

## Best Practices for Robust Product and Service Design



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## Our Agenda Today

■ **The Best Design is about:**

- **Decisions**
- **Priorities**
- **Options**

**Don't get intimidated by tools. They look complex but they really are simple once you get into them just a little bit.**

## Design

### ■ Product:

- Aerospace
- Defense
- Medical

### ■ Service

- Training classes
- Consulting services for design services, clinical studies, root cause analysis
- University of St. Thomas

## Practices

- Failure Modes and Effects Analysis (FMEA)
- Design Of Experiments (DOE)
- Pugh Concept Selection
- Set based Design
- Convergent/ divergent
- Learn or confirm
- Decoupling technologies
- Requirements
- Risk Management
- Monte Carlo Analysis
- Quality Functional Deployment (QFD)
- Triz
- User Experience (UX)

Only the top 5 are considered best.  
All are important, but some in  
only certain circumstances.

## Lessons from St. Thomas

- **Unique naming of similar core steps**
  - Requirements, concept, design, fabricate and test
- **Emphasis on steps varies greatly**
  - Research, concept development, concept alternatives, analysis versus test
- **Almost all had some surprise in the first test**
  - It is how you respond to errors, not the fact that you have errors.

## Typical Improvement Attempts

- **Stage Gate (control)**
- **Design For Six Sigma (tools)**
- **Toyota Product Development System/ Fast Cycle Time (speed)**
- **Open Innovation (external resources)**
- **Outcome Based Development (big picture)**

**No one process is going to be a magic solution**

## The Solution Framework

- Understand what is important for your business and for your market
- Vision of the end state
- Understanding the right customers
- Risk management/ contingencies
- Decision making
- Increase the speed... of learning!
- Smart prototypes, maximize the learning from each one

Requirements, planning and execution

## Product Development Decisions

- Define decision to be made
- What questions need to be answered
- Is information available?
  - Information is data with understanding
- If not, how can we best collect the needed information.
  - In a timely manner, to make the necessary decision
- The alternative is a focus on execution.
  - But the plan is full of uncertainty.
  - Typical plans are contingent on “yes, continue” decisions which are not really a decision at all.

## Failure Modes Effects Analysis Template

FMEA Template										Results of action			
Item/ Function	Potential Failure Mode	Potential Effects of failure	Sev Potential causes/ mechanisms of failure	Occ Current design controls	Detectability	RPN	Recommended actions	Target completion date	owner	action taken	sev	occ	del
Motor power	more burns out during stall	customer operation ceases immediately without recovery	excess drag on system stalls motor, overheats internal components	high temperatur e materials	9	432	Design in a thermal fuse	?	?	yes	8	2	9
Purchase Process	2 week delay in part availability	new ideas cannot be readily assessed	re-bid for comparable parts	frequent customer meetings indicates this will be known	6	336	create a standard price with changes negotiated later - with a trusted vendor	?	?	yes	7	1	6
Document review	wrong invoice number included on form	billing cycle is slowed down, impacting revenues	people completing paperwork are not always sure what the number is	self check, respond when customer questions it or does not pay on time	7	140	have our best person review all invoices before processing	? - improve data entry or data source quality with training, view, etc	?	no	5	4	7

### Identify Risks and Prioritize

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## Typical DOE Test Table

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

This is the most simple case. Can add more inputs and outputs. Do not have to test every combination.  
This case is often evaluated at 3 conditions, leading to 27 tests.

Best Practices - PDMA

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## Pugh Example – For Decision Making

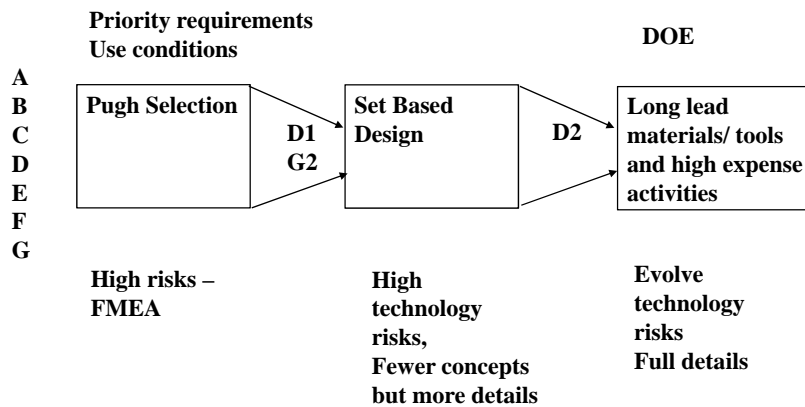
Concepts

	A	B	C	D	E	F	G	H
Requirement 1	+	+	+	0	+	+	+	0
Requirement 2	-	+	0	+	-	+	-	+
Requirement 3	+	0	+	+	0	-	+	+
Requirement 4	+	-	0	+	-	+	+	-
Requirement 5	+	+	-	+	+	+	+	+
Total +'s	4	3	2	4	2	4	4	3
Total -'s	1	1	1	0	2	1	1	1

Now what???

