BIOGRAPHICAL MEMOIRS

Henry Ellis Daniels. 2 October 1912 – 16 April 2000

David Cox

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Elected FRS 1980

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Early years and family background

Henry Ellis Daniels was born in London in 1912, the second child of a Jewish family that had come from the Russian territories of Poland and Lithuania as refugees from the pogroms there. His father's family had come from Poland to London, whereas his mother's were Litvak Jews who had arrived in Scotland; the herring boats that sold fish to the Baltic ports returned with many immigrants to Leith. When Henry was two years old, at the time of the Zeppelin raids on London, the family moved to Edinburgh to join the branch there. The life of the Jewish community in Edinburgh at that time is described by Daiches (1971), whose family were neighbours.

Education

Henry was educated at Sciennes School and at George Heriot's School. He claimed that his interest in science was first excited by being taken at the age of 12 to the Empire Exhibition in Wembley. Henry read mathematics at the University of Edinburgh. The Head of Department was Sir Edmund Whittaker FRS, the author of two influential books, *Modern analysis*, with G.N. Watson FRS, and *Calculus of observations*, with G. Robinson, an interesting mixture of numerical analysis and statistics. Henry maintained that the former book had been spoiled in comparison with the first edition, which was by Whittaker on his own, I think by overemphasis by Watson on the more formal side of analysis. Henry quite frequently spoke of Whittaker, always with much respect.

While an undergraduate he wrote two short papers on pure mathematical topics.

At Whittaker's suggestion he then went for two years to Cambridge under a Junior

Fellowship to Clare College, there beginning a long and in some respects uneasy association with that university. He attended some lectures on statistics and, probably at the suggestion of W.G. Cochran, who had recently switched from studying fluid dynamics to statistics, Henry decided on specialization in that subject. Although his precise programme of study at Cambridge is unclear, he met and became familiar with the work of many of the leading statisticians of that time. It was during that period that Henry wrote to R.A. (later Sir Ronald) Fisher (FRS 1929) about a wrong statement in *Statistical methods for research workers*. Fisher had said that one probability was somewhat greater than another; Henry pointed out that the inequality could go in either direction. Henry recounted later that he received no acknowledgement but that in the next edition Fisher changed 'somewhat' to 'sometimes', achieving correctness literally if not in spirit.

Henry obtained his PhD externally at the University of Edinburgh on the basis of his study of the strength of bundles to be described below. Although it is possible that he had a notional supervisor, it is clear that the work was entirely independent.

Early career

In 1935 B.H. Wilsdon came from the Building Research Station to be Director of Research of the Wool Industries Research Association (WIRA) in Leeds. He was an engineer who in his previous work had made extensive use of the then recent advances in statistical methods due to Fisher. One of Wilsdon's first steps was to advertise for a mathematical statistician; Henry applied and was appointed.

Except for war service Henry remained at WIRA for 10 years and there began a particularly productive period of his research career; his scientific conversation in later years quite frequently embraced that period.

Wilsdon's method as Director of Research was to appoint good people, to give them some broad encouragement and then to give them much freedom to pursue their own ideas. This was highly effective. WIRA spanned the biological, chemical, physical and engineering aspects of the two wool industries, worsted and woollen, including operational research but excluding economics, which was the province of the International Wool Secretariat. Among the contributions from WIRA before World War II was the development of a satisfactory chlorination process for making wool goods shrink resistant. During the war Wilsdon persuaded the Ministry of Supply to insert a shrink resistance test into the specification for wool products, it is said saving many millions of pounds in the currency of that time. This might partly explain why Wilsdon was later ousted in a coup, much to the regret of the staff.

Henry contributed to many aspects of the work at WIRA, both mathematical and statistical and also by running a fibre measurement laboratory, for which he developed some key techniques.

