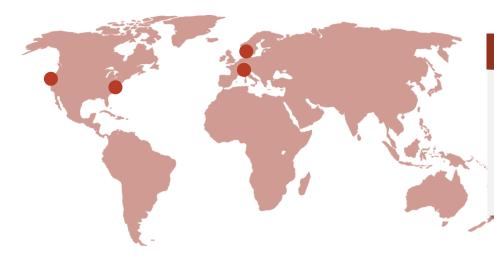
# Split-split plot designs in JMP

Stine Fangel, Statistician at Bavarian Nordic



## **Bavarian Nordic**

Cancer Immunotherapies and Vaccines for Infectious Diseases



#### FACTS

Founded 1994, IPO 1998 Listed on NASDAQ OMX Copenhagen: BAVA 400 employees worldwide Market Cap DKK 9.2bn

### **BAVARIAN NORDIC IN BRIEF**

- Vertically integrated multinational biotech company
- Revenue-generating
- Leader in vector-based active immunotherapy
- First product approved in 2013, smallpox
- Commercial scale cGMP manufacturing facility
- Long-term R&D and delivery contracts with the US government

BAVARIAN NORDIC

# **Clinical Pipeline**

		Phase 1	Phase 2	Phase 3	Market
Indication	Partner				
Smallpox	BARDA				
Smallpox	BARDA				
Prostate Cancer	Bristol-Myers Squibb				
Prostate Cancer	NCI				
Prostate Cancer	NCI				
Bladder Cancer	NCI				
Metastatic Tumors	NCI				
Ebola/Marburg	Janssen, NIH				
RSV		In 2015			
	Smallpox Smallpox Prostate Cancer Prostate Cancer Prostate Cancer Bladder Cancer Metastatic Tumors Ebola/Marburg	SmallpoxBARDASmallpoxBARDAProstate CancerBristol-Myers SquibbProstate CancerNCIProstate CancerNCIBladder CancerNCIMetastatic TumorsNCIEbola/MarburgJanssen, NIH	IndicationPartnerSmallpoxBARDASmallpoxBARDAProstate CancerBristol-Myers SquibbProstate CancerNCIProstate CancerNCIBladder CancerNCIMetastatic TumorsNCIEbola/MarburgJanssen, NIH	IndicationPartnerSmallpoxBARDASmallpoxBARDAProstate CancerBristol-Myers SquibbProstate CancerNCIProstate CancerNCIBladder CancerNCIMetastatic TumorsNCIEbola/MarburgJanssen, NIH	IndicationPartnerSmallpoxBARDASmallpoxBARDAProstate CancerBristol-Myers SquibbProstate CancerNCIProstate CancerNCIBladder CancerNCIMetastatic TumorsNCIEbola/MarburgJanssen, NIH





## Tv: Kartoffeldronning flygter fra spørgsmål om farlige fritter

Flensteds direktør er afsløret i at producere farlige pompetit Ekstra Bladet

sittes, men stikker af fra

Af: Christian Kloster

## Potato Queen Runs from Questions about Dangerous French Fries







How would I suggest this analysis was done?

- **Temperature:** 175°C, 187.5°C, 200°C (hard-to-change)
- Types of Potato organic, non organic
- Two Days (block)
- Responses: Acrylamide and Taste



One oven with room for two baking trays



## Requests

- Balanced design
- Estimations of block variation
- Montgomery, Design and Analysis of Experiments, eq. 13-16 ed. 5<sup>th</sup>.
- BlockWhole plot error $y_{ijk} = \mu + Day_i + Temp_j + (Day \cdot Temp)_{ij} + Type_k$  $+ (Temp \cdot Type)_{jk} + \epsilon_{ijk}$  $\begin{cases} i = A, B \\ j = 175, 187.5, 200 \\ k = Organic, Non Organic \end{cases}$ Subplot error

