

Design of Experiments and Golf

Ron S. Kenett

KPA Ltd.

Ron Kenett - a brief CV

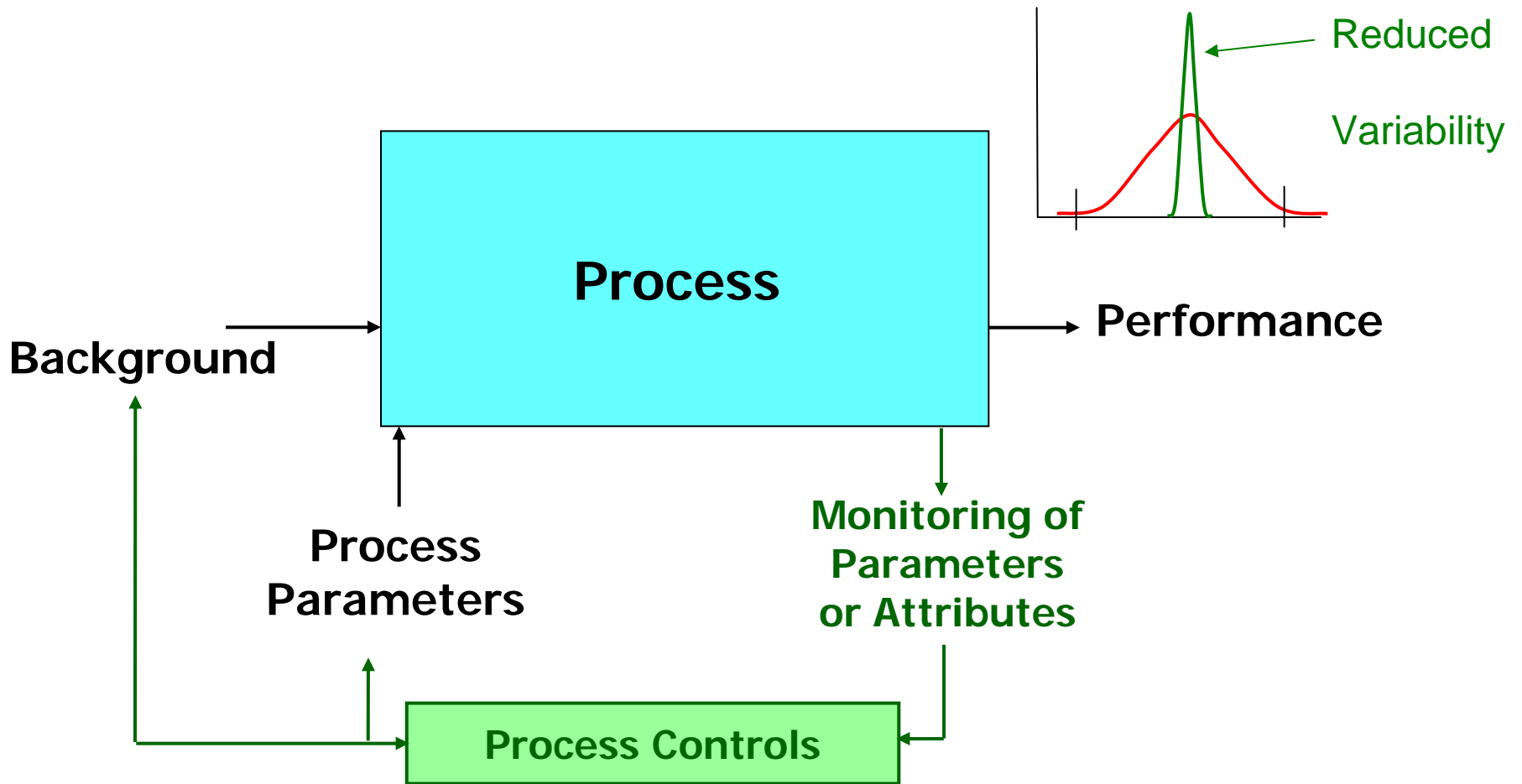
Chairman and CEO of the [KPA Group](#), Research Professor, [University of Torino](#), Turin, Italy, International Professor Associate, Center for Risk Engineering, [NYU-Poly](#), NY, USA and Visiting Professor at the [Faculty of Economics](#), University of Ljubljana, Ljubljana, Slovenia. Ron is Editor in Chief of the Wiley Encyclopedia of [Statistics in Quality and Reliability](#), Member of the Advisory Editorial Board of [QTQM](#) and Associate Editor of Applied Stochastic Models in Business and Industry. He is Chairman of the Board of Takeoff, an organization whose mission is to help start-up companies develop business and marketing plans and establish strategic partnerships and a Member of the Board of Directors of [Optimata](#) and the publicly traded biotech company [D-Pharm](#).

Professor of Management at the State University of New York (1987-1992), where he was awarded the General Electric Quality Management Fellowship. Director of Statistical Methods for Tadiran Telecommunications Corporation (1981-1990) and Member of the Technical Staff at Bell Laboratories in New Jersey (1979-1981).

Ph.D. in Mathematics (1978) from the Weizmann Institute of Science, Rehovot.

