

WIGMORE, FACT-FINDING AND PROBABILITY

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John Henry Wigmore was a remarkable man. Born in 1863, he graduated from Harvard in 1887, and after practising for a short time in Boston became Professor of Anglo-American Law at Keio University in Tokyo from 1889–1892. In 1892 he returned to America, and shortly afterwards he accepted a Chair at Northwestern University. There he remained for almost fifty years until his death in a road accident at the age of eighty.

He wrote extensively on a variety of subjects, but his lasting claim to fame is his treatise on Evidence, originally in four volumes, but which has been kept up to date, and now occupies twelve large volumes. Even those who disagreed with him recognised its merits. One of his critics, Professor Edmund Morgan of Harvard, reviewing the 3rd Edition (1940), said “Not only is this the best, by far the best, treatise on the Law of Evidence, it is also the best work ever produced on any comparable division of American Law.”¹

What is less well-known is that Wigmore was also an advocate of the teaching of the science (if it can be so dignified) of fact-finding. In 1913 he published *The Principles of Judicial Proof As Given by Logic, Psychology, and General Experience and Illustrated in Judicial Trials*. A second revised edition was published in 1931, and a third edition, revised and enlarged, (now called *The Science of Judicial Proof*) in 1937.

It is not my concern to analyse this book as a whole. It runs to over a thousand pages, and abounds in anecdotal material, much of which is fascinating. William Twining’s book² deals in detail with its history and significance. It is divided into five parts. Part I deals with the general principles of proof, Part II deals with circumstantial evidence, Part III with testimonial evidence, and Part IV with what Wigmore called “autoptic preference”, by which he meant the perception of a thing by the tribunal itself, or as it is commonly called, the examination of “real evidence”. Part V is entitled “Mixed Masses of Evidence, in Trials, for Analysis,” and introduces the reader to Wigmore’s “Chart Method”. This consists of listing the key items of evidence in a particular trial and arranging them on a chart with symbols indicating their significance for the ultimate conclusion of fact on each issue.

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¹ These details are taken from William Twining, *Theories of Evidence: Bentham and Wigmore* (London, Weidenfeld & Nicolson 1985) 189–90, and from the dust jacket of Wigmore’s *Science of Judicial Proof* (3rd ed., Boston, 1937).

² Twining, loc. cit.

William Twining has placed on record his experience of teaching a course on proof at Warwick University, using Wigmore's chart method.³ Whereas Wigmore illustrated the method by using the records of American cases, Twining took both American cases (Sacco and Vanzetti, Alger Hiss) and English cases (Tichborne, Thomson and Bywaters, Hanratty) for analysis. He reports that he is convinced that such exercises are "an excellent pedagogical device for a number of purposes."⁴

Wigmore's method, however, while it appears to be an excellent way of compelling the trier of fact to evaluate the significance of each item of evidence, is notably deficient in providing guidance for the task of combining the effect of individual items of evidence to arrive at a conclusion. Wigmore recognised that this process was usually a matter of inductive inference, and that a study of probabilities was important, but unfortunately he seems only to have had a distant acquaintance with probability theory, and in the brief passage in which he discussed the matter he was guilty of several errors.

In Part II, Chapter 17, Wigmore treats the subject of identification. Section 154, at pages 268 and following, is headed "Identification of Unique Objects; Principle of Permutations; Theory of Probabilities." After some preliminary remarks, he discusses the principle of permutations, or "the variant sequences in which a given number of things can occur in a series, using some or all of them in a combination." The principle is illustrated by an example, showing the number of ways in which the letters A, B, C and D can be arranged two at a time and three at a time, and correctly setting out the formula for calculating the result:

$$P = n(n-1)(n-2) \dots (n-r+1),$$

where P represents the number of possible permutations, n the total number of things, and r the number of things to be taken at a time.

Wigmore then goes on to assume that a corpse is to be described and lists thirty "simple items of description." For example, he gives "*Head*: eyes (blue), nose (long), lips (thin), chin (short), hair (red)." and similar lists for feet, clothes, hat, hands and body, with five items in each. He continued: "If now we expect to have knowledge of any five of these thirty items, and wish to know how many permutations of them are possible, the above formula becomes:

$$P = 30 \times 29 \times 28 \times 26 \times 27 \times 25 \times 24;$$

and the result becomes 7,800,432,000; i.e. possible ways in which five of these features might be found combined."