BAVARIAN NOR

7

# Design in JMP

## The trick is to ask for twice as many runs, twice as many whole plots and twice as many subplots as needed

Add Factor        Remove       Add N Factors       1         Name       Role       Changes       Values         Y Temperature       Categorical       Hard       175       187.5       200         Y Type of Potato       Categorical       Easy       Organic       Non Organic       A         Define Factor Constraints       Model       B       B       B       B         Mame       Estimability       Interactions        RSM       Cross       Powers        Remove Term         Name       Estimability       Intercept       Naccessary       Naccessary       Type of Potato       Necessary         Day       Necessary       Necessary       Necessary       Necessary       Necessary         Day       Necessary       Necessary       Necessary       Necessary         Day       Necessary       Necessary       Necessary         Design Generation       Necessary       Necessary			T <u>o</u> ols <u>V</u> iew				
Add Response V Remove       Number of Responses         Response Name       Goal       Lower Limit       Upper Limit       Importance         Taste       Maximize            Acylamide       Minimize            Johnal I ferr             Factors       Add Pactor V Remove       Add N Factors       1         Name       Role       Changes       Values          V Temperature       Categorical       Hard       175       187.5       200         Y Temperature       Categorical       Easy       Organic       Non Organic       A       B         Define Factor Constraints       Model         B           Mane       Estimability       Interactions V RSM Cross Powers V Remove Term            Name       Estimability       Intercept       Necessary            Temperature       Necessary       Necessary             Day       Necessary <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>							
Response Name       Goal       Lower Limit       Upper Limit       Importance         Taste       Maximize       I       I       Importance         Acylamide       Limimize       I       Importance         Add Factor       Remove       Add N Factors       1         Add Factor       Remove       Add N Factors       1         Name       Role       Changes       Values          Temperature       Categorical       Easy       Organic       Non Organic         Pay       Categorical       Easy       Organic       Non Organic         Model       Mane       Estimability       A       B         Define Factor Constraints       Name       Estimability       Intercept       Necessary         Intercept       Necessary       Remove Term       Necessary       Temperature       Necessary         Day       Necessary       Necessary       Temperature       Necessary       Temperature       Necessary         Day       Necessary       Necessary       Temperature       Necessary       Necessary       Temperature       Necessary         Day       Necessary       Necessary       Temperature		1					
Taste       Maximize	Add Response  Remove	Number of Resp	onses				
Acytamide   optional item     Add Factor s     Add Factor s     Add Factor r     Remove   Add N Factors     Add Factor r     Remove   Add Pactor r   Remove   Categorical   Easy   Organic   Name   Categorical   Vary Categorical   Very Hard   A     B        Policine Factor Constraints     Categorical   Very Hard   Addel     Man Effects   Interactions *   RSM   Cross   Powers *   Remove Term     Name   Estimability   Interactions *   Name	Response Name		Lower	r Limit Upp	er Limit	Importanc	e
optional item         Factors         Add Factor        Remove         Y Temperature       Categorical         Y Day       Categorical         Easy       Yorganic         Name       Categorical         Easy       Yorganic         Model       Mane Effects         Mane Effects       Interactions *         Name       Estimability         Intercept       Necessary         Type of Potato       Necessary         Day       Necessary         Day       Necessary         Day       Necessary         Day       Necessary         Day       Necessary         Day       Necessary         Temperature       Necessary         Day       Necessary         Day       Necessary         Day       Necessary         Day       Necessary         Temperature       Necessary <tr< th=""><th></th><th></th><th></th><th></th><th></th><th></th><th></th></tr<>							
Image       Remove       Add N Factors       1         Name       Role       Changes       Values		Minimize					
Add Factor        Remove       Add N Factors       1         Name       Role       Changes       Values <ul> <li>Temperature</li> <li>Categorical</li> <li>Hard</li> <li>175</li> <li>187.5</li> <li>200</li> <li>Organic</li> <li>Non Organic</li> <li>A</li> <li>B</li> </ul> Define Factor Constraints       Model         Mane       Estimability         Interactions *       RSM         Cross       Powers * Remove Term         Name       Estimability         Intercept       Necessary         Temperature       Necessary         Temperature       Necessary         Day       Necessary         Day       Necessary         Temperature       Necessary         Temperature       Necessary         Day       Necessary         Day       Necessary         Temperature       Necessary         Temperature       Necessary         Temperature       Necessary         Day       Necessary         Day       Necessary         Day       Necessary         Temperature       Necessary         Hard       to change factors can vary independently	opionaritem						
Name       Role       Changes       Values            • Temperature       Categorical       Hard       175       187.5       200            • Type of Potato       Categorical       Easy       Organic       Non Organic            • Day       Categorical       Easy       Organic       Non Organic            Define Factor Constraints             B               Man Effects        Interactions           RSM        Cross        Powers        Remove Term             Name        Estimability          Intercept        Necessary        Temperature        Necessary          Type of Potato       Necessary        Necessary        Temperature Type of Potato          Day       Necessary        Necessary        Organic       Necessary          Day       Necessary        Necessary        Necessary        Necessary          Day       Necessary        Necessary        Necessary        Necessary          Day       Necessary        Necessary        Necessary        Necessary          Day <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>							