B.Sc. in Mathematics (1974) from Imperial College of Science and Technology, with first class honors, London University, London, UK.

Sources of Variability



Interactions

Male



Female

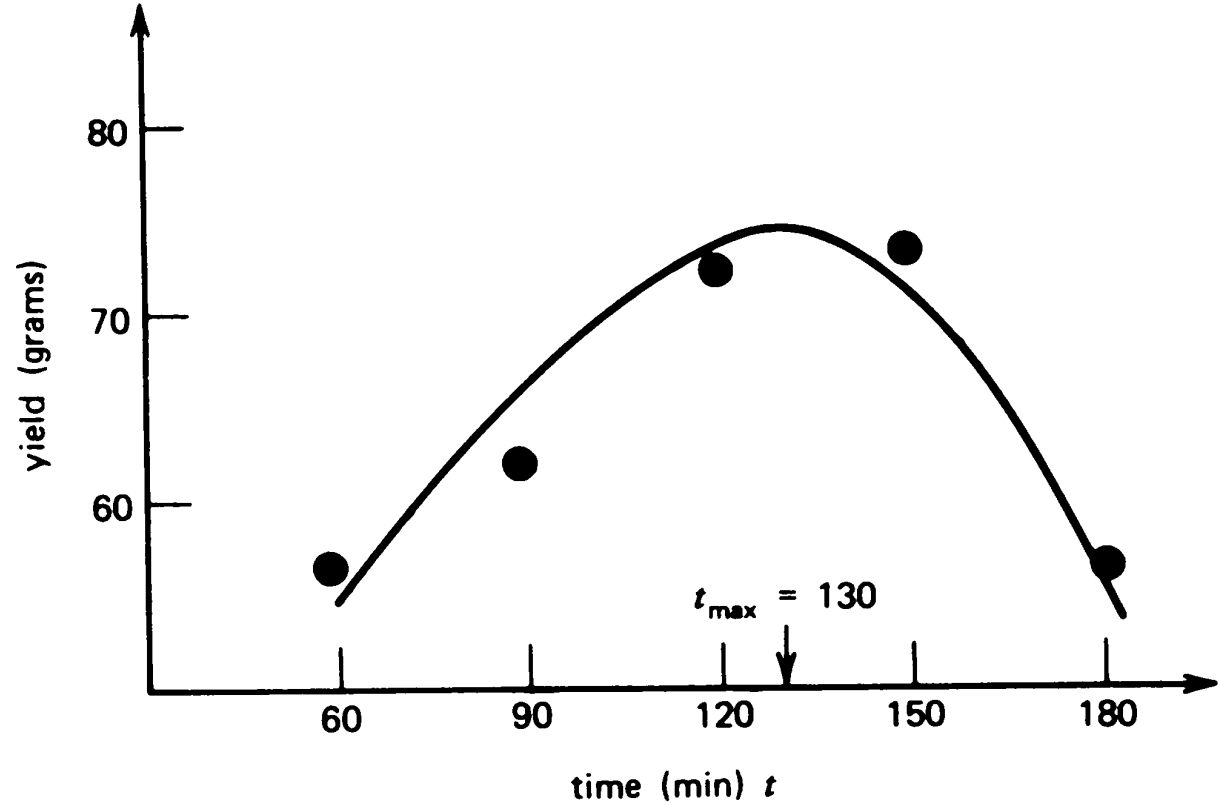
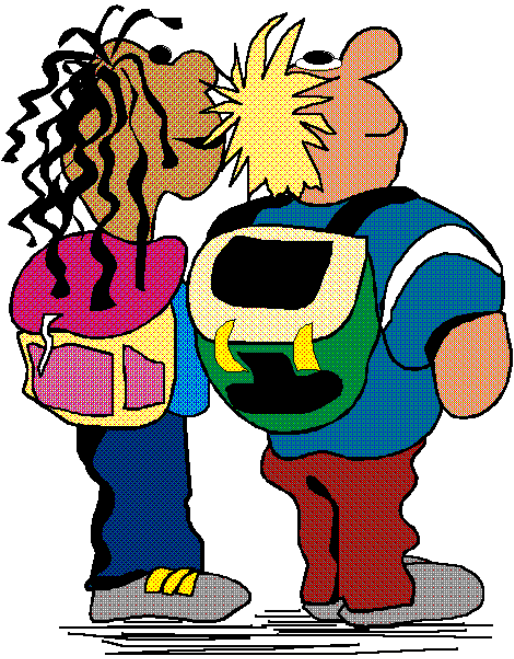


