

WILLIAM BAUM

DESIGN OF EXPERIMENTS & MULTIPLE RESPONSE OPTIMIZATION



FATHER OF DOE

**SIR RONALD
FISCHER**

WHY DESIGN OF EXPERIMENTS?

- ▶ Design of Experiments [DOE] provides the optimal mathematical solutions to conducting univariate and multivariate prospective (forward-looking) testing.
- ▶ One Factor At a Time [OFAT] modeling, by comparison, is extremely inefficient compared with many DOE plans.
- ▶ OFAT models can be misleading, because they do not account for common interaction or polynomial effects.
- ▶ But how does DOE work its magic?

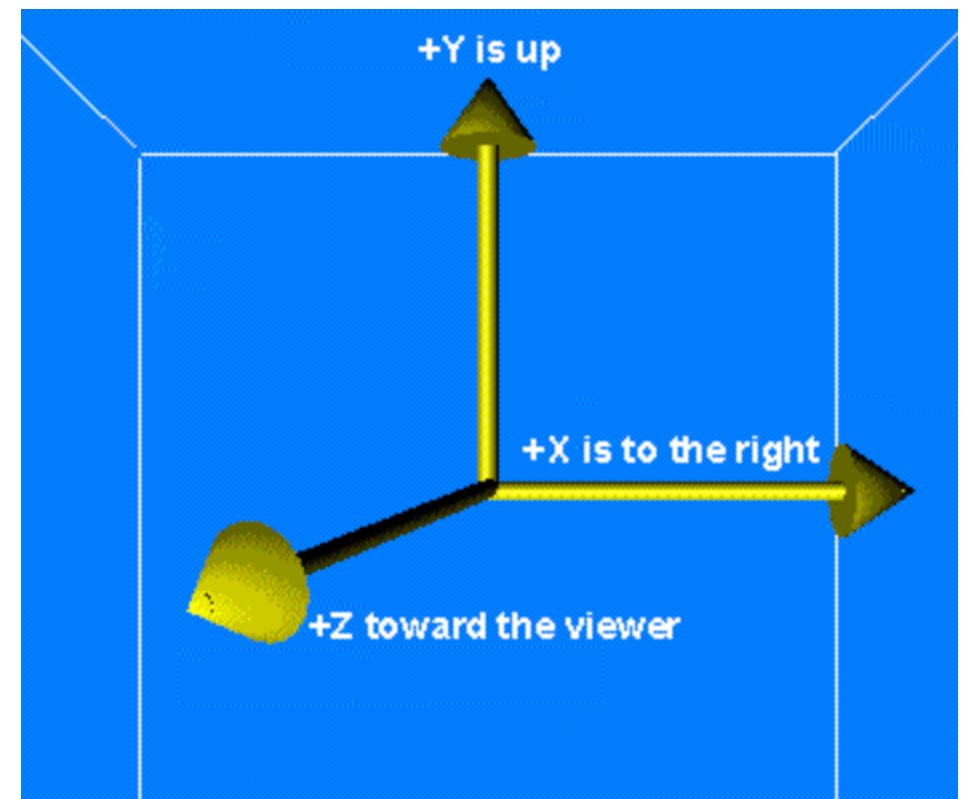


DESIGN OF
EXPERIMENTS

**THE UNDERLYING
STRUCTURE**

ORTHOGONAL DESIGN

- ▶ DOE provides optimal efficiency by creating orthogonal, or near-orthogonal designs.
- ▶ This allows one to better understand phenomenological causality and leads to better inference than models based solely on observations.
- ▶ This is because DOE systematically changes multiple input settings, simultaneously, and can model multiple outcomes.
- ▶ Constraints may be added to ensure DOE stays within budget.



