Experimental Design in Systematic Innovation

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Agenda

- **What is Systematic Innovation**
- **What is Experimental Design (Design Of Experiments, or DOE)**
  - **Factorial and Advanced**
  - **Robust Design**
- **How Experimental fits in Systematic Innovation**
  - **Within New Product Development process**
- **Case Study – Innovative and Robust**

What is Systematic Innovation

- **Culture (behaviors)**
  - **Open to ideas**
  - **Integrated in everything we do**
- **Processes**
  - **Business plan**
  - **Project selection**
  - **Execute**
  - **Constantly reinvent**
- **Tools**
  - **Brainstorming**
  - **TRIZ**

DOE Tools

- **Factorial Designs**
  - **Full (2^k form)**
  - **Fractional (2^{k-p} form)**
  - **Taguchi - maximum assumptions**
- **Advanced Designs (Response Surface Methods)**
  - **3 level (<u>not</u> a 3^k form)**
  - **5 level (composite with factorial as a basis)**
  - **Optimization**
- **Related Statistical Tools**
  - **Statistical Process Control (SPC)**
  - **Gage R&R studies (measurement system assessment)**
  - **Probabilistic Failure Assessment (PFA)**
    - **New use of old tools (Monte Carlo analysis)**

Model Building

- **The purpose of several tools is to create an equation**
  - **Y = z + a * A + b * B + c * A * B + error**
- **This is from ANOVA and DOE techniques**

Typical DOE Equations (for 3 variables)

<u>One Factor At a Time (OFAT) typical output (main effects)</u>

y = z + a*A + b*B + c*C

<u>Factorial typical output (main and interactions)</u>

y = z + a*A + b*B + c*C + d*A*B + e*A*C + f*B*C + g*A*B*C

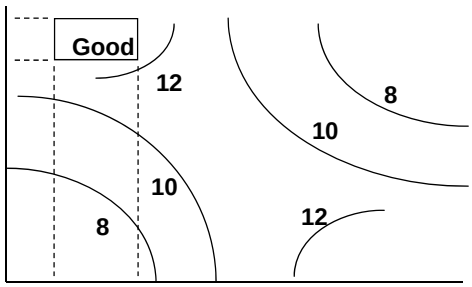
<u>Response Surface typical output (main, interactions, quadratic)</u>

$y = z + a*A + b*B + c*C + d[A]^2 + e[B]^2 + f[C]^2 + g[AB] + h[AC] + i[BC] + j[ABC] + p[A]^3 + q[B]^3 + r[C]^3 + s[A^2B] + t[AB^2] + u[A^2C] + v[AC^2] + w[B^2C] + x[BC^2]$

Typical DOE Test Table

Test #	Variable			Response			
	A	B	C	1	2	3	4
1	-	-	-				
2	+	-	-				
3	-	+	-				
4	+	+	-				
5	-	-	+				
6	+	-	+				
7	-	+	+				
8	+	+	+				

Tolerance "Postage Stamp"



How DOE fits into Systematic Innovation

Product/ Service Innovation	Project ID	Requirements	Concept	Design (Product or Mfg Process)	Marketing
Systematic/ Comprehensive	Morphological Analysis	DOE with simulations	Triz QFD (full)	DOE	DOE
Business/ Management	Business plan & Portfolio mgmt.	Risk (not FMEA)	Technology Road Map	Project Management	Profit/ Loss
Decisions	Idea Matrix	Lateral Thinking	Pugh Concept Selection	QFD	Conjoint analysis (pricing)
Non-systematic	Creativity Session (volume)	User Stories	Brainstorming	Rapid Prototypes	A/B Testing

Idea Matrix

Reduced Effort ==>

Goodwill efforts		Do it
Avoid it		Depends on which stakeholder

Interest ==>

Innovation Process – Roadmap

Strategy			
Process			
Product/ Service			
	Efficiency	**Evolution**	**Revolutionary**

Case Study – Innovative and Robust

- **New technology and new materials explored for new invasive medical device. Proof of Concept established.**
  - **Performance not consistent**
- **Testing to requirements taking too long.**
  - **DOE to develop a new, consistent, fast, test method**
- **Design options need explored.**
  - **Co-evaluation of 7 sets of design variables, using new test method and DOE**
- **Complex manufacturing operations.**
  - **Find essential and unimportant aspects of process, using DOE**
- **Result – Validation completed "clean" and FDA approval in 2 months.**

Conclusion

- **Innovation needs implementation and DOE can be a critical part of doing that**
- **For more about innovation and creativity, see these videos:**
  - **http://bit.ly/1oFa6iz - Innovation**
  - **http://bit.ly/18oPRQK - Creativity**
- **If you want to see more reference materials – visit our website**
  - **www.PerrysSolutions.com**
  - **If interested, email us to be on our quarterly newsletter where we share recent trends and learning points**
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