There are several errors in this passage. In the first place, the calculation is made as if the formula ended in the expression " $(n-(r+1))$ " instead of " $(n-r+1)$ ". So the calculation should have been $30 \times 29 \times 28 \times 27 \times 26$, equal

³ W. Twining "Taking Facts Seriously" (1984) 34 *Jnl. Legal Educ.* 22.

⁴ It seems that Twining's students took to this new discipline with enthusiasm, since he had to lay down ground rules, one of which was that no chart should exceed ten feet in length — a reaction to the delivery by a student of a chart 37 feet long: W. Twining, "Taking Facts Seriously" 31.

to 17,100,720. But in any case, Wigmore's arithmetic was wrong. The answer to the calculation he set out should have been 10,260,432,000.

Even more serious is the fact that in determining whether two descriptions are identical, "blue eyes and thick lips" must rank as identical with "thick lips and blue eyes". The correct formula to use would have been that for combinations, not permutations.

In any case, when a question of identification arises, the problem is likely to depend on what characteristics we actually have available, not how many possibilities there are. Wigmore appears to have realised this, for he goes on to say that knowing the possibilities does not tell us the probative significance of finding in a given case any one of these permutations. "For this purpose we must resort further to the theory of probabilities."⁵

Using the example of an urn containing 50 white balls and 50 black, he shows that the chance of drawing a white ball is one-half, and of two successive white balls is one-quarter. It is perhaps a minor criticism that this proposition is only true if the ball first drawn is replaced in the urn before the second ball is drawn (otherwise the probability of drawing a second white ball becomes 49/99). But when Wigmore went on to apply the multiplication rule to his example of the corpse, he failed to take account of the possibility that the different characteristics listed by him might not be independent. Thus blue eyes and red hair might be thought to be associated characteristics, and it would be wrong to multiply the probability of finding red hair by the probability of finding blue eyes. The correct way to calculate the probability of finding both characteristics is to multiply the probability of finding one by the probability of finding the other, given that the first characteristic has already been found: in mathematical terms,

$$\Pr(A \text{ \& } B) = \Pr(A) \times \Pr(B|A) = \Pr(B) \times \Pr(A|B)$$

where the symbol "|" means "given".

Wigmore, however, did understand that in the absence of some data on which to calculate the probability of finding a particular characteristic, "the formula can have only a loose or provisional significance as an estimate of probability."⁶

Other examples of the application of probability theory are given in the following pages of the book. It is difficult to determine how many of the problems involved were present to his mind. One passage quoted by him appears to assume that if the probability of finding particular defects in a typewriter was 1 in 100, and there were fewer than 100 machines of that type in existence, it would be certain that a given machine which produced those defects wrote any other document in which those defects occurred.⁷ Since the

⁵ Wigmore, *Science of Judicial Proof* (3rd ed., Boston, 1937) 270.

⁶ Id. 271.

⁷ Id. 273. This is the sort of problem discussed in R. Eggleston, *Evidence, Proof and Probability*, (2nd ed., London, Weidenfeld & Nicolson, 1983) Appendix III, 241-7, "The Island Problem". Using the formula discussed on pages 241-2, and taking the figures suggested, i.e. a probability of occurrence of the defects of 1 in 100, and a total stock of 100 typewriters, the probability of there being one or more other typewriters with the same defects will be greater than 0.6.

passage is quoted without comment, presumably Wigmore shared the view of its author.

At first sight it seems surprising that the book went through three editions without anyone picking up the errors or criticising the reasoning. The explanation is apparently that the section on probability was a new section added for the first time in the third edition, as appears from the Preface to that edition, and the accompanying table of corresponding section numbers. By this time, critical reviewers were probably few and far between. Actually, as Twining notes,⁸ *The Science of Judicial Proof* was by no means a best seller. Because of the enormous success of the *Treatise on Evidence*, Little Brown and Co were prepared to indulge Wigmore by producing further editions, but it was mainly regarded as bedside reading for practitioners, packed as it was with readable anecdotes. The copy I own (one of very few in Australia) was presented to Sir John Barry (then a junior barrister) by Mr. Eugene Gorman K.C. (as he then was) in 1938, having been purchased by Gorman in Los Angeles, no doubt because the anecdotal material caught his eye.