Name       Role       Changes       Values            • Temperature       Categorical       Hard       175       187.5       200            • Type of Potato       Categorical       Easy       Organic       Non Organic            • Day       Categorical       Easy       Organic       Non Organic            Define Factor Constraints             B               Man Effects        Interactions           RSM        Cross        Powers        Remove Term             Name        Estimability          Intercept        Necessary        Temperature        Necessary          Type of Potato       Necessary        Necessary        Temperature Type of Potato          Day       Necessary        Necessary        Organic       Necessary          Day       Necessary        Necessary        Necessary        Necessary          Day       Necessary        Necessary        Necessary        Necessary          Day       Necessary        Necessary        Necessary        Necessary          Day <td>Factors</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	Factors						
Temperature     Categorical     Hard     T75     187.5     200     Organic     Non Organic     A     B      Define Factor Constraints      Model      Main Effects     Interactions     RSM     Cross     Powers     Remove Term     Name     Estimability     Intercept     Necessary     Temperature     Type of Potato     Necessary     Temperature     Necessary     Necessary	Add Factor V Remove Ad	dd N Factors 1					
	Name	Role	Changes	Values			
✓ Day     Categorical     Very Hard     A     B       Define Factor Constraints     Model       Main Effects     Interactions ▼     RSM     Cross     Powers ▼     Remove Term       Name     Estimability       Intercept     Necessary       Temperature     Necessary       Day     Number of Whole Plots       4     Number of Subplots       12     Number of Runs:       C     Minium       C     Mercess Specified       24     Val	✓ Temperature	Categorical		175	187.5		200
Define Factor Constraints         Model         Main Effects Interactions ▼ RSM Cross Powers ▼ Remove Term         Name       Estimability         Intercept       Necessary         Temperature       Necessary         Type of Potato       Necessary         Day       Necessary         Temperature*Type of Potato       Necessary         Alias Terms       Alias Terms         4 Design Generation       Intercept 4         Hard to change factors can vary independently of Very Hard to change factors.         Number of Whole Plots       4         Number of Runs:       C         C Minimum       7         C Definit       24	✓ Type of Potato	Categorical	Easy	Organic			anic
Model         Man Effects       Interactions *       RSM       Cross       Powers *       Remove Term         Name       Estimability         Intercept       Necessary         Temperature       Necessary         Day       Necessary         Day       Necessary         Temperature*Type of Potato       Necessary         Alias Terms       Design Generation         Hard to change factors can vary independently of Very Hard to change factors.         Number of Whole Plots       4         Number of Subplots       12         Number of Runs:       C         Of Default       24	✓ Day	Categorical	Very Hard	A		В	
Type of Potato Necessary Day Necessary Temperature"Type of Potato Necessary Alias Terms Design Generation Hard to change factors can vary independently of Very Hard to change factors. Number of Whole Plots 4 Number of Subplots 12 Number of Runs: Minimum 7 Default 24 C User Specified 24	Intercept		Necessary	1			
Day       Necessary         Temperature*Type of Potato       Necessary         Alias Terms       Alias Terms         Design Generation       Image factors can vary independently of Very Hard to change factors.         Number of Whole Plots       4         Number of Subplots       12         Number of Runs:       C         C Minimum       7         C Default       24							
Temperature*Type of Potato       Necessary         Alias Terms       Alias Terms         Design Generation       Image: Comparison of the second			Necessarv				
Design Generation     Hard to change factors can vary independently of Very Hard to change factors. Number of Whole Plots     4 Number of Subplots     12 Number of Runs:     Minimum     7     Default     24     User Specified     24	Type of Potato						
Design Generation Hard to change factors can vary independently of Very Hard to change factors. Number of Whole Plots 4 Number of Subplots 12 Number of Runs: C Minimum 7 C Default 24 C User Specified 24	Type of Potato Day		Necessary				
Design Generation     Hard to change factors can vary independently of Very Hard to change factors. Number of Whole Plots     4 Number of Subplots     12 Number of Runs:     Minimum     7     Default     24     User Specified     24	Type of Potato Day		Necessary				
Design Generation     Hard to change factors can vary independently of Very Hard to change factors. Number of Whole Plots     4 Number of Subplots     12 Number of Runs:     Minimum     7     Default     24     User Specified     24	Type of Potato Day		Necessary				
Hard to change factors can vary independently of Very Hard to change factors.         Number of Whole Plots       4         Number of Subplots       12         Number of Runs:       7         C Minimum       7         C Default       24         C User Specified       24	Type of Potato Day Temperature*Type of Potato		Necessary				
Number of Whole Plots 4 Number of Subplots 12 Number of Runs: C Minimum 7 C Default 24 C User Specified 24	Type of Potato Day Temperature*Type of Potato Alias Terms		Necessary				
Number of Subplots 12 Number of Runs: <sup>(7)</sup> Minimum 7 <sup>(7)</sup> Default 24 <sup>(7)</sup> User Specified 24	Type of Potato Day Temperature*Type of Potato Alias Terms Design Generation		Necessary Necessary		tors.		
Number of Runs: C Minimum 7 C Default 24 C User Specified 24	Type of Potato Day Temperature*Type of Potato Alias Terms Design Generation	n vary independen	Necessary Necessary		tors.		
C Minimum 7 C Default 24 C User Specified 24	Type of Potato Day Temperature*Type of Potato Alias Terms Design Generation Hard to change factors cal Number of Whole Plots	n vary independen	Necessary Necessary		tors.		
C Default 24 C User Specified 24	Type of Potato Day Temperature*Type of Potato Alias Terms Design Generation Hard to change factors cal Number of Whole Plots	n vary independen	Necessary Necessary		tors.		
• User Specified 24	Type of Potato Day Temperature*Type of Potato Alias Terms Design Generation Hard to change factors cal Number of Whole Plots Number of Subplots Number of Runs:	n vary independen	Necessary Necessary		tors.		
	Type of Potato Day Temperature*Type of Potato Alias Terms Design Generation Hard to change factors can Number of Whole Plots Number of Subplots Number of Runs: Minimum 7	n vary independen 4 12	Necessary Necessary		tors,		
	Type of Potato Day Temperature*Type of Potato Alias Terms Design Generation Hard to change factors cal Number of Whole Plots Number of Subplots Number of Runs: Minimum 7 Default 24	n vary independen 4 12	Necessary Necessary		tors.		