Interactions



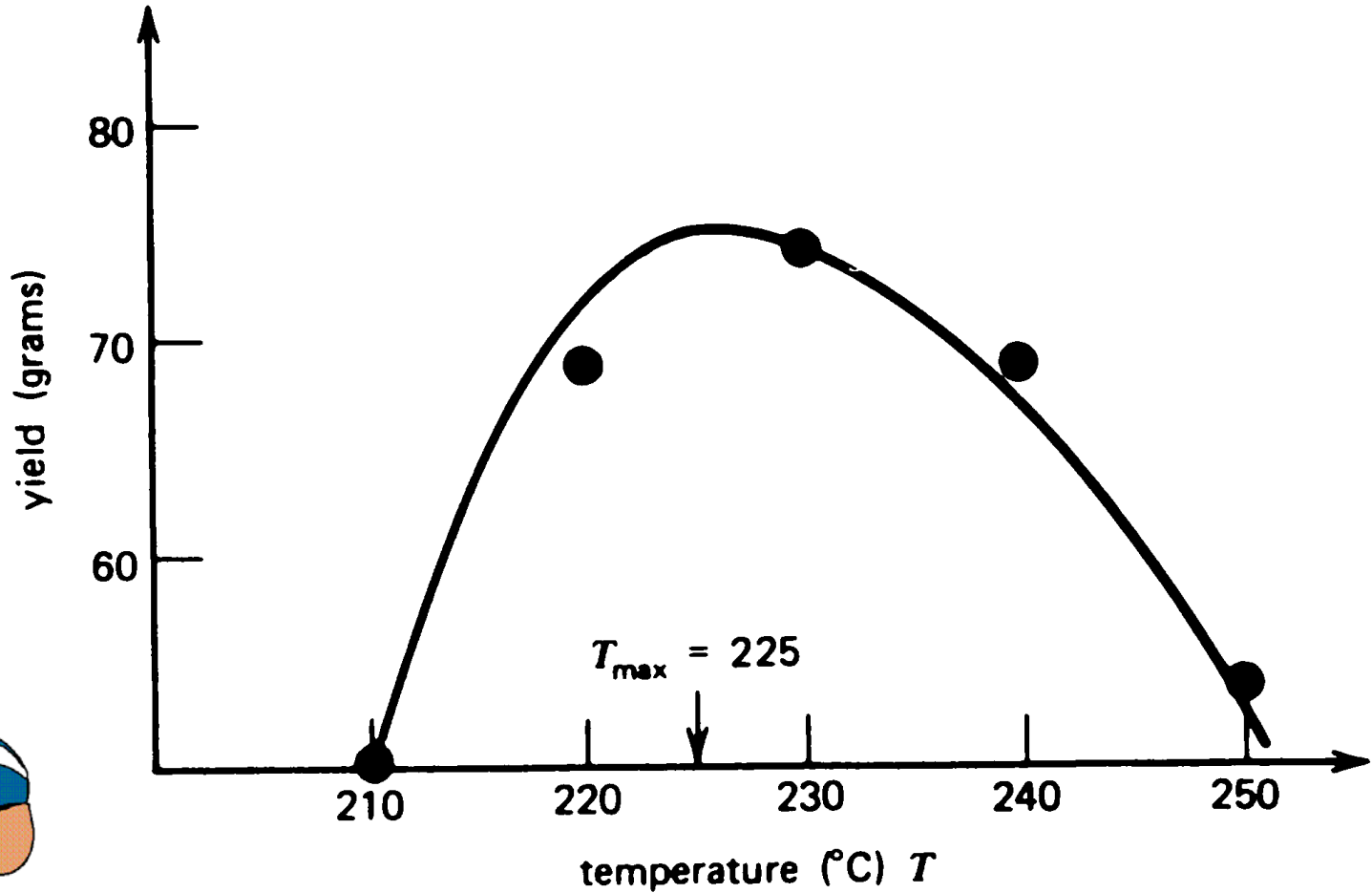
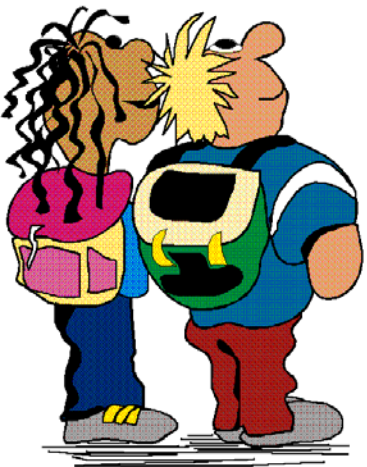
Interaction