While Wigmore was at Northwestern he taught a regular course on Proof, for which the book was the text. But not many law teachers shared his enthusiasm for teaching students how to deal with facts. Twining⁹ lists a number of similar ventures in American law schools, saying "These are fascinating in their diversity, but the more striking fact is that they did not become established; almost without exception they stand as monuments to the ephemeral contributions of individual teachers." So far as Wigmore's own course is concerned, it is significant that while he was Dean at Northwestern it was a regular part of the curriculum, first as a required course, and later as an option. After he ceased to be Dean it was relegated to the Summer Program.

In England, I think it is fair to say, there are few Law Schools that provide courses specifically aimed at teaching students how to deal with facts. Twining has now moved from Warwick to University College, London, and continues to deal with problems of proof; he has enlisted the aid of the Department of Statistics to assist in handling questions involving probabilities. John Jackson in Belfast has had success in introducing his students to probability theory. My enquiries did not reveal any other such courses, though of course there are other academic lawyers who are interested.

In Australia, enquiries were made from seventeen departments or faculties involved with law teaching. Two did not reply. Three of the remaining fifteen did not offer a full law course. This left twelve law schools teaching courses in Evidence. Of these, seven replied in terms that made it clear that although fact-finding might be dealt with incidentally in other courses, or as part of a traditional course in Evidence, problems of probability theory were not dealt with as such. Two others devoted a portion of their Evidence courses to probability problems, one had a course on litigation in which such questions were discussed, and two had or proposed a subject at post-graduate level in

⁸ W. Twining, "Taking Facts Seriously" 28. See also W. Twining, *Theories of Evidence: Bentham and Wigmore*, 164-66, 239.

⁹ W. Twining "Taking Facts Seriously", 28.

which there was specific discussion of probabilities on a theoretical level. One of these two also directed the attention of undergraduates to considerations of probability in dealing with evidence. While this is a better tally than I found five years ago, it still seems that only a minority deal specifically with probability theory.

In the United States, anti-discrimination laws and constitutional guarantees have made statistical analysis important for the resolution of some factual issues, and one quarter of the Law Schools surveyed by a committee of the American Statistical Association in 1981 provided courses in statistical theory or methods.¹⁰ For the most part, however, these would seem to be advanced courses aimed at students who are equipped with mathematical skills and training.¹¹ The need, in my view, is for courses which teach the basic rules about probability to all students.

To support this proposition, I shall discuss two areas in which a correct understanding of probabilities is fundamental to the resolution of questions which are not obviously of a statistical kind.

For the first of these two areas we can start with the Victorian case of *Doonan v. Beacham*.¹² In that case the plaintiff had been knocked down by a vehicle at the corner of Flinders and Swanston Streets, and she alleged negligence against the defendant. Her particulars of negligence specified various heads of negligence, which can be summarised as:

- driving at an excessive speed,
- failing to keep a proper lookout,
- driving on the wrong part of the roadway,
- failing to apply the brakes.

Sir Charles Lowe, in deciding whether to leave the case to the jury, examined each of these allegations in turn, and in each case decided that there was not sufficient evidence for a jury to find that that allegation was sustained. He therefore withdrew the case from the jury and entered judgment for the defendant. The plaintiff appealed to the Full Court which upheld the appeal, and this decision was affirmed by the High Court of Australia. The appellate courts said the trial judge should have considered the evidence as a whole, saying that the question for the trial judge was whether there was evidence "on which the jury could find, on the balance of probabilities and as a matter of reasonable inference, that the damage was caused by negligence which must have taken some form falling within the particulars."¹³

¹⁰ D. Kaye, "Thinking like a Statistician" (1984) 34 *Jnl Legal Educ.* 97.

¹¹ In reply to a query, Professor Kaye in a recent letter has expressed the opinion that "except for an occasional seminar, most of the little effort that exists is directed at statistical methods rather than at fundamental questions of proof". There has, however, been increased academic interest in the problems of applying probability theory to forensic evidence, as shown by two recent publications — *The Evolving Role of Statistical Assessments as Evidence in the Courts* (New York, Springer-Verlag, 1988) and *Probability and Inference in the Law of Evidence: The Uses and Limits of Bayesianism* (Dordrecht, Kluwer Academic Publishers, 1988). The latter volume, of 345 pages, is volume 109 of *Boston Studies in the Philosophy of Science*, and consists of papers reproduced from the *Boston University Law Review*.