Later academic career

In 1947 Henry was appointed Lecturer in Mathematics at the newly formed Statistical Laboratory at Cambridge. Until then statistics there had been focused largely in the Faculty of Agriculture, where G.U. Yule FRS had been Lecturer until his retirement in the early 1930s, when he was replaced by J. Wishart as Reader. Wishart's primary duties had thus been in the

Faculty of Agriculture, although he had given some lectures to mathematicians; Henry had attended these in the 1930s. When after World War II the Statistical Laboratory was established within the Faculty of Mathematics, Wishart was appointed as Director, but relations between Wishart and R.A. Fisher, who by then was Professor of Genetics, were bad. Nevertheless, Wishart was a successful Director and steered a sensible course between the theoretical and applied aspects of the subject; a laboratory of international standing was built up and a succession of very strong postgraduate students graduated from there. Scientifically Henry was a key force within the laboratory for the next 10 years, and many of the next generation of British and other statisticians were much influenced by him, not least by his powerful lectures on statistical theory. In 1952 he spent a sabbatical year at the University of Chicago.

Wishart was drowned in Mexico in 1956, and for a period Henry became Director. However, he was not happy with the position of statistics in Cambridge. Not only was there no professor but also—and Henry certainly attached much importance to this—no member of the laboratory had a College Fellowship despite the clear international standing that had been achieved. In 1957 he left to become the first Professor of Mathematical Statistics at the University of Birmingham. There he found a much more congenial scientific and social environment and built up a strong group with a particularly effective undergraduate programme. He also found many colleagues in other departments in the very strong research environment of the time. In 1975–76 he spent a sabbatical year at King's College, Cambridge, where one of his duties was to organize a seminar on mathematical biology; it was attended in particular by R.M. (later Lord) May (FRS 1979; PRS 2000–present).

In 1964 the University of Wales acquired a house, Gregynog, near Welshpool for use as a Conference Centre. At the initiative of Henry and of Professor D.V. Lindley, then at Aberystwyth, an annual series of statistical conferences was established, and Henry was a regular and enthusiastic attender for the rest of his life.

Henry expressed disapproval of the PhD system and of any idea of formal research training, although he did have occasional doctoral students. He was, however, very helpful and encouraging to individual research workers.

Henry was active in the Royal Statistical Society, especially in the immediate postwar years when the prewar Agricultural and Industrial Research Section was revived in modified form, leading, in particular, to the formation of the Research Section and to the establishment of the *Journal of the Royal Statistical Society*, series B. This speedily became one of the internationally leading journals in mathematical statistics and has remained so in largely unchanged form. Meetings of the Research Section, at which preprints of papers are available and whose final publication contains a full report of the discussion, have been widely copied across the world. Henry played a leading part in these developments. In 1974–75 he was President of the Society. He received the Guy Medal in Silver in 1957 and in Gold in 1984. In 1985 he was elected an Honorary Member of the International Statistical Institute.

Later years

In 1978 Henry took early retirement and, somewhat to the surprise of many of his friends, almost immediately returned to live in Cambridge. He resumed his connection with the Statistical Laboratory and in fact worked there regularly until his death. His enthusiasm for research remained undiminished. Although his interests remained wide, his own work concentrated on stochastic processes motivated partly by the theory of epidemics and partly by his longstanding interest in stochastic problems in physics.

Shortly before his death the Statistical Laboratory was preparing for a move to its new pavilion in the development near the Isaac Newton Institute. Henry prepared his papers for the move and it seems likely that much material, in particular papers based on his work at WIRA, was destroyed then.

At supper at Gregynog on 14 April 2000 Henry was talking enthusiastically about his latest results on epidemic models, which he hoped to present soon afterwards at a meeting in Switzerland. The next morning at breakfast he had a massive stroke and died the following day at the Royal Shrewsbury Hospital without resuming consciousness. At his request his funeral was conducted by a Humanist officiant.

