# MODELING
# A
# SOCIO-POLITICAL SYSTEM
# FOR
# PUBLIC POLICY CYBERNETICS

By

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**Abstract**

Mathematical model-building in the social sciences is concentrated so far in economics, leaving politics far behind. Based on a recent paradigm of **Sociophysics**, this article attempts an interdisciplinary general system model that combines all three social sectors: economics, politics, and ethnics. To do so, this preliminary study proceeds by a formalization of systems theory, along with its structures and functions. Because of its wide scope, the model is necessarily theoretical and fundamental, leaving specifics to later specialized studies. As such, this primary attempt incorporates the concepts of **political power** and **economic wealth** into the same model, thus indicating a simple way to approach a more realistic representation of society.

Key-words: Sociophysics; Sociopolitics; Sociocybernetics; Formal Modeling; Policy-Making.

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## INTRODUCTION

Model building is a well-established activity in many disciplines. **Models** try to describe, explain or prescribe particular aspects of structures or processes with a view to improving our understanding or control of various systems. The complexity of reality, however, has always limited the modeling process in depth or breadth. One could either model greater detail but narrow application or wide generality but little exactitude. This trade-off between quality and quantity is perhaps in the nature of things, but the task still remains to try and optimize these two.

One way to do this is by the judicious use of **mathematics**. As a symbolic language, mathematics adds rigor to our concepts and thus packs more information with greater validity. Economists, above all social scientists, have gone quite far in using mathematics for this purpose. But their endeavors are restricted to one sector of human activity. This uneven development has left great gaps of systematic knowledge in the social sciences and limited economic models to a one-dimensional mode. Presently, therefore, we have reached the stage where economic models should be expanded to include broader concerns or general social system models must be developed to include the economic sub-system among others.

This paper makes a first attempt to combine both economic and political concerns in a single and simple formal model. This means that it interfaces the flows of **wealth** and **power**, attempting to explain how they affect **public policy** making. Converting money into influence and vice versa is one of the most important transaction in social systems and thus is worthy of our efforts. At the same time of course, they are extremely difficult to exchange rigorously. Yet some attempt has to be made to gain more experience to a truer representation of reality.

The procedure followed here gives a brief introduction to systems theory upon which is based our mathematical construct. With this symbolic description of a social system, we then present a mathematical analysis of its operations, and finally conclude by focusing on their **politico-economic** interactions. What follows then is a basic introduction to a continuing project of social modeling, following three logical steps: system, structure and function.

# 1. THEORETICAL SYSTEMS

## 1.1. THE SOCIAL SYSTEM

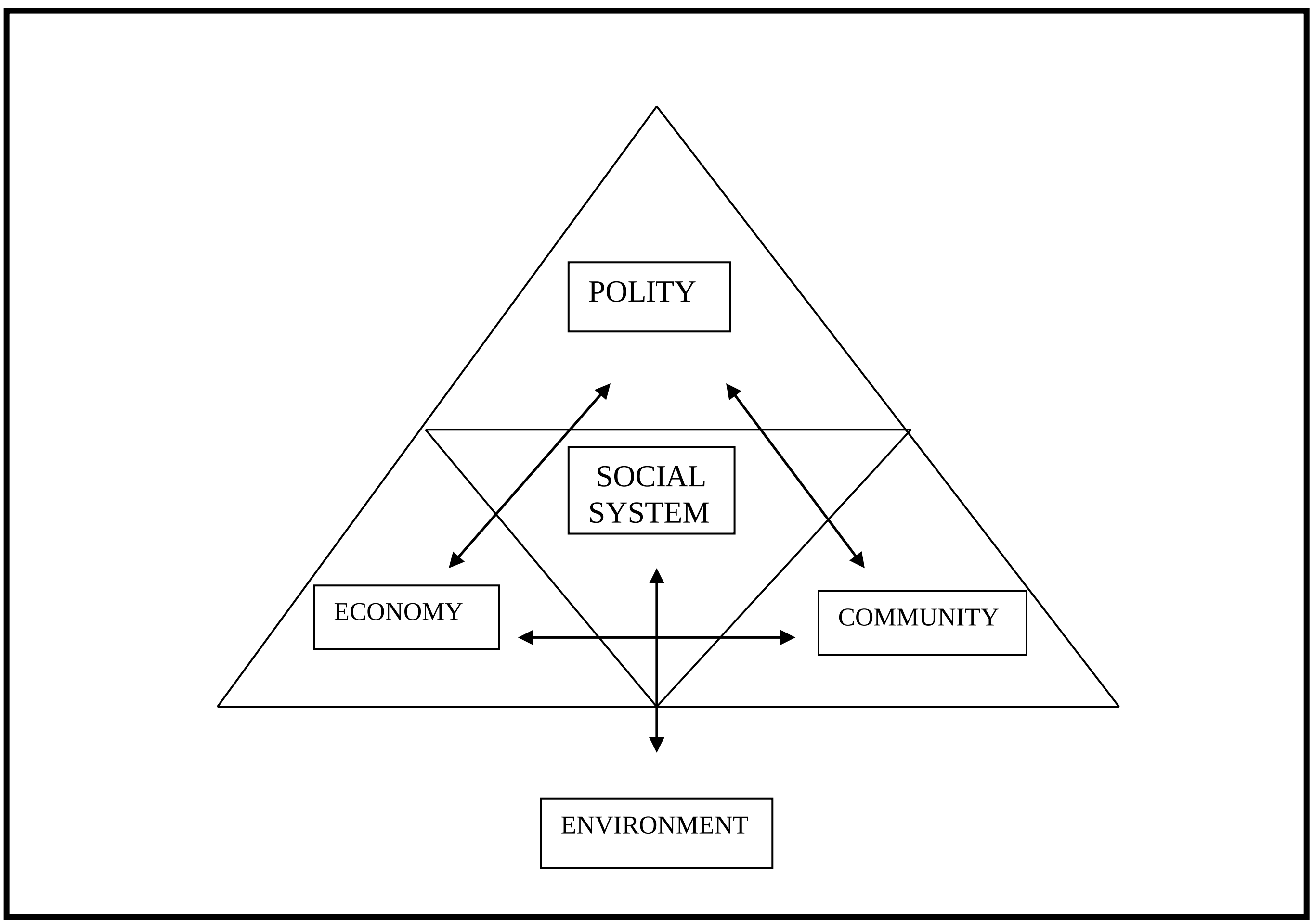
This study looks at “society” as a “system”. There are various ways of defining these two terms, but we chose one of the simplest definitions for both. To begin with, a **system** is a set of units or a group of interrelated components. "Real" systems, like society, exist in a spatial-temporal framework. For society, the spatial environment is ecology and the temporal environment is history.

