

Design Thinking

Unit 4 – Value Engineering

Dr. Christina Grace



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Value Engineering

- ❑ Definition: An organized study of the **functions** to satisfy the **user's needs** with a **quality** product at the **lowest life cycle cost** through applied **creativity**.
- ❑ Origins: During world war 2 when resources were scarce.
- ❑ What can be changed: Design, Materials, Process



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Value Engineering

- ☒ $\text{Value}^{\max} = \text{Performance}^{\max} / \text{cost}^{\min}$
- ☒ Product aspects: Functionality, Quality, Performance, Durability & Dependability, Aesthetics, Cost.



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Product Engineering

- ☒ Defining the problem
 - ☒ Who would need?
 - ☒ What is needed?
 - ☒ When is it needed?
 - ☒ Where is it needed?
 - ☒ Why is it needed?



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Steps in defining the problem

- ✉ Identify the background issues
- ✉ Know the resources and constraints of the firm
- ✉ Know the objective of the decision maker
- ✉ Know buyer behavior
- ✉ Know about legal and economic environment
- ✉ Know the marketing and technological skills of the firm



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Problem definition

- ☒ E.g. Improve fuel efficiency of four stroke petrol engine.
- ☒ Initial costs may be high, but due to better efficiency, life cycle cost may be low.



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Value Engineering Job Plan

- ☒ Orientation
- ☒ Information
- ☒ Functional analysis
- ☒ Creative alternatives
- ☒ Evaluation
- ☒ Development
- ☒ Presentation
- ☒ Implementation



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VEJP - Orientation

- ☒ Identify and prioritize issues
- ☒ Draft scopes and objectives
- ☒ Establish evaluation factors
- ☒ Determine study team
- ☒ Collect data
- ☒ Prepare for value study



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VEJP - Information

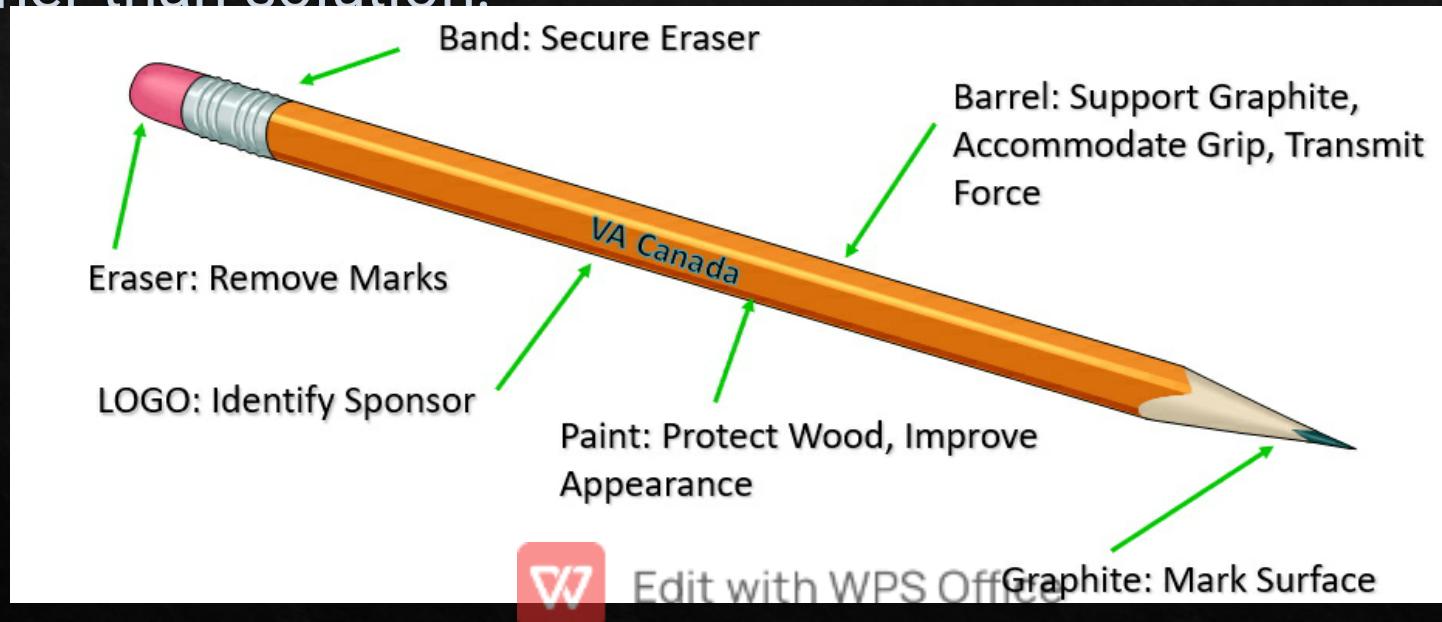
- ❑ Gathering and tabulation of information concerning the item as presently designed.
- ❑ Areas of high cost or low worth are identified.



