OBJECTIVE LOOK ON LINE CHARACTERISTICS

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În literatura dedicată design-ului, diferiți autori prezintă ca adevărate o serie de presupuneri referitoare la caracteristicile liniilor drepte. Aceste presupuneri nu au fost niciodată cercetate ştiinţific. Această lucrare prezintă rezultatele unui experiment ştiinţific efectuat pentru a verifica respectivele presupuneri. De asemenea, sunt prezentate distribuțiile caracteristicilor liniilor drepte, atunci când sunt trasate liber de subiecți.

In design literature, different authors presents as true a series of assumptions regarding the characteristics of straight lines. These assumptions were never checked from a scientific point of view. This paper presents the results of a scientific experiment carried out in order to verify the assumptions. Also, there are presented the distributions of straight line characteristics, when drawn without restricting the subjects.

Keywords: line characteristics, design theory, visual language

Introduction

The visual language is one of the tools the designers are using in their work. Because designer's first concern is about the meaning of products, for a designer is important to know the possible significances a line can convey.

There are two ways to achieve the significanceof a line. Firstly, the designer can use a lexicon of visual language. Secondly, the designer can get experience in time and she/he will create a personal lexicon as a formal document or as a professional skill.

A proper lexicon of visual language as an exhaustive tome does not exist. Instructive textbooks are used by teachers and professionals. The aim of these textbooks is to offer a basic design theory and to let the designer to gain experience.

The textbooks contain more or less theoretical information, some based on the author's experience in the field and some pure assumptions. Usually, there is nothing based on experimental research.

Let consider the straight line. Data taken from Euclidian geometry is the only pure scientific information mentioned in textbooks. There can be found assumptions about the significances of straight line considering it's characteristics. Some of them are mentioned below.

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Wassily Kandinsky wrote one of the most influential textbooks on design theory, *Point and Line to Plane* [1]. Some of his statements are: 1. The straight line is the more concise form of movement towards infinite. 2. The horizontal straight line is unconsciously associated by man to space where she/he is living. 3. The horizontal straight line is a cold line. 4. The vertical straight line is a warm line. 5. The diagonal straight line (inclined at 45°) is a combination cold-warm. 6. All other lines are deviations from diagonal. 7. A horizontal or vertical line placed in the centre of plane has a solitary aspect.

He proposed also some associations between lines and colours, as follows:

- horizontal - black;
- vertical - white;
- diagonal at 45° - red or green or grey;
- other diagonals - yellow or blue.

John Pile [2] considered that vertical lines suggest stability and immobility and implicitly dignity and solemnity. Vertical lines can also be seen as basic structural elements. Horizontal lines are associated to silence, tranquillity and relaxation. Gravity attracts bodies until they reach a support and compose a horizontal line. Diagonal lines suggest movement, dynamic forces and activity.

Other functions of straight lines are [3]:

- to define edges;
- to divide space;
- to adorn a surface.

Man perceives the discontinuity of space as lines and surfaces. Line can also be a mean for division of a homogeneous space. Line can also be employed to break the monotony of large spaces.

The above assumptions and other subjective information from the dedicated literature can be summarised in the following table.

Table 1

Correlation between line characteristics and significances

Orientation	*Position*	*Significances*					
horizontal	-	coldness	horizon	living space	silence	tranquillity	relaxation
vertical	-	warmness	gravity	stability	immobility	support	spirituality
diagonal (45°)	-	cold-warm	stop				
diagonal	-	movement	force	activity			
horizontal	centre	solitary					
vertical	centre	solitary					

The table contains a lot of subjective significances like “tranquillity”, “immobility” or “spirituality”, terms that are difficult to accept in an objective approach. These correlations indicated in the dedicated literature are to be tested.

Regarding the Kandinsky's associations between lines and colours, his statements are questionable, especially after other supposed correlations were discovered to be faulty. [4]

The significances of straight lines considered by design theorists should be perceived as such by the contemplator, otherwise the visual message conveyed by lines will be lost. This is a delicate issue. Are those significances mentioned in Table 1 true? Only a scientific research opposed to subjective assumptions will validate or refute them.

1. Design of experiment

The issue of truthfulness of supposed line significances was the main purpose of the experiment. In this regard, the assumptions were considered hypotheses.