The **Earth** is the natural environment of the **world** society, which is made up of many distinct social systems, represented socio-politically by its two hundred nation-states. As we define it, a **society** is a set of human actors and their actions. A "social system" is therefore a human group, interrelating and interacting within a geographical space and over a period of time. Persisting or prolonged interrelations form the structure of society, while the repetitive or continuous interactions form its process. Since humans are both logical and biological beings, they have needs and wants focused upon their perceived self-interest and survival. In that sense, societies are creations that serve to fulfill the necessities of physical life and the desires of human imagination. Because of this functional characteristic, social systems develop their capacities to produce exchange and distribute various goods or values for human consumption. Society, through different specialized organs and techniques, extracts matter and energy from its environment and transforms them into commodities that can maintain its members according to their culture or way of life.

The various specialized functions of society may be grouped into three distinct **sectors**: economy, community, and polity. The first forms the infrastructure of the system and produces its goods and services. The second forms its structure and consumes the products. Finally the third forms its superstructure and regulates or controls the overall operations of the system.

The **diagram** bellow illustrates some of the concepts defined and simplified here. The main structures of a typical society are shown as triangles, while the significant processes are shown as arrows. Within the large triangle are three smaller triangles representing the economic, cultural and political sectors of society. The arrows from and to each triangle show the inter-actions between them, as well as between the system and its environment.

For our purposes, we distinguish two main types of interactions, because these two types reflect the most important flows in society. One is **money** and represents the exchange of wealth among its sectors the other is **influence** and represents the impact of power in the system. Since the purpose of this study is to show how these flows interact, we proceed to formalize the structures and functions of the social system and then simulate its operation in these terms.



## 1.2. FORMAL MODELS

We now try to translate the verbal theory of the social system, formulated in the preceding chapter, into a formal model, utilizing **mathematics** as a collection of axioms or postulates from which certain consequences or conclusions follow according to a strict algorithmic code. Since a **model** is a representation of certain aspects of reality in some simplified form, a mathematical model is an abstract construct that reflects some phenomena or situations in the real world by representing and manipulating them symbolically.

With this in mind, let us choose **S** to represent the social system and **N** its natural environment. As a structural-functional system, society possesses or desires certain traits or values. If we let **G** represent these characteristics, then either S possesses G as its identity or tries to attain it as its goal. If S can maintain a set of G traits in spite of any disturbance or opposition, then it is said to be persisting or **homeostatic**; if it is moving towards G as its goal, it is developing or **teleonomic**.

Social systems always strive to attain or maintain some **G**, therefore they can be conceived or characterized in terms of a combination of their G state **values**: i.e. security, welfare, quality of life and sovereignty. As dynamic systems however, societies cannot be frozen into a certain **state** for any length of time. Even when they are at equilibrium, any state **A** is flexible and keeps changing within certain limits.

$\mathbf{A = \{S^G\}}$ at time t could thus be conceived as a state **vector** composed of a set of constants and variables. The **variable** components of G change through time and represent the **functional behavior** of the system during a sequence of successive states (t=0, … ∞). The **constant** components of G persist unchanged through time and represent the **structural parameters** of the system for the duration under consideration. (Usually, variables are symbolized by the last letters of the alphabet: x, y, z, and constants by the first: a, b, c ...).

With these **symbols**, we can show the social system described in the last chapter in terms of its **state vector** coordinates as a **bar equation**:

| | | |
|---|---|---|
| $S^{G}_{t}$ : | $x_i$ | = various influence or power flows in society |
| | $y_j$ | = various monetary or wealth flows in society |
| | $e_k$ | = various sectors of the economy |
| | $c_1$ | = various sectors of the community |
| | $p_m$ | = various sectors of the polity. |

The particular system, therefore, has two types of **variables** (x & y) and three types of **parameters** (e, c, p). The subscripts indicate the various sub-divisions within each type. Finally the two vertical bars indicate that G refers to a system, that is to say, the symbols in it are interrelated in some way. The particular way of interrelationship will be described later on.

## 1.3. SPACE-TIME CONTEXT

Society, like any real system, exists within some conceptual framework, the most primordial of which is space and time. The **s-t** framework provides the reference perspective for both conceptual and empirical investigations of reality. **Space** may be defined as a set of Cartesian coordinates **(x, y, z).** The orthogonal relationship among these coordinates defines three-dimensional space and measures or locates any body within it. Information about the size and position of anything physical can thus be given as a function of spatial coordinates: $f$(x, y, z). Spatial structures are made up of set of points in proximity and are necessary for any real system.

