

STUDY OF A WATER DOZER BY MEANS OF FAST AND VALUE ANALYSIS AND ENGINEERING

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Abstract: The aim of this work is to study the possibilities of improving the value of a water dozer using specific creativity techniques: FAST analysis, Value Analysis and Engineering (VAE), as well as statistic investigations amongst the product users. Conceiving novel solutions implies the use of Pareto technique and psychological creativity methods. The solutions assessment is achieved both through VAE techniques and multi-criteria analysis; experimental data were processed using specific software.

Keywords: FAST analysis, Value Analysis and Engineering, creativity methods, statistic investigations, specific software.

INTRODUCTION

For over 60 years since its invention, Value Analysis and Engineering (VAE) [1] continues to fascinate product designers. Part of them we propose a case study referring to the possibilities for improvement of a product using creativity techniques: VAE, FAST analysis, Pareto, survey techniques, psychological creativity methods.

1. PRODUCT DESCRIPTION

The Water Dozer is a machine used not only for instant water cooling, but for instant water heating. The instant system can heat the water to 94 °C, therefore the hot water is perfect for tea, coffee or instant soup. The cooling is achieved up to 6 °C, a function useful in hot weather, offering a cooling, refreshing drinking water.

This machine satisfies the needs of both a company and an individual in a house setting. Periodically a cleansing of the water path is required. This is achieved by a system with ozone.

The following are the principle parts of the Water Dozer: the casing, the water-collecting tray, the cup holder, a 19L exchangeable water tank, the water spouts, cold water tank, hot water tank, compressor, condensation maker, automating system (switch for hot water, temperature control for cold water, fuse, grounding, LED lights for hot/cold water, thermostat, etc.)

Technical Specs: Voltage:220V/50Hz; Thermal Output: 120W for cooling, 430 W for heating; Capacity: 5L/h for cooling/heating; Cooling agent: R-134a; Energy consumption 8.5-10.5 kwh/week.
The product is showed in fig. 1.

2. PRODUCT FUNCTIONS

After a brainstorming session, the following functions of the Water Dozer were deemed necessary:

- F1 – It is long-lasting;
- F2 – It is easy to maintain;
- F3 – It is esthetic;
- F4 – It survives environmental agents;
- F5 – It contains instructions;
- F6 – It transforms electric energy into heat or cold;
- F7 – It allows connection to an electrical source;
- F8 – It protects the user from electric shock;
- F9 – It is air-tight;
- F10 – It is hygienic;
- F11 – It allows temperature control;
- F12 – It allows turning the water on/off;
- F13 – It is easy to use;

The Result is confirmed through the FAST Analysis [2] showed in Fig. 2.

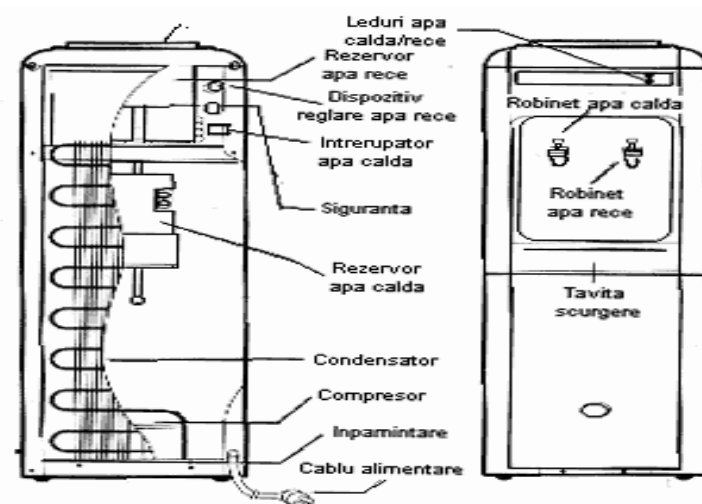


Fig.1. Water Dozer

Technical dimension of functions (fragment). Table 1

Subject	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
A	40	20	20	10	20	100	80	100	70	100	60	90	50
B	50	10	20	30	10	90	90	100	60	80	90	100	80
C	80	10	10	10	30	100	70	100	80	90	80	100	70
D	50	20	30	30	10	100	80	100	80	100	90	100	80
E	60	10	10	20	10	100	90	100	70	100	70	90	60
Total	280	70	90	100	80	490	410	500	360	470	390	480	340
Media	56	14	18	20	16	98	82	100	72	94	78	96	68
Specific weight $p_i[\%]$	0.06	0.04	0.01	0.02	0.03	0.12	0.11	0.14	0.07	0.13	0.09	0.1	0.08
Order	9	10	13	12	11	3	4	1	8	2	6	5	7
u_i	0.6	1	0.18	0.1	1	0.95	0.82	1	1	0.94	0.78	0.96	0.68
$U_i = p_i \cdot u_i$	0.036	0.040	0.002	0.002	0.030	0.114	0.090	0.140	0.070	0.122	0.070	0.096	0.054

3. TECHNICAL DIMENSION OF THE FUNCTIONS

For the stabilizing of the specific weight and intrinsic utility for the Water Dozer functions we conducted a survey among actual and potential users.

