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The Systemic Network Process SNP

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Abstract: The philosophy of the Systemic Network Process SNP based on the theory of sustainable systems was published in Washington 1994, in the Proceedings of the Third International Symposium on the Analytic Hierarchy Process. The theory of sustainable systems may provide a new philosophical foundation for decision theory. In this paper the economic development of Venezuela is analyzed as an example of global planning for sustainable development. A new ratio scale based on psychophysics is presented. The Systemic Network Process may be used in parallel to the Analytic Hierarchy Process of Saaty.

Keywords: unified science, sustainable systems, wisdom, significance of decision results

1. The need for sustainable development

"Capital, profit and power!" are the slogans of economists and politicians. However the corresponding environmental data are catastrophic. We are facing ecological catastrophe but we only conversate on a little bit more environmental protection by reducing emissions of pollutants. In contrast, we need a global societal change, a new orientation of the Western society. This means that we must change the basic assumptions of our economy. The time of linear development is over. Thus all linear models of economics as well as other scientific and political concepts become obsolete since they are products of isolated and limited disciplines but not of complex reality (Henderson, 1981). Today we need new methods and models which can help us not only to survive but also to prosper. We need educational systems based on a new weltanschauung and ethical-moral beliefs derived from the cosmological revolution. The cosmological revolution calls for unification and globalisation of encyclopedic knowledge into the theory of sustainable systems.

The philosophy of sustainable systems assumes a complex, dynamic, unpredictable but comprehensible world. There is awareness of the complete interrelatedness of the cosmos within a self-referential universe (Laszlo, 1993). Thus criteria and alternatives of decision making processes might be involved in a social structure which appears as a network hierarchy with feedback. It is assumed that the

order principle in nature is coevolution and love, in contrast to Darwinian selection. Coevolution and love may exist in the form of symbiosis, partnerships, and cooperation as incorporated in the concept of autopoietic structures (Maturana, 1992). Maturana argues that real consensus is impossible within dominance structures since it requires harmony and cooperation. Love is thus regarded as a constituent principle of autopiesis and in general, of sustainable systems.

2. The Systemic Network Process (SNP)

The Systemic Network Process (SNP) incorporates the systemic-evolutionary and biocybernetic-taoistic philosophy of sustainable systems (Marzen, 1996). The SNP is not a method, it is a methodology for handling complex decision situations which is able to make complex systems sustainable. Some properties of the SNP relevant for management are:

- Global planning based on a retrospective way of thinking: feedforward and feedbackward processes, from the present to the future and from the present to the past (the history of the system).
- Probability assessment of scenarios for future development based on holographic pictures.
- The final analysis offers several optimal ways for taking actions. To choose depends on their relative importance.
- Conversion along rays is order preserving (the psychological ratio scale has the form of Hilbert's metric). Rank reversal has no relevance since all scenarios are optimal and a composite scenario can be envisaged.

3. The mathematical foundation of sustainable systems

The principal merit of the theory of sustainable systems is that it can serve as a philosophy of realism in science. This theory is a serious attempt to find a straightforward explanation of what makes science significant. As a consequence of Gödel's work (Gödel, 1965), we now know that neither set theory nor number theory admits of formulation that is both consistent and complete. The argument that neither sets nor numbers can be regarded as real objects may be true. However if they are involved in a systemic-evolutionary framework the meaningfulness of assigning numbers to real objects and the significance of set theories can be analyzed within larger frames (Marzen, 1996). From the viewpoint of a realistic philosophy of mathematics, the incompletability theorem can be regarded as calling into question the independent reality of mathematical entities such as sets and numbers. Rather they are expressions of properties and relations, whose boundaries are defined within context of wisdom, and belong

to the inseparable functional-structural cosmic whole.

At present, there exist various rather different but apparently equally consistent forms of set theory, for example, Whitehead's and Russell's Principia Mathematica, Zermelo and Fränkel's theory, the system of Gödel, von Neumann, and Bernays (Barker, 1969). Barker argues that their theses about sets do conflict to some extent. This means that the mathematical foundation of sustainable systems is still missing and needs to be developed as a jigsaw-puzzle of significant mathematical concepts. This is a matter of further research. On the basis of a new set theory a new foundation of probability theory and the theory of social choice is evident.

The viewpoint taken here is that the social structure may be regarded as a network of conceptual units called holons in the social sciences (Koestler, 1970), quanta in physics, and neurons in brain research. The social structure appears as a network in which each conceptual unit has a self-reflection property. The interference of the conceptual units is a general wave problem.

If the universe consists of conceptual units such as holons, neurons, quanta, etc. each with its eigen-value function $\phi_n(x)$ a general wave problem must consider the superposition of all possible modes. The general solution:

$$y(x,t) = \sum_{n=1}^{\infty} B_n \phi_n(x) \cos \omega_n t$$

involves the amplitudes B_n of the different modes and the frequencies ω_n. The amplitudes B_n can be found using Fourier analysis. Fourier analysis is a special case of a general wave problem of expressing an arbitrary function as a sum of eigenfunctions, for example:

$$y(x,0) = \sum_{n=1}^{\infty} B_n \phi_n(x), \quad \text{at } t=0$$

Thus the theory of sustainable systems can include string theory as well as the theory of quanta and holons. Psychophysics can help to measure the mutual interaction of these particles.