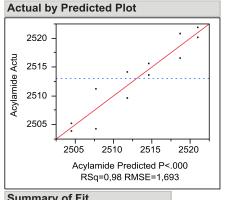
⊿7/0 Cols 💌					
24/12	Whole Plots	Subplots	Temperature	Type of Potato	Day
🚳 🚳 1	1	1	187.5	Organic	Α
🚳 🗟 🛛	1	1	187.5	Non Organic	Α
🚳 🖏 3	1	2	200	Organic	Α
S 4	1	2	200	Non Organic	Α
S 🖏 🖏 🖏	1	3	175	Non Organic	Α
S 6	1	3	175	Organic	Α
7	2	4	175	Organic	В
8	2	4	175	Non Organic	В
9	2	5	187.5	Organic	В
10	2	5	187.5	Non Organic	В
11	2	6	200	Organic	В
12	2	6	200	Non Organic	В
13	3	7	200	Non Organic	Α
14	3	7	200	Organic	Α
15	3	8	187.5	Non Organic	Α
16	3	8	187.5	Organic	Α
17	3	9	175	Organic	Α
18	3	9	175	Non Organic	Α
🙆 🚳 19	4	10	200	Organic	В
🙆 🗟 20	4	10	200	Non Organic	В
S 31 🕲	4	11	175	Organic	В
🔕 🗟 22	4	11	175	Non Organic	В
	4	12	187.5	Organic	В
🙆 🚳 24	4	12	187.5	Non Organic	В



