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The historian as unifier of probability's diversity

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THE HISTORIAN AS UNIFIER OF PROBABILITY'S DIVERSITY

Glenn SHAFER¹

RÉSUMÉ – L'historien comme fédérateur des divers usages en probabilité
Marc Barbut eut cette rare capacité de relier les nombreuses communautés qui étudient et utilisent les probabilités. La vocation de l'historien des probabilités requiert une constante ouverture et générosité d'esprit.

MOTS-CLÉS – Marc Barbut, Économie, Physique, Principe de Cournot, Probabilité de la diversité

SUMMARY – *Marc Barbut had the rare ability to bridge the many communities that study and use probability. The vocation of the historian of probability requires the endurance of the breadth and generosity of his spirit.*

KEYWORDS – Cournot's principle, Diversity of probability, Economics, Marc Barbut, Physics

The three decades since the founding of the Paris seminar on the history of probability and statistics in 1982 were three decades of leadership by Marc Barbut. Ernest Coumet conceived of the seminar and has been honored as the force behind its marriage of social history and the history of ideas. Bernard Bru led the seminar's revival of the study of the French school of probability. But it was Marc Barbut who held together its diverse participants and their often conflicting agendas, and it was Marc Barbut who communicated this spirit of breadth and universality to this journal and its editorial board.

My personal interactions with Barbut were marked by some small but telling examples of his breadth of spirit and sense of balance. One example was the balance between the natural and social sciences in his view of the history of probability. His own work was in the social sciences, but when he discussed the revival of the mathematics of probability in the early twentieth century, he was insistent on the role of physics and especially statistical mechanics. This he had learned as a student, from lectures by Paul Lévy at the Institut Henri Poincaré. Barbut's father had also attended lectures by Lévy, at the Ecole Polytechnique in 1919, and had preserved the lithographed notes from those lectures. Barbut and Mazliak reproduced them in the June 2008 issue of the *Electronic Journal*. Of the 29 hand-written pages, 11 were devoted to the kinetic theory of gases. Equally remarkable was Barbut's contention that values of expectations are more fundamental than probabilities of events. The opposition between value and probability goes back to Pascal's and Fermat's contrasting methods of solving the problem of points. For Pascal, the problem was game-theoretic: from the known prices of certain gambles, derive prices for other gambles. For Fermat, the problem was combinatorial: we count the chances. Though Barbut made a place for

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combinatorics in his own work, he saw Pascal's approach as more natural and intuitive. When he published his thoughts on this topic [Barbut, 2000], he insisted that he was making only a pedagogical point: the buying and selling of lottery tickets and insurance are more concrete and familiar for a beginner than probability and measure, and when we price gambles we are doing linear algebra, a chapter of mathematics more familiar than combinatorics. But I believe that Barbut's preference was more than pedagogical, and that it derived more from a classical French appreciation of mixed mathematics than from a Bourbakian preference for the algebraic. At its origin, Pascal's approach was mathematically less pure than Fermat's [Godfroy-Génin, 2000], and it is this very impurity that still gives soul and stature to probability, statistics, and their history.

With his characteristic generosity, Barbut raised these points with me as a way of supporting the game-theoretic foundation for probability that I developed with Vladimir Vovk [Shafer, Vovk, 2001]. This foundation extends Pascal's picture just as the measure-theoretic foundation extends Fermat's. Its practical application outside games of chance requires a principle analogous to the principle that Borel, Hadamard, and Lévy found to be fundamental to understanding statistical mechanics – the principle that an event with exceedingly small probability that we single out in advance will not happen. Bernoulli had enunciated this principle centuries earlier, with his concept of moral certainty, and Cournot had recognized it as the only way of giving probability a phenomenological meaning, Boltzmann had appealed to it explicitly, and as Barbut pointed out, Lévy did not neglect to underline it in his 1919 lectures. The game-theoretic version of the principle says that a gambling strategy that we specify in advance, so that it can be implemented, will not multiply the capital it risks by an exceedingly large factor.