In accordance with psychophysics, we measure entities by matching their properties with common standards, for example length. In this case, the creation of a ratio scale for relative importance is very natural (monopolar notion, Resher, 1969) and requires invariance up to linear transformation (rays). The invariance of measurement within a network feedback structure can be related to the invariance of the hierarchical feedback structure itself. We know that sustainable systems can make structural change within context of wisdom and change in time and space leads to self-similar structures with a fractile character. Self-similarity is expressed mathematically by the so-called Hamiltonian systems which preserve the volume of phase space (e.g. soliton waves theory). For chaotic dynamics the Kolmogorov measure K for entropy is used in which m is dimensionality and C_m (r) correlation dimension:

$$K = \lim_{r \to 0} \lim_{m \to \infty} \ln [C(r,m)/C(r,m+1)],$$

where $C_m(r) = \lim \ln N(r)/\ln r$, and $N(r)$ is the number of points whose distance from each other is less than r. In this form the lower the correlation dimension the more chaotic is the system (Grassberger and Procaccia, 1983).

For lower dynamics, the Hilbert metric d can be used:

$$d(x,y) = \log \frac{\max(x_i/y_i)}{\min(x_i/y_i)}$$

where x_i denotes the i^{th} coordinate of x (Kohlberg and Pratt, 1982). We conclude that models of dynamic systems or neural networks use only one fundamental scale, as given above. It includes implicitly the assumption that a value scale for physical stimuli might be related to their relative importance.

Thus a system is defined as consisting of basic set(s), and structure. The basic set is the holographic ψ-field which is the source of all fundamental forces (Laszlo, 1993). The boundaries of the system are designed within context of wisdom based on the integration of several rationalities (Marzen, 1996).

An Example of Global Planning: The Economic Development of Venezuela

Let us show how the Systemic Network Process (SNP) can be used as an integrative element of a powerful methodology for complex decision situations, for example, the global analysis of the welfare of Venezuela.

Phase One: Start with a set of systems variables covering all aspects of society. Reduce the complexity of the system by taking only relevant key factors from each set.

Using Haken's synergetics, the overall welfare of a nation (the system in question) can be expressed by the mutual interaction of a few key factors (systemic variables) (Fig.1). They can be identified as political power, human population, environmental burden, rehabilitation, economic and social-cultural considerations and quality of life. The network structure of these systemic variables allows us to understand the welfare of Venezuela and to find conditions for its (dis)equilibrium. This can only be explained by the assumption that all lower levels of complexity, expressed through various subcriteria, are automatically involved in the higher level of rough description (the rough network structure).

Phase Two: Determine the functional orientation of the focal system and the number of hierarchical levels. Find out the interdependence of all relevant factors

Venezuela is a member of the Organisation of Petroleum

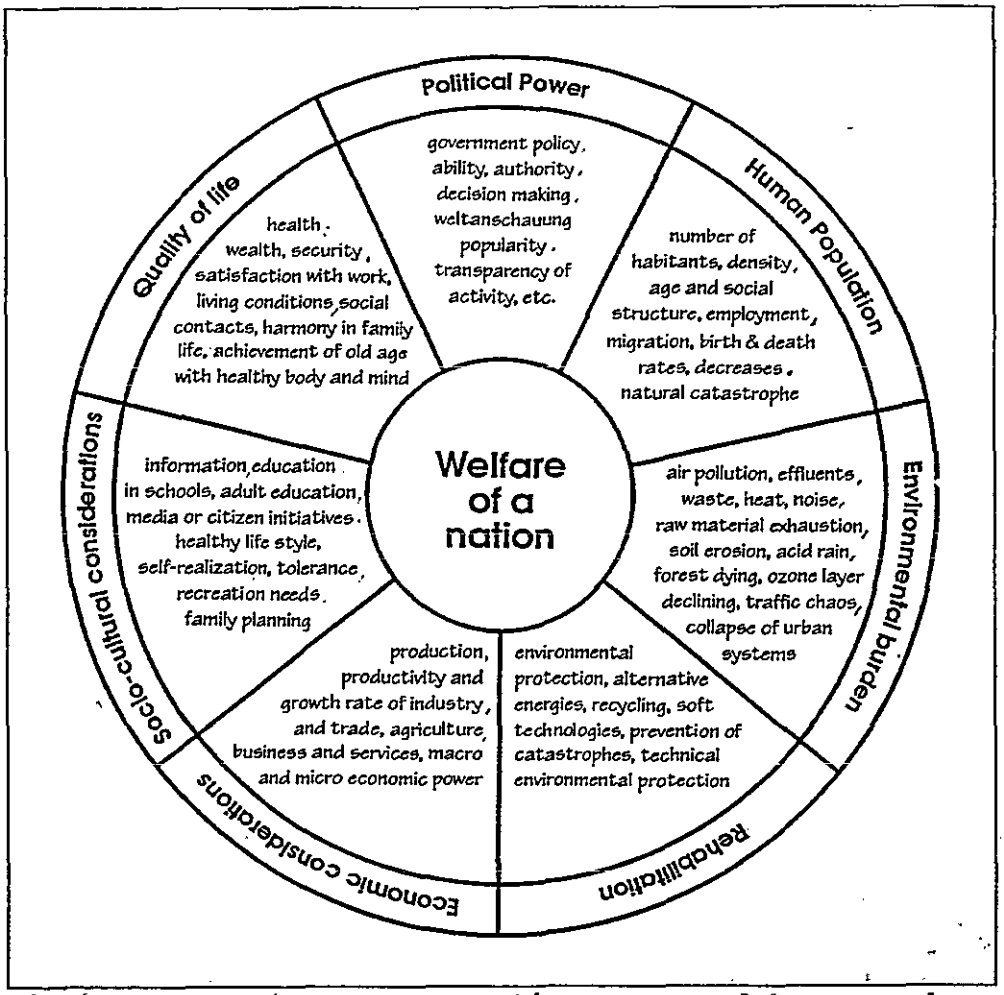

Figure 1: The welfare of a nation expressed by seven key factors (systems variables)