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VEJP – Functional Analysis

- It is a technique to identify and understand needs of the project, product, or service. It supports creative problem solving by focusing on the required performance or need rather than solution.



VEJP – Creative alternatives

- ¤ Generate many ideas to produce alternate means of performing the FUNCTIONS.

VEJP – Evaluation

- ¤ Ideas are systematically evaluated, shortlisted for their potential and selected for development.



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VEJP – Development

- ☒ Idea is developed to a sufficient degree to be able to compare it with the original product/ proposal

VEJP – Presentation

- ☒ Presenting the analysis to decision makers. Further discussions may happen.

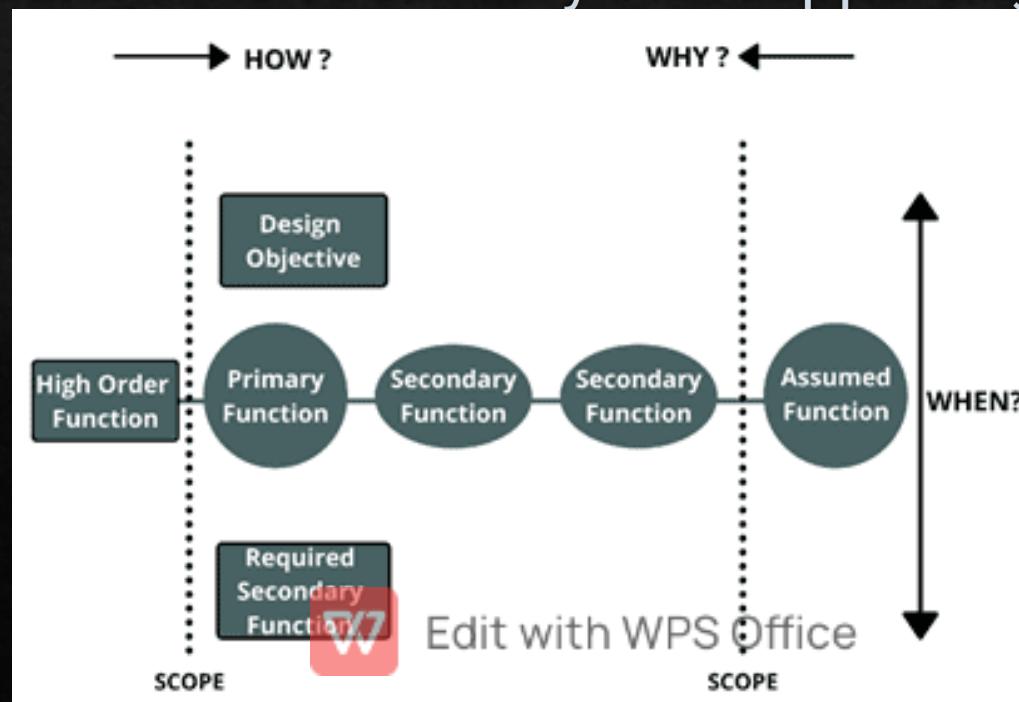
VEJP – Implementation

- ☒ Develop an implementation plan. Execute it. Monitor the plan to completion.