Generally, a **system** (S) is defined as an ordered set of internal (I) and external (N) spatial structures: **S = (I, N),** where I = (A, ρ) and N = (B, σ). A or B are structural elements and ρ or σ structural relations. This formal notation means that systems are structures, existing within a delimited space and are made up of sets of elements related to each other in some manner. Systems may be either abstract, like the one defined above, or concrete corresponding to something in the empirical world. Societies are of the latter category, although they can be formally defined as we have done here.

For research purposes, social systems may be studied in two-dimensional geographical space. Obviously **geography** is related to society and the field of **geopolitics** attests to it. Map-making is the most basic method of spatial analysis, illustrating various social data. Distance is the most significant measurement of space, because it determines many relationships among system components. One famous relationship is Newton's Universal Gravitation Law which relates the **force F** exercised between systems in terms of their mass **m** and distance **s** as: $F = m_1 m_2/s^2$. The closer and bigger the systems, the more powerful their re1ationship

In order to complete our conceptual framework, we must add the notion of time to that of space. **Time** is related to space in direct proportion: the greater the distance, the longer the time required to cover it. The passage of time measures change in space, since displacement in space consumes time.

Social systems exist in space and time, therefore they are indexed by them: $\mathbf{S = \mathit{f}\ (s, t)}$. Being dynamic, societies are in constant flux and undergo variation of their **endogenous** components over time. Thus component x changes over time as: $f\ (x_t, x_{t+1}, x_{t+2} \ldots x_{t+n})$. Similarly the **history** of x is: $f\ (x_t, x_{t-1}, x_{t-2} \ldots x_{t-n})$. For any particular discrete time period a change in x is the difference between its state in two time periods: i.e. $\Delta x = (x_t - x_{t-1})\Delta t$ or $x_t - x_{t-1} = \mathbf{\Delta x/\Delta t}$.

In general, **change** is a function of the difference between some supposed **G** (**Bold**) and actual G (Plain) distribution of characteristics: $\Delta G(s, t) = a[\mathbf{G}(s, t\text{-}l)\text{-}G(s, t\text{-}l)]\Delta t$, where "a" is the **sensitivity** parameter of the system. Furthermore, if we let $G^s_t = g(S^s_{Gt-1})$, where s is a spatial parameter and S is our system, thereby: $\Delta G(s, t)/\Delta\ t = c(KS\text{-}l)\ G\ (s, t)$. This means that the behavior of the system is a function of its structure. By its nature, a system normally tries to bring its actual traits G as close as possible to the desired values of **G**.

Finally we should add the impact of **exogenous** variables **N(s)** and other non-measured random disturbances **ε**(s, t), shown as:

$$\Delta G(s, t)/\Delta t = c(KS\text{-}l)\, G(s, t) + bN(s) + \varepsilon(s, t),$$ where **b** is a vector of coefficients.

Taking the **limit** as $\Delta t \rightarrow 0$, then $G(s, t) = KSG(s, t) + N(s)b + \varepsilon(s, t)$, thus completing the definition of a system's characteristics as determined by its structure in space and time, as well as its environmental interactions and other unknown factors.

## 2. DESCRIPTIVE ELEMENTS

### 2.1. SYSTEM FUNCTIONS

In the previous chapter, we defined the state vector of the social system under consideration. In order to complete the description of such system, however, we must also specify a set of rules or code for determining the values of G for any time t. This **code** is a set of functions F relating the various components of S. Since **science** is supposed to establish functional correlations among variables within certain parameters, this code is crucial to our study. Mathematically, functional relationships are shown as **equations**, thus:

$$G_t = F(X_{i,t}, Y_{j,t}, E_k, C_1, P_m)$$, or more simply: $\mathbf{S} = \boldsymbol{f}(\mathbf{G})$.

Clearly, these equations correspond to the state vector coordinates defined in the bar equation of section 1.2 and are another way of showing the same thing. Systems Theory tries to account for the important events going on in a set of Gs and Fs. It is such a set that composes the structure of S, whereas its behavior is a time series of Xs and Ys.

In this sense, our model represents the structural **content** of S in a particular environmental **context**. That is to say, it indicates how the structure operates under different conditions of variable behavior. Mathematical equations, as the above, show a functional identity between at least two variables: S and G or X and Y. In this case a **function** would be an ordered pair of elements (S & G), where the values of the independent variable G are equated to those of the dependent variable S; meaning that the kind of society we have depends on the interrelations and interactions of its characteristic components.

Specifying the relationship between **dependent** and **independent** variables may be simply **linear**, shown easily by a **regression** equation correlating two variables and two parameters, as**:** **y = a + bx**, where **y** is the dependent or output variable, **x** is the independent or input variable, **a** is the **intercept** parameter, representing the expected level of y when x = 0, (a = y); **b** the **slope**, representing the expected difference in y for a given difference in x, ($b = y_i - y_j./x_i - x_j$). The best way to illustrate this basic equation is by the system input-output diagram, in which **input + transformation = output.** Obviously, the formula: **bx + a = y**, is an expression of this system transformation process; **a, b,** being the structural parameters of the system that determine how the process is carried out.

Similarly, the same input-transformation-output process can be shown by a dynamic equation taking into account changes in time:

$$\mathbf{Y_t - y_{t-1} = a + b\,(x_t - x_{t-l})}$$
$$\mathbf{\Delta y_t = a + b\Delta x_t.}$$

In that case **a** will be the value of **y** at the starting time, and **b** = $y_t - y_{t-1}/x_t - x_{t-1}$. Clearly the two approaches of correlating x and y correspond to a spatial and temporal distribution and are equivalent.

