"Dunarea de Jos" University, Galati
Graphics, Mechanisms and Tolerances Department
THE 2nd INTERNATIONAL CONFERENCE ON ENGINEERING GRAPHICS AND DESIGN
- ICEGD, 2007 -
June 7 – 10, 2007, Galati, Romania

CREATING A SET OF DIFFERENTIAL EQUATIONS TO PREDICT CHANGES OF VISUAL PERCEPTION OF DESIGN OBJECTS

Iryna KUZNETSOVA
Sevastopol national technical university, Ukraine

ABSTRACT The thesis is devoted to developing the prediction model for the cyclicity of design, decorative, applied and graphic art (DDAGA) objects visual perception. Based on synergetics and information theory, the quantity of details and information parameters are proposed for prognostic systems of differential equations. The reasoning is given for considering regional, technological, marketing, historical, and underlying surface factors. A system of differential equations is developed for predicting the cyclicity of percepting elements in DDAGA objects, based on Solar activity *(SA) and geofluctuations.*
Keywords: *qualitative and mathematical model; visual perception; object of design, decorative, applied and graphic arts*

1. INTRODUCTION

To create a mathematical model of visual perception cyclicity of design, decorative, applied and graphic art (DDAGA) objects, a qualitative analysis was carried out. The qualitative analysis of DDAGA objects cyclicity prediction is made on the basis of SA. The asymmetry / symmetry cyclicity in DDAGA objects at different SA stages is investigated. The phase space is proposed as a basis for predicting the cyclicity of elements in DDAGA objects. Based on the visual-graphic interpretations of existing cultural cycle theories and considering the particulars of their authors' perception, a general theory of sociocultural dynamics is proposed.

2. INFORMATION

The phase space of perception cyclicity of art and design objects may be seen as placed within a trihedron formed by three axes: D, $\dot{D}$, and $\dot{I}$.

The researchers of the energy saving principle see in it, above all, the explanation of design features of an organism, its dimensions, forms, proportions, and parameter values. On the one hand, the optimum design principle is in itself, traditionally, a major focus of designers' work. On the other hand, it is important that the energy saving principle E = *min* (Fig. 1) is one of the basic principles of a human body.

Basing on the works by A. Kolmogorov, A. and Y. Sokolinykh, C. Shannon, G. Golitsyn, and others, we may note that the minimum potential energy E correlates with the maximum speed of information $\dot{I}$. This correlation is also shown on Fig. 1.

It is necessary to define what basic movements will occur in the proposed perception model. We know that solar spots are electric vortices, the essence of magnetism is reduced to rotation, and a rapid rotation causes a charged electric body to produce a magnetic field. Thus, the formula for predicting style changes in design and art objects depending on the natural phenomena should include a trigonometric function, that is a torque. Proceeding from the definition, we obtain the sine or cosine function..

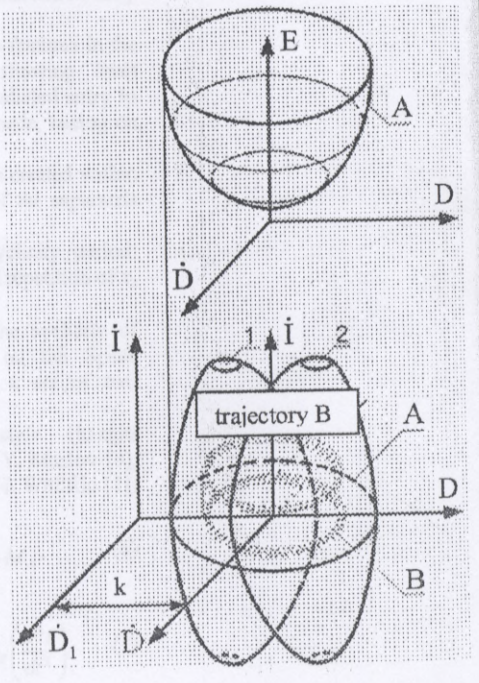


Fig. 1

The disturbing moment consists of restoring, decay (damping) moments, and the moment of inertia. Thus, the components may look as follows:

$$M_B + M_D + M_I = M_A. \quad (1)$$

The moment of inertia will consist of the permanent and periodic parts. The moment of inertia equals to:

$$M_i = f_1\left(\frac{d^2D}{dt^2}\right) \quad (2)$$

The restoring moment equals to:

$$M_B = f_2(D,t). \quad (3)$$

The damping moment equals to:

$$M_D = f_3\left(\frac{dD}{dt}\right). \quad (4)$$

According to Kolmogorov [3], scientific information expressed in the text differs from the artistic information in its composition. The Kolmogorov entropy shows the speed of losing information about the condition of a system:

$$\frac{d^2D}{dt^2} = f\left(D,\frac{dD}{dt}\right). \quad (5)$$

It has been known since the Poincaré's times that a singular point is a point where $\frac{d^2D}{dt^2}=0$ and $\frac{dD}{dt}=0$ simultaneously, which provides a basis for the construction of separatris surface.

