

Personal report

The major contribution of Professor George E.P. Box to applied statistics

Daniel Peña*

Departamento de Estadística y Econometría, Universidad Carlos III de Madrid, Madrid 126, Getafe 28903, Spain

Professor George Box was born in England in 1919. His education includes a PhD in Statistics and a DSc both from London University. He started his professional life working as statistician for 8 years in the large chemical company I.C.I. in England. Then he accepted an invitation to work as visiting professor at the University of North Carolina. From there he moved to Princeton, as Director of the Statistics Research group, and then he accepted the offer to move to Madison, WI, in 1960, to create a Department of Statistics. In a few years and under his leadership, the Department of Statistics of the University of Wisconsin was considered among the three best departments of statistics in the world. In 1986, he created the Center for Quality and Productivity Improvement that has had a pioneering role in the Quality Movement in the USA and elsewhere.

Professor Box has published nine books and more than 200 research papers. The importance of his contribution to Science has been recognized by receiving the most important awards, such as the Gold Medal of the Royal Statistical Society, the Shewart medal from the American Society for Quality Control, the Wilks memorial medal, the Youden Price, the Deming Medal, the British Empire Medal, and the Byron Bird Award for Excellence in Engineering Research. He has been elected Fellow of the Royal Society and got Honorary Doctor's degrees from the University of Rochester and Carnegie Mellon Univer-

sity. His outstanding ability to communicate as a teacher has been recognized by The Smith Reynolds Teaching Award from the University of Wisconsin, where he was appointed Vilas Research Professor in 1980.

The importance of the scientific contribution made by Professor Box is supported not only by his role on the philosophy, the theory and the practice of Statistics but also by the major impact these latter one have had in Engineering, Chemistry, Economics and Environmental Science, among other sciences. As an example, the methods he developed between 1962 and 1972 with G. Jenkins, for analyzing and forecasting *time series*, what was called *the Box–Jenkins approach*, are now learnt by all students of economics and engineering as part of their standard curriculum. These methods are taught at the PhD levels for students of Psychology, History, Sociology, Chemistry and Biology. Very few scientific developments of the last 25 years have had such a big impact over the scientific community.

The four points given below underline some of his main contributions:

(1) His first important contribution was *Evolutionary Operation*. He invented a very original and powerful procedure to improve continuously the working conditions of an industrial plant. This procedure was completely revolutionary and has had a great impact especially in the chemical industry.

(2) The second important line of research deals with *the methodology and philosophy of statistical models and statistical research* in the deepest sense. He invented and developed the idea of robustness,

* Tel.: +34-91-624-98-06; fax: +34-91-624-98-49.
E-mail address: dpena@est-econ.uc3m.es (D. Peña).

created the now standard procedures for transforming variables, extended the scope of *Bayesian Statistics*, developed new tools for model diagnosis and had a key role in the integration of the classical and Bayesian schools of thought in Statistical Inference.

(3) The third key contribution is *time series analysis and forecasting*. To give an idea of his influence in economics, today all major central banks and Statistical agencies are analyzing economic data and forecasting them by using the methods he developed with G. Jenkins and G.C. Tiao, among others.

(4) Finally, the fourth major contribution deals with the *Quality Control*. Professor Box has had a key role in showing the importance of sound statistical thinking in improving quality and productivity, and he has developed many statistical tools and procedures to improve quality and productivity in industry. His leadership in this area comes from the combination of theory and practice. As he said, “the way to improve a field is to do applications in this field”! He has combined research papers in the reference journals of the field with practical work as consultant in various companies (Ford, Hewlett Packard, Boeing Aircraft, . . .).

Let me finish by a personal experience. One of the most rewarding learning experiences in my life was to attend the Beer and Statistics Seminar that George Box run in the basement of his home in Madison, WI. Each week after dinner, at 8:00 p.m., a scientist was invited to present a problem he has found in his research that may require, for his solution, the analysis of data. The speaker could be a physicist talking about the big bang, a biologist with a microbiological problem, an economist trying to measure the hidden economy, or an engineer with a production problem.

In the open and exiting discussion that follows the presentation of the talk, I felt that science is a unique adventure that we approach from different corners but sharing a common method and a common perspective for the search of truth, for the understanding of the world and for ourselves. I also could feel that learning is fun and understanding can be one of the greatest pleasures than we can draw from life.

Only for this I will be always grateful to George Box. Science is a never ending activity and the great scientist must try to open new paths and lead the way to new generations. The important contributions made by many of George Box’s students and his leadership

in the statistical profession are the proof of the success that he has achieved in this crucial task.

(adapted from a text delivered by Professor Daniel Peña—J.R.C.)

Some references:

Up to now Prof. G. Box has published more than 200 papers. He has been the author or co-author of the following nine books devoted to different areas of applied statistics:

1. *Statistical Methods in Research and Production*, Oliver and Boyd, 1954 (with W.R. Cousins, O.L. Davies, F.R. Himsworth, H. Kenney, W. Spendley, W.L. Stevens).
2. *Design and Analysis of Industrial Experiments*, Oliver and Boyd, 1963 (with L.R. Connor, W.R. Cousins, O.L. Davies, F.R. Himsworth, and G.P. Sillitto).
3. *Evolutionary Operation—A statistical method for process improvement*, Wiley, 1969 (with N.R. Draper).
4. *Time Series Analysis Forecasting and Control*, Holden-Day, 1970 (with G.M. Jenkins), 2nd edn. (G.M. Jenkins and G.C. Reinsel), Prentice-Hall, 3rd edn.
5. *Bayesian Inference in Statistical Analysis*, Addison Wesley Publishing, 1973 (with G.C. Tiao).
6. *Statistics for Experimenters*, Wiley, 1977 (with W.G. Hunter and J.S. Hunter).
7. *The Collected Works of George E.P. Box*, Wadsworth, 1985. Two volumes, edited by G.C. Tiao.
8. *Empirical Model—Building and Response Surfaces*, Wiley, 1987 (with N.R. Draper).
9. *Statistical Control by Monitoring and Feedback Adjustment*, Wiley, 1997 (with A. Luceño).

Outside references devoted to GEP Box, a book and two interviews:

- (a) *Box on Quality and Discovery*, edited by G.C. Tiao, S. Bisgaard, W.J. Hill, D. Peña, S.M. Stigler, Wiley, 2000.
- (b) DeGroot, M.H. (1987). A conversation with George Box. *Statistical Science*, 2, 239–258.
- (c) Peña, D. (2001). George Box: An Interview. *International Journal of Forecasting*, 17, 1–9.