## Model specified in JMP

Report: Fit Model - JMI	)	
⊿ ■ Model Specificat	ion	
Model Specificat     Select Columns      LTemperature     LType of Potato     LDay     Taste     Acylamide	ion Pick Role Variables Y Traste Acylamide optional Weight optional numeric By optional Construct Model Effects Add Day& Random Temperature& Ra Temperature*Toa Nest Type of Potato Temperature*Typ Macros Transform Transform No Intercept	y& Random
		<u>↑</u> ■ – //.

#### Response Acylamide



Summary of Th	
RSquare	0,975025
RSquare Adj	0,954212
Root Mean Square Error	1,693529
Mean of Response	2513,036
Observations (or Sum Wgts	12

**REML Variance Component Estimates** 

	Var				
Var Ratio	Component	Std Error	95% Lower	95% Upper	Pct of Total
0,998062	2,8624833	5,8899104	-8,681529	14,406495	36,071
0,7688405	2,2050667	3,8228133	-5,28751	9,6976431	27,787
	2,8680417	2,3417462	0,9203844	39,871701	36,141
	7,9355917	6,3620993	2,5840847	102,3942	100,000
	0,998062	Var Ratio         Component           0,998062         2,8624833           0,7688405         2,2050667           2,8680417	Var Ratio         Component         Std Error           0,998062         2,8624833         5,8899104           0,7688405         2,2050667         3,8228133           2,8680417         2,3417462	Var Ratio         Component         Std Error         95% Lower           0,998062         2,8624833         5,8899104         -8,681529           0,7688405         2,2050667         3,8228133         -5,28751	Var Ratio         Component         Std Error         95% Lower         95% Upper           0,998062         2,8624833         5,8899104         -8,681529         14,406495           0,7688405         2,2050667         3,8228133         -5,28751         9,6976431           2,8680417         2,3417462         0,9203844         39,871701

-2 LogLikelihood = 40,066882331

Note: Total is the sum of the positive variance components

Total including negative estimates = 7,9355917

#### **Fixed Effect Tests**

Source	Nparm	DF	DFDen	F Ratio	Prob > F
Temperature	2	2	2	0,0203	0,9801
Type of Potato	1	1	3	06,3165	0,9801 0,0019 * 0,0429 *
Temperature*Type of Potat	2	2	3	10,7392	0,0429 *



## Check the design

- Can I estimate what I want?
- I usually also take a look at VIF (variance inflations factor)
- VIF describes how much multicollinearity (correlation between predictors) exists in a regression analysis



## Demo in JMP



## Case: Time added to the design



- Temperature: 175°C, 187.5°C, 200°C (very-hard to change)
- Types of Potato organic, non organic
- Time 25 minutes and 30 minutes (hard-to-change)
- Two Days (block factor)
- Responses: Acrylamide and Taste



One oven with room for two plates



## Requests

- Balanced design
- Estimations of block variation
- Montgomery, Design and Analysis of Experiments, paragraph 13-5.2, reduced

Block Whole plot error Subplot error

 $y_{ijk} = \mu + Day_i + (Day \cdot Temp)_{ij} + (Day \cdot Temp \cdot Time)_{ijl} + Temp_j + Time_l + Type_k + (Temp \cdot Type)_{jk} + (Temp \cdot Time)_{jl} + (Time \cdot Type)_{jl} + (Temp \cdot Type)_{jkl}$ 

$$+\epsilon_{ijlk} \begin{cases} i = A, B \\ j = 175, 187.5, 200 \\ k = Organic, Non Organic \\ l = 20, 25 \end{cases}$$