Exporting Countries (OPEC) and is the third largest oil producer and exporter, with a capacity of 2.6m barrels a day. Its base industries are oil and mining. Venezuela's economy, similar to many developing countries, is a mixed capitalist-socialist system. Thus a number of economic activities are operated by nationalised enterprises, e.g. water, telephone, electricity, supply services, transportation, ports, airports, banking, a large number of development banks and corporations. There are also varying degrees of private ownership and participation in the economic activities. In order to bridge the fiscal gap and deal with balance of payment problems, the new government had to turn to the International Monetary Fund (IMF), which imposed the usual conditions on its help. Accordingly the Venezuelan government has applied a macro-economic adjustment plan since 1989, whose aim is to readdress past imbalances, control inflation, reduce the budget deficit by lowering debt service payments and balance the current account, which, amongst other measures, implies speeding-up non-oil industrial production. This economic plan has required some tough measures, such as increasing the price of oil for local consumption, reducing subsidies for education and social programmes, raising utility charges, holding back wages, etc. The plan brought about additional social and economic constraints, and also allows market forces to operate more freely, through the elimination of

government price controls.
The initial impact was a severe recession, and the GDP fell by about 8.6 per cent (1987/88), accompanied by a burst of inflation and higher unemployment. By 1990 the economy had rebounded with a growth of 5.3 per cent (GDP), strengthened by reforms, a higher level of investment and windfall oil revenues during the Gulf war. Within the economic programme, a debt restructuring package was implemented in 1990 which allowed banks to choose from a menu of options including debt reduction, debt service reduction and new loans. The current post-oil boom period inherited a series of undesirable assets from the previous oil-boom era including important features such as the burden of external debt, a large number of loss-making corporations, a subsidised economic system, demanding for structural reform, a population accustomed to receiving subsidies for almost every product and service they consume, and many politicians and civil servants whose immoral attitudes deserve a separate analysis (Mena-Torres, 1993).

Various ethical-moral beliefs underlie the umbrella of a democratic structure (Fig.2), e.g., the illusion of the complete manageability of complex socio-technical systems (derived from the Western civilisation model). In particular, Anglo-Saxon management philosophy is characterised primarily by the over-stressing individual success as a political-cultural vision and focusing on competitiveness as the most important factor when taking action. Conflict is seen as the only source of creative power. Servatius (1991) pointed out that all nations have enthusiastically embraced this kind of military strategy by relating it to the notion of "management" and pursuing the single objective of making profits by beating or cheating others. Personal vanity also dominated political fields. The consequences of the mechanistic world view (selection of the "fittest") were the legitimate optimization of pleasure over pain on the free market and the "laissez-faire" economy. The ethical-moral beliefs inherited from socialist society are based on cheating the state and the creation of a parasitic society.

The driving forces on Venezuela's market will be a mixture of these ideologies and some others derived from local culture. Combined with the exclusive use of analytic approaches, they will lead to optimization and rationalization procedures and finally to social conflict and ecological disasters which will decrease the quality of life. Existing ethical-moral beliefs may lead not only to a decreasing quality of life, but even to extinction of life in the long term (Fig.2).

Now consider Venezuela's economic development using the various hierarchical levels assumed in the behavioral interpretation of human social systems, such as Biosphere, World Community, government, organisation and individual levels (Fig.3). At each level, one or more systems variables as defined initially in Fig.1, will be analyzed. For instance, at Biosphere level there is environmental burden; at World community level is decision making in the form of optimization procedures and policy of economic growth; at governmental level decision making, ability, authority, activity, e.g.rationalization procedures, export/import, unemployment, etc. At the organisational level economic criteria such as production, productivity

