

# Definitive Screening Designs (DSDs)

## Now available as a Minitab App

DSDs are Homegrown right here in Minnesota by a Cretin High School, College of St. Thomas, and a University of Minnesota Graduate - Chris Nachtsheim.



Chris won the 2011 ASQ Brumbaugh Award 2011 for the best paper published in the area of quality control for *“A Class of Three-Level Designs for Definitive Screening in the Presence of Second-Order Effects.”* Journal of Quality Technology, Vol 43, No. 1, (2011) pp. 2-15.

## Advantages of DSDs

- A screening design superior to Fractional Factorial Resolution III & IV or Plackett-Burman Designs
- Low number of runs,  $2(N+1)+(-1)^{N+1}$  for N = Number of Factors
- Added two Level Categorical Factors
- Main terms independent of interaction terms, unlike Res III
- Main terms independent of quadratic terms, unlike Res III, IV & V
- Estimable interactions terms, unlike Res III
- Estimable quadratic terms unlike Res III, IV & V with added center points
- Main terms independent of Blocking Factors
- Can project to RSM model (Full Quadratic) if only 2 or 3 active Factors from an original 6 or higher number of Factors

Factors	Num Runs
4	9
5	13
6	13
7	17
8	17
9	21
10	21
N	$2(N+1)+(-1)^{N+1}$

Stu Hunter says,  
“Puts Fractional Factorial Screening Designs to the side.”



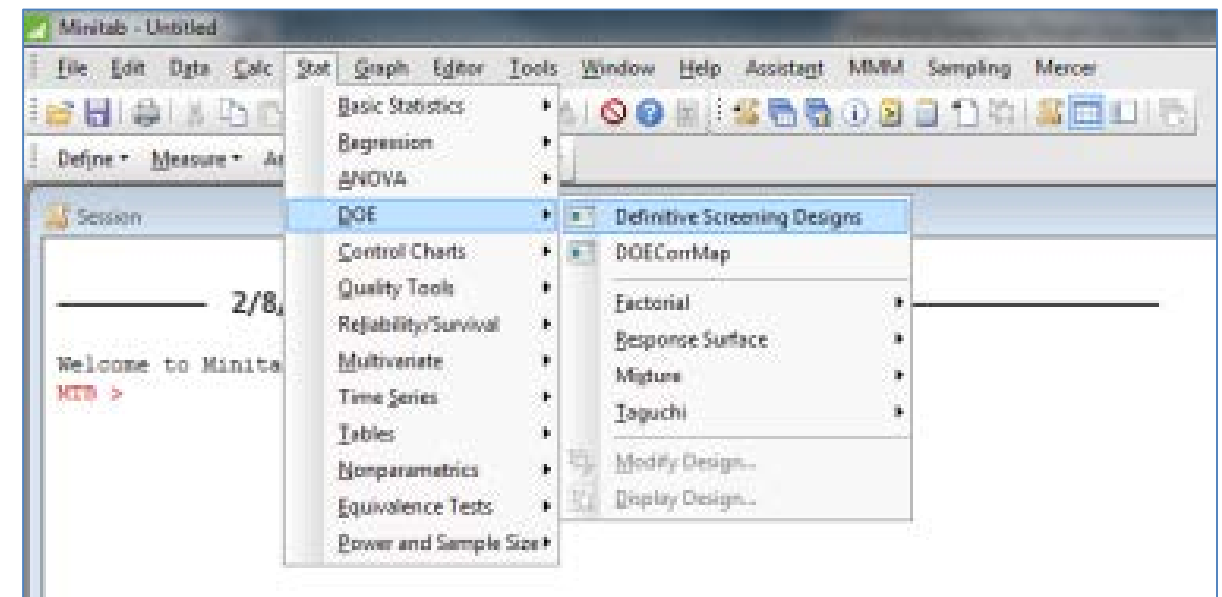
# Advantages of Minitab DSD App

- Minitab Macro written by Mike Mercer
- DSD App is embedded in Menu Structure
- Uses a Dialog Box to create Macro Code
- Continuous Factors - 4 to 20
- Categorical Factors - 0 to 5
- Blocking Factors - 1 to max # of Factors
- Center Points - Unlimited number

## Nachtsheim's Antwerp Catapult DSD Design

5 Continuous Factors  
1 Categorical Factor  
2 Center Points

Custom Dialog Box Driven Minitab Macro  
By Mercer Quality Consulting



### Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	7	25267.7	3609.67	47.17	0.000
Tension	1	6526.8	6526.80	85.29	0.000
Stop	1	8410.0	8409.99	109.89	0.000
Band Attach	1	841.5	841.52	11.00	0.011
Books	1	3048.2	3048.23	39.83	0.000
Ball	1	2073.6	2073.60	27.10	0.001
Books*Books	1	4589.1	4589.08	59.97	0.000
Tension*Band Attach	1	1314.5	1314.50	17.18	0.003
Error	8	612.2	76.53		
Lack-of-Fit	6	496.2	82.71	1.43	0.468
Pure Error	2	116.0	58.00		
Total	15	25879.9			

### Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	82.92	3.74	22.18	0.000	
Tension	25.90	2.80	9.24	0.000	1.03
Stop	29.40	2.80	10.48	0.000	1.03
Band Attach	9.30	2.80	3.32	0.011	1.03
Books	-17.70	2.80	-6.31	0.000	1.03
Ball					
Golf	-12.00	2.31	-5.21	0.001	1.11
Books*Books	-37.58	4.85	-7.74	0.000	1.15
Tension*Band Attach	13.77	3.32	4.14	0.003	1.15

