Von Versuchen und Versuchsplänen
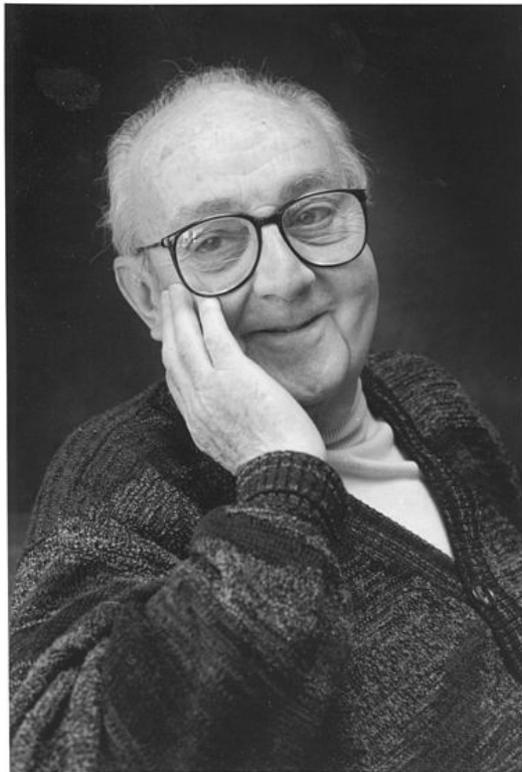
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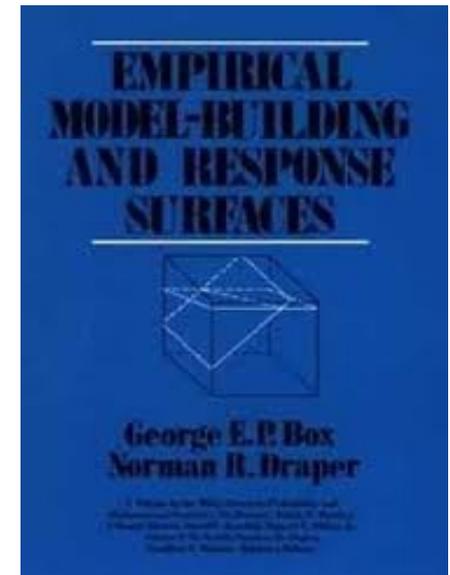*Univ.-Prof. Mag. Dr. Werner G. Müller*

Mgr. Eva Benková

Institut für Angewandte Statistik

George Edward Pelham **Box** FRS (1919 – 2013)

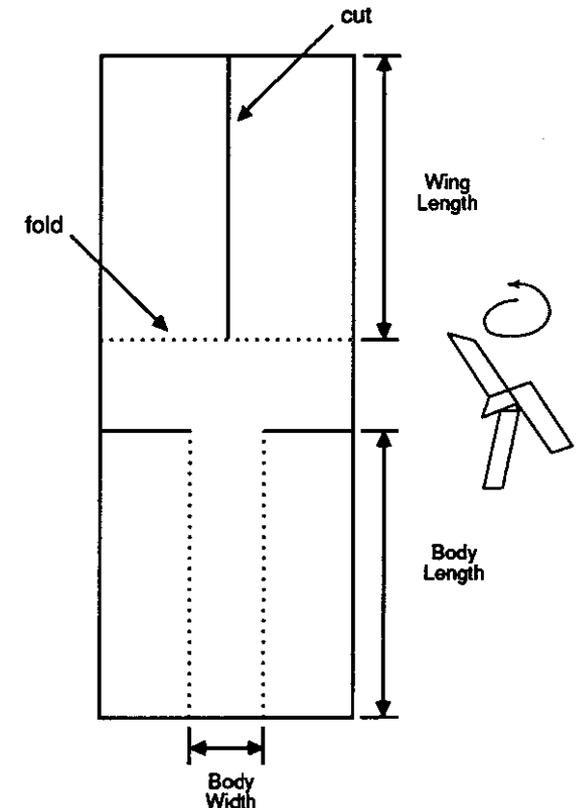"essentially, all models are wrong, but some are useful"