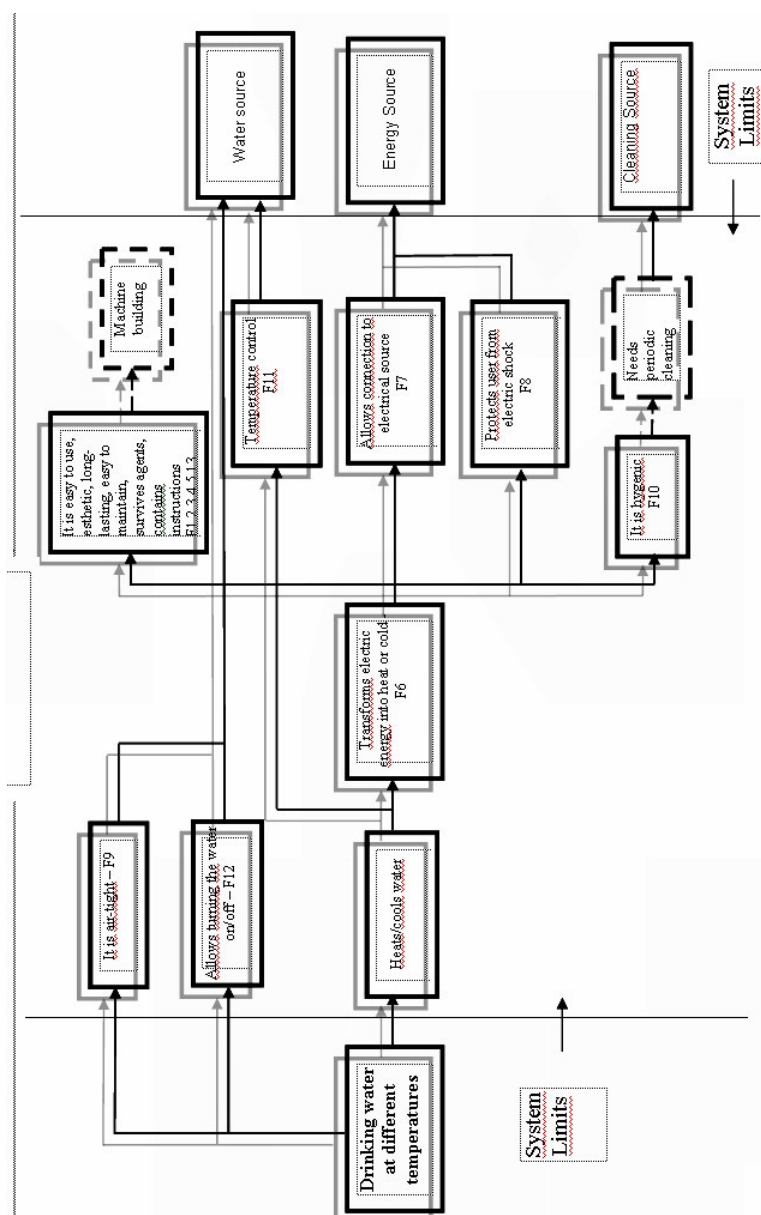


Fig. 2. FAST Analysis.

Economical Dimension of Functions. Table 2.

