

Design Concept Selection

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Members of the MMRA

adapted from Chrysler Group LLC “DFSS Pugh Matrix” 1/25/11

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Pugh Concept Selection

Techno-speak:

A Pugh Matrix requires multiple iterations of evaluation where alternative concepts are combined and/or changed to improve their performance compared to several criteria



English!

We've got a bunch of ideas...how do we choose the best one??



“A major advantage of controlled convergence over other matrix selection methods is that it allows alternative convergent (analytic) and divergent (synthetic) thinking to occur, since as the reasoning proceeds and a reduction in the number of concepts comes about for rational reasons & new concepts are generated.” – Dr. Stuart Pugh



Steps for Pugh Concept Selection

There are 3 Basic Steps to Concept Selection (picking the best idea that we're gonna run with) :

1. Gather Ideas

- Creation of Alternative Concepts (*Hmmm...what ways might we be able to do that?*)
- Identify Concept Evaluation Criteria (*Gee...what different things does it have to do?*)
- Prepare Evaluation Matrix (I ♥ Excel)
- Select DATUM (*Date 'em???*)

2. Conduct First Run (Pugh Matrix)

Criteria \ Concept	Today's Concept	Concept			
		Concept 1	Concept 2	Concept 3	Concept 4
Criteria 1	DATUM				
Criteria 2					
Criteria 3					
Criteria 4					
Criteria 5					
Criteria 6					

3. Conduct Controlled Convergence Runs

- Select new DATUM
- List Alternative Concepts

Design Concepts	Today's Concept	Concept					Hybrid Concept 5
		Concept 1	Concept 2	Concept 3	Concept 4		
Criteria 1	DATUM	R	+	S	R	R	
Criteria 2		R	-	R	S	R	
Criteria 3		R	S	R	R	S	
Criteria 4		R	S	R	R	R	
Criteria 5		R	R	S	R	R	
Criteria 6		R	R	S	R	S	



Creation of Alternative Concepts

There are several ways to identify Alternative Concepts :

Brainstorming



Group of experts pool their knowledge and experience to develop new, alternative concepts for intended functions

Technical Benchmarking



Group of experts evaluate multiple competitive and/or related designs to identify all the different ways currently being used to perform the same function(s)

Today's Activity

Morphological ("Morph") Matrix

Group of experts identifies all intended functions for of a given design, along with all possible choices for performing each function, then combines those alternatives in different ways to create new, feasible design concepts

Function	Design Parameter 1	Design Parameter 2	Design Parameter 3	Design Parameter 4
Input/Output	USB Cable	Wireless	Bluetooth	SD Card
Storage/Supply Method	Flash Memory	None	Hard Drive	SD Card
Power/Supply Electricity	Chemical Batteries	Zinc Air Fuel Cell	Hydrogen Fuel Cell	BTG
Form/Structure/Weight/Size/Color	Car Buds	Speakers	Paama Arc	Table Cancellation

Class Activity

Let's figure out the best concept
for an MP3 player!



*(This dude is
OLD!)*

Creation of Morph Matrix to Identify Concepts

Solutions Functions	Design Parameter (Way to do it) 1	Design Parameter 2	Design Parameter 3	Design Parameter 4

Creation of Morph Matrix to Identify Concepts

Solutions Functions	Design Parameter 1	Design Parameter 2	Design Parameter 3	Design Parameter 4
Import Music	USB Cable	Wireless	Bluetooth	SD Card
Store/Supply Music				
Store/ Supply Electricity				
Convert Electrical Energy To Sound Energy				

Creation of Morph Matrix to Identify Concepts

Solutions Functions	Design Parameter 1	Design Parameter 2	Design Parameter 3	Design Parameter 4
Import Music	USB Cable	Wireless	Bluetooth	SD Card
Store/Supply Music	Flash Memory	None (Stream Music)	Hard Drive	SD Card
Store/ Supply Electricity				
Convert Electrical Energy To Sound Energy				

Creation of Morph Matrix to Identify Concepts

Solutions Functions	Design Parameter 1	Design Parameter 2	Design Parameter 3	Design Parameter 4
Import Music	USB Cable	Wireless	Bluetooth	SD Card
Store/Supply Music	Flash Memory	None (Stream Music)	Hard Drive	SD Card
Store/ Supply Electricity	Chemical Battery	Zinc air fuel cell	Hydrogen Fuel Cell	RTG (radioisotope thermoelectric generator)
Convert Electrical Energy To Sound Energy				