When designing the experiment, the author of the present paper thought that this experiment was an opportunity to search the distribution of lines, when made by ordinary people asked to draw random lines.

So, the aims of experiment were:

- validation or invalidation of supposed significances;
- study of distribution of random lines drawn by people.

In this regard, the **procedure** of experiment was:

- tear of 2 A4 sheets of paper in 16 equal rectangular pieces;
- draw random lines, one on each small paper (condition: all 16 lines should be different);

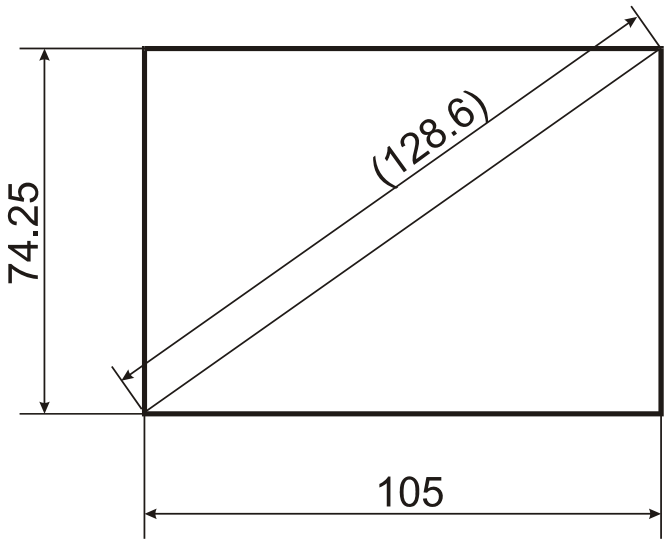

Fig. 1. Dimensions of small paper

- assign a significance to each line;
- record the name of the subject.

Remarks:

- all subjects were instructed with the same neutral examples taken from academic painting;
- orientation of the small paper was at subject's will;
- the dimensions of small paper are presented in Fig. 1.

After gathering the experiments results, the lines were evaluated in terms of objective and subjective parameters. The objective parameters are determined by a mathematical evaluation. The subjective parameters are determined interpretating the significance indicated by the subject.

The parameters are the following:

- objective parameters:
  - ♦ length (measured with a precision of 5 mm);
  - ♦ position (determined with grid A);
  - ♦ angle (determined with grid B);
  - ♦ boundary (expressed by number of reached margins).
- subjective parameters:
  - ♦ value (positive, negative or neutral value of significance);
  - ♦ abstraction degree (which can be abstract or concrete).

So, a line characteristic is actually the particular value of a parameter.

The ***length*** was measured with an ordinary rule and, because of precision chosen, were only 25 values, ranging from 5 to 125 mm.

The ***position*** of line was determined considering the position of line's middle in grid A (Fig. 2). The line exemplified in Fig. 2 is considered in sector B, even it reaches sectors C and F. For the portrait orientation of paper, a similar grid was used.

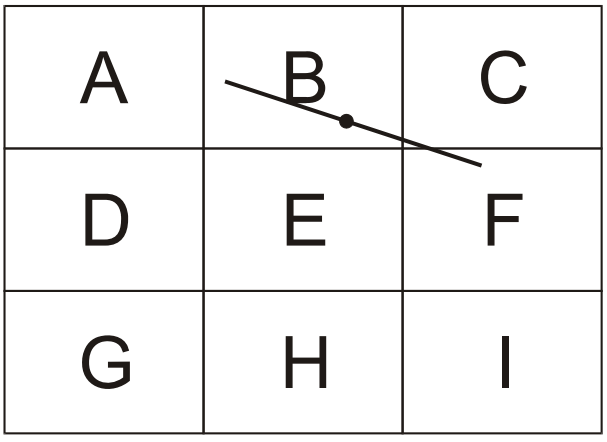

Fig. 2. Grid A - used for evaluation of line's position

The ***angle*** was determined with grid B (Fig. 3). The grid was placed over every piece of paper and oriented using as a reference the horizontal line located on the bottom of the grid. It was recorded the sector in which was the line. The sectors marked with Latin numbers have an opening of 6°. This value was considered to be enough to cover the drawing errors for horizontal, vertical and diagonal lines.