Adapting this general formula to social systems would make it much more complex, because social transformation processes are not as simple as a and b. Yet something like: **S = A + BG,** where A and B are complex parameters could serve as an adequate representation of our system. Of course, to be useful, this abstract equation will have to be analyzed in more detail, as we do later.

## 2.2. STRUCTURAL COMPONENTS

Before determining the exact formula correlating the various components of our model, we must outline them as accurately as possible. This means making an **inventory** of the pertinent variables and parameters of the social system. Using the concepts introduced so far, the components of S are two types of **flows** (X and Y) and three **sectors** (E, C, P), existing within a foreign environment (F). If we treat F as another sub-system, we have four **centers** of activity (**E, C, P, F**) interrelated by two kinds of **channels** (X and Y). As is well known, a number of items (n) have a total of (r) relationships according to the formula: $r = n^2 - n = n (n-l)$. For 4 n, the number of relationships adds up to 12, and since we have two directional relationships the total becomes 24. The following **tabulation** lists each of them:

**FLOW VARIABLES**

| FLOW | FROM→TO | POWER: (X) INFLUENCE | WEALTH: (Y) MONEY |
|---|---|---|---|
| CP | C→P | Public Opinion | Personal Income Taxes |
| EP | E→P | Business Lobby | Corporate & Sales Taxes |
| FP | F→P | External Pressures | Import Duties & Exchange |
| PC | P→C | Public (social) Policy | Social Welfare Subsidies |
| PE | P→E | Regulation of Economy | Development Grants |
| PF | P→F | Foreign Policy | Foreign Aid |
| EC | E→C | Commercial Advertising | Salaries & Profits |
| FC | F→C | Foreign Influences | Foreign Income |
| CE | C→E | Consumer Demand | Purchasing Power |
| CF | C→F | National Prestige | Payments Abroad |
| FE | F→E | Foreign Demands | Imports |
| EF | E→F | Economic Influence | Exports |

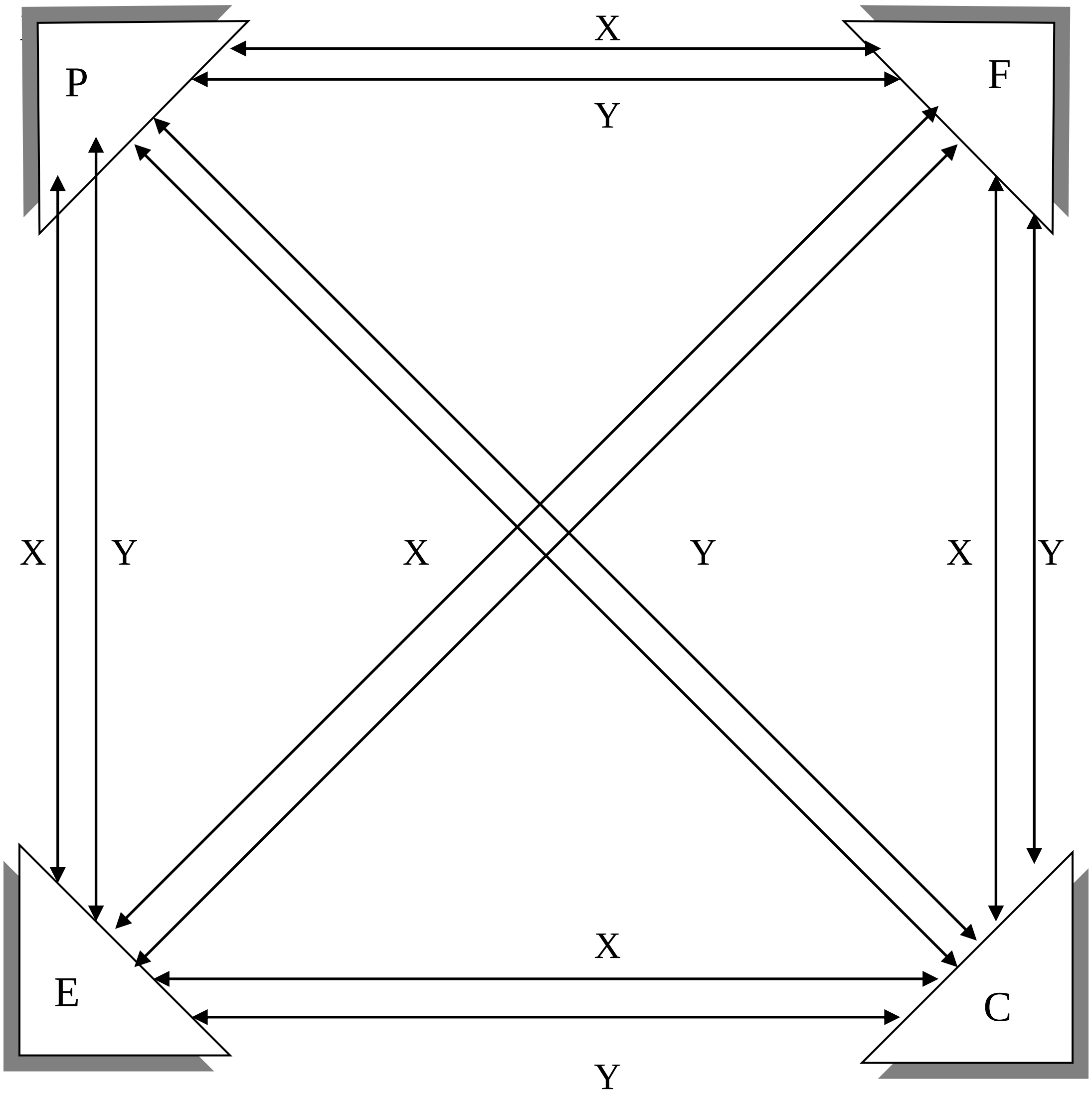
As the list indicates, we postulate that the two most important activities in the social system involve either the exchange of **wealth** (Y) measured by **money** or the exercise of **power** (X) measured by **influence**. These interactions take place among the four sub-systems (C, E, P, F) and are called by different names as shown in the above table.

