ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

THE CONCEPTUAL DESIGN OF A WINDSHIELD WIPER MECHANISM

Adrian-Constantin BUTA
Transilvania University of Braşov, Dept. of the Product Design and Robotics
e-mail: acbuta@unitbv.ro

Keywords: mechanism, design, Brainstorming, multi-criterion analysis, morphological analysis.

Abstract: The paper presents same aspects of the conceptual design. First will made a multi-criterion analysis of the existing windshields wipers mechanisms, after this, made a Brainstorming meeting and lastly with a morphological analysis will be choose the best variant of the windshields wiper mechanism.

1. THE MULTI-CRITERION ANALYSIS OF THE EXISTING WINDSHIELDS WIPERS MECHANISMS:

1.1. The variants for analyses:

i. linkage windshield wiper mechanism (*bars*);
ii. linkage and grooved roller windshield wiper mechanism (*roller)*;
iii. bar and gear windshield wiper mechanism (gear);
iv. an arm windshield wiper mechanism (*an arm*);
v. two arms windshield wiper mechanism and movement in same direction (same);
vi. two arms windshield wiper mechanism and movement in opus direction (*opus*).

1.2. The determinate of the criterions:

a) resistance of frictions (the criterion *R.F.*);
b) constant rotation movement (the criterion *C.R.*);
c) easiness to montage (the criterion *E.M.*);
d) more visibility (the criterion *M.V.*);
e) possibility of change (the criterion *P.C.*);
f) uniform cleaning (the criterion *U.C*);
g) cleaning more areas of the windshield (the criterion *C.W.*);
h) ergonomics (the criterion *Er.*);
i) design (the criterion *De.*).

1.3. The determinate of the criterion share:

The criterions shares (γ_i) are calculate with formula:

$$\gamma_i = \frac{p + \Delta p + m + 0{,}5}{-\Delta p' + \frac{N}{2}} \qquad (1)$$

where: p – is the sum of the element points on the line;
Δp – is the difference from last element point;
m – is number of the exceeded criterions;
N – is number of the considerate criterions;
$\Delta p'$ - is difference from first element point.

Table 1.

	R.F.	C.R.	E.M.	M.V	P.C.	U.C.	C.W.	Er.	De.	Puncte	Nivel	γ_i
R.F.	0,5	0,5	1	0	1	0	0	0	0	3	7	0,78
C.R.	0,5	0,5	1	1	1	0	0	0,5	0,5	5	4	2,00
E.M.	0	0	0,5	0	0	0	0	0,5	0,5	1,5	9	0,19
M.V.	1	0	1	0,5	1	1	0,5	0,5	0,5	6	3	2,83
P.C.	0	0	1	0	0,5	0	0	0,5	0,5	2,5	8	0,53
U.C.	1	1	1	0	1	0,5	0,5	1	1	7	2	4,00
C.W.	1	1	1	0,5	1	0,5	0,5	1	1	7,5	1	4,89
Er.	1	0,5	0,5	0,5	0,5	0	0	0,5	0	3,5	6	1,06
De.	1	0,5	0,5	0,5	0,5	0	0	1	0,5	4,5	5	1,60

1.4. The attach a N note:

The note must be a full number (maximum *10*).

Table 2.

Criterion	R.F.	C.R.	E.M.	M.V.	P.C.	U.C.	C.W.	Er.	De.
bars	7	10	8	9	10	8	9	9	10
roller	8	9	6	8	8	7	10	10	10
gear	8	8	4	7	6	7	8	8	9
an arm	10	8	10	10	8	8	6	10	10
same	9	7	9	10	7	9	8	10	10
opus	8	5	7	8	6	7	9	9	9

1.5. The calculation of the criterion share multiplies with the N note:

Table 3.

