MODELING THE IDENTITY OF THE ANIME CULTURE FAN

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ABSTRACT

The mathematical or economic approach to the effect that culture exerts on its consumer is less common. The present paper refers to a new cultural genre in Romania, the oldest in the world, the genre of Japanese animation, called "anime", which developed externally and internally a true market of its derived products. Lovers of this kind of animation are called "anime fans," and our research respects a cognitive pattern related to their identity. Exogenous influences with an implication in the consumer's decision are of particular importance in this respect. The study of their dynamics in the context of research is applicable to any decisional behavior.

Keywords: *system, influences, anime identity, optimal control*

1. INTRODUCTION

In Romania, anime fans existed long before TVR and other television stations began broadcasting anime series and movies (after the year 1989).

In this article, we will start from the results set forth in previous studies by the author [2] or in the literature. The mathematical model to which we refer represents an economic phenomenon existing on the Romanian market, that of the *e-marketing* of the anime culture, in particular, of the influences that are exerted on the preferences of the consumers of the products of this culture. The method used in the paper is a semi-inverse method of obtaining the analytical solution and its graphic representation for the optimal control problems correlated with this system, followed by the development of a corresponding application software. Assuming the optimal solution of a certain form and data assumptions, it is verified for the dynamic system that models the phenomenon, obtaining the analytical customized expression and the graphic representation for the trajectory and command [3].

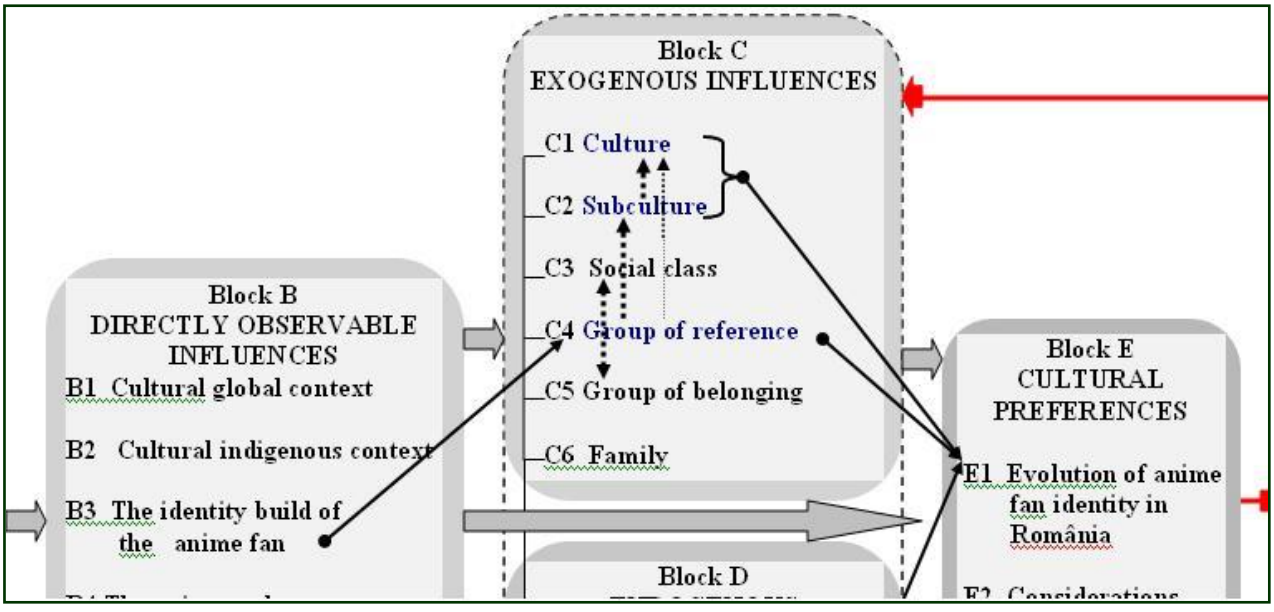


Figure 1. Cognitive model (processed sequence [1])