Research at WIRA

The variety of investigations at WIRA has already been described, and Henry played a role in many of them, this being by no means always apparent from his list of publications. Thus he helped A.J.P. Martin (FRS 1950) and R.L.M. Synge (FRS 1950) in their Nobel prizewinning work on paper chromatography, done—with the Director's encouragement—while they were supposedly investigating the scouring process. Henry suggested the use of Lissajous figures as the basis of a device for testing carpets.

He developed a number of delicate experimental techniques for fibre measurement that were used routinely in the laboratory that he ran. In view of the extreme variability of the raw material, careful attention to sampling issues was crucial both in specifying meticulously the procedures to be used in the laboratory and in indicating the theoretical relations between three distributions. These are the distribution of lengths of individual fibres in the population, the distribution obtained by taking all those fibres crossing a particular sampling point and the distribution obtained by clamping a fibre assembly at a point and combing out all those fibres, say to the right of the clamping point, and examining the distribution of length in the resulting 'tuft', what Henry called the combed tuft distribution. If $f(y)$ is the originating distribution of length with mean μ, the length-biased distribution and combed tuft distribution are respectively $yf(y)/\mu$ and $\mathcal{F}(y)/\mu$, where

$$\mathcal{F}(y) = \int_y^\infty f(x)\mathrm{d}x.$$

These relations are now familiar in the theory of stochastic point processes, the last under the name equilibrium recurrence time distribution. Henry was concerned with the implication of these relations for measuring length and properties correlated with length.

A substantial component of Henry's other work at WIRA concerned the use of statistical methods. He persuaded most of his colleagues that careful use of statistical methods of design and analysis was the way to deal with the substantial variability in the materials and processes in both industries. An idea of Henry's deep involvement in the substantive issues that this entailed can be obtained from his paper read to the Agricultural and Industrial Research Section of the Royal Statistical Society (1)*, where he described in considerable detail the

* Numbers in this form refer to the bibliography at the end of the text.

physical basis of the statistical problems that are the primary focus of the paper. A major part of the paper concerned the study of variation in the carding process in the woollen industry.

In fact the observed variation in mass per unit length results from many sources and the partitioning of variation into components is therefore important and the statistical techniques for doing this, by the estimation of so-called components of variance, had earlier been deployed in the cotton industry by L.H.C. Tippett, working at the Shirley Institute in Manchester, an analogous organization to WIRA. Henry made some important methodological developments and adapted the methods to take account of special features of carding. These involved a distinction that turns out to be of general importance between sources of variation that can be regarded as forming a physically clearly defined finite population and those in which random variation of potentially infinite repetition is possible. Careful definition of target parameters is needed in the two cases and the assessment of precision of the estimated components is quite different in the two cases. Henry explored this more theoretically in a second paper (3) and examined the relation with the non-central χ^2 distribution that had been introduced by Fisher in a rather different context; Henry showed how to use the relation to estimate confidence limits on the variance components. About 10–15 years later these ideas were further extensively developed by J.W. Tukey (FRS 1991) and others.

Wartime research

During the war, Henry worked for the Ministry of Aircraft Production, mainly, it is thought, on missile problems. On this basis of this work he published (7) an elegant paper studying errors in position finding on the basis of a series of bearings, each subject to error. This called for a mixture of spherical trigonometry and probability.

The paper is quite wide-ranging but probably the most striking result is the following, substantially generalizing a result for three position lines in the Admiralty Navigation Manual. Suppose that to determine the position of an unknown point P, position lines are drawn from n base stations; if there were no error the lines would all pass through P. Suppose further that the lines are subject to independent errors, that each is median unbiased, i.e. is equally likely to pass on either side of P and that no two lines are parallel. For $n = 3$ a triangle is formed. For general n the plane is divided into $(n^2 + n + 2)/2$ polygons, of which $2n$ extend to infinity and the remainder make up the largest possible closed polygon. Each combination of signs is equally likely and it follows that the probability that the closed polygon contains P is $1 - n/2^{n-1}$. Thus a distribution-free confidence region has been obtained for P. For $n = 3, 4, 8$ the probabilities are 0.25, 0.5 and very nearly 0.9. Henry showed that if the errors are independently normally distributed all with the same variance, the above confidence region can be substantially improved and he was able for $n = 3, 4$ to compare the expected area of the regions determined under the distribution-free and normal assumptions.