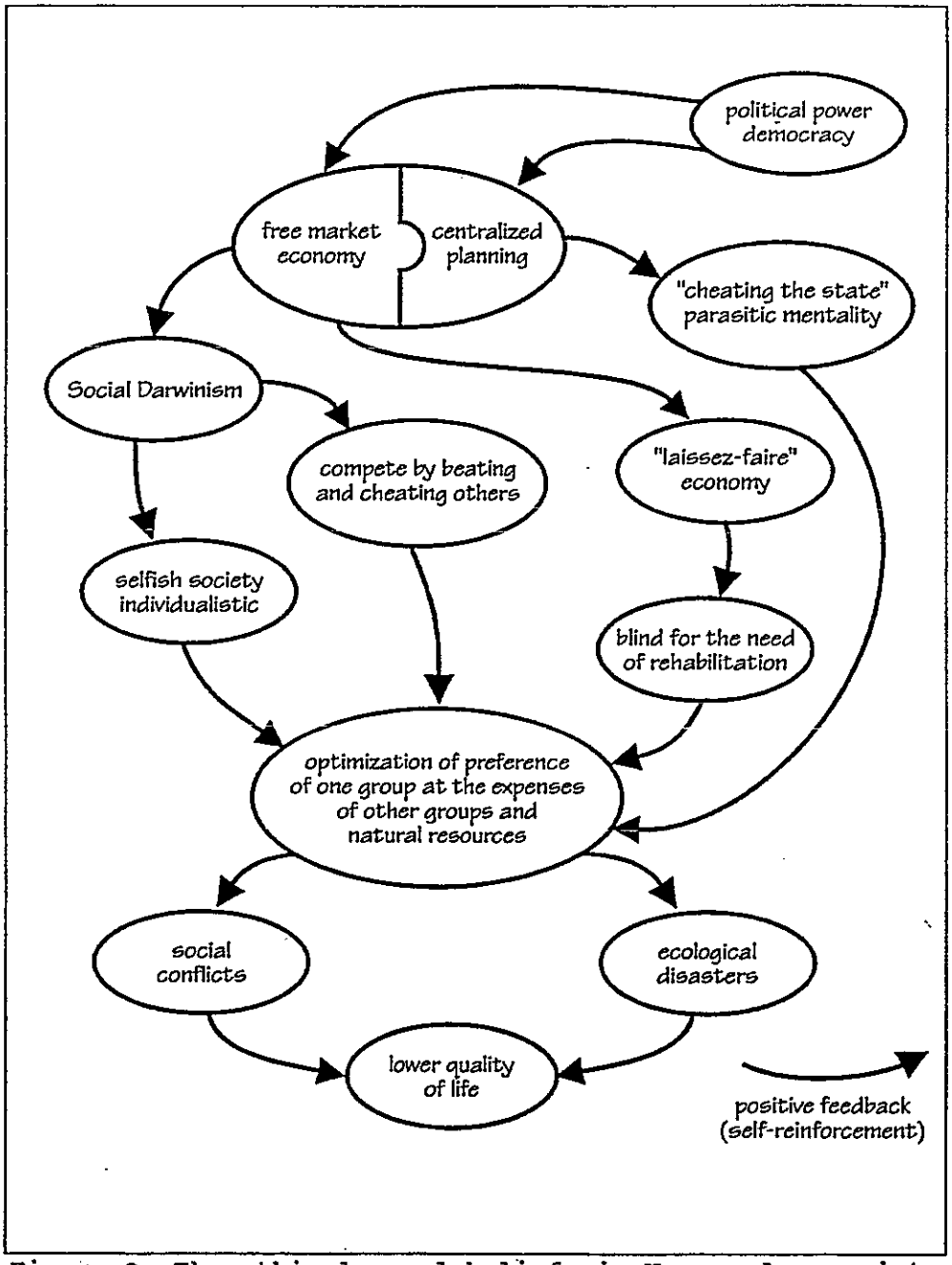

Figure 2: The ethical-moral beliefs in Venezuelan society

and growth rate of industry and trade, agriculture, business and services are considered. Finally, at the individual level, important factors are unemployment, quality of life related to health, wealth, security, satisfaction with work, living conditions, etc.

The mono-cultural economy of Venezuela, based on further increases in oil exports, is strongly related to the fluctuations of Anglo-Saxon stock market centred capitalism. The policy of economic growth in these countries cause increased oil imports which will lead to increased macro-economic burden and reduced quality of life. Increasing competition related to the policy of economic growth and the world wide crisis, lead in turn to further optimization, rationalization, the introduction of