2. THEORETICAL CONSIDERATIONS

Starting from the connections established between the components of the model (Figure 1), we will deal, in the first part, with the exogenous influences and their direct impact on the evolution of anime fan's identity, respectively, the impact on the system, by the answer it will give us. Looking only at the first 5 exogenous influences and considering the family included, up to one point, in the "group of belonging", by our opinion and also of many specialists in the field [7], we propose the following mathematical model, written in the system of equations with differences:

$$\begin{aligned} u_{1,n+1} &= -u_{2,n} - u_{4,n} \\ u_{2,n+1} &= -u_{4,n} \\ u_{3,n+1} &= -u_{5,n} \\ u_{4,n+1} &= u_{2,n} \\ u_{5,n+1} &= u_{3,n} \end{aligned} \qquad (1)$$

where: $u_{i,n}$, $i=1,2,3,4,5$ are the notations for the exogenous influences, that means for: culture, subculture, social class, reference group, group of belonging, the last including also the family. The ecuations explain the relations between the influences in the C block, so they represent the system variables. We agree that the incoming unidirectional flows of data to be noted with "minus' (-), the exiting unidirectional flows to be noted with "plu' (+), and the bedirectional flows with both signs. The image is part of the cognitive model of my research [1].

In fact, by my opinion, the cultural influence($u_{1,n}$) fluctuation, in a time unit, depends upon the subcultural influence($u_{2,n}$) and of the reference group($u_{4,n}$), the subcultural influence fluctuation is depending also upon the reference group, the social class($u_{2,n}$) influence and the group of belonging($u_{5,n}$) are influencing each other, the reference group is created and so is depending of the anime subculture.

In order to fit to the mathematical context to which we refer, we will consider that the number of periods n(*period=1 u.t.=unit of time*) is equal to the number of variables *p:* $n = p = 5$. For a longer period, we will consider the total time as multiple of 5 ($\equiv 0$, mode 5). Equations (1) can be written in the matrix form:

$$\begin{pmatrix} u_{1,n+1} \\ u_{2,n+1} \\ u_{3,n+1} \\ u_{4,n+1} \\ u_{5,n+1} \end{pmatrix} = \begin{pmatrix} 0 & -1 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} u_{1,n} \\ u_{2,n} \\ u_{3,n} \\ u_{4,n} \\ u_{5,n} \end{pmatrix} \qquad (2)$$

We will decrease in both members: $u_{i,n}$, $i=1,2,3,4,5$, obtaining a linear dynamical system with the "system matrix" *A*. In order to study the changes of the system following the changes of the various exogenous influences, we will use the vector $\omega_{i,n}$, $i=1,\ldots,5$, of identical components but with different coefficients, representing possible perturbations on the five exogenous influences, the coefficients forming the "disturbing matrix" *B*. The third matrix *C* transmits the response of the system following the action of the disturbing factors.

Using the previous notations, the equations (2) can be transcribed in the form of a general system of state equations, with the usual notations:

$$\begin{pmatrix} \frac{dx_1}{dt} \\ \frac{dx_2}{dt} \\ \frac{dx_3}{dt} \\ \frac{dx_4}{dt} \\ \frac{dx_5}{dt} \end{pmatrix} = \begin{pmatrix} 0 & -1 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} + \begin{pmatrix} e & 0 & 0 & 0 & 0 \\ 0 & d & 0 & 0 & 0 \\ 0 & 0 & c & 0 & 0 \\ 0 & 0 & 0 & b & 0 \\ 0 & 0 & 0 & 0 & a \end{pmatrix} \cdot \begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \\ \omega_5 \end{pmatrix} \qquad (3)$$

$$\cdot \begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{pmatrix} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{pmatrix} \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix}$$

more generally, a linear, dynamic type ($\sum$) system with quadratic matrix coefficients (3') in which: *X*=states space, *Y*= the output space**,** *y* vector = $(y_1, y_2, \ldots, y_5)$ is "*the system response*", $y \in Y$, $x = (x_1, x_2, \ldots, x_5)$ is the vector of exogenous influences / vector of states, $x \in X$**,** because we have noted: $u_{i,n}=x_i$**,** $\frac{dx_i}{dt} = u_{i,n+1} - u_{i,n} = \frac{u_{i,n+1} - u_{i,n}}{n+1-n}$**,** *W*= space of the allowed commands, $\omega=(\omega_1, \omega_2, \omega_3, \omega_4, \omega_5)$, the vector of the "*external disturbing factor*", $\omega \in W$, the system entrance, $(t_1,t_2) \subset R$ is the time interval, $t \in (t_1, t_2)$ is the time variable, but we agree to be a multiple of 5 to

