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Comment: Recollections about Harold Hotelling

W. Edwards Deming

It was in 1936, I believe, when at a meeting of the American Statistical Association in Atlantic City, Harold Hotelling told some of us that a woman in the Mathematics Department at the University of Toronto had written to him for advice. The head of the department had decided that there should be in their curriculum a course on statistics or possibly it was statistical theory. He had delegated the job to her.

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None of the others wished to teach it. She was a woman, and new in the department, so she was elected to teach the course. She wrote to Professor Hotelling with the question, "What should I teach?" His reply to her was merely, in his kind way, "Teach what you know."

This principle pervaded all his work. He tried to stay within his limitations, although I would remark that his limitations were well beyond the horizon. He took the point of view that statistical theory should be taught by someone that knows statistical theory. If one studies bacteriology, he studies it with someone that knows bacteriology. He had profound faith and respect for people that know statistical theory. In my own book, *Out of the Crisis* (1986), the following quotation is at the head of the chapter on page 465.

He wrote this memorandum to the Government of India on a visit to India at the invitation of Professor P. C. Mahalanobis:

"Research in statistical theory and technique is necessarily mathematical, scholarly, and abstract in character, requiring some degree of leisure and detachment, and access to a good mathematical and statistical library. The importance of continuing such research is very great, although it is not always obvious to those whose interest is entirely in practical applications of already existing theory. Excepting in the presence of active research in a pure science, the applications of the science tend to drop into a deadly rut of unthinking routine, incapable of progress beyond a limited range predetermined by the accomplishments of pure science, and are in constant danger of falling into the hands of people who do not really understand the tools that they are working with and who are out of touch with those that do.... It is in fact rather absurd, though quite in line with the precedents of earlier centuries, that scientific men of the highest talents can live only by doing work that could be done by others of lesser special ability, while the real worth of their most important work receives no official recognition.— Harold Hotelling, Memorandum to the Government of India, 24 February 1940."

An analytic study is one in which the problem is to make changes in a process or in a practice, with the aim to improve quality or yield in the future, next week or in next year's crop. Inference from an experiment is an example.

An enumerative study, in contrast, is to estimate what the result might be of the equal complete coverage of a frame. The 10-yr census is an example. The present worth of accounts receivable is another. The dollar value of a shipload of iron ore is another.

Statistical theory, as used in an enumerative study, does not help us in an analytic study. The theory of estimation and statistical tests of significance as commonly taught and used—e.g., the t test, z test, χ^2, goodness of fit—do not provide measures of degree of belief in a prediction. Tomorrow's run, or next year's crop, will be governed by conditions different from those that governed the data from a study of the past. Confidence limits are useful in enumerative problems, not in analytic problems.

Harold Hotelling was often critical of use of the wrong distribution for calculation of a probability in an analytic problem. Now, after many years, one might rightly question whether any distribution whatever should be used for an analytic problem. It may be that Hotelling, along with others, used the theory for enumerative studies to make calculations of probability in an analytic problem.

One must remember that in an analytic problem, there is no frame; hence, no complete coverage. There is no sample, no distribution of samples. There is no operational definition of a confidence interval. A test of significance has no meaning, is no aid to prediction, hence conveys no knowledge.

Harold Hotelling was a very kind man, always ready to help anyone. He helped other people to finish their books, but never took time to finish his own.

Comment

Shanti S. Gupta

I would like to express my appreciation to Professor Morris DeGroot for inviting me to comment on the two papers of Professor Harold Hotelling. During my 3 years (1953–1956) as a graduate student at the University of North Carolina at Chapel Hill, I took several courses from Professor Hotelling and attended several of the famous Sunday tea parties given by him and Mrs. Susanna Hotelling in their lovely home on

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the first Sunday of each month (the atmosphere at these gatherings at Hotellings' T's used to be, indeed, quite stimulating and, of course, very very sociable).

INTRODUCTION

It is close to half a century since the first of these two papers by Hotelling was published. The second paper, published nearly a decade after publication of the first, re-examines the issues raised in the first and amplifies on the organizational and teaching personnel issues. For one who reads (or rereads) these papers, the striking fact is the thoroughness with which