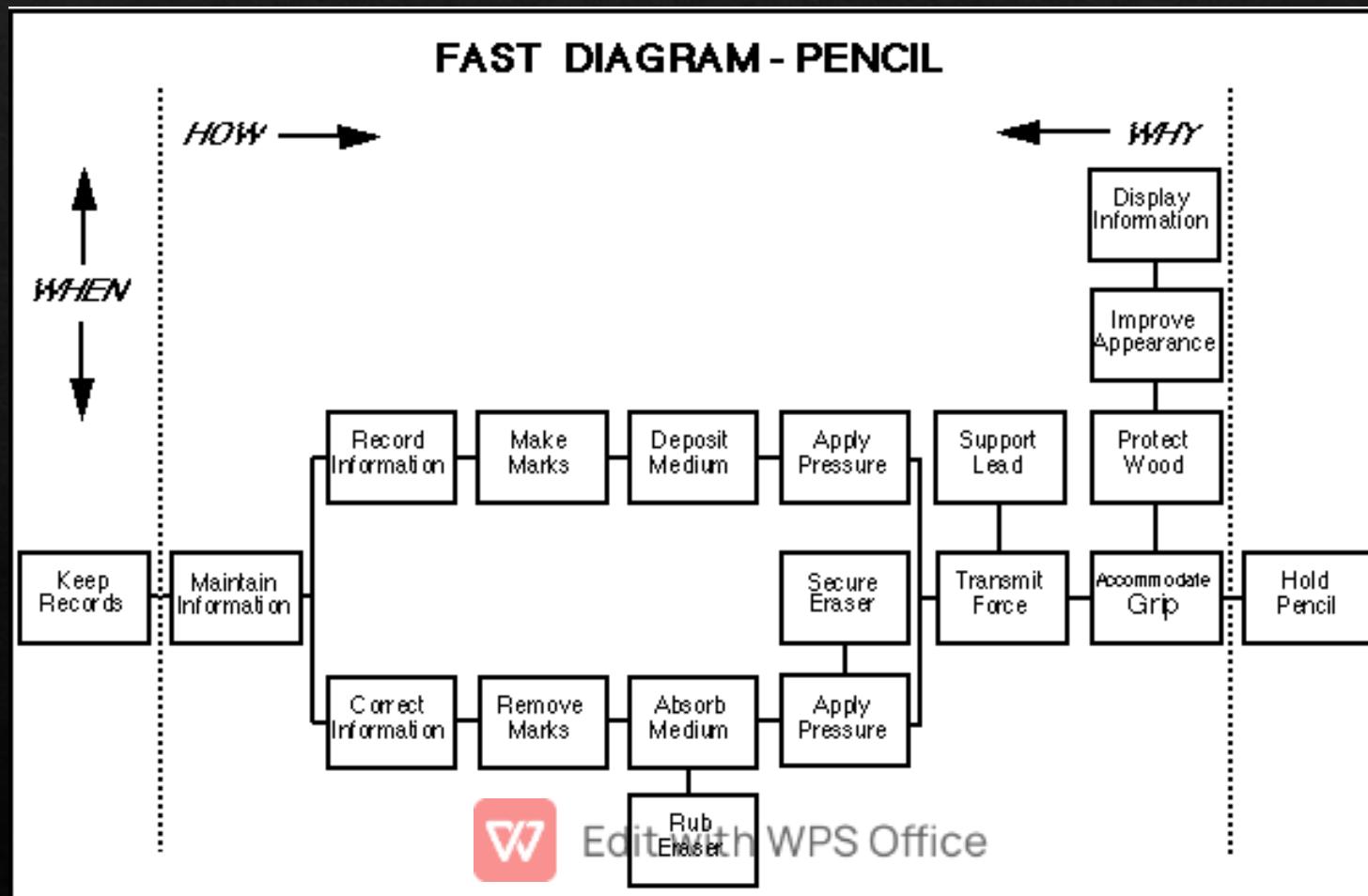


Functional analysis – FAST diagram

Expanding the function list using active verbs that express what the item does and nouns that express the measurable object of the verb. Build a function model using Function Analysis System Technique (FAST) to determine secondary and supporting functions.