¹² *Doonan v. Beacham* (1953) 87 C.L.R. 346.

¹³ *Id.* 351.

In fact, if the situation is analysed in terms of probability theory, we would apply the rule for determining the probability of alternative events. If we wish to estimate the probability of A or B happening, A and B being mutually exclusive events, we add the probabilities together. $\Pr(A \text{ or } B) = \Pr(A) + \Pr(B)$. Thus if we have a standard pack of cards, and we wish to find the probability of drawing either the ace of spades or a heart in a single draw, we add $1/52$ (as there is only one ace of spades) to $13/52$ (as there are thirteen chances of drawing a heart) giving the answer $14/52$. The events are mutually exclusive, as in one draw we cannot get both the ace of spades and a heart.

Where the events are not mutually exclusive, we must subtract from the addition the probability of an event happening which satisfies both requirements; otherwise we shall be double-counting. Thus if we want to estimate the probability of drawing an ace or a spade, we would add $4/52$ and $13/52$ and subtract the probability of drawing the ace of spades, which would be the happening of both events. This would give us $17/52 - 1/52 = 16/52$.

Clearly then, the trial judge should not have asked the question as to each head of negligence taken separately. On the other hand, as more than one of the events alleged could have happened, e.g. the defendant might have been driving at an excessive speed *and* have failed to keep a proper lookout, it would have been wrong merely to add the probabilities of each event together. Where there are more than two such events, the formula becomes increasingly complicated as the number of events increases. But if we can say that the accident is unlikely to have happened without negligence of some kind on the part of the defendant, we can say that negligence is more probable than not, without specifying which of the alleged acts or omissions occurred. This is in effect the approach adopted by the High Court, when it said that the question was whether the jury could find . . . that the damage was caused by negligence which must have taken some form falling within the scope of the particulars.

We are in effect saying that if the probability of "no negligence" is less than 0.5, the probability of negligence must exceed 0.5; $\Pr(A) = 1 - \Pr(\text{Not-}A)$. Of course, because of the rules about pleading, negligence and no-negligence here must be taken to refer to negligence of a kind falling within the terms of the particulars, but a defendant who asserts that he was or may have been negligent in a manner not pleaded could hardly be allowed to escape on that ground.¹⁴

In contrast we may take a case where the plaintiff has to prove that A *and* B *and* C have all happened before he can succeed. In *McQuaker v. Goddard*¹⁵ the plaintiff claimed that he had been bitten by the defendant's camel. To sustain his claim he had to prove (a) that he had been bitten by the camel (b) that the defendant owned the camel (c) that camels are wild beasts and not domestic animals (unless he could prove that the defendant knew that the camel was

¹⁴ See the remarks of Dixon C.J., Webb, Fullagar and Taylor JJ., in *Mummery v. Irvings*, (1956) 96 C.L.R. 99, 111-112.

¹⁵ [1940] 1 K.B. 687. It was found that camels were domestic animals, an expert witness testifying that camels are the oldest domestic animals known — so much so that they are unable to breed without human assistance. The wild camels of inland Australia appear to be unaware of this limitation on their activities.

savage). The rule for combining probabilities in such a case (assuming that each event is independent) is that the probabilities must be multiplied together — $\Pr(A \& B) = \Pr(A) \times \Pr(B)$. So if we have two packs of cards, and we wish to assess the probability of drawing an ace from one pack and a heart from the other, we must multiply $4/52$ by $13/52$. On the other hand, if the events are not independent, we must adopt a different rule. We multiply the probability of one event by the probability of the other event, *given that the first event has happened* — $\Pr(A \& B) = \Pr(A) \times \Pr(B|A)$. To illustrate, if we wish to estimate the probability of drawing a spade followed by a heart in two draws from the same pack, we take $13/52$ as the probability of drawing a spade on the first draw, and $13/51$ as the probability of drawing a heart on the second draw, given that a spade has been drawn on the first draw, since there will only be 51 cards left after the first draw, of which 13 will be hearts. If we had asked about the probability of drawing successive spades, the answer would have been $13/52 \times 12/51$, since on the second draw there would only be 12 spades left, given that the first draw resulted in a spade. This is the point that Wigmore missed when speaking of the probability of drawing a second white ball from the urn, and also in relation to the combination of such characteristics as red hair and blue eyes.

