ESD.71 Application Portfolio: Flexibility in the Product Design Process

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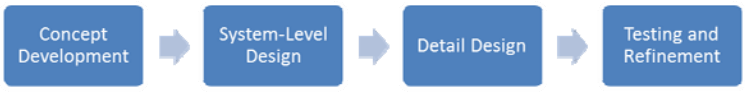
12/09/2010

Why Model Design?

Complex system

Significant early investment

Critical decision making



Uncertainties in:

-customer requirement

-technology performance

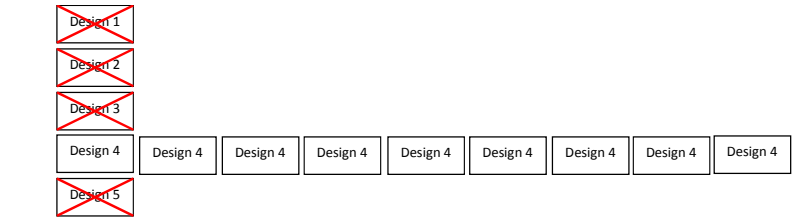
-market/competition

Point-based Design

One solution is chosen from initial set of ideas based on estimates of customer requirement and performance level

Design is frozen early to allow parallel sub-team work and optimization

Point-based (Deterministic) Model



Period	0	1	2	3	4	5	6	7	8
			Phase 1 Review Close 2 Designs		Phase 2 Review Close 1 Design		Phase 3 Review Close 1 Design		Phase 4 Review Final Design

Period	0	1	2	3	4	5	6	7	8
Design 1 performance level	73.6	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Design 2 performance level	82.6	67.3	71.0	82.6	75.9	80.6	78.1	78.6	78.4
Design 3 performance level	72.6	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Design 4 performance level	68.6	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Design 5 performance level	78.1	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Required performance level	80	77.9	82.2	81.0	81.6	80.4	77.9	77.9	77.9

Set-based Design

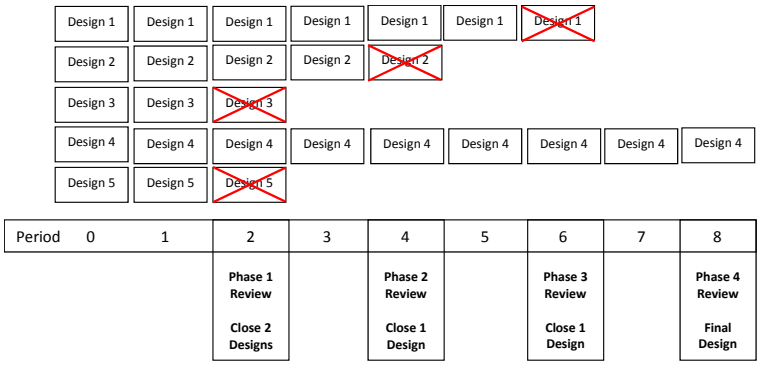
Term coined by Allen Ward

A design-space-spanning set of ideas is considered and analyzed

Slowly converge to final solution

Waste of resources in carrying extra designs ahead

Set-based (Flexible) Model



Period	0	1	2	3	4	5	6	7	8
Design 1 performance level	66.6	79.0	82.1	83.7	89.2	88.6	88.6	CLOSE	CLOSE
Design 2 performance level	77.3	86.6	93.0	90.9	90.9	CLOSE	CLOSE	CLOSE	CLOSE
Design 3 performance level	78.6	88.3	88.0	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Design 4 performance level	70.6	83.7	74.0	89.2	88.7	76.2	77.3	72.3	72.7
Design 5 performance level	66.3	86.0	96.4	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE	CLOSE
Required performance level	60	82.1	76.6	81.6	77.7	80.1	79.7	79.7	79.7

The Simulation Model

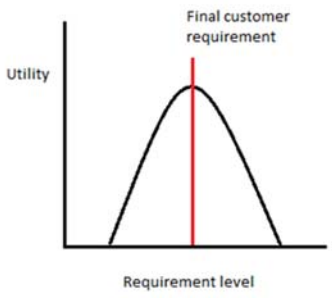
Explore parallel exploration and delay of decisions