Nr	Parts	Cost	Distribution of Functions												
			F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	F13
1	Casing and accessories	29	0%	0%	30%	25%	10%	0%	5%	0%	0%	0%	0%	0%	30%
			0.00	0.00	8.70	7.25	2.90	0.00	1.45	0.00	0.00	0.00	0.00	0.00	8.70
2	Cold water tank	7.27	10%	10%	0%	5%	0%	40%	0%	0%	10%	25%	0%	0%	0%
			0.73	0.73	0.00	0.36	0.00	2.91	0.00	0.00	0.73	1.82	0.00	0.00	0.00
3	Water spouts	10.91	5%	5%	0%	5%	0%	0%	0%	0%	25%	0%	20%	35%	5%
	Cold/hot		0.55	0.55	0.00	0.55	0.00	0.00	0.00	0.00	2.73	0.00	2.18	3.82	0.55
4	Hot water tank	46.36	10%	10%	0%	5%	0%	40%	0%	0%	10%	25%	0%	0%	0%
	w/ electrical resistance		4.64	4.64	0.00	2.32	0.00	18.54	0.00	0.00	4.64	11.59	0.00	0.00	0.00
5	Compressor	72.73	10%	10%	0%	5%	0%	70%	0%	0%	5%	0%	0%	0%	0%
			7.27	7.27	0.00	3.64	0.00	50.91	0.00	0.00	3.64	0.00	0.00	0.00	0.00
6	Condensation maker	60.91	10%	10%	0%	5%	0%	70%	0%	0%	5%	0%	0%	0%	0%
			6.09	6.09	0.00	3.05	0.00	42.64	0.00	0.00	3.05	0.00	0.00	0.00	0.00
7	Automating System	60.09	5%	5%	0%	5%	0%	0%	20%	30%	0%	0%	10%	5%	20%
			3.00	3.00	0.00	3.00	0.00	0.00	12.02	18.03	0.00	0.00	6.01	3.00	12.02
	Total Materials	287.27	22.28	22.28	8.70	20.16	2.90	115.00	13.47	18.03	14.77	13.41	8.19	6.82	21.26
	Total Salary	71.82	5.57	5.57	2.18	5.04	0.73	28.75	3.37	4.51	3.69	3.35	2.05	1.71	5.32
	Total Materials + Salary	359.09	27.85	27.85	10.88	25.20	3.63	143.75	16.84	22.53	18.47	16.76	10.24	8.53	26.58
	Tax 10%	35.91	2.78	2.78	1.09	2.52	0.36	14.38	1.68	2.25	1.85	1.68	1.02	0.85	2.66
	Total function cost	395.00	30.63	30.63	11.96	27.72	3.99	158.13	18.52	24.79	20.31	18.44	11.26	9.38	29.24
	Cost specific weight[%]	100	7.755	7.755	3.029	7.019	1.010	33.050	1.551	9.413	12.120	4.667	2.851	2.375	7.402

The survey contained the following questions:

- Is the list of functions that we compiled correct and complete?
- What are the characteristics for quality determined for the use of the functions and what are the minimum and maximum dimensions of these?
- What is the weight of the functions in a grid of 100 maximum points?
- What is the intrinsic utility of the functions for the analyzed product, in comparison to the ideal product?

Part of these results is shown in Table 1.

4. ECONOMICAL DIMENSION OF FUNCTIONS

Applying a logic engineering reasoning [3], we decided the cost distribution of the parts per function of the Water Dozer determining finally the cost of each function and the specific weight of these in the total, which means the economic dimension of these. The results are shown in Table 2.

5. SYSTEMIC ANALYSIS

Comparing the utility of the functions with the cost, we determined the linear regression: $k_{id} = a \cdot U_{ri}$ and a systemic analysis (Table 3, Fig. 3). After the analysis we observed that the economically outsized functions, from highest to lowest dimension (Pareto) are: F6, F4, F9, F1, F2, F3, and F13

Systemic analysis. Table 3.

Fi	ui	pi [%]	Ui	ki	Ui ²	ki*Ui	a*Ui	ki-a*Ui	(ki-a*Ui) ²
F1	0.6	6	3.60	7.755	12.960	27.918	3.585	4.170	17.386
F2	1	4	4.00	7.755	16.000	31.020	3.984	3.771	14.222
F3	0.18	1	0.18	3.029	0.032	0.545	0.179	2.850	8.121
F4	0.1	2	0.20	7.019	0.040	1.404	0.199	6.820	46.510
F5	1	3	3.00	1.010	9.000	3.030	2.988	-1.978	3.912
F6	0.95	12	11.40	33.050	129.960	376.770	11.354	21.696	470.727
F7	0.82	11	9.02	1.551	81.360	13.990	8.983	-7.432	55.241
F8	1	14	14.00	9.413	196.000	131.782	13.943	-4.530	20.523
F9	1	7	7.00	12.120	49.000	84.840	6.972	5.148	26.506
F10	0.94	13	12.22	4.667	149.328	57.031	12.170	-7.503	56.302
F11	0.78	9	7.02	2.851	49.280	20.014	6.992	-4.141	17.144
F12	0.96	10	9.60	2.375	92.160	22.800	9.561	-7.186	51.639
F13	0.68	8	5.44	7.402	29.594	40.267	5.418	1.984	3.937
Total		100	86.68	99.997	814.715	811.411			792.168

6. CONCLUSIONS SUGGESTIONS FOR IMPROVEMENT

Suggestions for improvement need to reflect economically outsized functions, in particular functions: F1, F2, F3, F4, F6, F9, F13.