OFAT: One Factor at a Time

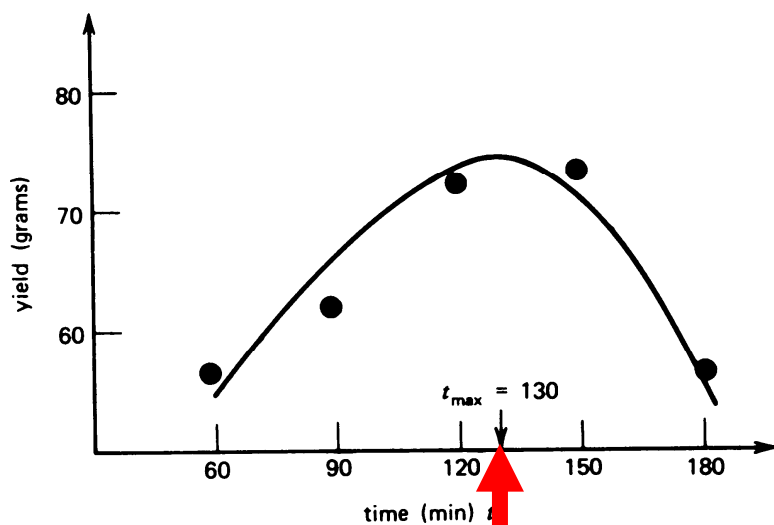


One Factor at a Time

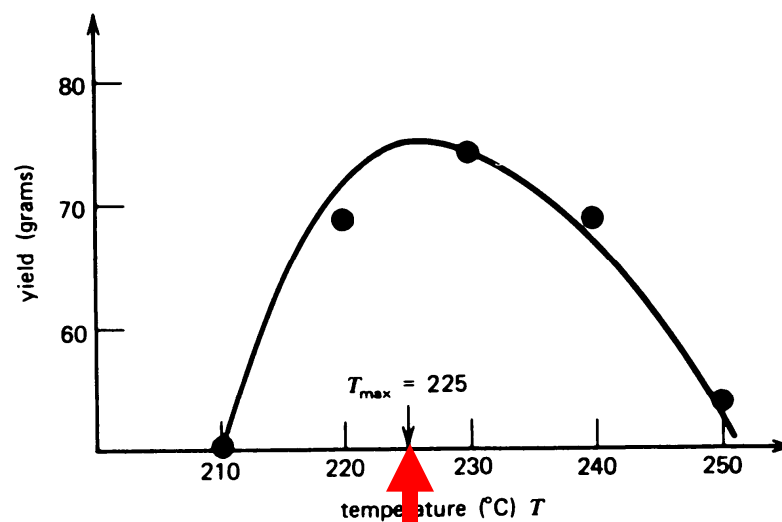
OFAT



One Factor at a Time

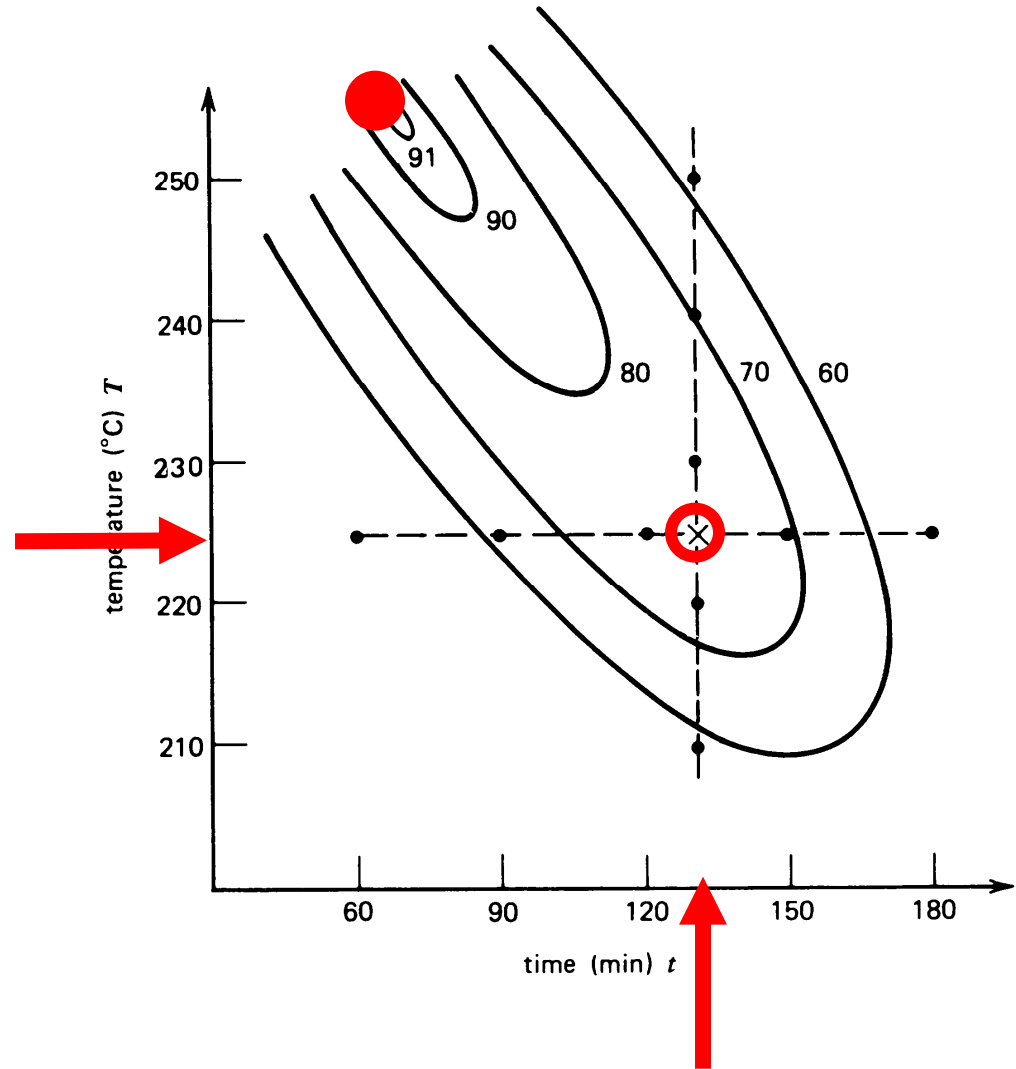


Experiment #1: Study Effects of Reaction Time on Yield
(Reaction Temperature held fixed at 225° C)