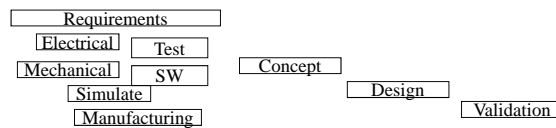
Winner but fails  
with requirement 1

## Convergent/ Divergent Concept



## Medical Device Program Management

- Organization needed critical Program Management help
- Came into an organization with no background in the product technology, no knowledge of the underlying therapy and no experience with systems/ processes for this organization.



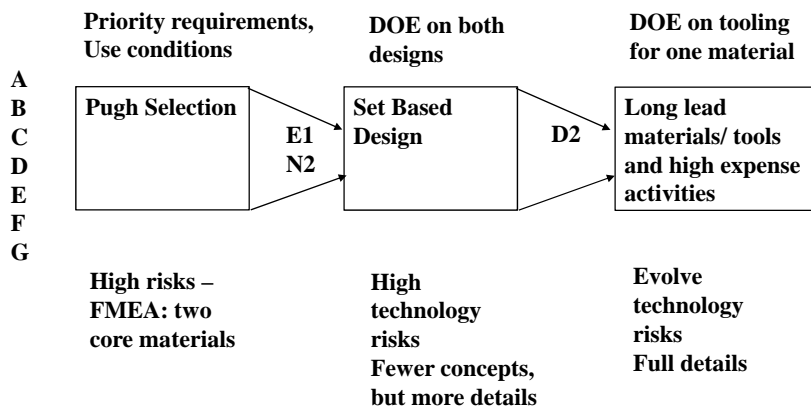
## Medical Device Project Situation

- Competitive, medical device required a fast New Product Development turn around.
- A typical 18 month device project was requested in 10 months.
  - Direct management supported 12 months as a possible stretch if we leveraged an existing design.
  - Leverage assumption ended up not being true!
  - Included design, manufacturing, tooling and reliability test functions
- Risks related to materials and tooling

## Medical Device Project Solution

- Requirements focus
- Carry parallel concepts
- Understand and develop regulatory approach
- DOE for:
  - Design (7 variables and 32 tests, versus potential of 2187 combinations using 3 conditions and all combinations)
  - Tooling (5 variables and 16 tests versus potential of 243)

## Convergent/ Divergent in Action





## Medical Device Project Results

- **Delivered project in 11 months, with a 3 week FDA approval.**
  - Yes, three weeks with the FDA is unheard of.
  - Beat competition to approval
- **The rationale for the potential schedule reduction to 12 months was inaccurate. The typical 18 month duration was more appropriate**
  - Many design and manufacturing issues on previous design. Long lead tooling could not be reused.
  - We also fixed the previous design and tools in this period of time.

Completed project in 60% of standard schedule

## Credit Card Direct Marketing

- **Goal: Increase effectiveness of offers via direct mailings**
- **Response: Sign up for card**
- **Risk: Burning up good leads with poor materials**
- **Approach: Ran efficient design with many ideas**
  - Envelope teaser, return address, "official" stamp, postage, graphics, price graphic size, sticker, personalize letter copy, copy message (targeted), letter headline, list of benefits layout, postscript on letter, signature by, product selection, value of free gift, reply envelope (new), information on buckslip (product or gift), second buckslip, interest rate
- **Results: Found 5 key main effects. Used learning to modify the strategy for future marketing campaigns.**

From "Testing 1-2-3" book

## Practice Links

Topic	Video Link
FMEA	<a href="http://bit.ly/2y0F6XS">http://bit.ly/2y0F6XS</a>
Design of Experiments	<a href="http://bit.ly/2peWLdi">http://bit.ly/2peWLdi</a>
Convergent/ divergent	<a href="http://bit.ly/2wlotUu">http://bit.ly/2wlotUu</a>
Set up for Innovation	<a href="http://bit.ly/13FB8vP">http://bit.ly/13FB8vP</a>
Requirements	<a href="http://bit.ly/1ciEAGP">http://bit.ly/1ciEAGP</a>
Risk Management	<a href="http://bit.ly/17q0y7g">http://bit.ly/17q0y7g</a>
Monte Carlo Analysis	<a href="http://bit.ly/1jleFNp">http://bit.ly/1jleFNp</a>
Quality Functional Deployment (QFD)	<a href="http://bit.ly/1mJqoGu">http://bit.ly/1mJqoGu</a>
Triz	<a href="http://bit.ly/1qdOM9r">http://bit.ly/1qdOM9r</a>
Statistics/ Decision Making	<a href="http://bit.ly/10qWaF3">http://bit.ly/10qWaF3</a>

## Perry's Solutions, LLC

- **Consulting and Training services from DOE and SPC to project planning and management**
  - High stakes product development problem solving and training
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