Ein Beispiel:
Das Papierhubschrauber-Experiment

4 Faktoren:

- A: Flügellänge (WL)

- B: Körperlänge (BL)
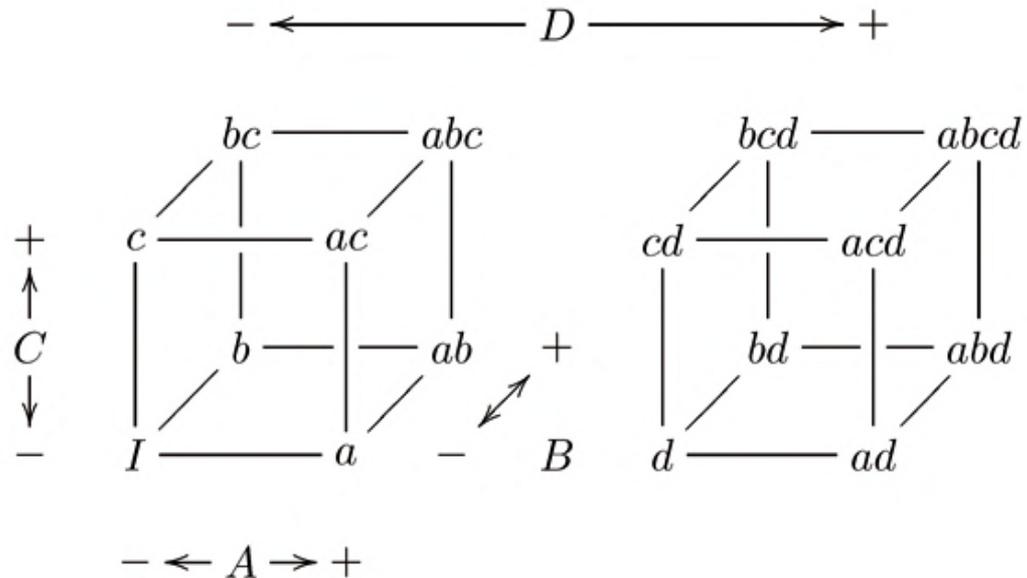
- C: Körperbreite (BW)

- D: Beschwerung (PC)

George Box. Teaching engineers experimental design with a paper

Helicopter. *Quality Engineering*, 4(3):453-459, 1992.

Vollfaktorielle Versuchspläne

Bei 2 Level: $2^4=16$ runs

Bei 3 Level: $3^4=81$ runs

Bei 8 Faktoren und 3 Level: 6561 runs!

Teilfaktorielle Versuchspläne

Table II Plan for L9 Taguchi design of experiment for factors *A*, *B*, *C*, and *D* and levels 1,2, and 3

		Factors		
Experiment	*A*	*B*	*C*	*D*
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	2	1	2	3
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

(D-)Optimale Versuchspläne

„Fit the design to the problem, not the problem to the design!"

	A	B	C	D
1	1	1	1	1
2	3	1	1	1
3	3	3	1	1
4	3	1	3	1
5	1	3	3	1
6	3	1	1	3
7	1	3	1	3
8	1	1	3	3
9	3	3	3	3

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Effizienzvergleich und Schätzung

|	**L9 Taguchi Design**	**D-optimal Design**
D-Kriterium	0,666	0,984
D-Effizienz	0.606	0.882

Kooperation mit Fa. Pöttinger, 2013

- Aufgabenstellung:
  Versuchsplanung und -optimierung einer
  konkreten Anwendung