In a case like *McQuaker v. Goddard* it would not be enough to prove (a) (b) and (c) on a mere balance of probabilities. Even if we assessed the odds in favour of each conclusion at 2 to 1 on, and assuming that each issue was independent in the sense described above, the resulting probability of all three being true would be $8/27$ (i.e. $2/3 \times 2/3 \times 2/3$) or 19 to 8 against. In this class of case, to invite a jury to decide each issue separately on a mere balance of probability would be to do an injustice to the defendant, whereas to pursue the same course in a case like *Doonan v. Beacham* would be unjust to the plaintiff.

In some American States, either party is entitled to ask for a special verdict in jury cases, and in those cases the jury is bound to answer the questions, and does not have the right possessed by juries at common law, to give a general verdict for plaintiff or defendant. In those States, it is the practice in negligence cases to ask the jury questions in the form "Do you find, on the balance of probabilities, that the defendant was driving at an excessive speed?" and so on for each particular of negligence. Assuming that juries answered the questions as asked, this could well result in the sort of injustice appealed from in *Doonan v. Beacham*, and indeed it has been suggested that defendants prefer to ask for special verdicts for this reason.¹⁶

The implications of this analysis have been generally ignored by judges. An academic argument has been pursued in England as to whether the law allows a tribunal of fact in a civil case to decide each issue separately on a balance of probabilities, the affirmative being sponsored by Jonathan Cohen of The Queen's College Oxford.¹⁷ As far as I am aware there is no judicial decision to

¹⁶ A.D. Cullison "Probability Analysis in Judicial Fact-Finding: A Preliminary Outline of a Subjective Approach" (1969) *Toledo Law Review*, 538, 579–82.

¹⁷ L. Jonathan Cohen, *The Probable and the Provable* (Clarendon Press, Oxford, 1977). See also R. Eggleston, *Evidence, Proof and Probability* (2nd ed., 1983) 34–44, W. Twining,

this effect. My own view, as indicated above, is that the mathematical rule should be followed. If this makes it difficult to prove a case in which there are multiple issues, that is a consequence which in my opinion justice requires. But the academic argument is overlaid with philosophical discussion as to whether there is a different kind of probability ("Baconian") from the mathematical or "Pascalian" sort (the terms have been coined by Jonathan Cohen after Francis Bacon and Blaise Pascal).

This then is my first example of the need for a study of probability theory by lawyers. Not all lawyers would agree with me about the application of the probability rules to cases with multiple issues,¹⁸ but the resolution of that question raises problems which are themselves of great academic importance. However the conflict is to be resolved, lawyers should at least be aware of the implications.

My second example derives from the criminal law. Where the prosecution relies on several pieces of circumstantial evidence, the books afford no satisfactory guidance as to how a jury should be directed in dealing with such matters. Yet the possibilities of fallacious reasoning abound. In the first edition of McCormick on Evidence,¹⁹ he gave an example of a case in which eye-witnesses have reported certain details about the criminal. After saying "we may estimate the probabilities that any unknown person would possess that particular mark" he continued:

"He was of medium height (one out of two), red haired (one out of five), had a noticeable paunch (one out of three), and walked with a slight limp (one out of ten) . . . Under that theory [of probability], in calculating the chances that A and the unknown are different persons, you do not merely add together the odds against the appearance of each of the several traits, but rather you multiply them. Accordingly, the odds against A's not being the criminal would not be twenty to one but three hundred ($2 \times 5 \times 3 \times 10$) to one."

As Cullison²⁰ remarks, "Imagine the havoc this theory would cause if such a case arose in a large metropolitan area where there could easily be hundreds of medium-height, red-haired, noticeably paunchy, adult males limping the streets every day." Taking McCormick's estimate of the odds, in a city having a million male inhabitants we could expect to find 3333 such specimens and the odds against any one found at random being the criminal would be 1/3333.

This error has been dubbed by Diaconis and Freedman²¹ "the fallacy of the transposed conditional" and when found in criminal cases consists in con-

Theories of Evidence: Bentham and Wigmore, 180-183; A. Ligertwood, *Australian Evidence* (Butterworths, 1988) 5-20.