	γ_i	bars		roller		gear		an arm		same		opus	
		N	*N**γ_i	*N*	*N**γ_i	*N*	*N**γ_i	*N*	*N**γ_i	*N*	*N**γ_i	*N*	*N**γ_i
R.F.	0,78	7	5,44	8	6,22	8	6,22	10	7,78	9	7	8	6,22
C.R.	2,00	10	20	9	18	8	16	8	16	7	14	5	10
E.M.	0,19	8	1,52	6	1,14	4	0,76	10	1,9	9	1,71	7	1,33
M.V.	2,83	9	25,5	8	22,7	7	19,8	10	28,3	10	28,3	8	22,7
P.C.	0,53	10	5,30	8	4,21	6	3,16	8	4,21	7	3,68	6	3,16
U.C.	4,00	8	32	7	28	7	28	8	32	9	36	7	28
C.W.	4,89	9	44	10	48,9	8	39,1	6	29,3	8	39,1	9	44
Er.	1,06	9	9,53	10	10,6	8	8,47	10	10,6	10	10,6	9	9,53
De.	1,60	10	16	10	16	9	14,4	10	16	10	16	9	14,4
Total		159,26		155,72		135,96		146,15		156,43		139,31	

Finally will calculate the sum for every type of windshield wiper mechanism.

On the first place is the linkage windshield wiper mechanism (159.26 points). On the second place is situate the windshield wiper mechanism with two arms and movement in the same direction (156.43 points) and the linkage and grooved roller windshield wiper mechanism is very close (155.72 points).

2. THE BRAINSTORMING METHOD:

The *Brainstorming* is a group method utilized for find the new ideas, like the following:

- it will be light;
- it will be cheap;
- it will be manufactured from plastic with insertion;
- it will be with colors arms;
- it will be in different colors;
- it will be colors in degrade;
- it will have round forms;
- it will have angular forms;
- it will be with a top arm and a down arm;
- it will be with arms on the lateral of the windshield;
- it will be with arms on the corners of the windshield;
- the windshield to be cleaning from top in down and reverse;
- the windshield to be cleaning with a single arm from left to right and reverse;
- the wiper mechanism to be manually;
- the wiper mechanism to be automatic or semi automatic;
- the wiper mechanism to be driven by electric motor;
- the wiper mechanism to be driven by hydraulic motor;
- the wiper mechanism to be driven by pneumatic motor;
- the washer liquid to come from one place;
- the washer liquid to be closed from wiper blade;
- the washer liquid to be in the wiper blade;
- the windshield to be warm;
- the windshield to be surface vibration;
- to exist the water sensor for the start the wiper mechanism;
- to exist the dirty sensor for the start the wiper mechanism;
- easy access for change the wiper mechanism;
- possibility to interchange the wiper mechanism pieces.

3. THE MORPHOLOGICAL ANALYSIS:

The morphological analysis means the choice for problem solution, but after to detail and inventory list for the entire necessary prerequisite from the further solution.

3.1. The inventory list:

- **The form of the wiper mechanism arms:**
  - Round (*ro*);
  - Angular (*an*);
  - Combine (*co*);
- **The color:**
  - A single color (*sg*);
  - Two colors (*2c*);
  - Many colors (*cu*);
- **The composite material:**
  - Plastic (*pl*);
  - Plastic with the insertion (*pi*);
  - Metal (*me*);
  - Aluminum (*al*);

- **The assembling on the car:**
  - Inferior side of the windshield (*in*);
  - Superior side of the windshield (*su*);
  - Lateral side of the windshield (*lt*);
- **The driving:**
  - By electric motor (*em*);
  - By hydraulic motor (*hm*);
  - By pneumatic motor (*pm*).