Creation of Morph Matrix to Identify Concepts

Solutions / Functions	Design Parameter 1	Design Parameter 2	Design Parameter 3	Design Parameter 4
Import Music	USB Cable	Wireless	Bluetooth	SD Card
Store/Supply Music	Flash Memory	None (Stream Music)	Hard Drive	SD Card
Store/ Supply Electricity	Chemical Battery	Zinc air fuel cell	Hydrogen Fuel Cell	RTG <small>(radioisotope thermoelectric generator)</small>
Convert Electrical Energy To Sound Energy	Ear buds	Speakers	Plasma Arc	Noise Canceling Headphones

Creation of Morph Matrix to Identify Concepts

Solutions Functions	Design Parameter 1	Design Parameter 2	Design Parameter 3	Design Parameter 4
Import Music	USB Cable	Wireless	Bluetooth	SD Card
Store/Supply Music	Flash Memory	None (Stream Music)	Hard Drive	SD Card
Store/ Supply Electricity	Chemical Battery	Zinc air fuel cell	Hydrogen Fuel Cell	RTG <small>(radioisotope thermoelectric generator)</small>
Convert Electrical Energy To Sound Energy	Ear buds	Speakers	Plasma Arc	Noise Canceling Headphones

Creation of Morph Matrix to Identify Concepts

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Convert Electrical Energy To Sound Energy	Ear buds	Speakers	Plasma Arc	Noise Canceling Headphones

Creation of Morph Matrix to Identify Concepts

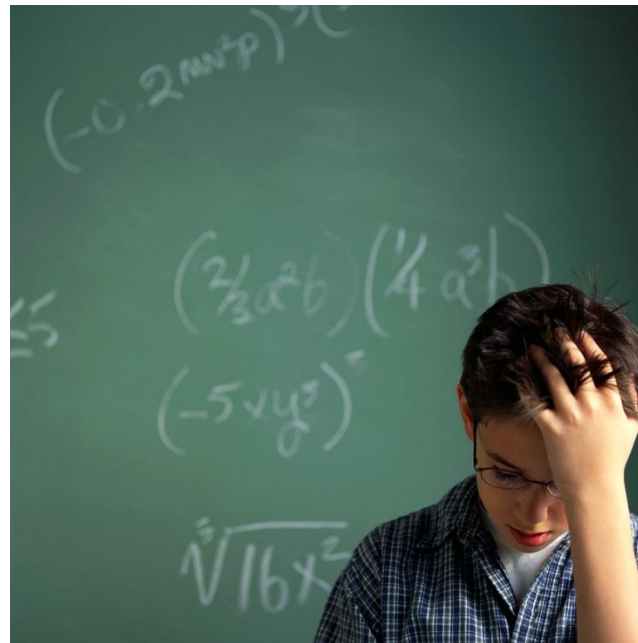
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Convert Electrical Energy To Sound Energy	Ear buds	Speakers	Plasma Arc	Noise Canceling Headphones

Creation of Alternative Concepts

$$4^4 = 256$$

Combinations → Potential Concepts to evaluate

Use a Pugh Matrix to
“synthesize”
the concepts!



Ugh...

Identify Concept Evaluation Criteria

There are several types of Criteria that should be included :

Customer Needs

For example :

- Voice of Customer
- Engineering Measures (“Best in Class” or “Competitive”)

Business Needs (Company)

For example :

- Cost
- Packaging
- Feasibility
- Manufacturability & Service
- ROI (Return on Investment)

“Do no Harm” Needs (Compromise)

For example :

- Effect on other subsystems
- Effect on other engineering groups

Criteria should also have clear
“Directionality”
ex. - for Cost, *LESS* is *BETTER*

Prepare Evaluation Matrix

Design Concepts Evaluation Criteria	ipod	Concept 1	Concept 2	Concept 3	Concept 4
Cost	DATUM				
Size					
?					
?					
?					
?					