¹⁸ A. Ligertwood, *op. cit.* 19.

¹⁹ C. McCormick, *Evidence* (1st ed., West Publishing Co., 1954) 364-5. This passage has since been replaced by a much more sophisticated treatment of the subject (2nd ed., West Publishing Co., 1972), 491-9.

²⁰ A.D. Cullison, "Identification by Probabilities and Trial by Arithmetic (A Lesson for Beginners in How to be Wrong with Greater Precision)", 6 *Houston Law Review* 471 (1969), 507.

²¹ P. Diaconis and D. Freedman, "The persistence of cognitive illusions", *The Behavioural and Brain Sciences* 4, pp. 333-4 (1981).

fusing the probability of finding the evidence given that the accused is innocent with the probability of innocence given that the evidence has been found; in symbols this can be expressed as confusion between $\Pr(E|\text{Not-G})$ and $\Pr(\text{Not-G}|E)$. In the article (at fn. 20) Cullison gives a number of examples of what he calls "the quite normal state of confusion" in legal circles. Other problems are associated with the fallacy — for example, the assumption made by the author of the passage cited by Wigmore,²² that if the odds against finding a second typewriter with the specified defects are 100 to 1, and less than 100 typewriters of that make exist, there can only be one such typewriter with those defects in existence.

Given that the fallacy of the transposed conditional is a common error, and having regard to the fact that scientific evidence regarding the occurrence of similar trace elements at the crime scene and in the suspect's clothing is becoming increasingly common, how are judges to ensure that juries do not commit the fallacy? The difficulty can be illustrated by a consideration of the South Australian trial of Edward Splatt for murder.

Splatt was convicted in November 1978 of the murder of a widow who lived alone in her house, which was ransacked by the criminal. She had been tortured and mutilated. Virtually the only evidence against Splatt was the fact that trace materials found on her bed corresponded with similar materials found either in Splatt's clothing or at his home. The materials found on her bed included particles of orange paint spray, weld splatter, foam spicules, starch particles, particles of wood, sugar crystals, yellow fibres, black wool fibres, blue and white cotton fibres, a red and white fibre with paint sticking to it, aluminium flakes, a brass particle, lavender, blood from the victim, and part of a feather. Paint and material particles, including zinc, were also found on the window sill at the point of entry. The sheets on the bed had been changed on the day before the murder.

The victim's house was diagonally opposite Wilson's factory, engaged in making steel crates to contain car engines, and Splatt was employed there as a spray painter. He lived 350 metres away. Some years earlier he had been convicted of shop-breaking and larceny.

Clothing was collected from the homes of the 16 workers at Wilson's, by far the most from Splatt's. His dark grey trousers, especially the cuffs from vacuuming, yielded many paint and metal particles and also starch particles, sugar particles and black wool fibres. His blue and white shirt yielded blue and white fibres, his car coat foam spicules and his car seat cover yellow fibres. However, he had no red and white clothes to explain the red and white fibre; no feather was found on his clothing nor lavender nor blood. Apart from a carpet fibre on his trousers which was said to resemble fibres in the victim's carpet, nothing was found on his clothing to connect him with any trace materials originating at the crime scene.

Following his conviction, Splatt protested his innocence for the next two years, and finally, as the result of an election promise, the newly elected Labor Party appointed a Royal Commission to investigate the conviction. The

²² *Supra* fn. 7

Royal Commissioner, after a hearing of 190 days, engendering 19000 pages of transcript, concluded that the doubts raised as to the evidence were such that it would be unsafe to sustain the conviction and Splatt was released after having served almost six years.

In the course of this long investigation, it became apparent that many of the "matches" between particles relied on by the prosecution could not be justified by the evidence. In particular the identification of the starch particles as corresponding to the seeds from Splatt's aviary lacked scientific justification; the identification of the wood particle found on his clothing as jarrah (corresponding with wood from the jemmied window) was not justified; the evidence at the trial that the foam spicules from the bed and from Splatt's coat "behaved the same in all tests" and that there were no dissimilarities between them was misleading; one of the black wool particles proved on closer examination to be dark blue and did not match Splatt's trousers, nor was there any trace on the bed of the lighter grey fibres found in those trousers; and the zinc particle, said to match a piece missing from a nail at Splatt's house, was actually of a different composition. In addition, the evidence at the trial that the particles found at the house were too large to have been windblown was found to be erroneous.