- Versuch Reibkoeffizient
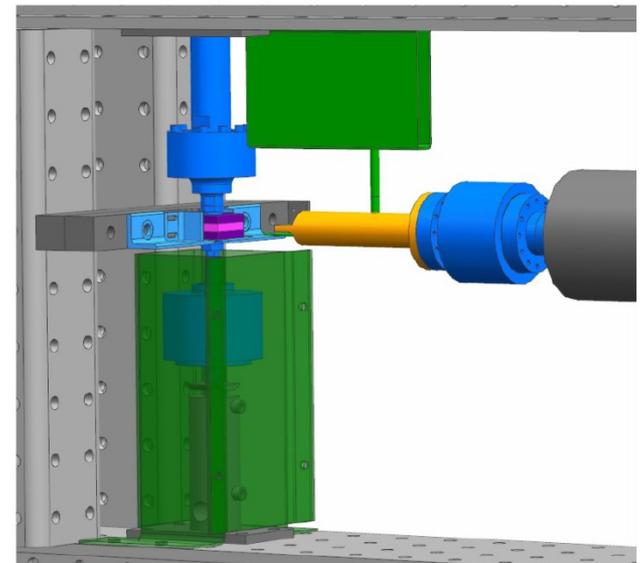
Versuch „Reibkoeffizient"

- Auswirkung unterschiedlicher Oberflächen von Metallplatten auf deren Reibung

- Miteinander verschraubte Platten (daher auch unterschiedlich große Schrauben und Anziehdrehmomente)

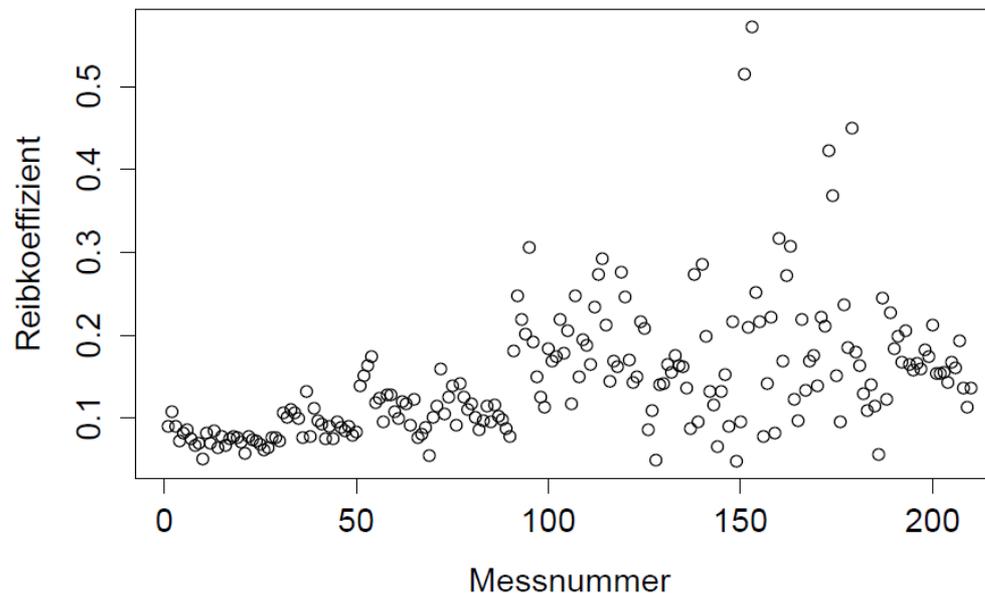- Erstellung eines Versuchsplans für das Experiment
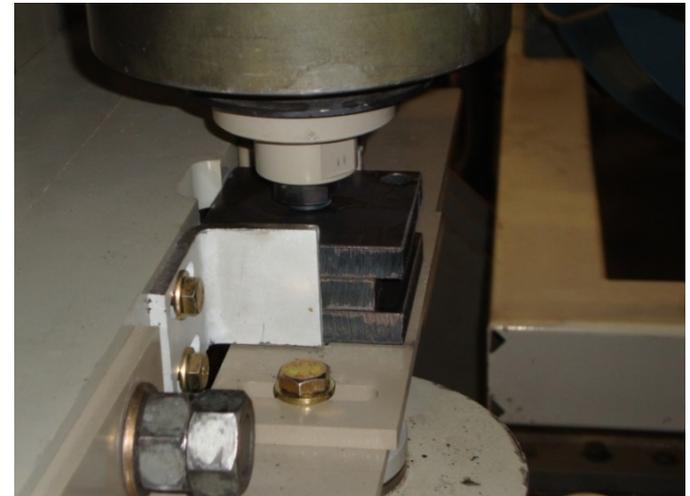
Resultate - Effizienz