3.2. The total number of combinations is: 3x3x4x3x3=324 [possible variants]:

11111	**11112**	**11113**	**11114**
11121	11122	11123	11124
11131	11132	11133	11134
11211	11212	11213	11214
11311	11312	11313	11314
11221	11222	11223	11224
11231	11232	11233	11234
11321	11322	11323	11324
11331	11332	11333	11334
12111	12112	12113	12114
12121	12122	12123	12124
12131	12132	12133	12134
12211	12212	12213	12214
12311	12312	12313	12314
12221	12222	12223	12224
12231	12232	12233	12234
12321	12322	12323	12324
12331	12332	12333	12334
13111	13112	13113	13114
13121	13122	13123	13124
13131	13132	13133	13134
13211	13212	13213	13214
13311	13312	13313	13314
13221	13222	13223	13224
13231	13232	13233	13234
13321	13322	13323	13324
13331	13332	13333	13334
21111	**21112**	**21113**	**21114**
21121	21122	21123	21124
21131	21132	21133	21134
21211	21212	21213	21214
21311	21312	21313	21314
21221	21222	21223	21224
21231	21232	21233	21234
21321	21322	21323	21324
21331	21332	21333	21334
22111	22112	22113	22114
22121	22122	22123	22124
22131	22132	22133	22134
22211	22212	22213	22214

22311	22312	22313	22314
22221	22222	22223	22224
22231	22232	22233	22234
22321	22322	22323	22324
22331	22332	22333	22334
23111	23112	23113	23114
23121	23122	23123	23124
23131	23132	23133	23134
23211	23212	23213	23214
23311	23312	23313	23314
23221	23222	23223	23224
23231	23232	23233	23234
23321	23322	23323	23324
23331	23332	23333	23334
31111	**31112**	**31113**	**31114**
31121	31122	31123	31124
31131	31132	31133	31134
31211	31212	31213	31214
31311	31312	31313	31314
31221	31222	31223	31224
31231	31232	31233	31234
31321	31322	31323	31324
31331	31332	31333	31334
32111	32112	32113	32114
32121	32122	32123	32124
32131	32132	32133	32134
32211	32212	32213	32214
32311	32312	32313	32314
32221	32222	32223	32224
32231	32232	32233	32234
32321	32322	32323	32324
32331	32332	32333	32334
33111	33112	33113	33114
33121	33122	33123	33124
33131	33132	33133	33134
33211	33212	33213	33214
33311	33312	33313	33314
33221	33222	33223	33224
33231	33232	33233	33234
33321	33322	33323	33324
33331	33332	33333	33334

3.3. Description of the combinations:

ro+sg+in+em+pl	**ro+sg+in+em+pi**	**ro+sg+in+em+me**	**ro+sg+in+em+al**
ro+sg+in+hm+pl	ro+sg+in+hm+pi	ro+sg+in+hm+me	ro+sg+in+hm+al
ro+sg+in+pm+pl	ro+sg+in+pm+pi	ro+sg+in+pm+me	ro+sg+in+pm+al
ro+sg++su+em+pl	ro+sg+su+em+pi	ro+sg+su+em+me	ro+sg+su+em+al
ro+sg+lt+em+pl	ro+sg+lt+em+pi	ro+sg+lt+em+me	ro+sg+lt+em+al
ro+sg+su+hm+pl	ro+sg+su+hm+pi	ro+sg+su+hm+me	ro+sg+su+hm+al
ro+sg+su+pm+pl	ro+sg+su+pm+pi	ro+sg+su+pm+me	ro+sg+su+pm+al

