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Personal report

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

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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 eight books and more than 175 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 University. 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, created the now standard procedures for transforming variables, extended the scope of *Bayesian Statistics*, developed new tools for model diagnosis and had a

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74 key role in the integration of the classical and Baye-
75 sian schools of thought in Statistical Inference.

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

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

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

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

113 Only for this I will be always grateful to George
114 Box. Science is a never ending activity and the great
115 scientist must try to open new paths and lead the way
116 to new generations. The important contributions made
117 by many of George Box’s students and his leadership
118 in the statistical profession are the proof of the success
119 that he has achieved in this crucial task.

120 (adapted from a text delivered by Professor Daniel
121 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:

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| 1. Statistical Methods in Research and Production, Oliver and Boyd, 1954 (with W.R. Cousins, O.L. Davies, F.R. Himsforth, H. Kenney, W. Spendley, W.L. Stevens). | 127 |
| 2. Design and Analysis of Industrial Experiments, Oliver and Boyd, 1963 (with L.R. Connor, W.R. Cousins, O.L. Davies, F.R. Himsforth, and G.P. Sillitto). | 128 |
| 3. Evolutionary Operation—A statistical method for process improvement, Wiley, 1969 (with N.R. Draper). | 129 |
| 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. | 130 |
| 5. Bayesian Inference in Statistical Analysis, Addison Wesley Publishing, 1973 (with G.C. Tiao). | 131 |
| 6. Statistics for Experimenters, Wiley, 1977 (with W.G. Hunter and J.S. Hunter). | 132 |
| 7. The Collected Works of George E.P. Box, Wadsworth, 1985. Two volumes, edited by G.C. Tiao. | 133 |
| 8. Empirical Model—Building and Response Surfaces, Wiley, 1987 (with N.R. Draper). | 134 |
| 9. Statistical Control by Monitoring and Feedback Adjustment, Wiley, 1997 (with A. Luceño). | 135 |

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

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| (a) Box on Quality and Discovery, edited by G.C. Tiao, S. Bisgaard, W.J. Hill, D. Pena, S.M. Stigler, Wiley, 2000. | 155 |
| (b) DeGroot, M.H. (1987). A conversation with George Box. <i>Statistical Science</i> , 2, 239–258. | 156 |
| (c) Peña, D. (2001). George Box: An Interview. <i>International Journal of Forecasting</i> , 17, 1–9. | 157 |