To indicate the harmonicity of perception, the golden section (GS) is generally used. Among the papers discussing the phase space, E. Shuster's remark [9] about the character of separatris surface being defined by the golden section deserves special attention. The potential ambiguity of image perception will be visually reflected in the projections (1, 2) of the separatris surface on Fig. 1.

Basing on our previous researches we have to consider the following coefficients in deriving the formulae:

1) coefficients of the detail change formula:

Coefficient *P* defining the underlying surface influence.

Our earlier hypothesis concerning the national Ukrainian embroidery, as well as some other hypotheses assume that perception on the territory of Ukraine is subdivided according to the principle: steppe—foothills—mountains; the subdivision works not only in creating graphic objects, but also in the use of colors. Researches have shown that the more diverse is the underlying surface and the more broken the locality, the higher should be the coefficient of "the picturesque." Moreover, "the picturesque" component increase is added when the water surface is taken into consideration. The quantitative representation of these coefficients remains problematic for the time being, since the systematic research of the influence of the land or water surfaces for the Crimean region has only just started under the author's supervision. Thus, the total *Pi* coefficients should be taken into consideration.

It is expedient to introduce a separate coefficient *R* for regionality of perception. Our statistical research, undertaken under the influence of I. Ten's and F. Shmit's papers [3; 4] has shown that "the picturesque" increases with the latitude toward the North of Ukraine. At this stage of research, the character of dependence in creating the formula may be assumed to be linear. However, this is a provisional assumption, which requires further elaboration. Statistical researches of the influences of low-frequency fluctuations (Solar activity—SA) on the human body have shown that the regional influence should necessarily be taken into account after every 1000 km (with the change of the rhythm phase).

Coefficient *Tp* defines technological progress. Its influence is estimated with the exponent *exp Tp*, proceeding from the general development tendency described by others authors.

2) Coefficients for the formula of information speed change:

Coefficient *J*, that defines the reduction of influence of the regional development history following the end of the influence term:

Besides, the Σ *Ji* influence of the development history should be summed up, which agrees with the principles of the self-developing systems. The sum can also be included in the change of details formula.

Coefficient *B* characterizing the influence of the neighboring regions should also be regarded as the final coefficient *Bi*:

Coefficient *M* is determined by the economic and marketing factors. For high cost models of analog designing, coefficient *M* will be higher. For nonconventional modelling of these objects in high cost traditional analog designing (aircraft construction, shipbuilding, etc.), the influence of coefficient *M* may grow considerably.

Thus, the change of DDAGA object's features in the process of its creation has the following limit conditions: 1) region; 2) the date of predicted entry to the segmented market. Comparison is made, basing on the SA cyclicity.

True objects of arts or design shall be created within the boundary layer (on the boundary of the separatris surface).

Well known is the approximate cyclicity period: repetition of τ_1 after about 11 years, and repetition of τ_2 after about 55 years. That is, $\tau_2 \cong 5\,\tau_1$.

Ultimately a theoretical model of the cyclicity of DDAGA objects' perception based on the Space activity is proposed in the form of a set of two equations:

I. The rotary movement of style changes ("analytical"—"synthetic" in terms of Y. Maslov [4], or "linear"—"picturesque" in terms of H. Wöllflin [1]) is described by the formula:

$$I_n\left(\frac{d^2D}{dt^2}\right) + A\left(\frac{dD}{dt}\right) + f_2(D,t) = M_A, \quad (6)$$

where M_A is the disturbing moment:

$$M_A = (F_G Z_G + F_{SA} Z_{SA})\cos D + M_K\left(\frac{d^2I}{dt^2}\right). \quad (7)$$

where F_{SA} is the force of Solar activity; it may be defined by Volf's numbers, and the prognosis curve may be built by the astronomers' prognosis curve; F_G is the force of geofluctuations (GF); a prognosis similar

to that proposed on the basis of Volf's numbers may be developed; M_K is the moment of unexpected influences in the Space.

The moment of inertia is defined as:

$$M_I = I_n\left(\frac{d^2D}{dt^2}\right), \quad (8)$$

where *In* is the mass of all design objects multiplied by *r*.

The damping forces moment is calculated by the formula:

$$M_D = A\left(\frac{dD}{dt}\right). \quad (9)$$

The restoring moment

$$M_B = f_2(D,t) = Q \cdot \cos\left[\sigma_K t - \varepsilon(t)\right], \quad (10)$$

where Q is the volume of design and art objects V, multiplied by coefficient ρ. M_B also includes the arm of statistical stability as function of D: $l(D)$ is the arm of statistical stability, $\Delta l(D,t)$ is the harmoniously changing increase caused by SA and GF, σ_K is frequency, and $\varepsilon(t)$ is random phase. Thus,

$$M_B = Q\left\{l(D) + \Delta l(D)\cos\left[\sigma_K t - \varepsilon(t)\right]\right\} \quad (11)$$

II. The longitudinal movement of information (the increase of its speed along the axis):

$$V\left(\frac{d^2I}{dt^2}\right) = F_G + F_{SA} \quad (12)$$

where V is the volume of design and art objects.