## Sub-subplot error

Reference: http://www.public.iastate.edu/~dnett/S402/wsplit2plotwpblock.pdf

## 2nd Design in JMP

ja: DOE - JMP							<u>_                                    </u>
File Edit Tables Rows Cols DOE	E <u>A</u> nalyze <u>G</u> raph	T <u>o</u> ols <u>V</u> iew	<u>W</u> indow <u>H</u> elp				
Custom Design							
Add Factor V Remove Ad	d N Factors 1						
Name	Role	Changes	Values				
✓ Temperature	Categorical	Hard	175	187.5		200	
✓ Time	Categorical	Easy	20		25		
✓ Day	Categorical	Very Hard	A		В		
Define Factor Constrain	nts						
⊿ Model							
Main Effects Interactions	RSM Cro	oss Powers	Remove Term				
Name		Estimabilit					
Intercept Temperature		Necessary Necessary					
Time		Necessary					
Day		Necessary					
Temperature*Time		Necessary					
D Alias Terms							
Design Generation							
Hard to change factors can		tly of Very Ha	rd to change factors	i.			
Number of Whole Plots	4						
Number of Subplots	12						
Number of Runs:							
C Minimum 7							
© Default 24 © User Specified 24							
Make Design							

🛄 Custom Desi	ign - JMP					Ľ
<u>File E</u> dit <u>T</u> ables	s <u>R</u> ows <u>C</u> ols	DOE Analy	/ze <u>G</u> raph T <u>o</u> ol	ls <u>V</u> iew	<u>W</u> indow <u>H</u>	elp
🖽 🔁 🖬 🖉	l   X 🗈 🛍	🗎 🖹 🖗	s 📙 i 🗗 i 🛤	} <u>}</u> ∎ <b>8</b> ∦	;≠ " " "	F
⊿ _ 5/0 Cols 💌						<b></b>
24/12	Whole Plots	Subplots	Temperature	Time	Day	
🚳 🚳 1	1	1	175	20	A	
🚳 🗟 2	1	1	175	25	Α	
🚳 🗟 3	1	2	187.5	25	Α	
🚳 🗟 4	1	2	187.5	20	Α	
🚳 🗟 5	1	3	200	25	Α	
🚳 🗟 6	1	3	200	20	Α	
7	2	4	200	20	Α	
8	2	4	200	25	Α	
9	2	5	175	25	Α	
10	2	5	175	20	Α	
11	2	6	187.5	20	Α	
12	2	6	187.5	25	Α	
13	3	7	175	20	В	
14	3	7	175	25	В	
15	3	8	200	20	В	
16	3	8	200	25	В	
17	3	9	187.5	25	В	
18	3	9	187.5	20	В	
🚳 🚳 19	4	10	200	25	В	
🚳 🚳 20	4	10	200	20	В	
🚳 🚳 21	4	11	187.5	25	В	
🚳 🐼 22	4	11	187.5	20	в	
🚳 🐼 23	4	12	175	20	в	
6) 🗟 24	4	12	175	25	В	-
•						
					🏠 🗆 🤊	1



# Add *Type of Potato* to the design, double and then randomize

戰 Split-split plot design 2 - JMP										
File Edit Tables Rows Cols DOE Analyze Graph Tools View Window Help										
24/0 Rows	Temperature	Time	Day	Type of Potato	Order	Random				
1	200	20	Α	Organic	1	0,4737168204				
2	200	25	Α	Organic	2	0,242281988				
3	175	25	Α	Organic	3	0,4911673993				
Sort - JMP						_ D ×				
Select Column Taste Acylamic Type of F Order Replace table Keep dialog	de Potato N	20		By ≜ Ord ≜ Rar optiona ≜ ₹	adom al	Action OK Cancel Recall Help				
	200	25	B	Non Organic	10	0,9684270401				
23	187.5	25	B Non Organic 11 0,8177753647							
24	187.5	20	в	Non Organic	12	0,6766095655 🗸				
evaluations done										