Contributions to statistics

Rank correlation

Studies of rank correlation have a long history, going back in particular to the psychologist C.E. Spearman FRS, who suggested the coefficient of rank correlation that bears his name. In the period around 1950 Henry made a number of influential contributions to the theory. One reason for studying the procedures is for their non-parametric character, enabling the assessment of the relation between two random variables X, Y in a way that is invariant under separate monotonic transformations of the values. However, Henry's interest arose from more practical concerns. Workers of experience in the industry could judge the fineness of samples of wool by ranking. How did their judgements relate to physical measurement of fibre diameter? Again, the appearance of a piece of woven fabric could be judged by expert ranking of different specimens. How could the agreement or disagreement between different judges be analysed?

Henry's most significant contribution is probably the synthesis of previous measures of rank correlation into one form. Let two samples of n values $x_1, \ldots, x_n$ and $y_1, \ldots, y_n$ be arranged in order. For every pair x_i and x_j define a score a_{ij} depending on which is the greater. Require that $a_{ji} = -a_{ij}$. Similarly define scores $b_{ij} = -b_{ji}$ for the y's. Then a general measure of rank correlation is defined by

$$\Gamma = \sum a_{ij} b_{ij} / \surd(\sum a_{ij}^2 \sum b_{ij}^2).$$

The two most widely used statistics, at that time and since, are probably Spearman's coefficient, which is essentially the ordinary correlation of the ranked values of the x's and y's, and Kendall's coefficient, essentially the proportion of concordant pairs. Both can be recovered as special cases of Γ. From this general representation Henry obtained a number of results. The null hypothesis of no relation between the ranks is equivalently that all permutations of say $y_1, \ldots, y_n$ are equally likely for fixed $x_1, \ldots, x_n$. Under this hypothesis the joint moments of two different coefficients can be obtained and hence the limiting form of the joint characteristic function can be established to show the asymptotic bivariate normality of the two statistics as $n \to \infty$.

Next it can be shown that the correlation between Kendall's and Spearman's coefficients is $2(n+1)/\surd[2n(2n+1)]$, as had been conjectured by Kendall, and so is close to one if n is appreciable. In subsequent papers the general relation between the coefficients is discussed. It was shown that, whereas broadly the coefficients give similar conclusions, there could be serious discrepancies, in particular when the individuals were divided into two groups with a strong positive correlation within groups and a negative correlation between groups.

In one of Henry's few joint papers, written with M.G. Kendall (5), the behaviour of Kendall's rank correlation, t_K, was studied in the non-null case when correlation is present in a hypothetical population of repetitions. The unbiased character of t_K follows essentially because it is a proportion. Its variance can be calculated from the scoring representation introduced in the earlier paper and has, for a ranking of size n, the form

$$k_n \operatorname{var}(\tau_{Ki}) + l_n(1 - \tau_K^2),$$

where $k_n = 4(n-2)[n(n-1)]$ and $l_n = 2/[n(n-1)]$. Here τ_K is the population value of t_K, and τ_{Ki} is the proportion of concordant pairs in which item i in one ranking is fixed. Reasons are given why the second term will often give a reasonably sharp upper bound, and this leads to simple statistical procedures based on arcsin t_K. Asymptotic normality is proved by the same route as is described above. These ideas are explored further in (6).