Converting that table into the diagram below illustrates the interrelation of all these flows represented by arrows to and from each sub-system shown as a triangle: three of which (C, E, P) are internal to S and one (F) is external. In this way, we account for both intra-systemic (domestic) and inter-systemic (foreign) relations.

On the basis of these postulated structures and processes, we hypothesize that the way these various flows are distributed among the sub-systems is the most significant **macro-index** of G. That is to say: the relative distribution and rate of flow of power and wealth among the polity, economy and community of a social system and its environment provide the best indicator of political stability, economic performance, social welfare and national sovereignty.

Most important, and this is the **central hypothesis** here, there is a definite relationship between X and Y, so that one can be translated or converted into the other by the mechanisms of each sub-system. It is our main objective to find out how this conversion process works under different conditions.

# SOCIAL SYSTEM MODEL



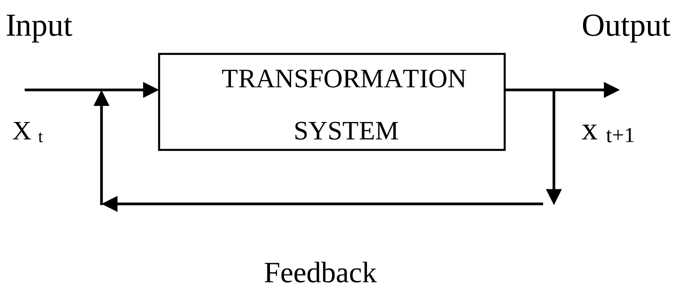

N. B.

SUB-SYSTEMS: P = Political (Government)
(Triangles) E = Economic (Production) = Internal Structures
C = Cultural (Consumption)
F = Foreign (Environment) = External Structures

INTERACTIONS: X = Power (Influence) = Process Flows
(Arrows) Y = Wealth (Money)

## 2.3 FEEDBACK SYSTEMS

From the point of view of social science, an important class of systems involves **feedback**: i.e. the output of one time cycle becomes the input of the next.




The feedback process is represented by the change of x which is $\mathbf{X_t + \Delta x = X_{t+1}}$. The difference $\Delta x$ is equal to $X_t$ multiplied by its net rate of change:

$$\Delta x = rx_t;\ \text{where } r = k\Delta t\ \&\ x_t \pm rx_t = x_{t+1} = x_t\,(1 \pm r)$$

As each cycle is repeated, the value of t is increased by 1. Thus, a feedback system means that its characteristics at any particular time are a function of its **history**:

$$\text{i. e. } \mathbf{G_t = f\, \Sigma\, G_{t-n}}$$

Societies are feedback systems because they evolve in a cumulative way by building on their past. The best way to understand this evolution mathematically is to use **discrete** time series. Although real time is continuous, social events may be considered as distinct and separate phenomena with a beginning and end in a particular time period: t = ...-3, -2, -1, 0, +1, +2, +3...

All feedback systems must contain some operation involving their past: $\mathbf{x_t = a + bx_{t-1}}$. This is a first-order equation because its feedback goes back one cycle only. These types of linear equations can be solved by their parameters:

$$x_t = \frac{a}{1-b}(l - b^{t+l}).$$

For higher order equations, the solution becomes the sum: $\mathbf{x_t = \Sigma\ ab^i x_{i-1}}$.

The most important consideration in feedback systems is how to maintain their stability and thus keep them from exploding as a result of accumulating feedbacks of many cycles. Unstable feedbacks, either of positive or negative nature, are a well-known bane of social systems as the population explosion or the arms race can attest.

Feedbacks can be handled mathematically by the parameter (b), already introduced in the formula $x_t = a + bx_{t-1}$. This parameter summarizes our ignorance of the exact feedback process. Whatever that process is, we want the feedback to counteract any exponential growth of the variables and thus compensate for them. If the feedback is to move the system towards stabilization, its absolute value must be less than 1 for either positive or negative type ($|b| < 1$) otherwise the system will self-destruct. In other words, **stability** means that $\mathbf{\Delta x/\Delta t = 0 = a + bx}$**, or** $\mathbf{x = -a / b}$, thus stopping any further increases and stabilizing the value of x at the ratio of its parameters.

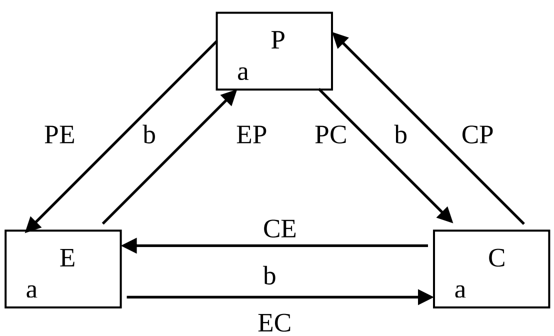
So far we considered the single self-feedback system as the simplest case. Feedbacks, however, operate between systems to form a closed loop of continuous interactions where the inputs of one are the outputs of the other system, so: $y = a + bx$. The **time lag** in this case can be shown as: $\mathbf{y_t = ax_t - by_{t-1}}$ for one cycle or **first order** equation. On the basis of this explanation, we can next tackle the model of our social system which is more complex and requires multivariate analysis for its solution.