Functional analysis – FAST diagram



Functional analysis – Divan (case study)

1. Write all the individual parts/ components of the product.
2. Write the functional analysis of the parts – Name of the part, Quantity, It's function (verb and a noun), Role of each function wrt part (basic/ secondary), Role of each function wrt assembled product (basic/ secondary)



Functional analysis – Divan (case study)

Part Name/ Description	Quantity	Function		Part		Assembly	
		Verb	Noun	Basic	Secondary	Basic	Secondary
Steel Frame (Complete)	1	Hold	Assembly	X		X	
		Hold	Parts		X		
		Provide	Strength		X		
		Provide	Grip		X		
Bed Top (Diwan Top)	1	Holds	Material		X		
		Provide	Surface	X			
		Improve	Appearance	X			
Side Strip (Long)	2	Support	Frame			X	
		Improve	Appearance	X			
Side Strip (Short)	2	Support	Frame			X	
		Improve	Appearance	X			
Leg Strip	4	Support	Frame			X	
		Improve	Appearance	X			



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Functional analysis – Divan (case study)

3. Write down cost of each part
4. Identify interacting functions and give weightage
5. Find creative alternative
6. Do function cost worth analysis
7. Evaluate
8. Build Cost Benefit matrix
9. Present, and Implement

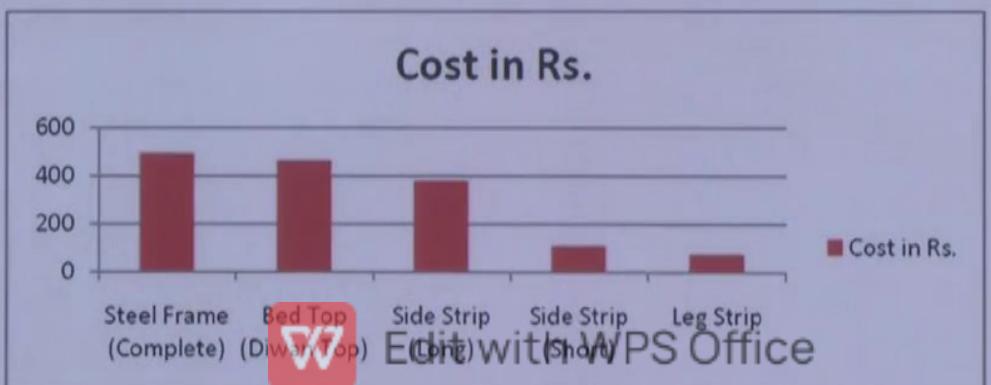


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Functional analysis – Divan (case study)

Costing of different parts

Sr. No.	Part	Quantity	Cost in Rs
A	Steel Frame (Complete)	1	495.00
B	Bed Top (Diwan Top)	1	465.00
C	Side Strip (Long)	2	380.00
D	Side Strip (Short)	2	111.00
E	Leg Strip	4	75.00
Total			1526.00



Functional analysis – Divan (case study)

Functional evaluation of different parts

	B	C	D	E
A	A3	A3	A3	A3
B	B2	B2	B2	
C		C1	C1	
D			D1	
E				E

Key Letter	Part	Function	Weight	% Cost
A	Steel Frame (Complete)	Hold Assembly	12	32.43%
B	Bed Top (Diwan Top)	Provide Surface	06	30.47%
C	Side Strip (Long)	Support Frame	02	24.90%
D	Side Strip (Short)	Support Frame	01	7.28%
E	Leg Strip	Improve Appearance	01	4.92%

The chart displays the weight and percentage cost of five parts (A, B, C, D, E) across three performance levels: Major, Medium, and Minor. Part A is the major performance component, while parts B, C, D, and E are minor performance components.