<http://www.euclideanspace.com/maths/algebra/matrix/orthogonal/index.htm>



MULTIPLE RESPONSE OPTIMIZATION

A BRIEF INTRODUCTION

MULTIPLE RESPONSE OPTIMIZATION

- ▶ Why optimize one outcome, when you can do so for multiple outcomes (responses) at once? **Seldom is only one outcome important.**
- ▶ You can do it easily with Multiple Response Optimization [MRO]!
- ▶ Uses individual and collective **Desirability Functions [DF]**:
 - ▶ Minimum
 - ▶ Maximum
 - ▶ Target (when most desirable outcome falls between Min and Max)
 - ▶ Composite (Optimizes all DFs, together, to inform a final decision)



DESIGN OF
EXPERIMENTS

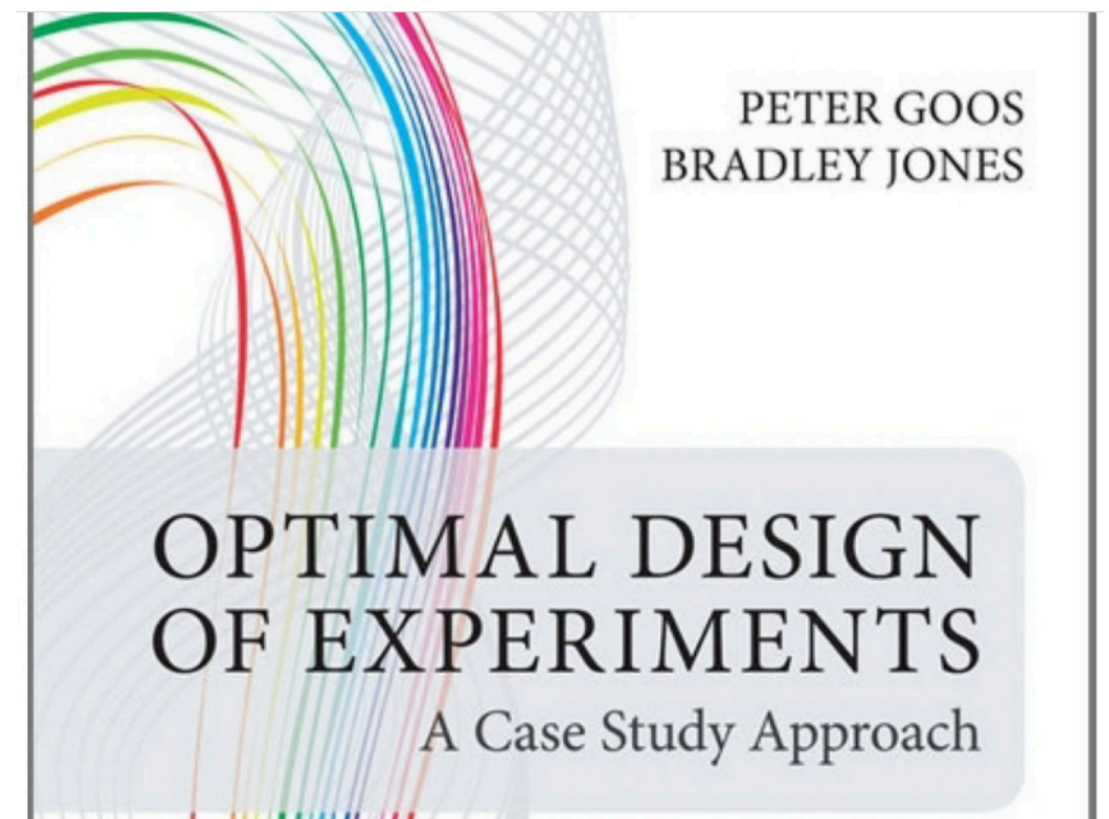
**READING &
RESOURCES**

RESOURCES

- ▶ pyDOE - <https://pypi.org/project/pyDOE/>;
<https://pythonhosted.org/pyDOE/>
- ▶ It seems that Data Science continues to learn from its older sibling, statistics.
- ▶ Data Camp just launched a new course in R to teach DOE <https://www.datacamp.com/courses/experimental-design-in-r>
- ▶ Check out Bradley Jones and his optimal designs, using JMP Discovery Software, by SAS. www.jmp.com
- ▶ <https://cran.r-project.org/web/packages/desirability/index.html>

RECOMMENDED READING

- ▶ Optimal Design of Experiments: A Case Study Approach;
Peter Goos, Bradley Jones; SAS
- ▶ Also...
- ▶ For a general survey, the JMP community is awesome. You can access free materials, here:
- ▶ https://www.jmp.com/en_us/applications/design-of-experiments.html



THANK YOU
FOR
LISTENING!