Customer requirement and design performance levels treated as random walking variables, with fixed volatility

Development cost per design period increases over project life

Effective annual discount rate of 10%

The Simulation Model

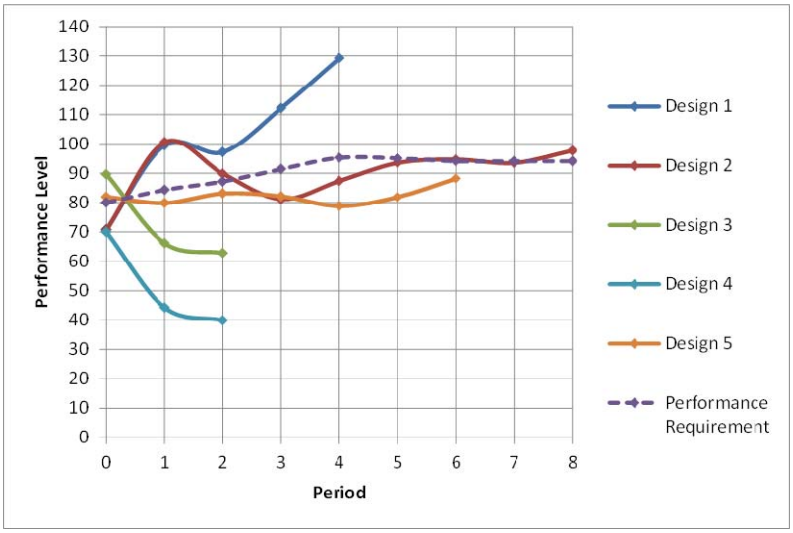


Sales revenue a parabolic function of difference between final customer requirement and design performance level

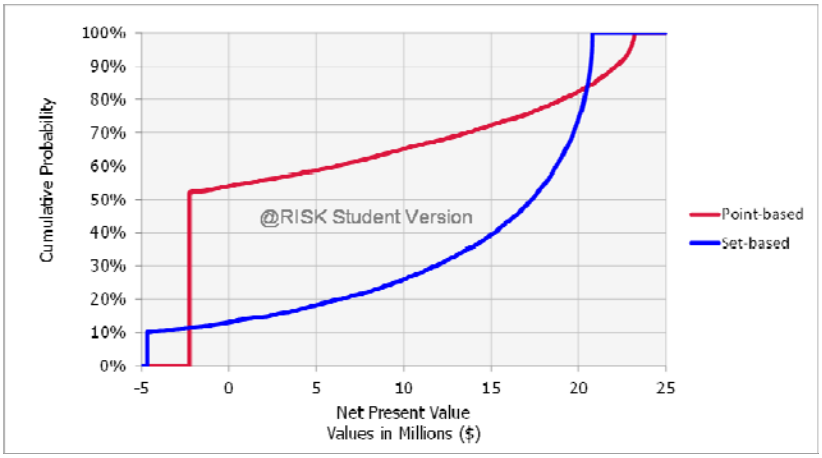
No revenue for first 16 months of development

Sales revenue for following 24 months

The Simulation Model



Simulation Results



Monte Carlo simulation with 5000 runs

Simulation Results

Metric	Point-based	Set-based	% Difference
ENPV	**$6,023,742**	$13,500,280	**124%**
P_5	-$2,243,407	**-$4,657,918**	**108%**
P_{95}	$22,948,920	**$20,775,600**	**9%**
Std Dev	**$10,040,560**	$8,410,015	**16%**
Development Cost	$2,243,407	**$4,657,917**	**126%**
ENPV/Development Cost	4.03	**4.00**	**1%**

Questions?

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Title slide pictures from:

1) http://www.pharmaceutical-int.com/article/center-of-competence-for-isolator-technology-h2o2-decontamination.html

2) http://www.solardave.com/index.php/pros-and-cons-of-solar-panel-micro-inverters-video/