# 3. ANALYTIC METHODS

## 3.1. MULTIVARIATE ANALYSIS

In order to study our model of the social system, one must relate the two types of flows among the three sub-systems. Since we have postulated a linear relationship, we shall use regression equations, but the previous **bivariate** formula no longer suffices. A multiple regression equation will be necessary to indicate how each sub-system interacts with the others.

Since our social system has three internal and one external subsystem, we begin its analysis by considering only the internal components at this stage. Taking either the X or Y flows separately, the system looks like this:




Three **simultaneous** equations for each flow describe the operation of this **loop**:

$$\Delta xP / \Delta t = aPxP + bCPxC + bEPxE - bPExP - bPCxP$$

$$\Delta xC / \Delta t = aCxC + bPCxP + bCExE - bCExC - bCPxC$$

$$\Delta xE / \Delta t = aExE + bPExP + bCExC - bEPxE - bECxE$$

(The Y equations would be identical to the above by replacing X by Y)

This means that the values of P, C, E, change according to their internal changes at the rate of “a”, plus their inputs and minus their outputs at the rate of b.

The intra sub-system feedbacks are contained in the "a" parameter and the inter sub-system feedbacks in the "b", so in order to solve the net change of the system we must construct the determinant of the **slope matrix** as:

aPaCaE + bPE + bECbCP + bPCbCEbEP - aPbECbCE - aCbEPbPE – aEbCPbPC

$$
= \begin{vmatrix} aP & bCP & bEP \\ bPC & aC & bEC \\ bPE & bCE & aE \end{vmatrix}
$$

The product aPaCaE represents the three internal feedbacks in P, C, E.

The product bPEbECbEP represents the slope of the loop P→E→C→P.

The product bPCbCEbEP represents the slope of the loop P→C→E→P.

The remaining three negative terms are products of each internal feedback times the other two external ones. If one of the loops is broken, its b = 0, so its determinant disappears.

The conditions for a stable system require both that $\Sigma bii < 0$ and $|bij| < 0$, because the number of sub-systems is odd for both X and Y loops.

Now when we add another sub-system to include the environment into our calculations, we have a two-way four-variable loop for X and Y, which represents the complete model. This addition complicates the equations much more, because it creates a geometric increase of interactions:

$\Delta XP / \Delta t$ = aPXP + bCPXC + bEPXE + bFPXF - bPCXP - bPEXP - bPFXP

$\Delta XC / \Delta t$ = bPCXP + aCXC + bECXE + bFCXF - bCPXC - bCEXC - bCFXC

$\Delta XE / \Delta t$ = bPEXP + bCEXC + aEXE + bFEXF - bEPXE - bECXE - bEFXE

$\Delta XE / \Delta t$ = bPFXP + bCFXC + bEFXE + aFXF - bFPXF - bFCXF – bFEXF

In this case, the **determinant** of the slope matrix becomes:

$$
\begin{vmatrix} aP & bCP & bEP & bFP \\ bPC & aC & bEC & bFC \\ bPE & bCE & aE & bFE \\ bPF & bCF & bEF & aF \end{vmatrix}
$$

aPaCaEaF + bPCbCEbEFbFP + bPEbCFbEPbFC + bPFbCPbECbFE

- bFPbECbCEbPF - aPaEbFCbCF - aFaCbEPbPE – bFEbEFbPCbCP

The **stability** conditions for this four-variable determinant are the same as for three-variable with one exception: $\Sigma bij < 0$; but $|bij| > 0$, because of the even number (4) of sub-systems.

For the diagrammatic representation of this loop see the system drawing in the previous section. These equations thus form a complete mathematical model of the operation for the conceptual system presented so far.

## 3.2. CYBERNETIC SYSTEMS

Stability conditions for dynamic systems are not easily attained, because it is difficult to balance the diverse changing variables and disturbing factors tending to destabilize them. For social systems, such disturbances are due both to internal dynamics and external impacts. In simple societies, these forces may be handled in a reactive *ad hoc* fashion, but as a system becomes more complex and feedbacks become more unpredictable, disturbances tend to multiply and get out of hand.

In this case, modern societies must develop cybernetic institutions to **control** social change more systematically. In order to do that, they must have implicit or explicit standards set for the **normal** behavior of the system, upon which their actual behavior can be compared and corrected. The comparative measure of the gap between the **ideal** and the **real** gives the magnitude of the instability of a system.

On that basis, social control means trying to bring the actual performance of the system as close as possible to the established norms. We can indicate this activity as minimizing the difference between two states: **Xi** and Xi. The equation describing such difference would be: $\Delta Xi = k\ (\mathbf{Xi} - X)\ \Delta t$, where k = parameter of system sensitivity; **Xi** = **desirable** state variables; Xi = **observable** situation variables.