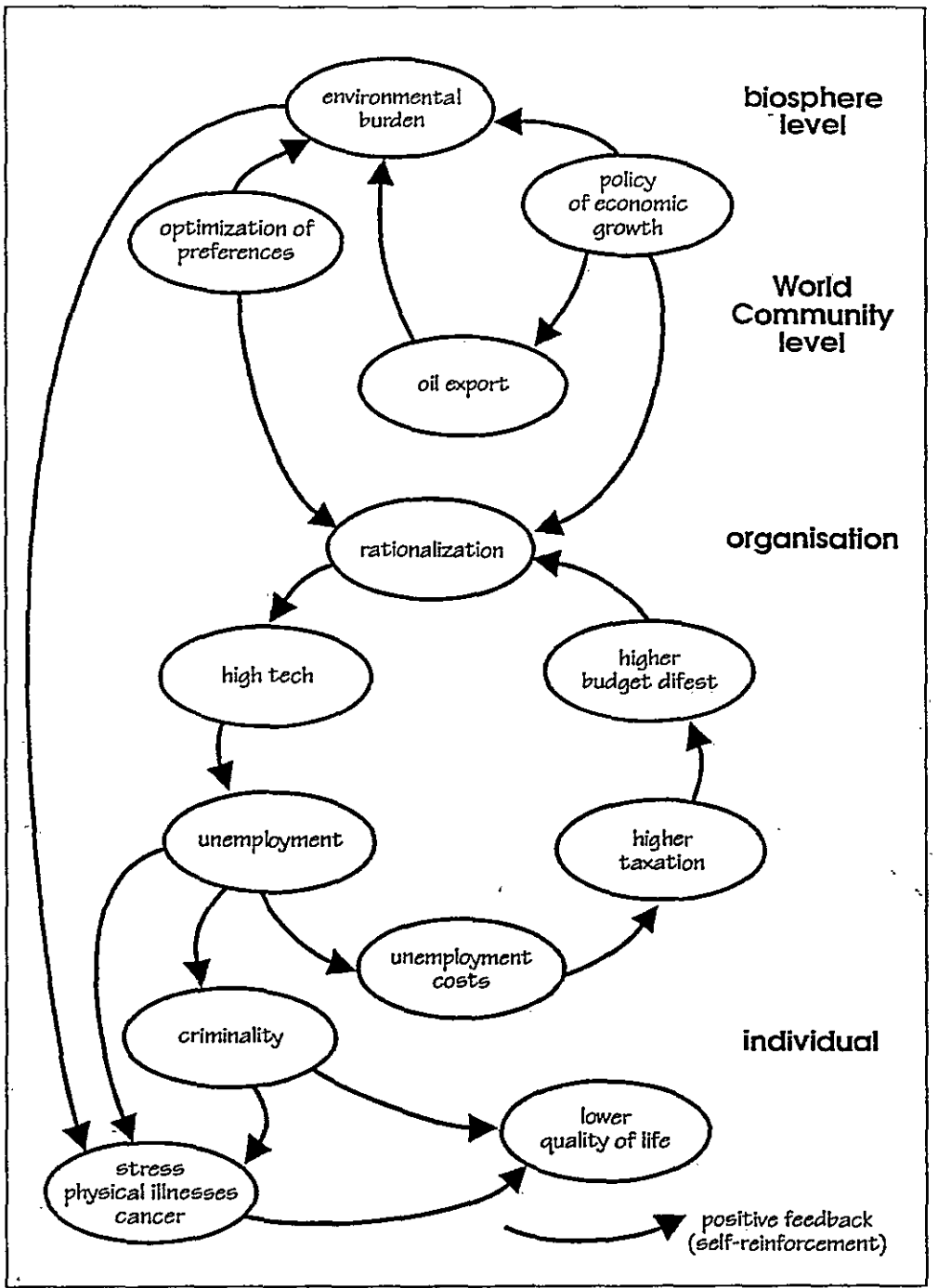

Figure 3: The economic development in Venezuela will lead to decreasing quality of life based on positive feedback

high tech, followed by unemployment, higher unemployment costs, higher budget deficit, higher taxation, lower quality of life, and all in a society traumatised by increased, and increasingly violent crime.

Phase three: Develop the opposite poles (chaos, catastrophe). Introduce negative feedbacks by the use of biocybernetic principles (Vester, 1992) and taoistic wisdom (Marzen, 1996).

The global analysis of the driving forces of the Venezuela economy, shows that a democracy based on the mixture of socialist and Anglo-Saxon capitalistic structures does not provide a useful cultural-political vision for sustainable systems. This kind of "laissez-faire" economy will lead to the collapse of societal forms and institutions when there are only relations to acting and non-compensating positive feedbacks within self-reinforcing processes (Fig.3). There are many optimal ways in which negative feedback can be introduced which will bring Venezuelan economy, in the long-term, to balance (Fig.4). Two principles may be important for Venezuela such as minimum foreign exchange requirement and maximum availability of foreign exchange. This implies a systemic-evolutionary comprehension of the threshold values in oil export growth, and the need to restructure oil production; in the long-term it may need to be replaced by various environmentally friendly energy resources. Structural, cultural and strategic change in Venezuela is only possible if the government adopts the new cultural-political vision of sustainable systems, based on a consensus society and a social market economy. Consensussociety implies the development of self-referential property and the acceptance that Social Darwinism and exclusive use of majority rule, combined with analytic approaches, will not lead to sustainable development. The way to social justice is through agreement by all political parties on the need to prioritise projects according to their relative importance, and this may involve part time restrictions on everyone so as to give future sustainable development. Consensus society and a social market economy might be related to fair competition based on loyalty, honesty, and cooperation. This implies education of industrial and political management in systemic-evolutionary and biocybernetic-taoistic terms. The consequence may be socio-cultural evolution of ethical-moral beliefs, yielding consensus through harmony and love, regarded by Maturana as a precondition of an autopoietic structure, i.e. of sustainability. Subsidies can be helpful in the short-term if they develop the "do it yourself" ability of human social systems. Subsidies on mineral oil are not justified. The use of mineral oil will probably reduce around the year 2000 because of the development of other environmentally friendly energy sources, e.g. solar, wind, water, biomass, etc. This implies a change in Venezuelan government policy from economic growth to qualitative growth based on a higher quality of life. This will lead to the introduction of higher taxation for business which pollutes the environment, and the stimulation of new businesses based on alternative energy sources and other natural resources. Reducing working time, job sharing and new training schemes could reduce unemployment.

The viewpoint taken here is that renewal based upon the values and principles of sustainable development is the big idea for the next millennium.

Companies that embrace environmental considerations wholeheartedly and with integrity, alongside economic and social concerns, will not only shape the future but benefit from improved customer and employee relations, new technologies and management systems, wider market opportunities, lower costs and, ultimately sustained profitability.