Asymptotic theory

A classical problem in probability theory with strong statistical implications concerns the sum S_n of n independent and identically distributed copies of a random variable X. In its simplest version, where X has finite variance σ^2, we may take without loss of generality $E(X)=0$ and consider the normalized sum $S_n^* = S_n/(\sigma\sqrt{n})$. If $M_Y(t) = E(\mathrm{e}^{Yt})$ denotes the moment-generating function, essentially the Laplace transform, of the distribution of any random variable Y, then

$$M_{S_n^*}(t) = [M_X(t/\sigma\sqrt{n})]^n$$

and formal passage to the limit shows that as n increases the limiting form is $\exp(\frac{1}{2}t^2)$, corresponding to the standard normal limit. To obtain higher terms in an asymptotic expansion the most direct route is to expand in further powers of $1/\sqrt{n}$ and then to invert, leading to an expansion in Hermite polynomials, the Edgeworth expansion. This gives good results in the centre of the distribution but very slow convergence in the tails. One way round this is the device of exponential tilting due to A.J. Khintchine. Henry, in one of his most influential papers (8), took the more direct route of applying a saddlepoint expansion to the contour integral version of the inversion of the Laplace transform. An extension of the argument applied to ratios of random variables.

Several subsequent papers took this idea further. It was applied to the distribution of the serial correlation coefficient (9) and to the distribution of an estimate defined implicitly as the solution of an estimating equation (16). In a very short discussion contribution (10) he established the connection with the likelihood ratio statistic; 20 or more years later this was the starting point for the working out by others of a major development of the higher-order distribution theory of statistics based on the likelihood function.

Robust statistics

Interest in the sensitivity of the methods introduced by Fisher to the assumption of normality of distribution started in the early 1930s, although the term robust was not introduced until much later. Henry wrote one of the early more theoretical discussions of this (2), concentrating, however, on the effects of non-constancy of variance and dependence between errors, rather than on distributional shape.

Miscellanea

Especially in the period between the end of World War II and 1970, Henry published on a wide range of issues in statistical theory. These rarely lacked an imaginative and original twist. There was an important paper (13) on spectral analysis of time series, a topic that had interested Henry since his war service. One remarkable paper examined with great care the asymptotic distribution of maximum likelihood estimates when standard regularity conditions concerning differentiability of the log likelihood function breakdown (12). Another (14), strongly motivated by the so-called spacing transformation arising in a statistical context, established a representation of a set of ordered positive real numbers in terms of a sequence of permutation matrices, convergence often being rapid. For this let $0 < x_1 < \ldots < x_n$ with $\sum x_i = 1$. Write

$$y_1 = nx_1, \quad y_2 = (n-1)(x_2 - x_1), \ldots, y_n = x_n - x_{n-1},$$

so that $\sum y_i = \sum x_i$. Now let P_1 be the permutation matrix needed to rearrange the y_i in increasing order. The transformation and permutation can now be repeated, defining a new permutation matrix P_2, and so on. Then the sequence $P_1, P_2, \ldots$ determines the original sequence of x_i in a sense that Henry carefully examined.

Contributions to applied probability

Strength of bundles

In one of his most important and striking papers Henry discussed the following problem, which he stated in a textile context but which here is described more generally (4).

Consider a system of n components, the breaking loads of which have a probability density, say $f(x)$. When a load S is applied there is perfect load sharing in that initially each component experiences a load S/n. If one of the components fails under this load, the remaining components now experience an increased load, namely $S/(n-1)$. This process continues until either all components have failed or the system survives with, say, r components surviving, each of the surviving components sharing the load equally. The breaking load of the system is the largest S for which failure does not occur.

Henry starts with a quite extensive discussion of the relation between the above simple representation and the behaviour in testing at a constant rate of extension, bearing in mind that different components can have different load–extension curves, not necessarily obeying Hooke's law. Then the behaviour for very large n is considered; then the distribution of individual breaking loads is given directly by $f(x)$. The proportion of components surviving an individual load x is $\mathcal{F}(x)$ and so the total load is then $S = nx\mathcal{F}(x)$ and the breaking load of the system occurs when $x = x_n$, where

$$d/dx_n[x_n\mathcal{F}(x_n)] = 0.$$

A geometric interpretation of this is given.