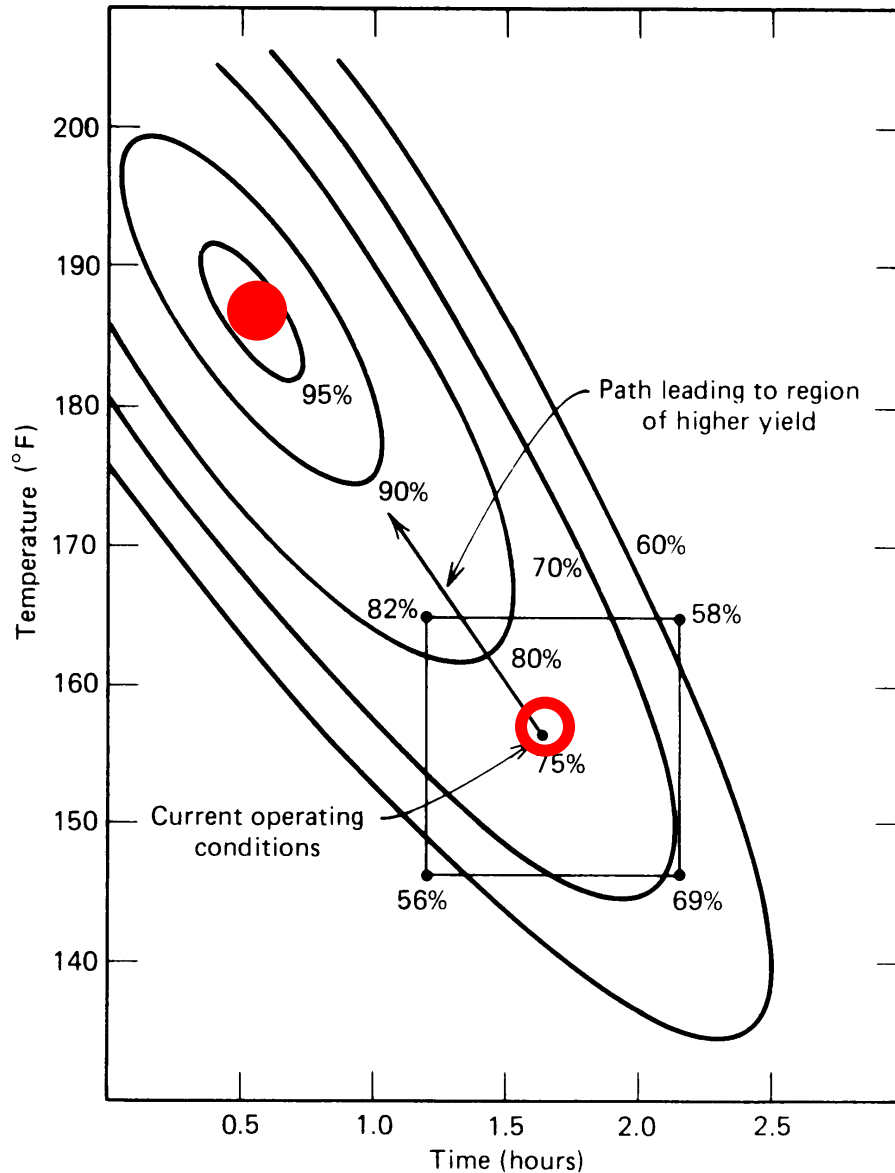
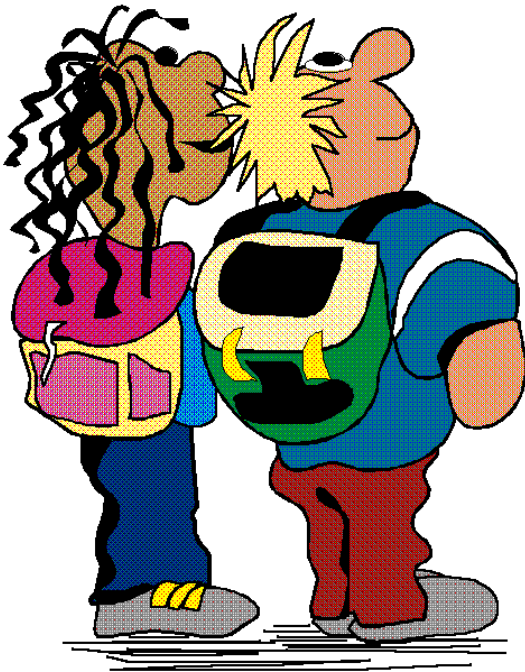
Experiment #2: Study Effects of Reaction Temperature on Yield
(Reaction Time held fixed at 130 minutes)

How can we reach the top?



DOE: Design of Experiments

DOE



Golf Anyone ?



