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## Comment

George Box

Reading this stimulating paper, I was particularly intrigued by the section on Theory, Application and Education. As Harry Roberts points out, experience with the modern quality movement highlights many important issues. It underlines the necessity for a much wider definition for theoretical statistics. It makes explicit the necessarily iterative nature of investigation as exemplified by the Shewhart Cycle, by the goal of *never-ending* improvement and by the complementary roles of Tukey's exploratory and confirmatory data analysis. It demonstrates how simple graphical techniques, such as Ishikawa's Seven Tools, although ludicrously simple mathematically, can be enormously powerful scientifically because they are devoted to the inductive step of hypothesis *generation* that mathematical statistics so often ignores.

Most subjects have a theoretical as well as an applied side, and ideally each nourishes the other; but

for statistics I believe this has not always been true. In my view, statistics has no reason for existence except as the catalyst for investigation and discovery. If this is true then, above all else, the proper study of the statistician is scientific method and therefore statistics should serve the needs of that study. An understanding of the process of investigation involves such things as the roles of induction as well as deduction, the nature of scientific learning, the importance of subject matter knowledge, the psychology of investigators and the management of data acquisition and experiment. The *theory* of statistics should be concerned with all these things.

Unfortunately, its domination by mathematics has led to the teaching and propagation of ideas that I believe are in some cases actually antithetical to good statistical practice. Consider the process of investigation itself as exemplified, for example, by any good detective novel, by any reasonably honest account of scientific research (such as Watson's account of the discovery of the double helix) or by the process of finding out why a manufacturing system is producing low quality product. This process of investigation employs induction and deduction in an iterative

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