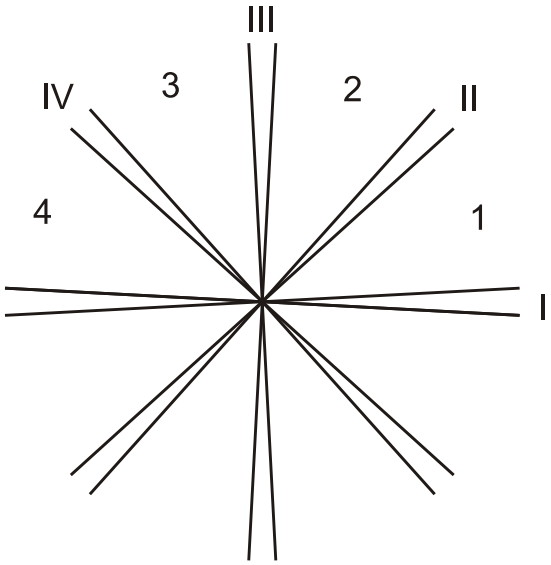

Fig. 3. Grid B used for evaluation of line's angle

The ***boundary*** parameter was expressed by the number of paper's edges that the line reaches.

The significance indicated by subject was recorded as a quote. Afterwards, the significance was evaluated in terms of ***value***. The value can be **positive**, **negative** or **neutral**. For example, the significance "development" has a positive value. "Falling" has a negative value. "Horizon" is a neutral significance.

The ***degree of abstraction*** has two main values: **abstract** and **concrete**. Each of them can be detailed.

The **abstract** value can be *conventional*, *innovative* or *fake*. For example, an ascending line considered as "progress" has an abstract-conventional value. A vertical line considered as "dream" has an abstract-innovative value. An association between a line and a colour is obviously faked.

The **concrete** value can be *direct* or *assumed*. For example, a diagonal line in a corner considered as "sofa in room's corner" has a direct-concrete value. A vertical line considered as "man in front of a closed door" has an assumed-concrete value.

All the evaluation results (primary data) were recorded in a table. The table's heading is presented in Table 2.

Table 2

Table for recording primary data

No.	*Gender*	*Length*	*Position*	*Angle*	*Boundary*	*Quote*	*Value*	*Abstraction degree*

In the "Quote" column, there were recorded the significances mentioned by subjects. The abstraction degree values were coded as follows: *A(C)* - abstract-conventional, *A(I)* - abstract-innovative, *F* - fake, *C(D)* - direct-concrete and *C(A)* - assumed-concrete.

2. Distribution of line characteristics

The subjects of this experiment were 343 persons. Subsequently, 5488 pieces of paper or lines were gathered. The distribution according to gender is: 189 females (55.1%) and 154 males (44,9%). Most of the subjects were students.

The ***length distribution*** is presented in Table 3, but more explanatory is the histogram displayed in Fig. 4.

Table 3

Length distribution

Length	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*50*	*55*	*60*	*65*
Frequency	46	63	91	148	165	241	174	324	258	305	258	312	226
Length	*70*	*75*	*80*	*85*	*90*	*95*	*100*	*105*	*110*	*115*	*120*	*125*	
Frequency	279	701	217	135	186	116	161	518	86	57	71	350	

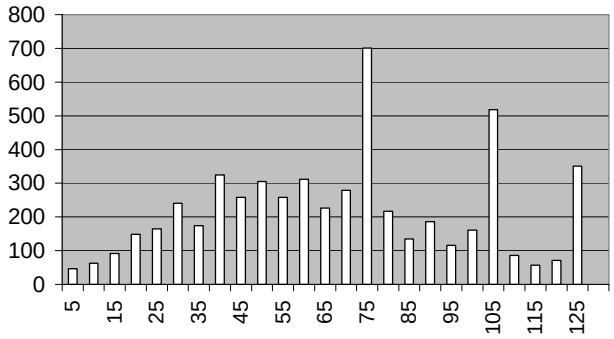

Fig. 4. Histogram of length distribution

As can be observed from the histogram, three values stand out: *75*, *105* and *125*. These values have together 28.59%, which is far from expected. These values match the dimensions of the piece of paper (Fig. 1). The hypothesis that immediately arises is that one third of the people are inclined to draw a line from edge to edge when they are drawing a horizontal, a vertical or a diagonal line. For

the horizontal direction, this hypothesis is confirmed by experimental data in a degree of 73,89%, which is not really relevant. But for the vertical direction, the hypothesis is true (95,36%). For the diagonal of the piece of paper, the hypothesis is far from true (30,28%).