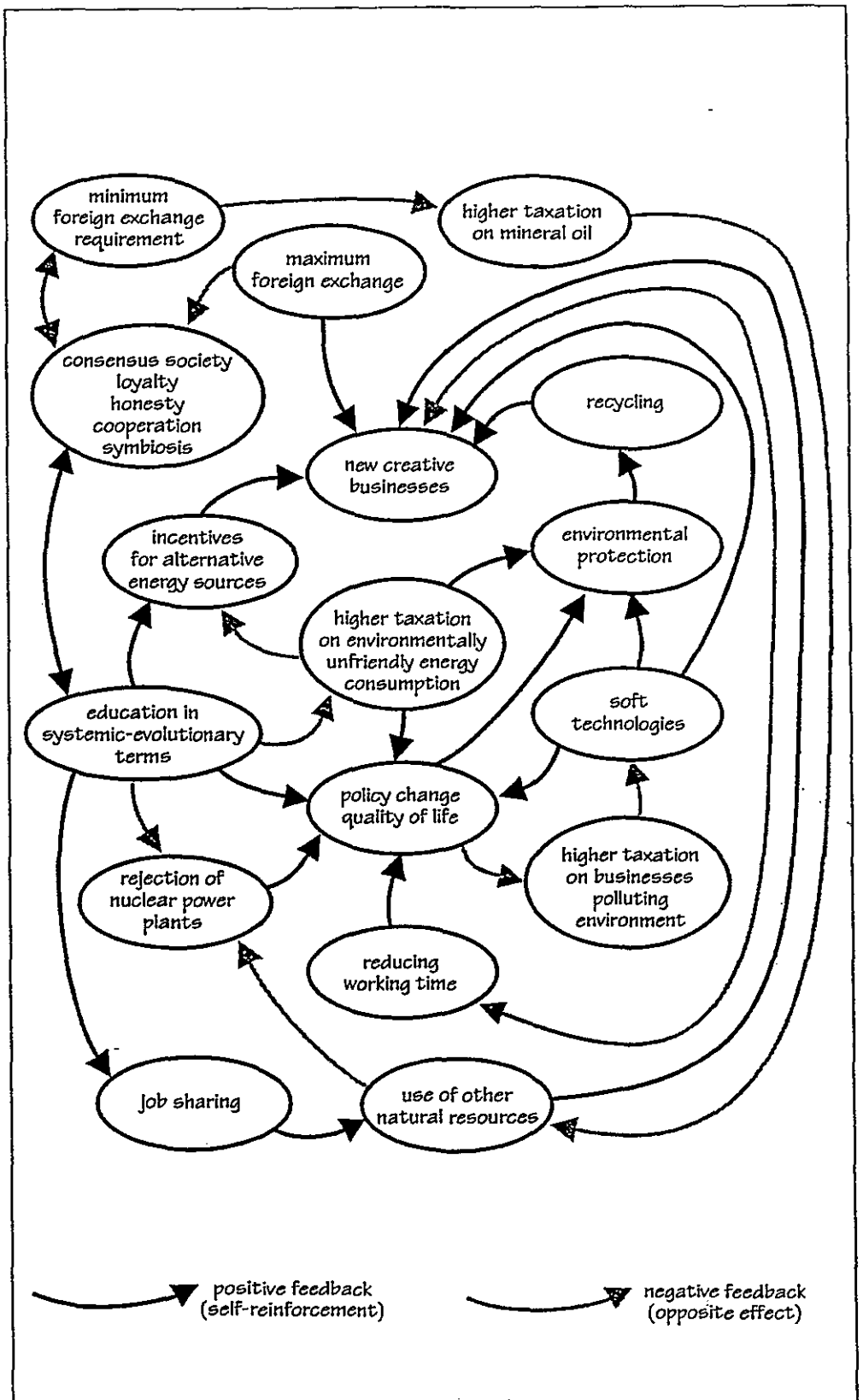

Figure 4: Introduction of negative feedback (opposite effects) to enhance economic development in Venezuela

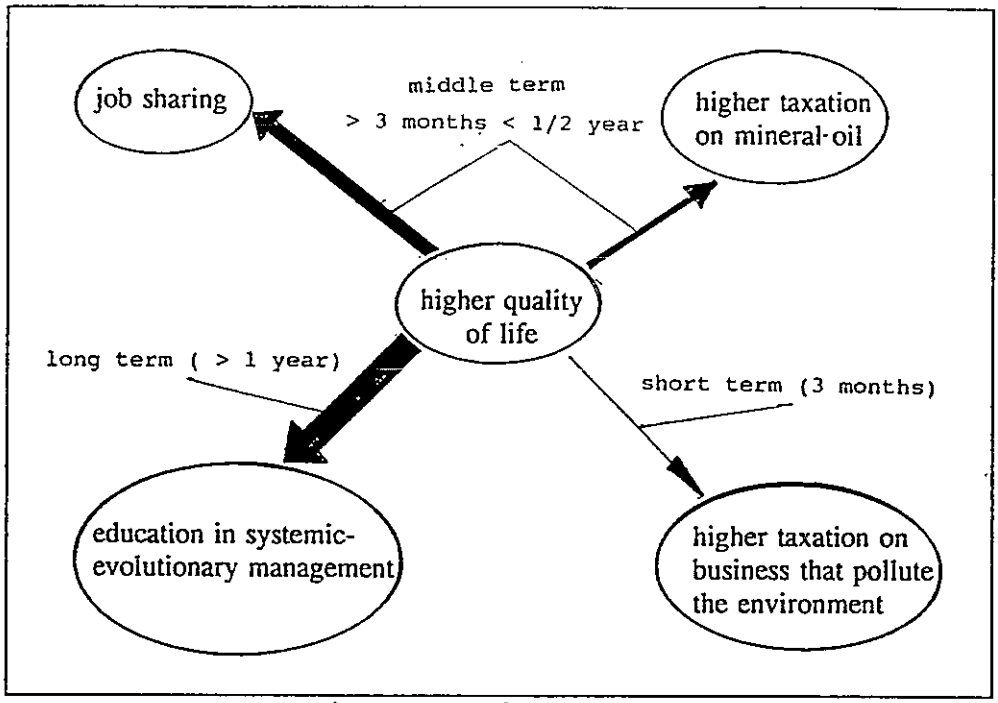

Figure 5: Time aspects

Phase four: Elaborate time aspects. Find out the active, passive, critical and buffer elements.