As we commemorate Barbut's passing, we can celebrate that the breadth and generosity of his spirit endure in the Paris seminar and in this *Electronic Journal*. This is of no small importance, because probability and statistics continues to diversify, and only a broad-minded history can weave its many threads into a whole cloth. Since World War II, the entire enterprise of scientific research has diversified, so that intellectual progress relies more and more on relatively small and specialized communities built around journals or annual workshops. Often these increasingly numerous communities have a few hundred members or fewer, but they quickly develop their own traditions, vocabularies and certainties, and often their own ways, new or not so new, of using and thinking about probability. One of the vocations of the historian, I believe, is to help bring such communities together, to help them learn from one another and from the past. Innovations in one community can be less foreign and more digestible in another if the problems they address can be put in a shared historical context, and mutually beneficial traffic across communities can take place when historical memory pierces some of the walls that each community creates in order to channel its own progress.

Here is one broad question for historical research in probability that could have community-bridging significance. To what extent have those who studied and used probability, in different times and fields, believed that all events have probabilities, or that only some events have probabilities? And how and why has thinking about this question changed?

Consider economics. From the early twentieth century to the early twenty-first century, there was a remarkable change in economists' attitudes about the existence of meaningful probabilities. In the 1930s, it was a commonplace, at least in English-language writing on economics, that not all events have probabilities. John Maynard Keynes, Irving Fisher, and Frank Knight all said as much, each in their own way, and mathematicians such as Andrei Kolmogorov concurred. But today it is uncontroversial in economics to posit the existence of "true" probability distributions. Finance theorists, for example, do not hesitate to assume that there are true probability distributions for future prices, and this assumption is not shaken when predictions go badly wrong. The iconoclast Nassim Taleb, in his celebrated *Black Swan*, garnered great attention with the thesis that markets and financiers badly underestimate the probabilities of improbable events, but even he dared not suggest that some relevant events do not have probabilities at all.

There is little historical work providing context or explanation for this remarkable shift in economists' attitudes, though Perry Mehrling [2010] has touched on the issue. Similar shifts seem to have taken place in many fields other than economics. Even statistical mechanics could be cited as an example, in a very elementary way. Boltzmann's probabilistic explanation of the second law of thermodynamics concerns what happens when a physical system starts in a highly ordered

state, from which probabilities for evolution are well defined and well justified. The continued philosophical dissatisfaction with Boltzmann's picture seems to involve a demand that one also explain the highly ordered state by means of probabilities [Goldstein, 2001]. Today, it seems, a probabilistic theory is deemed unsatisfactory unless it provides probabilities for everything in sight. Was this taken equally for granted a hundred years ago?

The increasing abandon with which many scientists accede to the existence of "true" probabilities (even as some insist that all probabilities are subjective) is surely related to a question that I have repeatedly asked (in [Shafer, 2007], for example) but never answered: why did Cournot's principle disappear? How did a principle that made sense to the most sophisticated mathematicians in the early twentieth century come to be so widely dismissed as ridiculous? The theory of algorithmic complexity has given us ways to make precise the intuition that only a few events of small probability are simple enough to formulate and use as tests of a probabilistic theory [Bienvenu *et al.*, 2009], yet it is now widely taken as common sense that Cournot's principle is silly because anything that happens has small probability.

Many believe that the success of probabilistic prediction in quantum mechanics was a decisive influence – that the success of a theory that puts probabilities at the foundation of physics persuaded scientists that Huygens' ease of happening or Bernoulli's equal possibility were so fundamental to reality that probabilities must be everywhere, and that questions about knowing these probabilities and predicting from them are somehow secondary and immaterial to the structure of reality. Yes, we may worry about the role of the observer, and we may admit that we can confirm probabilities only by confirming what they predict with overwhelming probability, but all this becomes less important than our conviction that probabilities are real.

There are evidently large philosophical shifts at work here. The picture can hardly be fully understood however, by surveying changes in how one group, be it physicists or be it philosophers, think about probability. Philosophers of probability, like physicists and like others, have become one more specialized group that develops and uses probability with its own vocabulary, preoccupied more with questions it has generated internally than with problems in other disciplines. A full understanding requires broad study across many scientific disciplines. This is work for historians.

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