The ***position distribution*** is presented in Table 4, but more descriptive is the pie-chart displayed in Fig. 5.

Table 4

Position distribution

Position	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*
Frequency	351	687	260	488	2599	307	197	416	183
Percentage	6.40	12.52	4.74	8.89	47.36	5.59	3.59	7.58	3.33

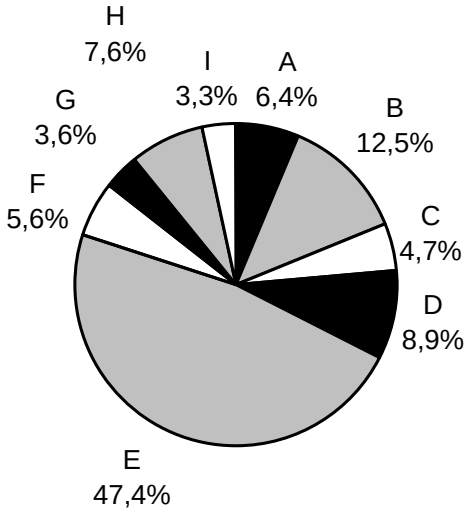

Fig. 5. Pie-chart of position distribution

As can be observed, near half of the lines are ***centric*** (in sector E).

The upper sectors (A, B and C) gathered 23.66% of the lines and the lower sectors (G, H and I) gathered only 14.50%. So, for the non-centric lines, there is a tendency to draw lines in the upper area of the paper rather in the lower area.

The left sectors (A, D and G) collected 18.88% of the lines and the right sectors (C, F and I) - 13.66%. The tendency to draw lines in the left area rather in the right area appears to be less prominent.

The ***angle distribution*** is presented in Table 5 and in histogram displayed in Fig. 6.

Table 5

Angle distribution

Angle	*I*	*II*	*III*	*IV*	*1*	*2*	*3*	*4*
Frequency	1453	463	1151	374	618	565	494	370
Percentage	26.48	8.44	20.97	6.81	11.26	10.30	9.00	6.74

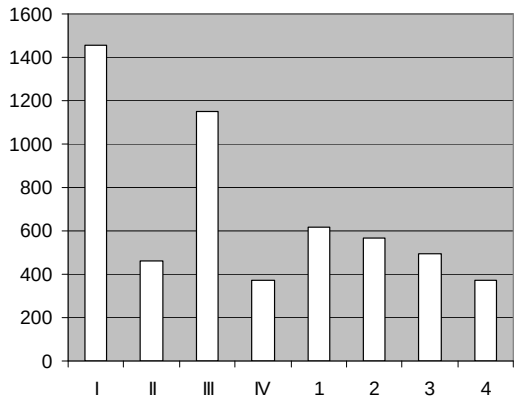

Fig. 6. Histogram of angle distribution

More than one quarter of the lines are horizontal and one fifth are vertical. Together, the horizontal, vertical and diagonal lines have 62.7%, which demonstrates a tendency to draw lines with an orthogonal system in mind.

The ***boundary distribution*** is presented in Table 6.

Table 6

Boundary distribution

Boundary	*0*	*1*	*2*
Frequency	2627	779	2082
Percentage	47.87	14.19	37.94

Regarding boundary distribution, a conclusion is obvious: people are more inclined to draw a line that reaches both edges or none (85.81% together), rather a line that reaches only one edge (14.19%).

3. Connotations of line characteristics

As it was mentioned above, line significances were recorded in Table 2. Each significance was evaluated in terms of value. The proportion of positive, negative and neutral values is indicated in Table 7.

Table 7

Value distribution

Value	*0*	+	-
Frequency	5242	121	125
Percentage	95.52	2.20	2.28

The neutral significances are overwhelming, indicating that the subjects are not able or not willing to associate simple lines with values that can have emotional connotations.