equate the number of the studied periods with the number of the exogenous influences established by the literature [7]. The system can be written in statement variables terms, with ω the entrance of it, and all the system coefficients as quadratic matrices:

$$\begin{pmatrix} \frac{dx_1}{dt} \\ \frac{dx_2}{dt} \\ \frac{dx_3}{dt} \\ \frac{dx_4}{dt} \\ \frac{dx_5}{dt} \end{pmatrix} = A \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix} + B \cdot \begin{pmatrix} \omega_1 \\ \omega_2 \\ \omega_3 \\ \omega_4 \\ \omega_5 \end{pmatrix} \qquad (\Sigma) \qquad (3')$$

$$\begin{pmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \end{pmatrix} = C \cdot \begin{pmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{pmatrix}$$

We are in the context (initial conditions) of the semi-invert algorithm for obtaining the optimal solution of the dynamic systems with quadratic cost function [3][4][5], when the system's solving is reduced to find the solution for a matrix type Bernoulli equation:

$$\frac{dp(t)}{dt} + (A + A^*) \cdot p(t) - c \cdot B(t) \cdot B^*(t) = 0 \qquad (4)$$

with the initial particular restrictions, as follows:

$$\begin{aligned} &A,B,C \in M_5(R), \quad X = Y = R^5, t_1 = 0, \\ &(t_1,t_2) \subset R, \quad p(t_2) = C_0 = e^{At_2}, \quad t_2 = 5 \cdot t, t > 0 \\ &det(A + A^*) \neq 0, \quad B = B^*, \quad x_0 = x(0), \quad c = 1 \end{aligned} \qquad (5)$$

where A^* and B^* are the notations for the transposed matrices A and B, $\mathcal{M}_5(\mathbb{R})$ is the square matrices space of five order with real coefficients, leading to the following form:

$$\frac{dp(t)}{dt} + (A + A^*) \cdot p(t) - B^2 = 0 \qquad (6)$$

with the solution:

$$p(t) = [C_1 - e^{(A+A^*) \cdot t} \cdot C_2]^{-1} \qquad (7)$$

with: C_1 and C_2 constant matrices coefficients. As a result, the dynamic system solution (3) will have the next form:

$$x(t) = x(0) \cdot e^{\int_0^t (A - B^2 \cdot p(v)) dv} \qquad (8)$$

and the optimal command will have the usual expression:

$$\omega(t) = -B \cdot p(t) \cdot x(t) \qquad (9)$$

Taking into account the above results, we will consider, for start, the functional $\boldsymbol{B_3}$ -> $\boldsymbol{C_4}$(Figure 1), so that the disturbing matrix will have the form:

$$B = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \qquad (10)$$

with the initial condition:

$$x(0) = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} \qquad (11)$$

meaning a single representative of the anime identity.
so there is a single "anime fan" supposed, representative for the fan's reference group (Figure 2a) or subculture only (Figure 2b).
The trajectory of the solution and the response of the system provide an increase in the exerted influence of the fan's identity, and the decrease of the other exogenous factors influence.

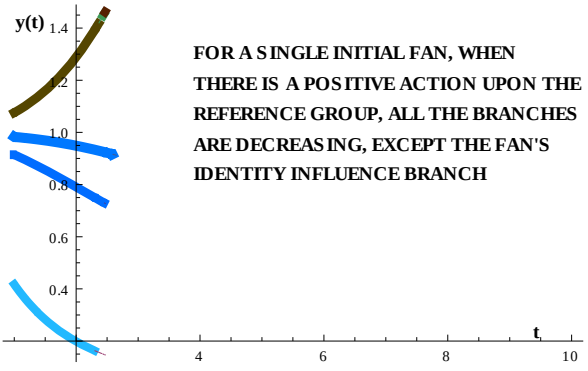


Figure 2 In the case of an initial fan, it is shown that only one of the system's influences has an upward trajectory.