Conduct First Run

Design Concepts Evaluation Criteria	Today's Concept	Concept 1		Concept 2		Concept 3		Concept 4	
Criteria 1	DATUM	+	Rationale	+	Rationale	S	Rationale	-	Rationale
Criteria 2		-	Rationale	-	Rationale	S	Rationale	+	Rationale
Criteria 3		S	Rationale	+	Rationale	-	Rationale	S	Rationale
Criteria 4		+	Rationale	S	Rationale	+	Rationale	-	Rationale
Criteria 5		-	Rationale	+	Rationale	+	Rationale	-	Rationale
Criteria 6		S	Rationale	S	Rationale	S	Rationale	S	Rationale

Can we combine strengths of all concepts?



Design Concepts Evaluation Criteria	Today's Concept	Concept 1		Concept 2		Concept 3		Concept 4		Hybrid Concept 5	
Criteria 1	DATUM	+	Rationale	+	Rationale	S	Rationale	-	Rationale		
Criteria 2		-	Rationale	-	Rationale	S	Rationale	+	Rationale		
Criteria 3		S	Rationale	+	Rationale	-	Rationale	S	Rationale		
Criteria 4		+	Rationale	S	Rationale	+	Rationale	-	Rationale		
Criteria 5		-	Rationale	+	Rationale	+	Rationale	-	Rationale		
Criteria 6		S	Rationale	S	Rationale	S	Rationale	S	Rationale		

Is Criteria 6 Useful?
Can we strengthen concept?



Conduct Controlled Convergence Runs

Evaluation Criteria \ Design Concepts	Concept 2	Concept 1		Concept 3		Hybrid Concept 5		New Concept 6	
Criteria 1	NEW DATUM	S	Rationale	-	Rationale	+	Rationale	+	Rationale
Criteria 2		-	Rationale	-	Rationale	S	Rationale	+	Rationale
Criteria 3		-	Rationale	-	Rationale	-	Rationale	-	Rationale
Criteria 4		S	Rationale	S	Rationale	+	Rationale	+	Rationale
Criteria 5		-	Rationale	S	Rationale	+	Rationale	+	Rationale
Criteria 7**		-	Rationale	-	Rationale	S	Rationale	S	Rationale

Evaluation Criteria \ Design Concepts	Concept 2	Concept 1		Concept 3		Hybrid Concept 5		New Concept 6		Hybrid Concept 7	
Criteria 1	NEW DATUM	S	Rationale	-	Rationale	+	Rationale	+	Rationale		
Criteria 2		-	Rationale	-	Rationale	S	Rationale	+	Rationale		
Criteria 3		-	Rationale	-	Rationale	-	Rationale	-	Rationale		
Criteria 4		S	Rationale	S	Rationale	+	Rationale	+	Rationale		
Criteria 5		-	Rationale	S	Rationale	+	Rationale	+	Rationale		
Criteria 7		-	Rationale	-	Rationale	S	Rationale	S	Rationale		

Choose Strongest Concept(s)

Design Concepts	New Concept 6	Concept 2		Hybrid Concept 5		Hybrid Concept 7	
Evaluation Criteria							
Criteria 1	NEW DATUM	-	Rationale	S	Rationale	S	Rationale
Criteria 2		-	Rationale	-	Rationale	S	Rationale
Criteria 3		S	Rationale	S	Rationale	+	Rationale
Criteria 4		-	Rationale	S	Rationale	S	Rationale
Criteria 5		-	Rationale	S	Rationale	S	Rationale
Criteria 7 **		S	Rationale	S	Rationale	S	Rationale

Morph Matrix – Group Example - Lunchbox

Solution Function	Parameter 1	Parameter 2	Parameter 3	Parameter 4
Function 1				
Function 2				
Function 3				
Function 4				

Pugh Matrix – Group Example – First Run

Concept	Today's Device	Concept 1		Concept 2		Concept 3		Concept 4		Hybrid Concept	
Criteria											
Criteria 1	DATUM										
Criteria 2											
Criteria 3											
Criteria 4											
Criteria 5											
Criteria 6											

Pugh Matrix – Group Example – Controlled Convergence

		Concept X		Concept Y		Hybrid Concept		New Concept	
Concept	"Best" Concept from 1 st Run								
Criteria	DATUM								
Criteria 1									
Criteria 2									
Criteria 3									
Criteria 4									
Criteria 5									
Criteria 6									