The ***distribution for degree of abstraction*** is presented in Table 8 and in histogram displayed in Fig. 7.

Table 8

Distribution for degree of abstraction

Degree of abstraction	*C(D)*	*C(P)*	*A(C)*	*A(I)*	*F*
Frequency	1995	1667	485	1320	15
Percentage	36.35	30.38	8.84	24.05	0.27

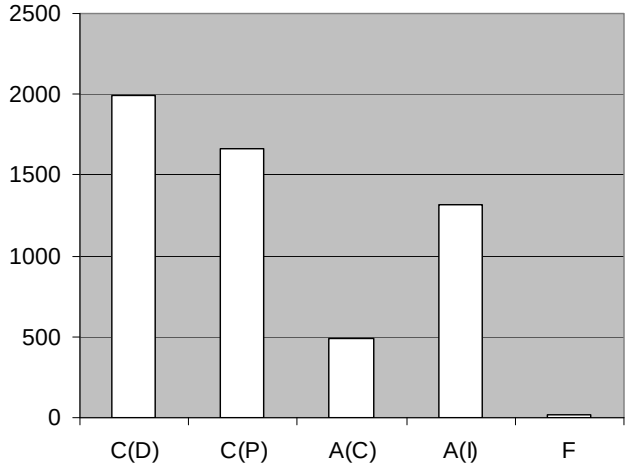

Fig. 7. Histogram of distribution for abstraction degree

A large proportion of significances were concrete (66.73%). There are two explanations for this fact. First, most of subjects were students at a technical university and it is expected to think more in a concrete way. Second, it is easier to find an association between a line and a concrete object rather to something abstract. The tiny proportion of fakes proves the seriousness of the subjects.

The histogram indicates also that the abstract-conventional significances were in a small proportion. This is a sign that there are not so many conventions regarding abstract meanings and they are not widely acknowledged.

4. Significances of line characteristics

The table that contains all recorded results (primary data) was sorted by each parameter and significances analysed. For example, data was sorted by position and the rows that contain the value B (upper-centre) were analysed in search for a common significance. It was discovered that significances “sky”, “roof” and “horizon” repeat 26, 14 and 48 times. These significances and the associated frequencies were recorded in a new table (Table 9).

Table 9

Table for recording secondary data

Parameter	*Value*	*Significance*	*Frequency*	*Frequency of parameter's value*	*Overall frequency of significance*	*Ratio R_1 [%]*	*Ratio R_2 [%]*

The frequencies of parameter's values were taken from the distribution of line characteristics. The ratios were calculated with the following equations:

$$R_1 = \frac{Frequency}{Frequency\ of\ \ parameter's\ value} \times 100 \quad (1)$$

$$R_2 = \frac{Frequency}{Overall\ \ frequency\ of\ \ significance} \times 100 \quad (2)$$

Ratio R_1 measures the weight of significance for that particular value of the considered parameter. Ratio R_2 assesses the uniqueness of association significance - value of parameter.

High scores at both ratios R_1 and R_2 mean that the association between line characteristic and significance is strong and relevant.

A high score for ratio R_1, but accompanied by a low score for ratio R_2, means that the significance is relevant for that characteristic, but the significance is also associated to other characteristics of the same type.

A high score for ratio R_2, but correlated with a low score for ratio R_1, means that the line characteristic highly expresses that specific significance, but the significance is not relevant for that characteristic.

Low scores at both ratios R_1 and R_2 indicates weak and irrelevant associations.

After all major significances were recorded and all the calculations done, two facts emerged as obvious. 1. The large diversity of significances with low importance makes impossible the creation of a lexicon of straight line's significances. 2. The angle is the most prominent parameter with 44 appearances in the table. It is followed by position (6) and length (3).

Afterwards, the data was sorted by ratio R_1. The new order of the table was analysed carefully. The first ten rows are presented in Table 10.