There were other criticisms to be made of the trial evidence but in the light of these alone it was not surprising that the Commissioner found that Splatt should be released forthwith.

Counsel for Splatt offered Professor Darroch as a witness to testify as to the use that should be made of probability theory in handling the evidence about the particles. This evidence criticised aspects of the prosecution case at the trial; for example, the failure to present to the court a tally of the number of particles counted at each location. It also provided a theoretical framework on which to base an analysis of the cogency of the prosecution evidence about the particles. In addition, it exposed the inadequacy of the traditional direction as to circumstantial evidence given to the jury at the trial. It is this direction that concerns us here.

The trial judge, after telling the jury that the case must be proved beyond reasonable doubt, and that, the evidence being circumstantial, the facts must be such as to be inconsistent with any other rational conclusion than the guilt of the accused, attempted to assist the jury in the task of assessing the evidence. Using a metaphor which derives from a statement of Lord Cairns²³ the learned judge said:

"It is sometimes said that in dealing with circumstantial evidence you should consider the weight which is to be given to the united force of all the circumstances put together. You may have a ray of light so feeble that by itself it will do little to elucidate a dark corner but, on the other hand, you may have a number of such rays of light, each of them insufficient in itself to light up that dark corner but all converging and brought to bear upon the same point and, when united, producing a body of illumination which will clear away the darkness you are endeavouring to dispel. So that if you imagine somebody in that room of Mrs Simper's and you know it is a form,

²³ *The Belhaven and Stenton Peerage Case* (1875) 1 App. Cas. 278, 279.

you know it is a person but you can't see who it is, then you look at each of the pieces of evidence which the Crown has tendered and you say "Right, that provides one ray of light" if you find it proved, and you have to decide whether, in the end, all those rays of light are sufficient to show up this accused as the man in the room attacking Mrs Simper."

In a later passage the trial judge told the jury:

[You will have to decide] whether you are satisfied that the similarities are such, and so many, that the trace elements from the deceased's source and those from the accused's source must have come from the same source, and you may, as [counsel for the Crown] pointed out, come to this conclusion if you believe that the number of similarities are too great to be attributed to coincidence, or chance. If you reach that conclusion, then you probably will not have any difficulty with the final one which is a finding that the accused must have been so closely in contact with the deceased that he must have been the killer.

These passages or similar statements made at other times in the course of the summing up represent the total amount of guidance given to the jury as to how they were to go about their task. In fact, legal literature does not provide much more in the way of explanation as to how circumstantial evidence is to be assessed. Wills refers to the ray of light metaphor and also to an analogy of a rope made of many strands — "The rope has strength more than sufficient to bear the stress laid upon it though no one of the filaments of which it is composed would be sufficient for that purpose."²⁴

In his evidence to the Royal Commission Professor Darroch explained the way in which the problem of assessing this sort of evidence should be attacked. He pointed out that an important factor in the assessment was the number of particles which could not have come either from Splatt's environment or the victim's. This included the red and white fibres and some chips of non-spray paint. In fact it was not known how many non-matching materials there were, because a complete list of materials found by the police on the bed was never reported. Of course, the list of non-matching particles was added to when it was found by the Royal Commissioner that some of the materials claimed to be matching did not in fact match either the accused's or the victim's environment.

Professor Darroch, using Bayes Theorem, went on to point out the importance to the enquiry of deciding what was the probability of finding the trace materials at the crime scene on the assumption that Splatt was innocent, and the very low probability that must be found to justify a finding beyond reasonable doubt. The statements of the trial judge left open the possibility, not only that the jury might not realise how very improbable the coincidence must be if they were to be satisfied of Splatt's guilt, but that they might commit the fallacy of the transposed conditional, discussed above.