It is advisable to develop a precise temporal network for economic activities, because delays can be crucial for the prosperity of a business organisation. Causal loops diagrams can include arrows with different thickness, to show time effects (Fig.5). For instance, global structural and socio-cultural changes in Venezuela must be seen as long-term strategies. Taxation could be considered a short or medium term activity.

A good simulation model of an inter-linking structure of systems variables could take into account the intensity of relationships between systems variables. Let us use a simple mathematical model, the so-called paper computer (Vester, 1992) which uses a pairwise-comparison multicriteria matrix (Table I). Take a few criteria which, through their mutual interaction, determine the wealth of Venezuela. These criteria are selected from the maps on Fig.2 and 3 and 4 as follows:

- centralized planning (CP)
- free market (FM)
- world wide crisis (WC)
- parasite mentality (PM)
- Social Darwinism philosophy (SD)
- policy of economic growth (PEG)
- social market economy (SME)
- consensus society (CS)
- education in systemic-evolutionary terms (ESE)
- environmental burden (EB)
- oil export (OE)
- minimum foreign exchange requirements (MFER)
- maximum foreign exchange (MFE)
- unemployment (U)

Table I: Criterion matrix

influence from ↓ on →	CP	FM	WC	PM	SD	PEG	SME	CS	ESE	EB	OE	MFER	MFE	U	BD	QL	Active sum AS	Quotient (AS/PS) x 100
CP		2	0	2	0	1	2	2	4	4	4	4	4	2	2	4	37	0.88
FM	1		0	0	0	2	1	0	0	2	2	4	4	2	2	2	22	0.76
WC	1	2		0	0	1	1	1	1	1	2	2	2	2	2	1	19	2.71
PM	2	2	0		1	1	2	2	2	4	1	1	1	2	4	2	27	2.07
SD	4	4	0	1		2	2	2	2	4	4	4	4	2	2	4	41	3.73←
PEG	2	2	0	0	0		0	0	0	4	4	2	2	2	2	4	24	0.96
SME	4	2	0	2	2	1		4	4	4	4	4	4	4	2	4	45	1.8
CS	4	2	1	4	4	4	4		4	4	4	4	4	4	4	4	63	2.17
ESE	4	4	1	4	4	4	4	4		4	4	4	4	4	4	4	65	2.6
EB	2	1	1	0	0	2	2	4	4		4	0	0	2	1	4	27	0.68
OE	4	4	4	0	0	4	0	0	0	4		4	4	4	4	4	40	0.96
MFER	4	1	0	0	0	0	0	0	0	1	4		4	2	2	1	19	0.43
MFE	4	2	0	0	0	0	0	0	0	2	4	4		4	4	2	26	0.67
U	2	1	0	0	0	0	4	4	0	0	1	0	0		4	4	20	0.5
BD	4	0	0	0	0	2	1	2	0	2	4	2	2	2		2	23	0.03←
QL	0	0	0	0	0	1	2	4	4	0	0	0	0	0	0		11	0.24
PS	42	29	7	13	11	25	25	29	25	40	42	39	39	40	39	46		
AS x PS	1554	638	133 ↓	351	451	1125	1827 ↑	1625	1080	1680	741	1014	800	897	506			