Adapting this general control equation to our system parameters, we have:

**X**P = _______ + **b**CPxC + **b**EPxE + **b**FPxF + **a**P

**X**C = **b**PCxP + _______ + **b**EcxE + **b**FCxF + **a**C

**X**E = **b**PExP + **b**CExC + ______ + **b**FexF + **a**E

**X**F = **b**PFxP + **b**CFxC + **b**EfxE + ______ + **a**F

These four equations for the normal system state should be recognized as similar to the set of actual state equations given in the previous section. If we add the dynamic element to the above static equations, they become:

$$\mathbf{X}P/\Delta t = -kPxP + kP\mathbf{b}CPxC + kP\mathbf{b}EPxE + kP\mathbf{b}FPxF + kP\mathbf{a}P$$

$$\mathbf{X}C/\Delta t = kC\mathbf{b}PCxP - kCxC + kC\mathbf{b}ECxE + kC\mathbf{b}FCxF + kC\mathbf{a}C$$

$$\mathbf{X}E/\Delta t = kE\mathbf{b}PCxP + kE\mathbf{b}CExC - kExE + kE\mathbf{b}FExF + kE\mathbf{a}E$$

$$\mathbf{X}F/\Delta t = kF\mathbf{b}PFxP + kF\mathbf{b}CFxC + kF\mathbf{b}EFxE - kFxF + kF\mathbf{a}F$$

This set of **discrete** difference equations maintains the standard format of the differential equation: dX /dt = Bx + A, whose solution is found in the following determinant matrices:
(where the **bold** items are always normative values):

$$X = \begin{vmatrix} XP \\ XC \\ XE \\ XF \end{vmatrix} \quad B = \begin{vmatrix} -kP & kP\mathbf{b}CP & kP\mathbf{b}EP & kP\mathbf{b}FP \\ kC\mathbf{b}PC & -kC & kC\mathbf{b}EC & kC\mathbf{b}FC \\ kE\mathbf{b}PE & kE\mathbf{b}CE & -Ke & k\mathbf{Eb}FE \\ kF\mathbf{b}PF & kF\mathbf{b}CF & kF\mathbf{b}EF & -kF \end{vmatrix} \quad A = \begin{vmatrix} kP\mathbf{a}P \\ kC\mathbf{a}C \\ kE\mathbf{a}E \\ kF\mathbf{a}F \end{vmatrix}$$

This exposition of the cybernetic process permits a quantitative comparison between stated goals and measured performance of a system, given standardized indicators for these measurements. Once this **comparative** evaluation is done, it can be used as input to bring the actual state of the system as close as possible to the desirable one, thus bridging the gap between them.

### 3.3. POLITICAL SUB-SYSTEM

Complex systems are more functionally differentiated than simple ones. As seen, our social model distinguishes three main sub-systems and their environment. Each of these sub-systems serves as a **focus** where the two kinds of social processes (wealth and power) interact. It is there, where money and influence are exchanged and the **conversion** value of both is set.

In traditional *laissez-faire* societies, the convertibility of these two currencies is determined by a relatively "free market". In modern "socialistic" systems, however, state institutions try to control the conversion process through economic and social **policies**. All governments, to a larger or lesser extent, interfere in the socioeconomic operations of their countries in order to bring about a closer correspondence between their policy-goals and the system's performance.

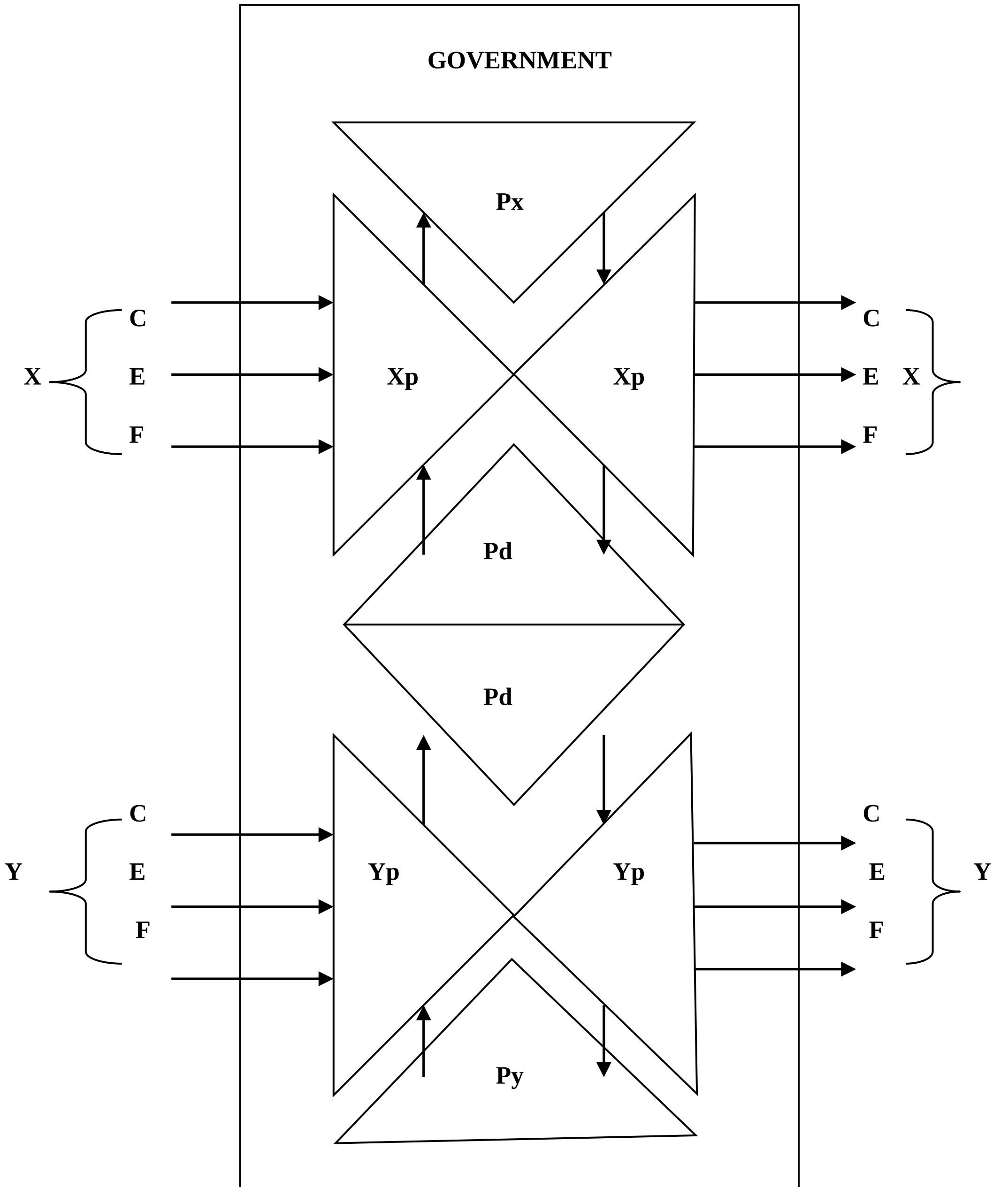
Our model accepts this thesis in which the **political** sub-system acts as the cybernetic mechanism of society. Accordingly, we describe the control process by which governmental decision-making allocates **values** (financial or influential) to the various sectors of society. The main instruments used by governments for this control are the state **budget** and public **law**. Through the judicious use of positive and negative inducements or rewards and sanctions, governments try to attain their objectives of maintaining or changing the social system according to their **ideology**.