For the same disturbance, but only with an initial cultural component, when x(0) = (1,0,0,0,0), the exogenous

influences have descending or not represented trajectories:

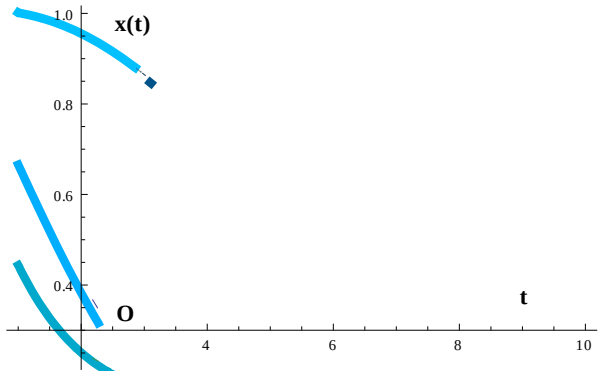


Figure 3. The trajectory of influences for the situation where there is no initial anime fan, not even subculture, but only the existence of the culture influence, the other exogenous influences are on descending trajectories.

3. ANALYSING THE ANIME PHENOMENON ACCORDING TO THE COGNITIVE MODEL

3.1 The functional processing

What is of interest, however, is mainly, in addition to the block C, where the exogenous influences are recorded, as a result of the intervention on the reference group C_4, due to the advent of the anime fan's identity in Romania, what is interesting, therefore, is the system's response, materialized in the main functional *C->E*, but also in the secondary functionalities, respectively: *C1,C2,C4->E1* (Figure 1), so we will analyze, one by one, the behavior of each influence in the response given by the system.

a) We assume that under the initial conditions, we include the existence of an "anime fan":

$$x(0) = \begin{pmatrix} 0 \\ 0 \\ 0 \\ 1 \\ 0 \end{pmatrix} \quad (12)$$

We keep the same matrix B, but in the system response we only highlight the branch that refers to the subculture-C_2

$$C = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad (13)$$

The result is (Figure 4):

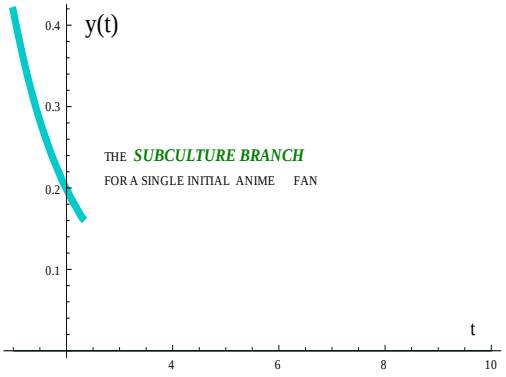


Figure 4. The subculture branch no longer exerts a significant influence upon the system

b) Referring now to the anime fan's identity branch, meaning the influence of the reference group, we modify the *C* matrix to retain only this branch as follows:

$$C = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad (14)$$

The result is an ascending trajectory, both for the C_4 influence and the structure of the system response (Figure 5).

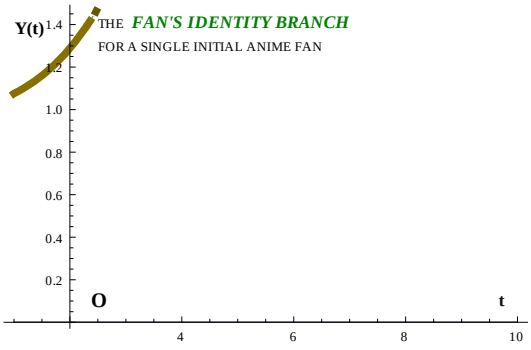


Figure 5. The branch of the reference group is expected to exert a significant influence upon the system over a longer period (the time will take the form: 5t, where t is the studied period)

For the same initial conditions, the other exogenous influences no longer exert a significant influence upon the system, having descending behavior, both in the trajectory structure and the resulting response. (Figure 6 a,b).