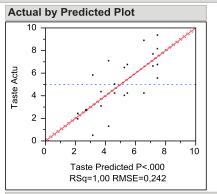
	s <u>R</u> ows	<u>Cols D</u> OE <u>A</u> nal			ndow <u>H</u> e	
🖳 🎦 🚰 🖳	1   % 🗈	a 🛍 🖶 😹 i	s 📕 🗄	*   F* 5% #\$ \$*	• ** #	
1 6/0 Cols 💌						
24/0 Rows	Day	Temperature	Time	Type of Potato	Taste	Acylamide
1	A	200	20	Organic	1,3	57,4
2	A	200	20	Non Organic	0,5	59,0
3	A	200	25	Organic	5,6	62,2
4	A	200	25	Non Organic	4,2	65,0
5	Α	175	25	Organic	5,0	54,4
6	Α	175	25	Non Organic	4,3	55,3
7	Α	175	20	Non Organic	1,9	40,5
8	Α	175	20	Organic	2,6	40,1
9	Α	187.5	20	Organic	4,2	52,2
10	Α	187.5	20	Non Organic	4,0	52,8
11	A	187.5	25	Non Organic	6,6	62,9
12	A	187.5	25	Organic	6,7	60,3
13	в	175	20	Organic	2,7	24,0
14	в	175	20	Non Organic	2,4	25,5
15	в	175	25	Non Organic	3,1	35,3
16	в	175	25	Organic	4,2	34,8
17	в	200	20	Non Organic	5,8	34,1
18	в	200	20	Organic	7,1	33,1
19	в	200	25	Organic	9,4	39,7
20	в	200	25	Non Organic	8,9	40,9
21	в	187.5	25	Organic	8,2	40,2
22	в	187.5	25	Non Organic	7,6	41,2
23	в	187.5	20	Organic	6,7	34,6
24	в	187.5	20	Non Organic	6,5	35,7
4					1	
valuations done						<u>↓</u> ▼ □ ☆



## Model specified in JMP

Report: Fit Model - JMF				<u>_   ×</u>
⊿ ■ Model Specificat	ion			
Select Columns	Pick Role Variables	Personality:	Standard Least Squa	ares 🔻
DWhole Plots etc. (6/0	Y Taste	Emphasis:	Effect Screening	-
Temperature     Time	optional Weight optional numeric	Method:	EMS (Traditional)	•
Type of Potato Taste	Freq Optional numeric	Help	Run	
Acylamide	By optional		🔽 Keep dialog open	
	Construct Model Effects	Remove		
	Add Day& Random	& Random		
	Cross Day*Temperature*		om	
	Nest Macros ▼ Temperature Temperature*Time	-		
	Degree 2 Attributes •	e of Potato		
	Transform  Temperature*Time No Intercept	e*Type of Pota	to	
			<b>1</b>	□ ▼ <i> </i>  .

#### **Response Taste**



#### **REML Variance Component Estimates**

		Var							
Random Effect	Var Ratio	Component	Std Error	95% Lower	95% Upper	Pct of Total			
Day	18,584761	1,0930056	3,4056578	0,1128147	6,62e+14	22,544			
Day*Temperature	55,897805	3,2874577	3,5111957	0,84172	202,89929	67,808			
Day*Temperature*Tim	6,9534062	0,4089432	0,3583131	0,123914	7,7916059	8,435			
Residual		0,0588119	0,0339551	0,0244212	0,2851846	1,213			
Total		4,8482186	3,9660612	1,553479	67,934185	100,000			
-2 LogLikelihood = 58,984486717									
Note: Total is the sum of the positive variance components									

Note: Total is the sum of the positive variance components Total including negative estimates = 4,8482186

#### Fixed Effect Tests

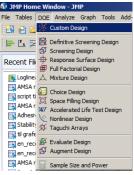
Tixed Ellect Tests									
Source	Nparm	DF	DFDen	F Ratio	Prob > F				
Temperature	2	2	2	1,3599	0,4237				
Time	1	1	3	37,4461	0,0088 *				
Temperature*Time	2	2	3	1,7288	0,3167				
Type of Potato	1	1	6	43,4652	0,0006 *				
Temperature*Type of Potato	2	2	6	4,1577	0,0736				
Time*Type of Potato	1	1	6	0,3175	0,5935				
Temperature*Time*Type of Potat	2	2	6	0.5645	0.5962				



## Demo in JMP



# Summary / Conclusion



- I have very often used these text books designs, also at different workplaces
- And yes you do have less power, for the factor you split on, however, not less power for the interactions

## Wish list for developments in JMP DOE menu

 Possibility to add hierarchy block factors, so these workarounds are not necessary