Then the case of small n is analysed. Then the order statistics, i.e. the ranked values, of the individual breaking loads are denoted in descending order by $x_1,\ldots,x_n$. The condition for equilibrium under load S with r survivors is $S \leqslant rx_r$ and therefore the breaking load of the system is $S_n = \max(rx_r)$. Again a simple geometric representation is given. The probability distribution of breaking load is then obtained by noting that the probability B_n that the system succumbs under load S is

$$n!\int_0^{b_n} dx_{n-1}\int_{x_{n-1}}^{b_{n-1}} dx_{n-2} \cdots \int_{x_2}^{b_2} dx_1 \int_{x_1}^{b_1} dx_0,$$

where $b_r = 1 - \mathcal{F}(S/r)$. Various properties of these functions are then explored. Thus B_n is represented as a special form of determinant and also various explicit series expansions for them are given. The explicit formulae are unrevealing and quite complicated, even for $n = 4$. This leads on to a major and characteristic part of the paper in which a quite intricate analysis is made of B_n for large n, leading eventually to the striking result that the asymptotic distribution of system breaking load is normal with mean determined by the simple argument above and with a variance $nx_n^2\mathcal{F}(x_n)[1-\mathcal{F}(x_n)]$. The only regularity condition required is that $\mathcal{F}(x)$ tends to zero more rapidly than $1/x_n$.

Some 30 years after the publication of the paper its importance was recognized for the statistical theory of the strength of fibre composites. The paper was entitled part I. I know that over many years Henry did substantial work on part II and that interesting connections were established with other probabilistic problems. This work was not published, except perhaps in small part in (17), and, rather puzzlingly, was not among his papers left on his death. I recall also many notebooks of work on textile physics that disappeared.

Green's functions and stochastic processes

A powerful example of Henry's imaginative deployment of asymptotic analysis is provided by his study (11) of diffusion-like approximations to Markov stochastic processes initially formulated in terms of differential or differential-difference equations whose solution in explicit form is not available. When the changes in the state space are relatively local, a diffusion approximation is available based essentially on a specification of how the mean jump in a small time depends on position in state space. This yields useful approximations that are, however, often rather crude, especially in the tails of the distribution. The paper proceeds via a highly informal analysis of some special cases before reaching a rather general formulation. This involves what physicists call the WKB method although, as Henry noted, Harold and Bertha Jeffreys traced the method back at least to A.G. Green FRS. In its simplest form the method hinges on expanding the probability $p(x,t)$ of state value x at time t not via a Taylor series in x for $p(x,t)$ itself but rather in one for $\log p(x,t)$. This leads to a first-order nonlinear partial differential equation whose solution typically has constant relative error and is closely related to a saddlepoint expansion applied to the moment-generating function in those cases in which the moment-generating function can be found in sufficiently explicit form.

Later work

As noted above, although Henry's scientific and statistical interests remained wide his research in later years concentrated largely on problems in stochastic processes, usually motivated either by problems in physics or via the probabilistic theory of epidemics. Many of the issues reduced to some form of the so-called curved boundary problem. In the simplest version of this a random walk continues until a boundary or barrier is hit, and the distribution of first passage time to the barrier is studied. If the barrier is linear and the mean path of the random walk intersects the barrier, the distribution of first passage time has a simple form, the inverse Gaussian distribution. If the barrier is gently curved near the point of intersection, the inverse Gaussian provides an approximation, the so-called tangent approximation, the direction of the error being determined by the local convexity or concavity of the barrier. There are many variants; the task is essentially to improve on that idea.

Two of his last papers (18, 19) dealt with this. The latter, published posthumously, used a perturbation expansion of the barrier taken with a corresponding expansion of the probability density of first passage time. Comparison of terms in the expansion led to a series of equations for the Laplace transforms of the required functions. These were used particularly for a numerical check on the results of the previous paper, with excellent results. The earlier paper noted that for a linear barrier the diffusion equation and its associated boundary condition were probably best solved by the method of images, requiring a single 'negative' image point. By adding a second such image the boundary condition could be satisfied approximately, or in some cases exactly, for curved barriers. More generally a continuous line of images could be introduced and the integral equation specifying them could be discretized for numerical work. In the latter paper, Henry remarked that the results in the former paper meant that 'for most practical purposes' the problem was now solved.