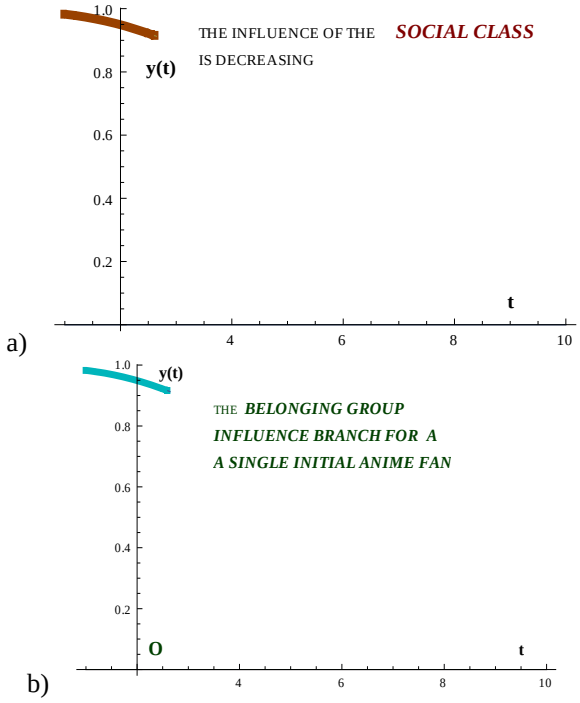
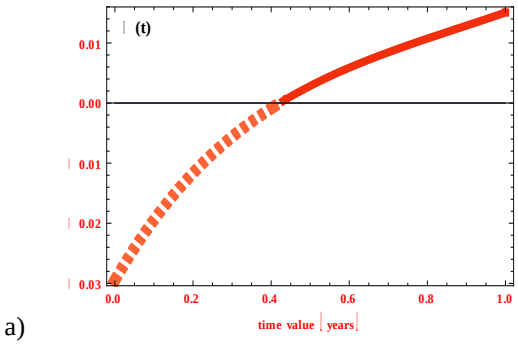


Figure 6. a) social class b) belonging group

The optimal command is given by the same algorithm, and, in the context of an initial single anime fan, with the same disturbing matrix B, we obtain the next results, meaning the necessity of an ascending action upon the system of exogenous influences.



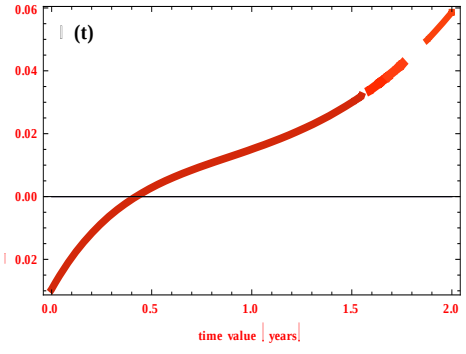


Figure 7. The optimal command upon the system of the exogenous influences, with the initial conditions including the existence of an anime fan, for growing periods of time: a) t = 1 u.t. b) t = 2 u.t.

If we exclude the anime fan from the original conditions, including instead the culture and the subculture influences, the other two influences of interest in the present study (Figure 1), and keep the rest of the initial conditions, especially the disturbing action on the reference group, we get the next results. Therefore, the initial conditions are:

$$x(0)=\begin{pmatrix}1\\1\\0\\0\\0\end{pmatrix} \qquad (15)$$

With these initial conditions, we will follow the path of the cultural influence in the context of the response, keeping the continuous action on the reference group/ anime fans group (Figure 8).

Unlike the component of the cultural influence, the subculture is present in ascending curve (Figure 9) both in the solution trajectory and in the structure of the system response, in the conditions of the positive action upon the anime fan's group and the presence of the anime subcultures in the initial conditions.

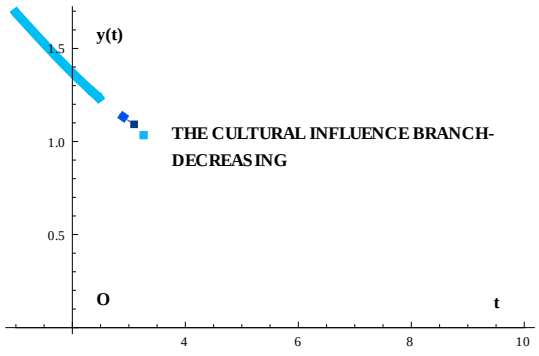


Figura 8. The influence of the cultural component of the response is decreasing in the absence of fans in the initial condition

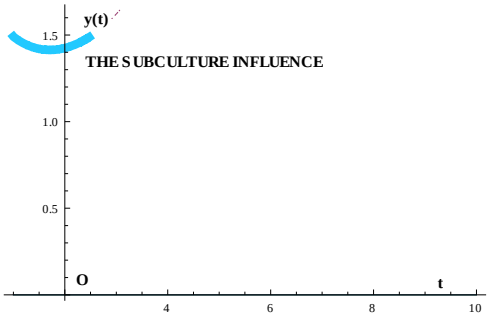


Figure 9. The influence of the subcultural component of the response is increasing in the presence of the initial culture and subculture influences

The other two components of the response structure, respectively the influences of the social class and the group of belonging(Figure 10), are decreasing, therefore, they are not important for the development of the anime culture, and do not support a secondary functional relation, highlighted in the presented model of research.