Design	D-Effizienz	D_S-Effizienz
D-optimal	1,0503	1,0355
D_S-optimal	1,0490	1,0589
Vollversuch	1	1
bestes aus 1.000 zufälligen Designs	0,9981	0,9114

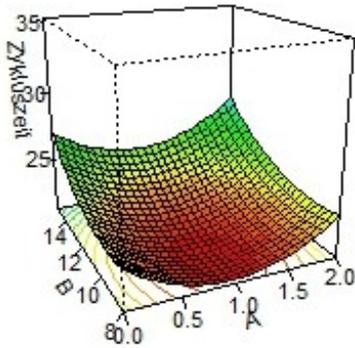| Anzahl Messungen	relative Effizienz
210	1,0503
200	1,0003
150	0,7499
100	0,4993
50	0,2487

Heteroskedastie

Dette, H., Müller, W.G., "Optimal Design for Regression Models with a Constant Coefficient of Variation", *Journal of Statistical Theory and Practice, 7:658-673, 2013*.
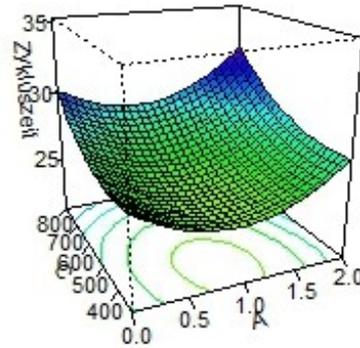
Kooperation mit Fa. Greiner, 2018

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- Aufgabenstellung:
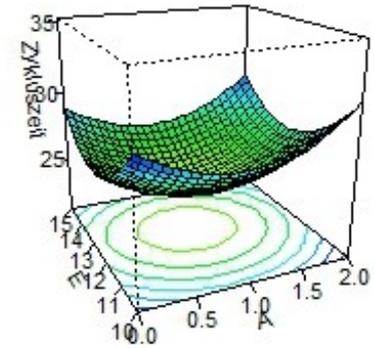 Versuchsplanung und -optimierung eines
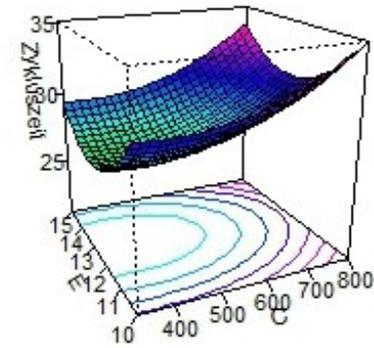 Produktionsprozesses

- Versuch Spritzguss

greiner packaging

Slice at C = 414.67, E = 12.05

Slice at B = 14.89, E = 12.05

Slice at B = 14.89, C = 414.67

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Nebenbedingungen
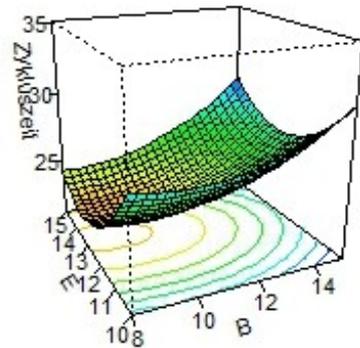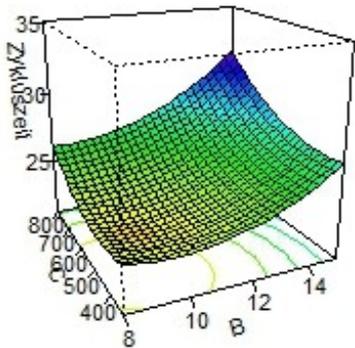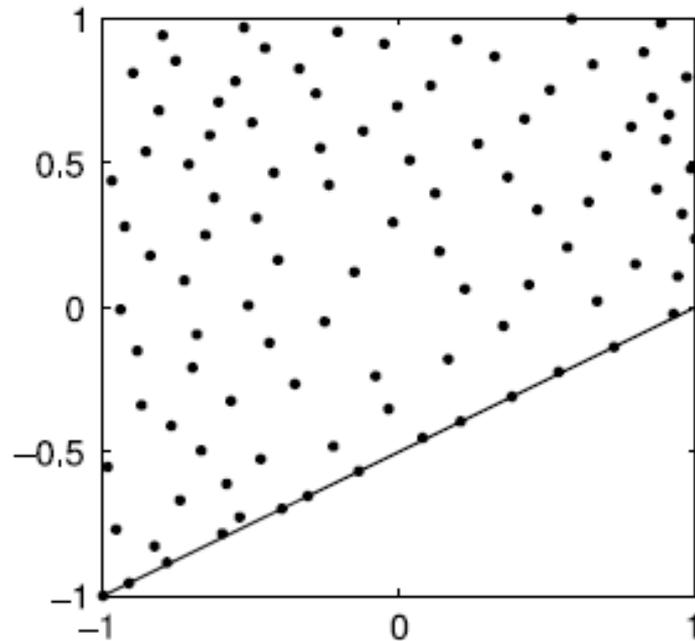
Benková, E., Harman, R., Müller, W. G., 2016. Privacy sets for constrained space-filling. *Journal of Statistical Planning and Inference* 171, 1-9.