Performance Level	Part	Weight	% Cost	
Major Performance-3	A	12	32.43%	
	Medium Performance-2	B	06	30.47%
		C	02	24.90%
		D	01	7.28%
		Minor Performance-1	E	01

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Functional analysis – Divan (case study)

Creative phase

The following ideas were generated during this phase :

1. Make the design simpler
2. Use the wheels for movement
3. Make it in powder coating
4. Reduce the thickness of the board
5. Use waste pieces of required size in some places
6. Reduce the size of the board in some places
7. Reduce the gauge of the pipe



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Functional analysis – Divan (case study)

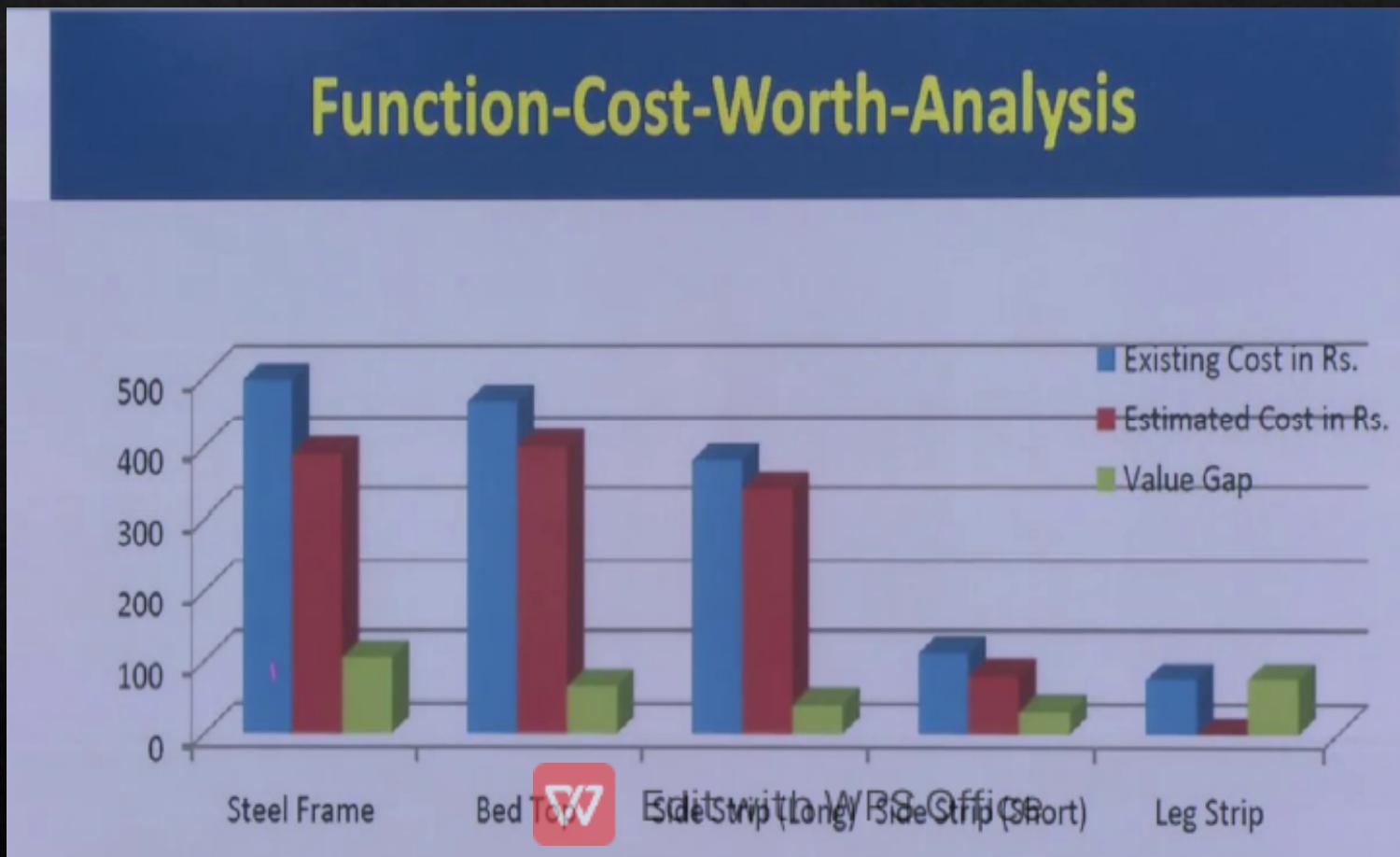
Function-Cost-Worth-Analysis

Function		Existing Cost in Rs.	Worth		Value Gap	Ranking
Verb	Noun		Tentative Alternative	Estimated Cost in Rs.		
Hold	Assembly	495.00	M.S.	390.00	105.00	I
Provide	Surface	465.00	Board	400.00	65.00	III
Improve	Appearance	380.00	Board	340.00	40.00	IV
Improve	Appearance	111.00	Board	80.00	31.00	V
Improve	Appearance	75.00	Eliminate	00.00	75.00	II
	Total	1526.00		1180.00	346.00	



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Functional analysis – Divan (case study)



Functional analysis – Divan (case study)

Evaluation phase

- Parameters
 - a) Rigidity b) Light Weight
 - c) Durability d) Appearance
- Alternative –I Change gauge of material (Pipe)
- Alternative –II Reduce thickness of Board (Wherever Required)

A	B	C	D	RAW SCORE	FINAL SCORE
	A3	A2	A2	07	7
B	B2	B2	04	4	
C	C1		01	1	
D		D1	01	1	

Weightage of the Parameters



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Functional analysis – Divan (case study)

Evaluation phase

- Evaluation matrix for existing and proposed

5	Excellent
4	Very Good
3	Good
2	Fair
1	Poor

Parameters weightage Alternative	Rigidity	Light Weight	Durability	Appearance	Total
7	4	1	1	1	
Existing	4 28	3 12	3 3	3 3	46
Alternative -I	4 28	4 16	3 3	3 3	50
Alternative -II	4 28	5 20	3 3	3 3	54



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Functional analysis – Divan (case study)

- Cost Benefit Matrix

Sr. No	Parameters	Existing	Alternative I	Alternative II