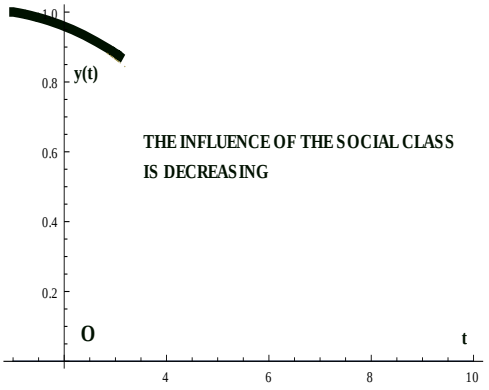


Figure 10. The influence of the social class in the structure of the system response becomes insignificant for the present study

Excluding the subculture and the presence of the anime fan, meaning the influence of the reference group, from the initial condition, including instead only the culture influence, and preserving the form of the disturbing matrix, thus the positive action on the group of fans, we will find that all the components of the response, are irrelevant to the evolution of anime culture, and consequently, to the cognitive model and the present study.

This demonstrates the necessity of the existence of the anime subculture or the reference group, represented even by a single fan, or both, in order to obtain ascendant influences on the evolution of anime culture.

3.2 Simulations using the mathematical model

We will present the evolution of each component in the response structure, following initialization with only the cultural component that means with not a single fan anime, initially:

$$x(0) = \begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix} \quad (16)$$

We will only highlight in the response matrix the component whose evolution we want to follow.

i) In order to follow the cultural influence component of the answer, we use the response matrix of the following form:

$$\boldsymbol{C} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad (17)$$

obtaining a descending influence(Figure 11):

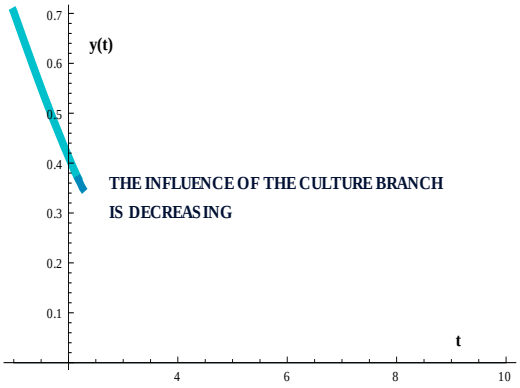


Figure 11. The trajectory of the cultural influence in the structure of the system response

ii) Similarly, for the subculture component, the response matrix will be:

$$\boldsymbol{C} = \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad (18)$$

resulting in(Figure 12):

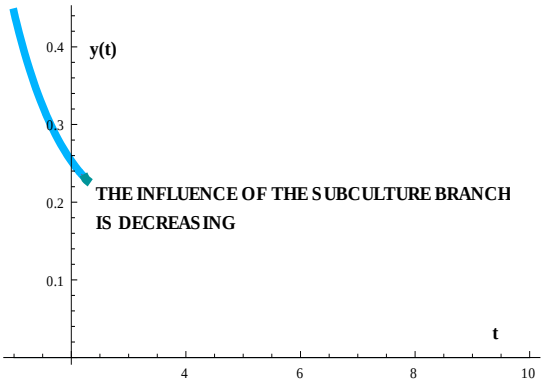


Figure 12. The trajectory of the subculture influence in the structure of the system response

iii) Also, in order to follow the social influence component of the answer, we use the next response matrix:

$$\boldsymbol{C}=\begin{pmatrix}0&0&0&0&0\\0&0&0&0&0\\0&0&1&0&0\\0&0&0&0&0\\0&0&0&0&0\end{pmatrix} \quad (19)$$

obtaining (Figure 13):