ro+sg+lt+hm+pl	ro+sg+lt+hm+pi	ro+sg+lt+hm+me	ro+sg+lt+hm+al
ro+sg+lt+pm+pl	ro+sg+lt+pm+pi	ro+sg+lt+pm+me	ro+sg+lt+pm+al
ro+2c+in+em+pl	ro+2c+in+em+pi	ro+2c+in+em+me	ro+2c+in+em+al
ro+2c+in+hm+pl	ro+2c+in+hm+pi	ro+2c+in+hm+me	ro+2c+in+hm+al
ro+2c+in+pm+pl	ro+2c+in+pm+pi	ro+2c+in+pm+me	ro+2c+in+pm+al
ro+2c+su+pm+pl	ro+2c+su+em+pi	ro+2c+su+em+me	ro+2c+su+em+al
ro+2c+lt+pm+pl	ro+2c+lt+em+pi	ro+2c+lt+em+me	ro+2c+lt+em+al
ro+2c+su+hm+pl	ro+2c+su+hm+pi	ro+2c+su+hm+me	ro+2c+su+hm+al
ro+2c+su+pm+pl	ro+2c+su+pm+pi	ro+2c+su+pm+me	ro+2c+su+pm+al
ro+2c+lt+hm+pl	ro+2c+lt+hm+pi	ro+2c+lt+hm+me	ro+2c+lt+hm+al
ro+2c+lt+pm+pl	ro+2c+lt+pm+pi	ro+2c+lt+pm+me	ro+2c+lt+pm+al
ro+cu+in+em+pl	ro+cu+in+em+pi	ro+cu+in+em+me	ro+cu+in+em+al
ro+cu+lt+hm+pl	ro+cu+in+hm+pi	ro+cu+in+hm+me	ro+cu+in+hm+al
ro+cu+in+pm+pl	ro+cu+in+pm+pi	ro+cu+in+pm+me	ro+cu+in+pm+al
ro+cu+su+em+pl	ro+cu+su+em+pi	ro+cu+su+em+me	ro+cu+su+em+al
ro+cu+lt+em+pl	ro+cu+lt+em+pi	ro+cu+lt+em+me	ro+cu+lt+em+al
ro+cu+su+hm+pl	ro+cu+su+hm+pi	ro+cu+su+hm+me	ro+cu+su+hm+al
ro+cu+su+pm+pl	ro+cu+su+pm+pi	ro+cu+su+pm+me	ro+cu+su+pm+al
ro+cu+lt+hm+pl	ro+cu+lt+hm+pi	ro+cu+lt+hm+me	ro+cu+lt+hm+al
ro+cu+lt+pm+pl	ro+cu+lt+pm+pi	ro+cu+lt+pm+me	ro+cu+lt+pm+al
an+sg+in+em+pl	**an+sg+in+em+pi**	**an+sg+in+em+m**	**an+sg+in+em+al**
an+sg+in+hm+pl	an+sg+in+hm+pi	an+sg+in+hm+me	an+sg+in+hm+al
an+sg+in+pm+pl	an+sg+in+pm+pi	an+sg+in+pm+me	an+sg+in+pm+al
an+sg++su+em+pl	an+sg+su+em+pi	an+sg+su+em+me	an+sg+su+em+al
an+sg+lt+em+pl	an+sg+lt+em+pi	an+sg+lt+em+me	an+sg+lt+em+al
an+sg+su+hm+pl	an+sg+su+hm+pi	an+sg+su+hm+me	an+sg+su+hm+al
an+sg+su+pm+pl	an+sg+su+pm+pi	an+sg+su+pm+me	an+sg+su+pm+al
an+sg+lt+hm+pl	an+sg+lt+hm+pi	an+sg+lt+hm+me	an+sg+lt+hm+al
an+sg+lt+pm+pl	an+sg+lt+pm+pi	an+sg+lt+pm+me	an+sg+lt+pm+al
an+2c+in+em+pl	an+2c+in+em+pi	an+2c+in+em+me	an+2c+in+em+al
an+2c+in+hm+pl	an+2c+in+hm+pi	an+2c+in+hm+me	an+2c+in+hm+al
an+2c+in+pm+pl	an+2c+in+pm+pi	an+2c+in+pm+me	an+2c+in+pm+al
an+2c+su+pm+pl	an+2c+su+em+pi	an+2c+su+em+me	an+2c+su+em+al
an+2c+lt+pm+pl	an+2c+lt+em+pi	an+2c+lt+em+me	an+2c+lt+em+al
an+2c+su+hm+pl	an+2c+su+hm+pi	an+2c+su+hm+me	an+2c+su+hm+al
an+2c+su+pm+pl	an+2c+su+pm+pi	an+2c+su+pm+me	an+2c+su+pm+al
an+2c+lt+hm+pl	an+2c+lt+hm+pi	an+2c+lt+hm+me	an+2c+lt+hm+al
an+2c+lt+pm+pl	an+2c+lt+pm+pi	an+2c+lt+pm+me	an+2c+lt+pm+al
an+cu+in+em+pl	an+cu+in+em+pi	an+cu+in+em+me	an+cu+in+em+al
an+cu+lt+hm+pl	an+cu+in+hm+pi	an+cu+in+hm+me	an+cu+in+hm+al
an+cu+in+pm+pl	an+cu+in+pm+pi	an+cu+in+pm+me	an+cu+in+pm+al
an+cu+su+em+pl	an+cu+su+em+pi	an+cu+su+em+me	an+cu+su+em+al
an+cu+lt+em+pl	an+cu+lt+em+pi	an+cu+lt+em+me	an+cu+lt+em+al
an+cu+su+hm+pl	an+cu+su+hm+pi	an+cu+su+hm+me	an+cu+su+hm+al
an+cu+su+pm+pl	an+cu+su+pm+pi	an+cu+su+pm+me	an+cu+su+pm+al
an+cu+lt+hm+pl	an+cu+lt+hm+pi	an+cu+lt+hm+me	an+cu+lt+hm+al
an+cu+lt+pm+pl	an+cu+lt+pm+pi	an+cu+lt+pm+me	an+cu+lt+pm+al
co+sg+in+em+pl	**co+sg+in+em+pi**	**co+sg+in+em+me**	**co+sg+in+em+al**
co+sg+in+hm+pl	co+sg+in+hm+pi	co+sg+in+hm+me	co+sg+in+hm+al
co+sg+in+pm+pl	co+sg+in+pm+pi	co+sg+in+pm+me	co+sg+in+pm+al