1	Steel Frame	495.00	297.00	297.00
2	Plywood	781.00	756.00	680.00
3	Hardware	50.00	50.00	50.00
4	Frame Painting	100.00	100.00	100.00
5	Other	100.00	100.00	100.00
Total		1526.00	1303.00	1227.00



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Functional analysis – Divan (case study)

- The samples as per alternative-I & alternative-II were manufactured and are tested with the costumer.
- Reports were found to be satisfactory for both alternatives
- In Alternative-I and Alternative-II, weight reduction was found with cost reduction.
- The proposal was put up to the management / finance department for approval

- The total saving incurred per product by the implementation of above recommendations are 19.60% for alternative-II and 14.61% for alternative-I.



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Functional analysis

Customer Requirements/ Functions	Importance	Mechanisms				
		Lead	Eraser	Body	Paint	Band
Make Marks	30	◎ 150				
Remove Marks	20		◎ 100			
Prevent Smudges	15	○ 45		○ 45		
Support Lead	5			◎ 25		
Improve Appearance	10			○ 30	○ 30	△ 10
Accommodate Grip	20			◎ 100	△ 20	
Column weight	555	195	100	200	50	10
Mech. weight	1.0	.351	.180	.360	.090	.018
Mech. target cost	2.80	.98	.51	1.01	.25	.05
Mech. actual cost	2.92	.20	.43	.94	.10	.25

© Strong correlation weight factor = 5
○ Moderate correlation weight factor = 3
△ Weak correlation weight factor = 1

Functional analysis

			Functions of pen				Total value of function
Components	Cost	Value:	Mark paper	Protect nib	Prevent leaks	Look attractive	
Barrel	42		80	60	40	80	40
Top	18		5	40	4	20	9
Nib	114		90	80	14	20	110
Clip	120				30	10	90
			90	19	46	139	20

High value, low cost so no need to change

Function value is divided between components ($40 = 10 + 20 + 10$)

High value, high cost so possible improvement

Total cost of function: Component cost is divided between functions ($120 = 30 + 90$)

Low value, high cost so look for improvement

Value of 'protect nib' is quite high and cost is low ($5 + 14 = 19$) so no need to change

Value of clip = $10 + 10 = 20$ but cost is high (120) so look for improvement



Functional analysis