Consideration of the probability of finding the materials on the bed on the assumption that Splatt was innocent would involve considering every possibility that the materials might have got there by other means. Most of the materials were of a common sort. Indeed, it seems that the starch might well

²⁴ *Wills on Circumstantial Evidence* (6th ed. London, Butterworth & Co., 1912) 421-2.

have come from the victim's habit of eating biscuits in bed, and the foam spicules from her mattress. The principal problem was with the metal and spray-paint particles. Yet sources of these consistent with Splatt's innocence could easily be overlooked; in fact, it was not until some time after he gave evidence that Professor Darroch realised that their presence could easily be explained if the criminal had waited in the shadow outside the factory, where these particles were known to be present on the entrance driveway. There was evidence that a person had been seen in the vicinity carrying a hessian bag at about midnight on the night of the murder, and if that person had put the bag down in the driveway and then taken it into the bedroom, a rational explanation for the particles would be supplied. In addition, the failure to concentrate more attention on this aspect resulted in the too hasty dismissal at the trial of the possibility that the particles were windblown. It was excluded on the basis of a statement by a witness who was by no means an expert on such matters.

Professor Darroch also criticised the "rays of light" metaphor. He gave an example to illustrate the dangers of relying on such a metaphor as a guide. He postulated the case of a murder committed in a mining town where many of the men work in the mine. On the bed of the victim traces are found of copper, zinc, iron, lead, silver, marcasite and many other things. Some blue fibres are also found on the bed. A suspect is produced who wears blue overalls to work, and in whose overalls are found traces of the same minerals. Each of those traces might be thought of as a ray of light, and following the metaphor, their combined effect might be thought to throw more light than any one of them. But if many of the men work at the mine and they all wear blue overalls, the combined effect of all these traces is no stronger than that of any single one — each tells us that the murderer worked at the mine, and the combined effect is the same.

As pointed out above, if in such a case there are 10,000 male workers in the town, of whom 200 work underground in the mine, the chances of finding the evidence in an innocent person are 199/9,999 or approximately one in fifty, whereas the probability that the accused is innocent given the evidence is 199/200 or 99.5% (assuming that the crime was committed by only one person) since there are 199 innocent mine workers.

Professor Darroch's evidence was the subject of strong objection by counsel for the Crown, who described it as "mumbo jumbo". In the event, the Royal Commissioner did not have to decide whether the summing up adequately informed the jury as to the way in which they should go about their business. There were too many deficiencies in the Crown case for the verdict to be allowed to stand. He did however express the view that experts in probability theory should be permitted to give evidence in jury trials of this kind, though when the evidence first came under discussion he had expressed the view that in a trial before a judge and jury, "evidence of this kind could be very difficult to accommodate." He also criticised (though in rather restrained terms) the traditional direction as to circumstantial evidence, as applied to such a case,

and quoted with approval Darroch's example of the mining town as exposing the weakness of the rays of light metaphor.²⁵

The two examples I have given show that it is not merely when explicit statistical evidence is given that judges (and for that matter counsel and their instructing solicitors) may need to understand the basic rules of probability theory. Other examples can be given.²⁶ It may be asked, why do so few law schools concern themselves with the problems of fact-finding? One common objection is that it is not the business of law schools to teach students how to think.²⁷ But one may guess that more often the reason is that lawyers tend not to handle numbers easily. This is probably less true today than in the past, because of the number of students taking combined courses which involve mathematics or statistics. In any event, if there is a substantial body of knowledge that it is essential for lawyers to have at their disposal, and it is not taught elsewhere, there is surely a good case for its inclusion in the undergraduate curriculum.

²⁵ The account given in this article of Splatt's case is derived from a paper submitted jointly by Professor Darroch and myself to the Tenth Conference of the International Association of Forensic Sciences in Oxford in September 1984 ("Juries and Circumstantial Evidence: Reflections on *R. v. Splatt*"). It is available in microfiche from AC Associates, 39 Whitley Avenue, Solihull, B91 3JD, U.K. I am indebted to Professor Darroch for his help in this and other respects. Quotations from the judge's summing up are from the Criminal Appeal Record in the case.

²⁶ See, for example, R.M. Eggleston, "Focusing on the Defendant", 61 A.L.J. 58 (1987), and "The Mathematics of Corroboration" [1985] *Crim. Law Rev.* 640. On the subject of corroboration, the Northern Ireland Court of Appeal (*McCormick*, [1984] 1 N.I.J.B.) and the Privy Council (*A.G. of Hong Kong v. Wong Muk Ping* [1987] A.C. 501) have come to the same conclusion as that arrived at by the author, but without express reference to probability theory.

²⁷ W. Twining, "Taking Facts Seriously" 23.