Factorial Experiments

- In a factorial experiment, **all possible combinations** of factor levels are tested

- The golf experiment:

- Type of driver
- Type of ball
- Walking vs. riding
- Type of beverage
- Time of round
- Weather
- Type of golf spike
- Etc, etc, etc...

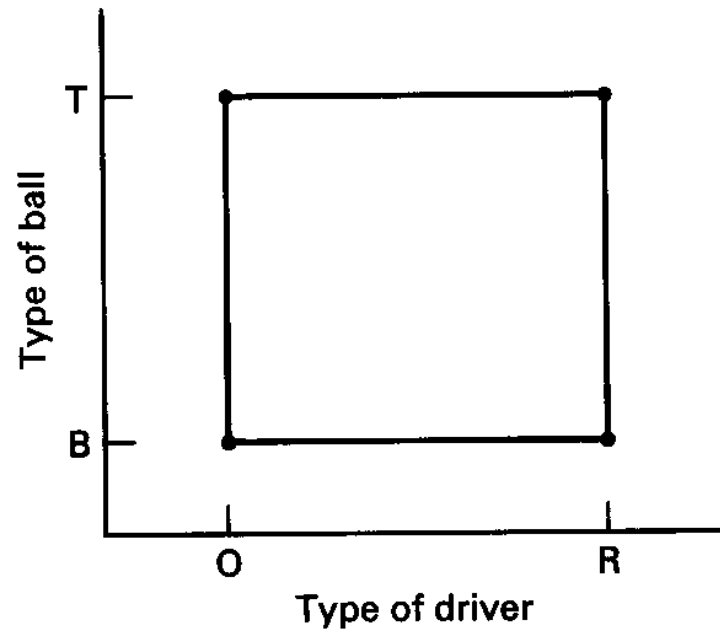
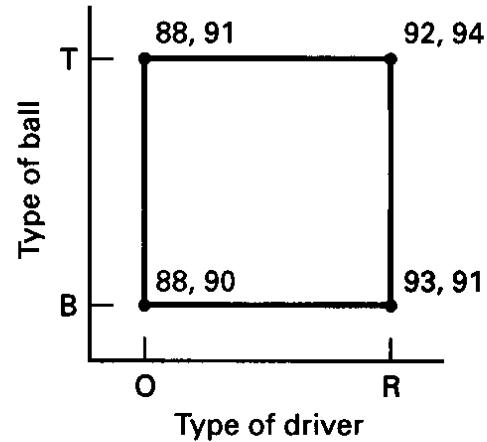
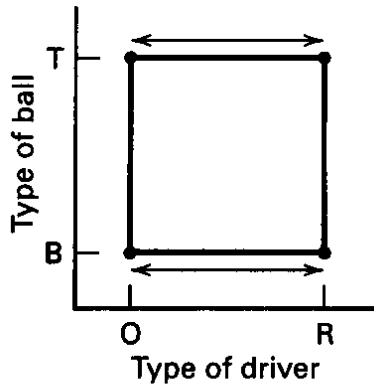


Figure 1-4 A two-factor factorial experiment involving type of driver and type of ball.

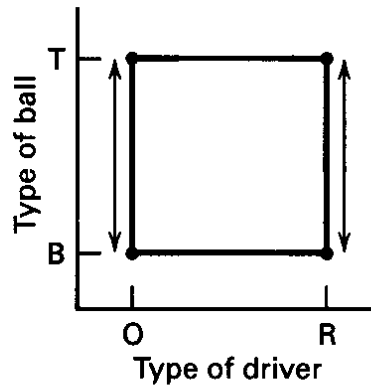
Factorial Experiment



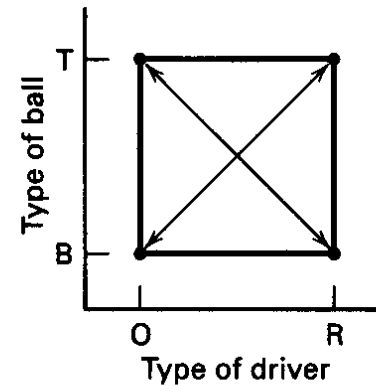
(a) Scores from the golf experiment



(b) Comparison of scores leading to the driver effect



(c) Comparison of scores leading to the ball effect



(d) Comparison of scores leading to the ball-driver interaction effect

Figure 1-5 Scores from the golf experiment in Figure 1-4 and calculation of the factor effects.

Experiments with Several Factors

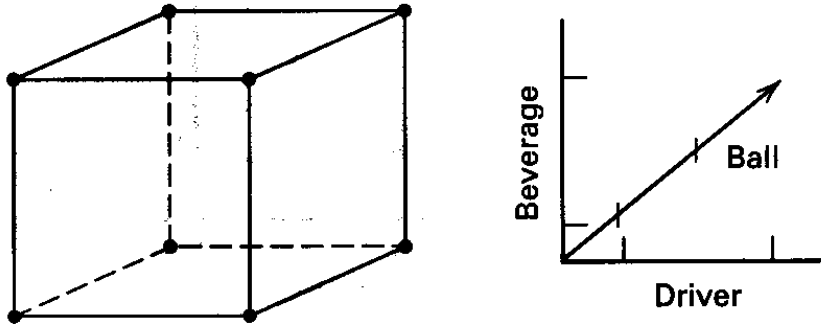


Figure 1-6 A three-factor factorial experiment involving type of driver, type of ball, and type of beverage.