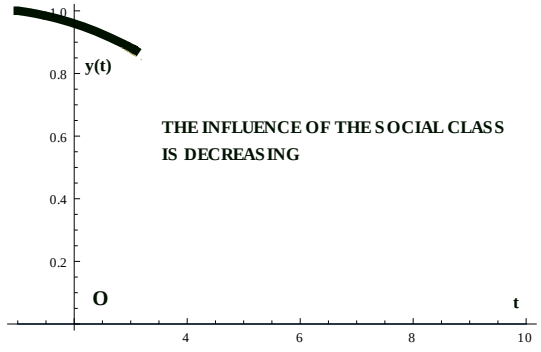


Figure 13. The trajectory of the social class influence in the structure of the system response

iv) Analogously, in order to follow the cultural influence component in the answer structure, we will use the following form for the response matrix:

$$\boldsymbol{C}=\begin{pmatrix}0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&1&0\\0&0&0&0&0\end{pmatrix} \quad (20)$$

The trajectory of the reference group influence component will have a descendent behavior (Figure 14)

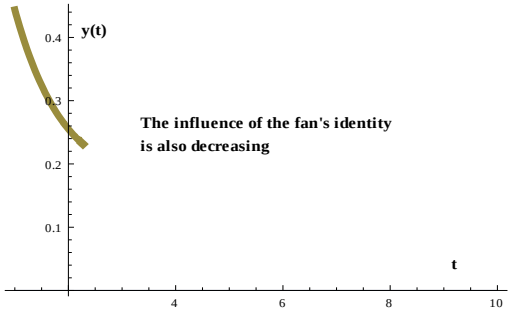


Figure 14. The trajectory of the influence of the reference group in the structure of the system response

v) Finally, in order to follow the evolution of the last component, the influence of the group of belonging, for the same initial and disturbing conditions, we use the matrix of the answer, thus:

$$\boldsymbol{C}=\begin{pmatrix}0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&1\end{pmatrix} \quad (20)$$

and we obtain the evolution for the influence of the membership group in the response structure provided by the system (Figure 15):

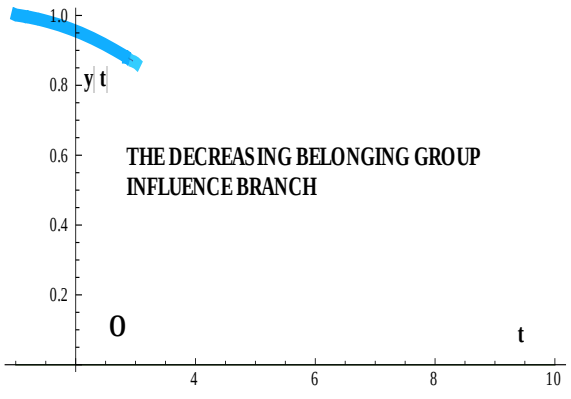


Figure 15. The trajectory of the membership group influence in the structure of the system response

So, adapting the conclusions already accepted, we can write, generalizing the previous results:

Theorem

The optimal control problem for the exogenous influences model with the restriction n = p (number of influences equal to the number of studied periods), expressed by the equations (3'), the coefficients of the dynamic system being square, symmetrical matrices, which verify the sufficient condition det $(A + A^{*}) \neq 0$*, has an analytically and graphically determinable solution.*

4. CONCLUSIONS

1) The present study opens the possibility of analyzing the system formed by exogenous and subsequently endogenous influences, which determine the evolution of new cultural trends, determined by the changes in the international cultural market of e-marketing of new cultural products, products that make their entrance due to cultural events or the Internet.

Such a situation is the phenomenon of the existence of the anime culture in our country, started from at least one fan of this genre, in *underground*, before '89(the evidence of this fact is found in the anime's descriptions and in the comments [8]), then more and more, with the broadcasting of anime series on television channels, followed by anime conventions, but especially through e-marketing and Facebook.

2) The algorithm used in this study leads to much more research possibilities, in the sense of initial assignment *x(0)*, and by modifying the disturbing matrix B, which would determine at least 5^5 possibilities. The results can be generalized, in a future study, what we have seen in the present paper were only situations related to the cognitive model.

The method used can be generalized for time-dependent symmetric matrices, noting that for the existence of the solution, the sufficient condition is: $det(A+A^{*}) \neq 0$.

We specify that the algorithm of "Mathematics 7.0" created by the authors, offers the possibility of interactive insertion of a very large number of values, which allow analysis of the system of exogenous influences on the consumer's decision in the context of any research model.

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