As the quantity of details cannot be a negative value, the beginning of coordinates shifts by the value of K. Then:

$$D_1 = D + k. \quad (13)$$

The above summarizing yields:

$\exp T_p, R, \Sigma P_i$ are the coefficients of the rotary movement formula (6),

$\Sigma J_i, \Sigma B_i, M$ are the coefficients of the movement formula (12).

The resulting set of equations:

$$\begin{cases} \left\{\exp T_p R \Sigma P_i\left\{I_n\left(\frac{d^2D}{dt^2}\right) + A\left(\frac{dD}{dt}\right) + Q\left\{l(D) + \right.\right.\right. \\ \left.\left.\left. + \Delta l(D)\cos\left[\sigma_i t - \varepsilon(t)\right]\right\}\right\} = \\ = (F_G Z_G + F_{SA} Z_{SA})\cos D + M_K\left(\frac{d^2I}{dt^2}\right), \\ \Sigma J_i \Sigma B_i M V\left(\frac{d^2l}{dt^2}\right) = F_G + F_{SA}. \end{cases} \quad (14)$$

3. CONCLUSION

The mathematical model of predicting the cyclicity of DDAGA objects' perception has been created, based on synergy influenced by Space cyclicity (SA and GF). The model is "rigid" and requires further research oriented toward either its "loosening," or more precise definition of coefficients.

REFERENCES

[1] Вельфлин Г. Основные понятия искусства. Проблема эволюции стиля в новом искусстве: Пер. с нем. - М. - Л. : AKADEMIA, 1930. – 289 с.

[2] Голицин Г.А., Петров В.М. Информация – поведение – творчество. – М.: Наука, 1991. – 224 с.

[3] Колмогоров А.Н. Три подхода к определению понятия «количество информации» // Проблемы передачи информации. - М.: Наука, 1965. – Вып.1. Т.1. - С.3-11.

[4] Маслов С.Ю. Симметрия познавательных механизмов и ее следствия // Семиотика и информатика.– М.: ВИНИТИ, 1983. – Вып. 20. - С.3-31.

[5] Соколов А.А., Соколов Я.А. Математические закономерности электрических колебаний мозга (Материалы первых Лазаревских чтений). – М.: Наука, Гл. ред. восточной литературы, 1976. – 97 с.

[6] Тэн И. Лекции об искусстве (Философия искусства). Третья часть. Живопись в Нидерландах. – М.: Изд-во Всероссийского Центрального Исполнительного Комитета Советов Р., С., К. и К. Депутатов, 1919. – 124 с.

[7] Шеннон К. Работы по теории информации и кибернетике. – М.: Иностранная литература, 1963. – 412 с.

[8] Шмит Ф.И. Искусство - его психология, его стилистика, его эволюция. - Харьков: Союз, 1919. – 328 с.

[9] Шустер Э. Детерминированный хаос. – М.: Мир, 1988. – 240 с.

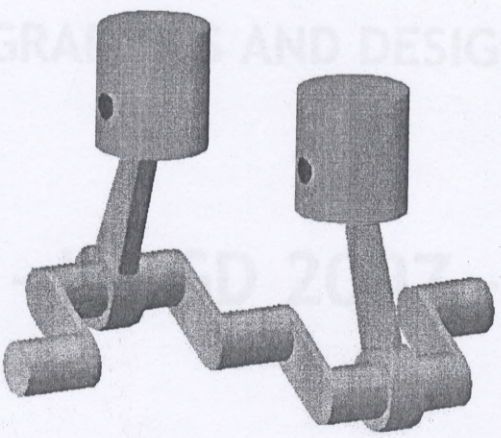
ABOUT THE AUTHORS

Kuznetsova Iryna, Cand.Sc., Sevastopol national technical university, Department of Descriptive Geometry and Graphics in Sevastopol, Ukraine. Her research interests is cyclicity of percepting elements in design, decorative, applied and graphic art objects. She can be reached by e-mail: iakuz@lik-info.com or through postal address: App.11/7, Nadegda Ostrovskaja str./ Sevastopol 99028, the Krimea, Ukraine

Dunarea de Jos University
Galati - ROMANIA

PROCEEDINGS

of the
2nd INTERNATIONAL CONFERENCE
on Engineering Graphics and Design
June 7-10 2007 Galati - ROMANIA



GMT

GALAȚI 2007

"Dunarea de Jos" University, Galati
Graphics, Mechanisms and Tolerances Department
THE 2nd INTERNATIONAL CONFERENCE ON ENGINEERING GRAPHICS AND DESIGN
- ICEGD, 2007 -
June 7 – 10, 2007, Galati, ROMANIA

PROCEEDINGS

ON THE 2nd INTERNATIONAL CONFERENCE ON ENGINEERING GRAPHICS AND DESIGN

- ICEGD 2007 -

CONTENTS

Section I - THEORETICAL GEOMETRY AND GRAPHICS

Section II - APPLIED GEOMETRY AND GRAPHICS

Section III - ENGINEERING COMPUTER GRAPHICS

Section IV - GRAPHICS EDUCATION