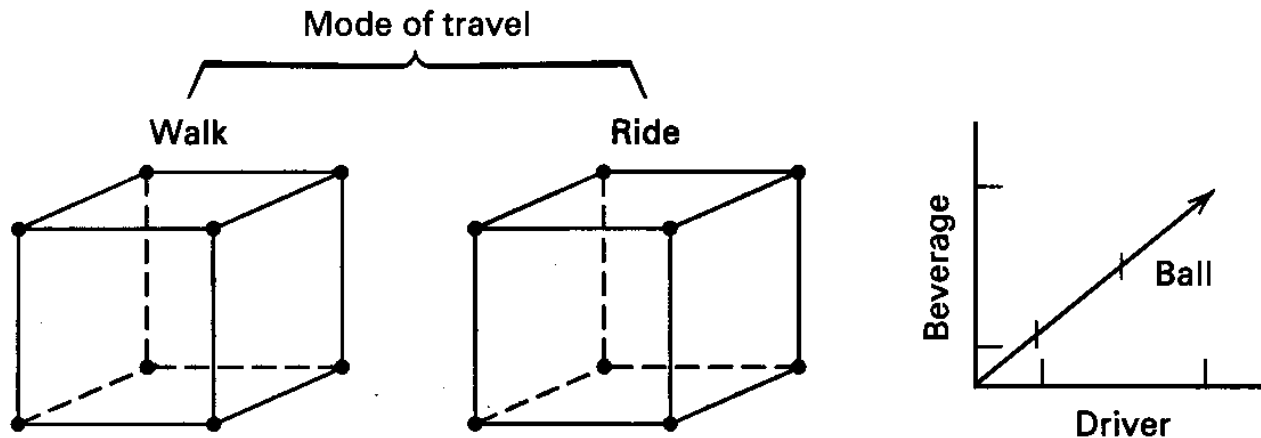


Figure 1-7 A four-factor factorial experiment involving type of driver, type of ball, type of beverage, and mode of travel.