Vielen Dank für
die Aufmerksamkeit!

A letter from Günter Pilz

Dear near-ring friends,

this time I want to tell you what near-rings have done for me. Since more than 50 years, I suffer from unusual tiredness in the late afternoon / early evening hours. Since the early 90's, this lead to total paralizations for 2-3 hours each, in which I could hear and see everything, but I could not move my eyes or any other part of my body. I was a Zombie.

After „using up" more than 120 doctors, a hospital in Marburg (near Frankfurt), specializing on rare diseases, found out that the paralizations must be caused by a genetic defect in one of the (many) ion channels leading into the cells. But they told me that the investigation will be complicated and might take up to about 6 years. I found these 6 years too long, since some time before, a group of doctors had told me „If you are lucky, you have one more year to live. If you are unlucky, it might be 5 years". I asked what they meant, and they said that they expect my life to become so dreadful that I would like to die, the sooner the better. So I listed all substances which go into and out of cells, wrote down, what I had eaten (so I knew how much calcium, sodium, etc. were in my last meal), took a bathroom scale right after the meal, and pressed it with both hands. One hour after the meal, I did the same. The differences got up to + 12 kilos!

So I could use statistical regression (which is basically pure algebra) to find out that most chemicals are irrelevant, only a few remained „suspicious". Since most procedures in the body do not rely on a single substance, I also used the best tool to study (positive and negative) synergies of these „suspicious substances: **BIB-Designs!** Of course, I took them from planar near-rings, constructed by the Clay-Ferrero method. After only 6 weeks (due to my frequent meals), I had the result with 99.99% reliability: potassium is bad for me, and sodium is good. Nothing else counts. That also makes medical sense, since potassium and sodium are antagonists. I even can easily tell now, what kind of food will make me stronger by so many kg in the scale pressing. For instance, 100 g carrots will weaken me by 2.5 kg, while a hamburger will strengthen me by 7.2 kg. Mathematics and Statistics can really be super-cool !!

With these information, only a few weeks later the doctors in Germany could identify the ion channel and even the locus of the defect gene in it! This channes brings too much potassium iones into the cells; this destroyed the electrif field inside the cells, my "batteries are empty", and I cannot move for a while, until the cells are re-charged. Of course, there is neither a name nor a cure for this rare defect (just 1 case world-wide), but I can at least avoid total paralizations by the intake of healthy food: very few vegetables and fruits, but much salt, sausages, and the like. Many diets are much worse than this one... That keeps me relatively OK, but I do not dare to travel non-trivial distances any more.

So I can really say: „ALGEBRA , STATISTICS, AND IN PARTICULAR PLANAR NEAR-RINGS, **HAVE SAVED MY LIFE**!" That was REALLY Applied Algebra, at least for me!

And the story became even more bizarr: the doctors in Marburg wanted to write a paper on my case, and due to my collaboration, they „forced" me to be a coauthor. This paper was written and sent to a journal. So I am now both coauthor and object of a study! Very strange. All good wishes and kindest regards!
Guenter Pilz

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