From a mathematical standpoint there are 5 methods for increase in value of the product:

1. Increase of utility faster than that of cost;
2. Increase of utility and maintaining the cost;
3. Increase of utility and decrease of cost;
4. Maintaining of utility and decrease of cost;
5. Decreasing utility slower than that of cost.

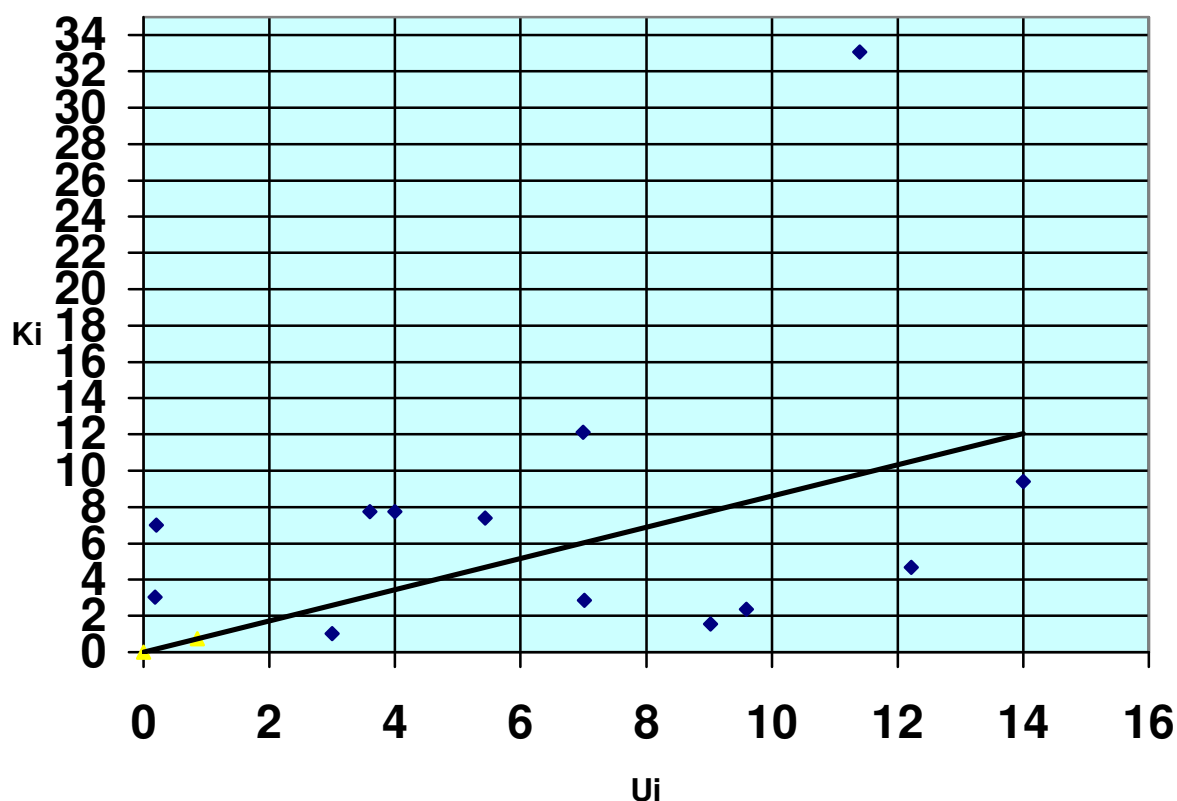


Fig.3. Regression Analysis

In the case of the Water Dozer we propose:

- Decrease in material cost for the water tanks, compressor and condensation maker. This way the following functions are improved: F1, F2 and F6 by applying method nr. 4;
- The improvement of function F6 consists of redesigning the machine by adding a new tank that will have a connection between the cold and hot water tanks and a thermostat spout. In this case we will have one spout on the outside which will give water at a certain temperature (4 options). This will give us two warm water options and two cool water options. In this case the improvement for function F6 is done through method nr. 1;
- Redesigning the casing and accessories so that the machine would be smaller, have smaller cup-holders included on an attachment to the wall. We have a more user-friendly machine that is smaller and safer from agents. This way we improve functions F3, F4 and F13 using method nr. 3.
- Replacement of the spouts with others that is more expensive, but better. In this case we improve F9 through method nr. 1

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