A Fractional Factorial Experiment

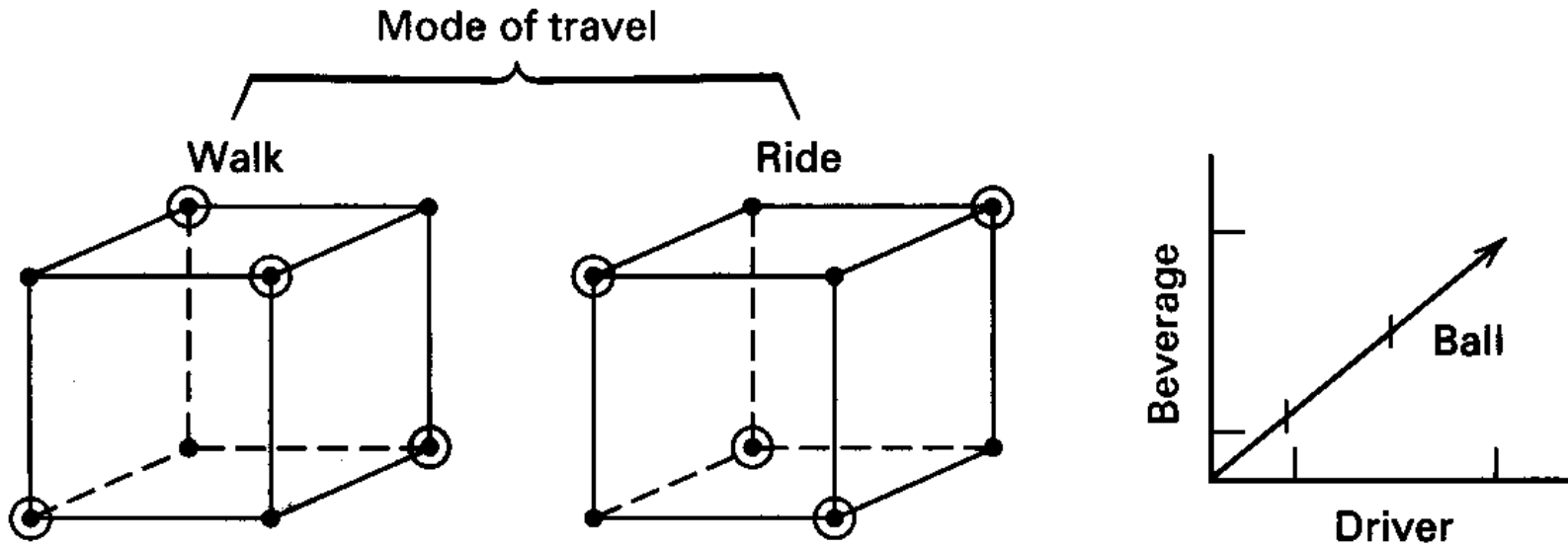
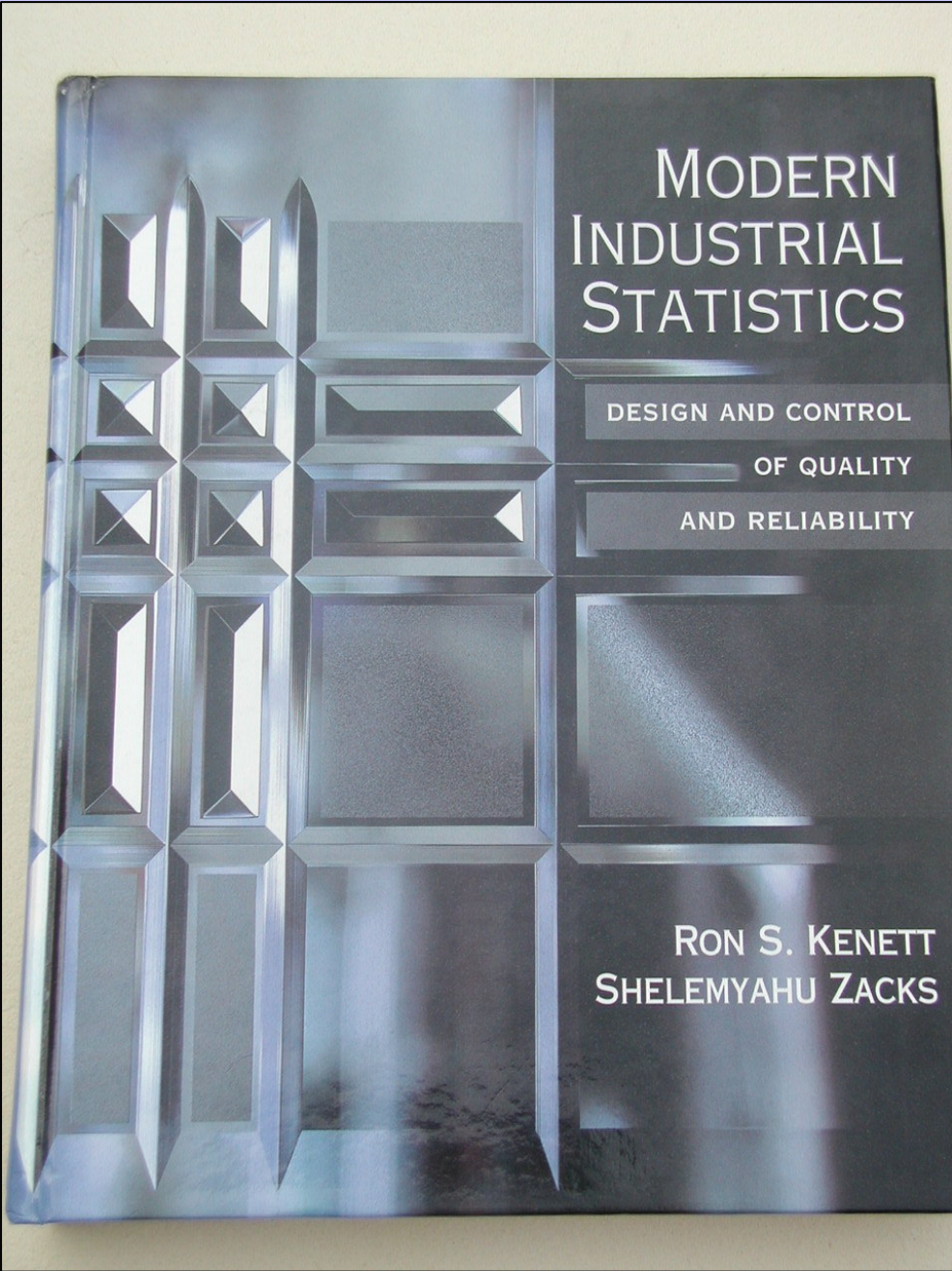


Figure 1-8 A four-factor fractional factorial experiment involving type of driver, type of ball, type of beverage, and mode of travel.



MODERN INDUSTRIAL STATISTICS

DESIGN AND CONTROL
OF QUALITY
AND RELIABILITY

RON S. KENETT
SHELEMYAHU ZACKS

R.S. Kenett and S, Zacks,
Modern Industrial Control:
Design and control of
quality and reliability,
Duxbury press, San
Francisco, 1998, Spanish
edition 2000,
2nd paperback edition 2002,
Chinese edition 2004.

Process Improvement and CMMI for Systems and Software

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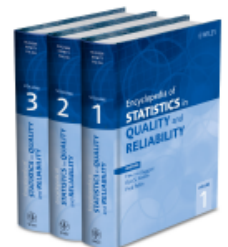
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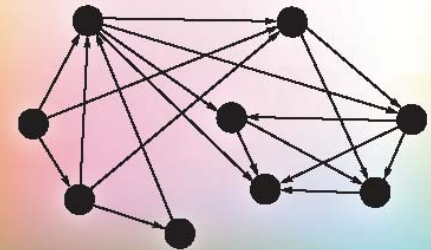
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