into a detailed account of the famous case of Marie Roget, made popular by the detective story based on it which was written by Poe. The point in question was the dead girl's identity, and each characteristic of the corpse was given some probability of random occurrence in the population. These were all multiplied together to give the probability that they would all occur together by chance. The authors then adduce that:

"*We have thus obtained the formula for calculating the chance of occurrence of any number of details: we first estimate the chance of occurrence of each detail separately; we put it in the form of a fraction, and we multiply all the fractions together. The result will give the chance of occurrence.*"

After some calculations for the occurrence of several characteristic elements in a given configuration, where they point out that Balthazard's estimate of one in four is much too modest and that the real figure is closer to 1 in 50, or 1 in 100, they go on to infer another basic principle:

"*Still, as it is, the 64,000,000,000 possible patterns of Galton's estimate are more than four times as many as there are fingers in the world, counting the number of human inhabitants as 1,400,000,000, the latest estimate. This number, confessedly a low one, would thus supply without repeating, four and one-half worlds like ours, each with 1,400,000,000 inhabitants.*"

The previous example illustrated the danger in the uncritical application of the first of these two principles. The first principle is correct only when the probabilities are independent. The second statement is incorrect under any conditions; nevertheless, it is a widely accepted interpretation of probability to the uninitiated. The error is in the assumption that a probability of 1/100 means that only one such event will occur out of every one hundred. The probability of the one spot appearing uppermost in one roll of a die is 1/6, and yet most people would not be surprised to see two one spots uppermost (or two two spots, or three spots etc.) if six dice were tossed. In fact, the probability of the duplication of some number in one toss of six dice is about .985.

This mis-interpretation appears in many discussions of fingerprint identification in the criminalistic literature. It should be noted that Galton made a correct statement in this respect when he said that the chance of a duplication was smaller than 1 to 4. He surely did not mean to imply that 1 in 64 billion was the chance referred to, although it is certainly true that it is smaller than 1 to 4.

Since almost all other probability calculations are some modification of the above, they will not be specifically mentioned here. Almost all of the calculations have been ultra-conservative — the actual probabilities are far less for a chance occurrence. This has been noted by several authors. As chance woud have it, these conservative probabilities, combined with erroneous interpretations, gave final results that are approximately reasonable. Attempts to apply the erroneous reasoning demonstrated above to other types of evidence may not result in such a fortuitous result. Calculations based on a recent study (4) (from which this material is adapted) indicated that Locard's rules are reasonable from a probabilistic point of view. This study presents a method of an approximate evaluation of the rather vague criterion of "rarity of its type" as suggested by Locard in the class 2 category of trace fingerprint impression.

The actual origin of (or reasons for) the criterion of the "12 point rule" is still somewhat obscure. It is possible that this criterion was simply passed along from the anthropometric system of Bertillon. It will be recalled that this system had been established and was operative before the use of fingerprints became fashionable, and that 11 measurements were used for identification. In 1903, sometime before fingerprints had supplanted body measurements for identification purposes, the Will West incident occurred (13). This may have cast some doubt on the adequacy of 11 points in any identification system, and it is not too unreasonable to imagine the following line of reasoning as fingerprints became the leading method of identification: "Since 11 characteristics were almost, but not quite, enough in the Bertillon system, we had better set a limit of 12 for fingerprints if we want to be sure of an identification." Why Bertillon chose 11 measurements is another question.

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