co+sg++su+em+pl	co+sg+su+em+pi	co+sg+su+em+me	co+sg+su+em+al
co+sg+lt+em+pl	co+sg+lt+em+pi	co+sg+lt+em+me	co+sg+lt+em+al
co+sg+su+hm+pl	co+sg+su+hm+pi	co+sg+su+hm+me	co+sg+su+hm+al
co+sg+su+pm+pl	co+sg+su+pm+pi	co+sg+su+pm+me	co+sg+su+pm+al
co+sg+lt+hm+pl	co+sg+lt+hm+pi	co+sg+lt+hm+me	co+sg+lt+hm+al
co+sg+lt+pm+pl	co+sg+lt+pm+pi	co+sg+lt+pm+me	co+sg+lt+pm+al
co+2c+in+em+pl	co+2c+in+em+pi	co+2c+in+em+me	co+2c+in+em+al
co+2c+in+hm+pl	co+2c+in+hm+pi	co+2c+in+hm+me	co+2c+in+hm+al
co+2c+in+pm+pl	co+2c+in+pm+pi	co+2c+in+pm+me	co+2c+in+pm+al
co+2c+su+pm+pl	co+2c+su+em+pi	co+2c+su+em+me	co+2c+su+em+al
co+2c+lt+pm+pl	co+2c+lt+em+pi	co+2c+lt+em+me	co+2c+lt+em+al
co+2c+su+hm+pl	co+2c+su+hm+pi	co+2c+su+hm+me	co+2c+su+hm+al
co+2c+su+pm+pl	co+2c+su+pm+pi	co+2c+su+pm+me	co+2c+su+pm+al
co+2c+lt+hm+pl	co+2c+lt+hm+pi	co+2c+lt+hm+me	co+2c+lt+hm+al
co+2c+lt+pm+pl	co+2c+lt+pm+pi	co+2c+lt+pm+me	co+2c+lt+pm+al
co+cu+in+em+pl	co+cu+in+em+pi	co+cu+in+em+me	co+cu+in+em+al
co+cu+in+hm+pl	co+cu+in+hm+pi	co+cu+in+hm+me	co+cu+in+hm+al
co+cu+in+pm+pl	co+cu+in+pm+pi	co+cu+in+pm+me	co+cu+in+pm+al
co+cu+su+em+pl	co+cu+su+em+pi	co+cu+su+em+me	co+cu+su+em+al
co+cu+lt+em+pl	co+cu+lt+em+pi	co+cu+lt+em+me	co+cu+lt+em+al
co+cu+su+hm+pl	co+cu+su+hm+pi	co+cu+su+hm+me	co+cu+su+hm+al
co+cu+su+pm+pl	co+cu+su+pm+pi	co+cu+su+pm+me	co+cu+su+pm+al
co+cu+lt+hm+pl	co+cu+lt+hm+pi	co+cu+lt+hm+me	co+cu+lt+hm+al
co+cu+lt+pm+pl	co+cu+lt+pm+pi	co+cu+lt+pm+me	co+cu+lt+pm+al