Table 10

First 10 rows of secondary data sorted by ratio R_1

Parameter	*Value*	*Significance*	*Frequency*	*Frequency of parameter's value*	*Overall frequency of significance*	*Ratio R_1 [%]*	*Ratio R_2 [%]*
Angle	III	wall	45	463	63	**9,72**	71,43
Angle	I	horizon	138	1453	149	**9,50**	92,62
Position	B	horizon	48	687	149	**6,99**	32,21
Position	A	corner	24	351	68	**6,84**	35,29
Angle	III	(column of) infinite	26	463	38	**5,62**	68,42
Angle	III	window	26	463	38	**5,62**	68,42
Angle	4	slope	19	370	118	**5,14**	16,10
Angle	III	fall	23	463	47	**4,97**	48,94
Position	C	sun	12	260	28	**4,62**	42,86
Angle	1	slope	28	618	118	**4,53**	23,73

According to this criterion, the most important significances are "wall" (element of support and division) for vertical line and "horizon" for horizontal line. The vertical can be also an expression of "infinite", a "window" (seen as an element of division) and a "fall" (expression of gravity). The condition for a horizontal line to become a horizon is to be placed up (sector B).

Then the data was sorted by ratio R_2. The new order of the table was analysed carefully. The first ten rows are presented in Table 11.

Table 11

First 10 rows of secondary data sorted by ratio R_2

Parameter	*Value*	*Significance*	*Frequency*	*Frequency of parameter's value*	*Overall frequency of significance*	*Ratio R_1 [%]*	*Ratio R_2 [%]*
Angle	I	sky	28	1453	28	1,93	**100,00**
Angle	I	death	10	1453	10	0,69	**100,00**
Position	B	sky	26	687	28	3,78	**92,86**
Angle	I	horizon	138	1453	149	9,50	**92,62**
Angle	I	water*	46	1453	51	3,17	**90,20**
Angle	I	earth	26	1453	29	1,79	**89,66**
Angle	III	stability	6	463	7	1,30	**85,71**
Angle	I	silence	12	1453	14	0,83	**85,71**
Angle	III	post	20	463	24	4,32	**83,33**
Angle	I	table	15	1453	18	1,03	**83,33**

*water = still water, lake, sea, ocean

Considering this criterion, the strongest association are between "sky" and horizontal line and also between "death" and horizontal line. The "sky" is above the centre (sector B). Horizontal line is also strong related to "horizon", "water" and "earth", actually three forms of the same thing - horizon. The associations between vertical line and "stability" and "post" (element of support) are related to two hypotheses presented at the beginning of the present paper.

After reviewing the hypotheses, a new search for significances was performed. No evidence was found for "cold" (horizontal line), "hot" (vertical line), "spiritual" (vertical line), "dynamic" (diagonal line), "stop" (diagonal line) or similar terms.

Taking into account the above results and the considerations about the combination of scores of ratios R_1 and R_2, the hypotheses fall into three categories. The first category contains the hypotheses that were confirmed by the high scores at both ratios R_1 and R_2. The second category contains the hypotheses partially confirmed by the high scores at ratio R_2, but with low scores ratio R_1. The third category includes the unconfirmed hypotheses. The evaluation of hypotheses is presented in Table 12.

Table 12

Results of hypotheses evaluation

Hypothesis	*Confirmed*	*Significant, but not relevant*	*Not confirmed*
Straight line is an expression of infinite.	✓		
Horizontal line is a cold element.			✓
Horizontal line expresses the horizon.	✓		
Horizontal line expresses silence.		✓	
Vertical line is a warm element.			✓
Vertical line is related to gravity.	✓		
Vertical line expresses stability.		✓	
Diagonal line means stop.			✓
Diagonal line expresses movement and force.			✓
Central horizontal and vertical lines are solitary.			✓

Conclusions

When asked to draw lines without any restrictions, peoples are tending to:

- draw verticals lines from edge to edge;
- avoid drawing a line that reaches just one edge;
- draw lines in the centre area of paper;
- draw horizontal and vertical lines rather than inclined.

When asked to associate significance to a line, people are inclined to:

- confer a significance of neutral value, not a positive/negative one;
- give a concrete significance, rather than an abstract one.

Angle (orientation) of lines is the most important parameter for significance.

Some of the well-known assumptions of design are true:

- Straight line is an expression of infinite.
- Vertical lines are associated to support and gravity.
- Horizontal lines are linked to horizon.

Rest of the assumptions are unconfirmed:

- Lines have thermal connotations.
- Diagonal lines have a dynamic nature.

R E F E R E N C E S

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