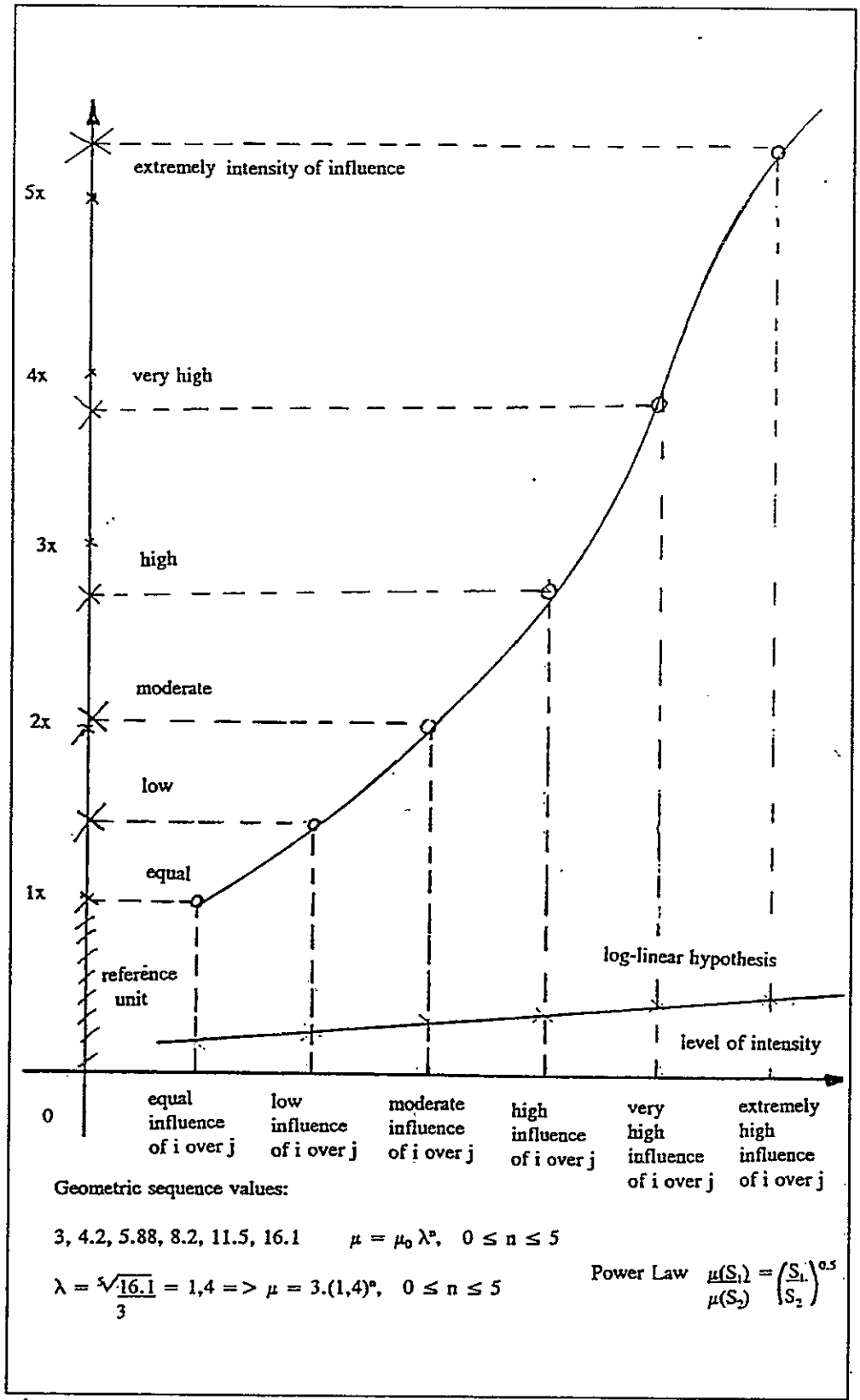

Figure 6: Construction of a psychological value function for the intensity of influence between criteria

- budget deficit (BD)
- quality of life (QL)

The pairwise comparison of these criteria is performed on a fundamental ratio scale of influence of i over j using the power law of psychophysics as shown in Fig.6. To help to the decision maker we can use the position of multiples of the reference unit on the vertical axes as given in Fig.6. The geometric sequence values can be produced if the decision maker has been questioning "a priori" identification of intensity levels. For instance, the values 3, 4.2, 5.88, 8.2, 11.5, and 16.1 are calculated "a posteriori"as a consequence of matching physical length (optical unit) on a vertical bar with the psychological values (feelings) of a decision maker. Such a value function has the ability to preserve self-similarity on rays since the logarithms of their values lie on a straight line. Once the value function has been created and the values of pairwise comparison have been introduced in table I, the active sum (AS) and passive sum (PS) are determined by means of horizontal and vertical summation of the values. Finally, the magnitude Q(Q=AS/PS) x 100 and the magnitude P(P = AS x PS) are calculated using AS and PS values. The interpretation of the Quotient Q and the Product P is given as follows:

- Active element (highest Q): the factor with the highest Q might influence very strongly all other factors: in contrast, the influence from other factors is weak. Active elements are ideal for controlling, e.g. ethical-moral beliefs in the form of Social Darwinism as already discussed.

- Passive element (lowest Q): its influence on other criteria is weak, but their influence can be strong. Passive elements are not appropriate for controlling, e.g. budget deficit.

- Critical element (highest P): its influence on other criteria is very strong, but the influence from the others can be strong as well. The critical element could be used for controlling; however, dangerous causal loops are possible, e.g. social market economy and consensus society.

- Sluggish element (lowest P): its influence on other criteria is weak and the influence from the others is weak as well. Sluggish elements are not appropriate for controlling, as is evident in the case of world wide crisis.

This phase allows systems behaviours to be checked by creating possible future development paths presented in different scenarios. Further analysis is not envisaged in this paper (see for further details, Marzen, 1996).

5. Conclusion

It can be concluded that renewal is needed not only in multicriteria decision-aid but in general, in all

scientific fields. No one generation before had more knowledge available. But how the puzzles of knowledge are interrelated in a holographic cosmic whole, makes for all of us great difficulties. Heisenburg's fuzzy relation shows that we cannot do simultaneously both, systemic and analytic thinking. However, systemic and analytic thinking are complementary. We are now required to revise our weltanschauung and develop analytic approaches which harmonize with the new systemic-evolutionary paradigm. Sustainable development requires flexibility, responsibility and creativity since not only several criteria, rather various concepts from different fields need to be conglomerated. The degree of creativity depends on the willingness to accept unconventional ways of thinking and acting. The responsibility may be expressed by the awareness to replace the elicitist mentality by serving society above self.

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