3.4. The choice of the testing variant:

Same variants can't be realizable. After this, it remains the following 36 variants:

co+sg+in+ae+pl	co+sg+in+ae+pi	co+sg+in+ae+me	co+sg+in+ae+al
co+sg+in+ah+pl	co+sg+in+ah+pi	co+sg+in+ah+me	co+sg+in+ah+al
co+sg+in+ap+pl	co+sg+in+ap+pi	co+sg+in+ap+me	co+sg+in+ap+al
co+2c+in+ae+pl	co+2c+in+ae+pi	co+2c+in+ae+me	co+2c+in+ae+al
co+2c+in+ah+pl	co+2c+in+ah+pi	co+2c+in+ah+me	co+2c+in+ah+al
co+2c+in+ap+pl	co+2c+in+ap+pi	co+2c+in+ap+me	co+2c+in+ap+al
co+cu+in+ae+pl	co+cu+in+ae+pi	co+cu+in+ae+me	co+cu+in+ae+al
co+cu+in+ah+pl	co+cu+in+ah+pi	co+cu+in+ah+me	co+cu+in+ah+al
co+cu+in+ap+pl	co+cu+in+ap+pi	co+cu+in+ap+me	co+cu+in+ap+al

The variant from plastic material is too easy but not represent resistance for a long function in time and the variants from plastic with the insertion and aluminum is more expensive. The driving by electric motor is familiar; the driving by pneumatic motor is expensive and we stop to driving by hydraulic motor.

co+sg+in+ah+me co+2c+in+ah+me co+cu+in+ah+me

From remain variants is possible to choice any colors for windshield wiper mechanism, because this aspect is not important for a good function.

4. CONCLUSION

The paper try to substitution, in industrial design domain, the capability, intuition, inspiration from design gifted with calculus procedure (the mathematics science, the nature experience, the science history and the arts) to every professional who are necessary instruction.

5. REFERENCES

[1] Alexandru, C., Buta, A.C., „Mecanismele ştergătoarelor de parbriz – Modelare şi prototipare virtuală", Editura Universității „Transilvania", Braşov, 2006;
[2] Bobancu, Ş., Cozma, R., Lixandroiu, D., Foisoreanu, V., „Tehnici de creativitate", Editura „Lux Libris" Braşov, 1998;
[3] Buta, A.C., Alexandru, C., „Sistematizarea structurală a mecanismelor ştergătorului de parbriz", IMT Oradea – 2005, (abstract book), vol. IV, pag. 188b, Oradea, 2005;
[4] Buta, A.C., Alexandru, P., „Asupra structurii mecanismelor ştergătoarelor de parbriz", „Constantin Brâncuşi", Scientific Conference, vol. I, pag. 92–96, Târgu–Jiu, 2005;
[5] Vişa, I., Alexandru, P., Talabă, D., Alexandru, C., „Proiectarea funcțională a mecanismelor – metode clasice şi moderne", Editura „Lux Libris" Braşov, 2004;
[6] Diaconescu, D., „Designul conceptual al produselor", Editura Universității „Transilvania", Braşov, 2005.