The diagram in the next page illustrates how this conversion process by representing what has been so far the "black box" of the **Polity** triangle in the social system model. We now open up this box to look inside its contents that are connected to the inputs and outputs of the political sector or sub-system. There are the two types of system flows interrelating the polity (P) to the other three sectors (C, E, F). Thus we have three X and three Y connections on both sides of the diagram.

At the input side, each of the incoming arrows feed into two switching mechanisms that transform them into outputs and transmit them back into the system. For X flows, the switch is done by the institutions of the political sector, the apex of which is the **legislature** (Xp). The power brokers in this institution reflect the various political influences in the system ($X_{CP}$; $X_{EP}$; $X_{FP}$) calculate their relative weight or strength and arrive at a net result that is promulgated as law or policy ($X_{PC}$; $X_{PE}$; $X_{PF}$) and diffused through the social system.

Similarly, the various sources of government income ($Y_{CP}$; $Y_{EP}$; $Y_{FP}$) are pooled into the state coffers (Yp) where they are reallocated to cover government expenditures according to budgetary priorities. The budget is supposed to reflect government policy decided by the **cabinet** ($P_D$), which is the final arbiter between political (Px) and financial (Py) exigencies. In this way public demands and supports in the form of taxes and opinions are transformed into subsidies and regulations.

## THE POLITY




## SYMBOLS

CHANNELS

X = Communication of Power; Influence; Information; Policies; Decisions; Opinions; Orders.
Y = Transmission of Energy; Wealth; Money; Capital; Currency; Taxes; Payments; Credit.

SECTORS

C = Community: Consumers; Public
E = Economy: Producers; Workers
P = Polity: Citizens; Voters
F = Ecology: Foreigners; Outsiders

INSTITUTIONS

Py = Civil Service; Administration; Ministries
Yp = Treasury; Finance; Budget; Revenue
Pd = Cabinet; Presidium; Decision-Makers
Xp = Parliament; Congress; Legislature
Px = Policy-Planning; Staff Consultants

Relating these inputs and outputs to and from the political subsystem in mathematical form, we have the following equations:

XPC = gCPxP + gPCPx + gCpD YPC = hCPYP + hPCPY + hCPD

XPE = gEPxP + gPEPx + gEpD YPE = hEPYP + hPEPY + hEPD

XPF = gFPxP + gPFPx + gFpD YPF = hFPYP + hPFPY + hFPD

Where g and h are sensitivity parameters of the various political institutions.

Moreover, in order to standardize the units of X and Y, both wealth and power are calculated as percentage ratios. This means that the sum of all Xs and Ys must equal 100%; i. e. $\Sigma$ Xip = $\Sigma$ Ypi = $\Sigma$ Yip = 1.

The principal function of political activity, therefore, is to **reallocate** relative portions of a given amount of money or order in society.

## CONCLUSION

Since this is a continuing project, the conclusion here is only a partial one to round out this phase. As such it will simply highlight what we have done so far and set out the agenda for the next phase.

The mathematical model presented herein is **structural-functional** and takes into account the dynamics of social change along two **loci** (wealth and power) and four **foci** (political, economic, cultural, foreign). Since it was postulated that the political sub-system provides the cybernetic mechanism of society, **government** was chosen as the central institution to illustrate the operation of the model. Of course, the same could be said for business or families, if we were primarily interested in economic or cultural institutions.

Having listed the simultaneous equations relating the inputs and outputs of the political sub-system, we have a theoretical-symbolic model of **socio-cybernetics**. This abstract model formalizes explicitly what is implicitly understood as the public policy-making process, wherein economic interests and political forces shape government decisions, including legislation and regulation.

The next step would be to operationalize these general equations by quantifying the particular parameters necessary for their solution. This would require a determination of the socioeconomic indicative **data** for substitution in each item. More specifically, since we consider the government budget as the clearest index of policy priorities, we shall have to compare various budget items longitudinally to establish some trends whose average will set our parameters.

Next we will have to see how this budget breakdown correlates with the distribution of influence among the various sectors of society. Here quantification is much more difficult, since there is virtually no hard data on influence flows. There are however simulation games and statistical sampling techniques to generate such representative figures and that is what should and could be undertaken in subsequent more refined studies.

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