### Regression Equation

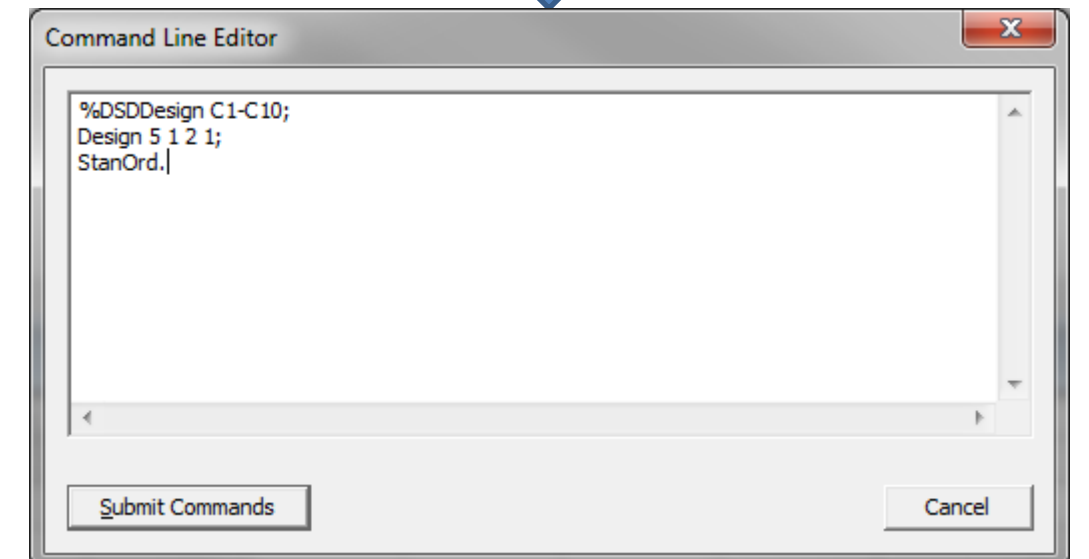
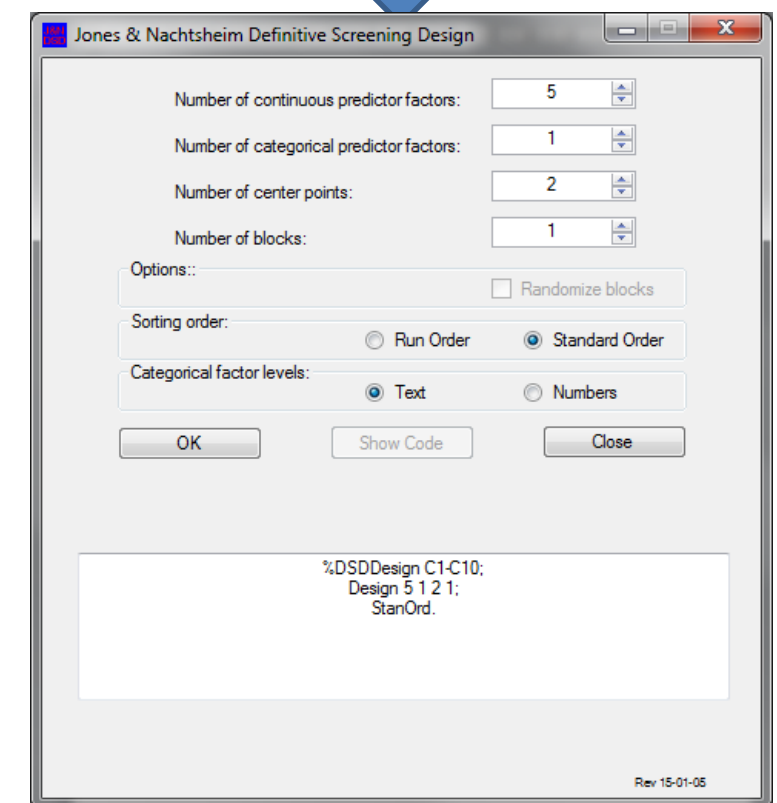
Distance =

$$82.92 + 25.90 * \text{Tension} + 29.40 * \text{Stop} + 9.30 * \text{Band Attach} - 17.70 * \text{Books} - 12.00 * \text{Ball(Golf)} + 12.00 * \text{Ball(PingPong)} - 37.58 * \text{Books*Books} + 13.77 * \text{Tension*Band Attach}$$

Quadratic Term

2 Factor Interaction Term

Minitab Analysis Catapult DSD



StdOrder	RunOrder	CenterPt	Blocks	Tension	Stop	Cup	Band Attach	Books	Ball	Distance	
1	6	1	1	0	1	1	1	1	Golf	57	
2	13	1	1	0	-1	-1	-1	-1	PingPong	37	
3	16	1	1	1	0	-1	1	1	PingPong	95	
4	4	3	1	1	-1	0	1	-1	Golf	38	
5	14	1	1	1	-1	0	-1	-1	Golf	-12	
6	10	1	1	-1	1	0	1	-1	PingPong	78	
7	7	1	1	1	1	-1	-1	0	Golf	95	
8	9	1	1	-1	-1	1	0	1	PingPong	-15	
9	4	1	1	1	1	1	-1	-1	PingPong	134	
10	15	1	1	-1	-1	-1	-1	1	Golf	6	
11	8	1	1	1	1	-1	1	1	-1	Golf	69
12	5	1	1	-1	1	-1	-1	1	PingPong	39	
13	2	0	1	0	0	0	0	0	PingPong	97	
14	12	0	1	0	0	0	0	0	Golf	78	
15	11	0	1	0	0	0	0	0	PingPong	83	
16	7	0	1	0	0	0	0	0	Golf	72	

Can perform optimization on the resultant model