Early work on the theory of epidemics was deterministic, based essentially on mass-action-like nonlinear differential equations expressing the rate of increase in new infected individuals as a function of the number of susceptible individuals and the number of infectious individuals. In some contexts stochastic effects are crucial and then the Chapman–Kolmogorov equations of the corresponding Markov process are studied. Henry examined simple questions about such processes that were difficult of resolution. For example, one of his first papers on this theme examined the distribution of the total size of an epidemic (15) in the model formulated by M.S. Bartlett FRS. Henry represented this distribution in terms of a very special kind of random walk on a lattice, and by a characteristic sleight of hand expressed the required probability distribution in terms of the quantities B_n defined above in connection with the strengths of bundles of fibres.

Some personal aspects

Henry was a man of wide interests and incisive wit. Some faint flavour of his conversation can be obtained from an interview reported some years ago (Whittle 1996). This flavour is hard to capture. I recall his remark some years ago: 'What an excellent student X is: in his examination he reproduced my lecture notes word for word including the mistakes'. Giving a talk about his work shortly before his death, he remarked that the results could be applied to mathematical finance, a topic he disliked: 'soft pornography for the benefit of pure mathematicians', as he put it.

He showed by analysis of the dynamics of a bicycle that a firm away press on the left handlebar would steer the bicycle left. Attempts to verify the conclusions experimentally by graduate students and colleagues—though not by Henry himself—were inconclusive; it is reported that injuries were relatively minor. Henry did, however, claim that the principle had before the war saved him from a nasty bicycle accident in Devon or Cornwall.

Henry was deeply interested in music. He was a fine pianist but in later years concentrated on the English concertina, an instrument designed by the physicist Wheatstone to be capable of playing various parts in the chamber music repertoire. Henry claimed to be the only person in the country able to tune the instruments, this requiring careful filing of the metal 'reeds'. In connection with his skills as an experimental physicist, Henry was in demand among his friends as a watch-repairer. It was claimed at one point that the size of his department was settled by the number of watches he could reasonably maintain at a time. He helped the watchmaker George Daniels, not a relative, to design a watch showing sidereal as well as solar time with an accuracy of half second a year. For this he was elected Freeman and then Liveryman of the Worshipful Company of Clockmakers, something he greatly prized.

Valerie Farrow (now Mrs V. Glass) in the WIRA days was a research assistant in the fibre measurement laboratory and had in particular the formidable duty of dusting Henry's desk without disturbing any of the large apparently random piles of paper on it. She recalls his humour, much appreciated by the other research assistants, and especially great personal kindness to her when major problems arose.

Henry's lecturing style, in teaching and in giving research talks, was deceptively laid-back. In describing his own work, a problem would be stated, often a problem simple to state and seemingly almost impossible of resolution. Some mathematical manoeuvres would follow, presented in a relatively offhand way, and suddenly a simple and elegant result would emerge. It was only when one tried and totally failed to do something similar oneself that Henry's formidable technical mastery and originality became clear. The notes on his work sketched above give but a pale shadow of that originality. His style in teaching was not dissimilar: apparent ease based on total mastery and quite often hidden novelty of presentation and content. Particularly in his early years at Cambridge the lectures would unobtrusively contain important new material, such as the notion of asymptotic sufficiency, never published by Henry.

He married Barbara Pickering in 1950; there are two children, Peter and Sheila.

Henry continued to the end of his life travelling to conferences, often accompanied by Barbara. He was a highly respected and personally extremely popular member of the international research world in his field, regarded with admiration and affection alike for his dedication to research, for the power and elegance of his contributions and for his personal characteristics.

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The frontispiece photograph is reproduced by courtesy of King's College, Cambridge.

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