The enlargement of the Analytic Hierarchy Process in respect to global planning and sustainable development

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Abstract: The MCDM's mental model of reality is analyzed on the basis of a jigsaw-puzzle of scientific and non-scientific concepts emerging as a functional-structural "whole" of a generalised science from which the theory of sustainable systems was developed. It is shown that the AHP of Saaty is compatible with the philosophy of sustainable systems and can be enlarged to a general methodology for complex decision situations in management.

Keywords: Systems thinking, Sustainable development, Significance and Meaningfulness of decision results, evolution

1. The mental model of reality incorporated in MCDM

The systematic analysis of complex situations in multi-criteria decision making results in two mental models of realities: multi-objective decision making (MODM) and multi-attribute decision making (MADM). MODM involves linear or non-linear optimization procedures with several objectives. MADM is concerned with problems of choice from a set of alternatives, producing of a rank order of alternatives, or classification of alternatives in a group.

Tversky and Simonson's descriptive theory of context-dependent preferences (1993, pp.1179) shows that various assumptions made in preference theory, as incorporated in multi-criteria decision models, may not be valid, e.g. the assumption that preference between options does not depend on the presence or absence of other options (independence of irrelevant alternatives), or that value maximization implies that the ordering of options is independent of the choice set.

Let us associate Tversky and Simonson's assumptions with results from quantum theory which say that particles behaviours at micro and macro levels are characterised by local or non-local connections. Local connections describe relationships between particles, and non-local connections describe relationships between particles and the whole (universe) (Capra, 1983, p.93). It can be argued that the descriptive research of Tversky and Simonson can be interpreted as an expression of the self-reflexion property of sustainable systems. According to this property, human social systems may be able, through learning, to develop awareness that criteria, constraints and objectives may have local inter-connections, as well as non-local connections to the whole (society), through invisible cyclic relationships whose knowledge may be important for survival.

Lootsma's suggestion (Lootsma, 1993, p.95) that numerical scales for verbal comparative judgements can be expressed by one fundamental ("natural geometric" scale) related to the power law of psychophysics, may be regarded as a step in the direction of sustainable development. This assumption leads to the same type of measurement scales for relative importance of information (entropy) as those involved in non-linear dynamic systems (e.g. Kolmogorov and Hilbert metrics). The introduction of such concepts as compromise, polarization and extremeness aversion (Tversky and Simonson, 1993, p.1183) may also be considered as an element of sustainable development. However, changes in the form of sustainable development are impossible within the framework of enlarged reductionist-rationalistic approaches as Tversky proposes, but are possible within systemic-evolutionary considerations, as incorporated in the theory of sustainable systems.

2. The mental model of reality incorporated in the theory of sustainable systems

According to the view of a generalised science, incorporated in the Theory of Sustainable Systems (Fig.1), the universe can be described as the unity and mutual interrelation of all things and events, and the experience of all phenomena in the world as manifestations of a basic oneness. All things are seen as interdependent and inseparable parts of the cosmic whole (Capra, 1983, p.111). The structure of the whole together with its parts, might be autopoietic (Maturana, 1992), is involved in a continuous dynamic process of creation and destruction which varies in time and space.

The development of cognitive science in the last decade has shown that systemic-evolutionary thinking contrasts with fundamental assumptions of conventional science about inanimate and animate nature, social forms and, in particular, the purposefulness of human social systems. For instance, according to the Cartesian tradition we have been educated to believe that it is possible to produce a true mapping of the external world into an internal mental model of reality. Rationality, in the sense of description and governance of a subject-independent reality, was for centuries the ideal of perception theory in contemporary science. In accordance with this tradition, the construction of reality could be regarded as a non-stop approximation process to an objective existing world. Scientists followed the rules of logic and reasonability.

It can be argued that systemic-evolutionary thinking has radically refuted this scientific postulate. Biological and neurophysiological research helped to revitalise the ancient philosophical view of the world, which says that the perception of the external world by human beings is a complex process of cognition related to neuronal activities (Wimmer, 1992, pp.86).

In particular the learning ability of a social system might show awareness of cognitive dissonance with other systems and relevant environments. The knowledge of the degree of dissonance determines the weltanschauung of a focal system (the system in question) which, with its specific identity, can be regarded as the most important criterion for sustainability. Systemic-evolutionary rationality focuses on the sustainability of human social systems and not on their economic-rational objectives. Sustainable systems may have the ability to observe themselves by working out recognitions of their self-observation. Thus attention is transferred from the observed object to the observation of the observer. This reflexion property of human social systems was called cybernetic second order (v. Foerster, 1990). Reflexion involves self-awareness, self-conception and self-conceptualisation. These cognitive processes are related to the creation of boundaries between the focal system and its environments within contexts of meaning (Luhmann, 1971).

Sustainable systems may have the higher cognitive ability to differentiate between significant and insignificant concepts, opinions, ethical-moral beliefs, assumptions, values, theories, etc. This may be similar to the way the human brain works (Edelman, 1994). We shall assume that significant systems design can be a consequence of the synthesis of various rationalities (Marzen, 1994), for example, systemic-evolutionary rationality (Luhmann, 1976), communicative rationality (Habermas, 1981), active rationality (Weber, 1964), and spontaneous rationality (Spinner, 1986).

For instance, the systemic-evolutionary rationality, is very useful for global analysis of complex systems since it helps create the view of the rational "whole". Communicative rationality shows that there may be some useful ethical-moral beliefs which can help maintain the systems, while other beliefs may lead systems to destruction. Spontaneous rationality draws our attention to the fact that in a dynamic world we must always maintain a balance between opposite effects. For example we need to balance the consequences of reductionist-rationalist thinking as incorporated in active rationality with the creation of the view of rational whole. The active rationality which is exclusively based on reductionist-rationalist approaches, does not consider, for example, the causal chains that are put into action in the social

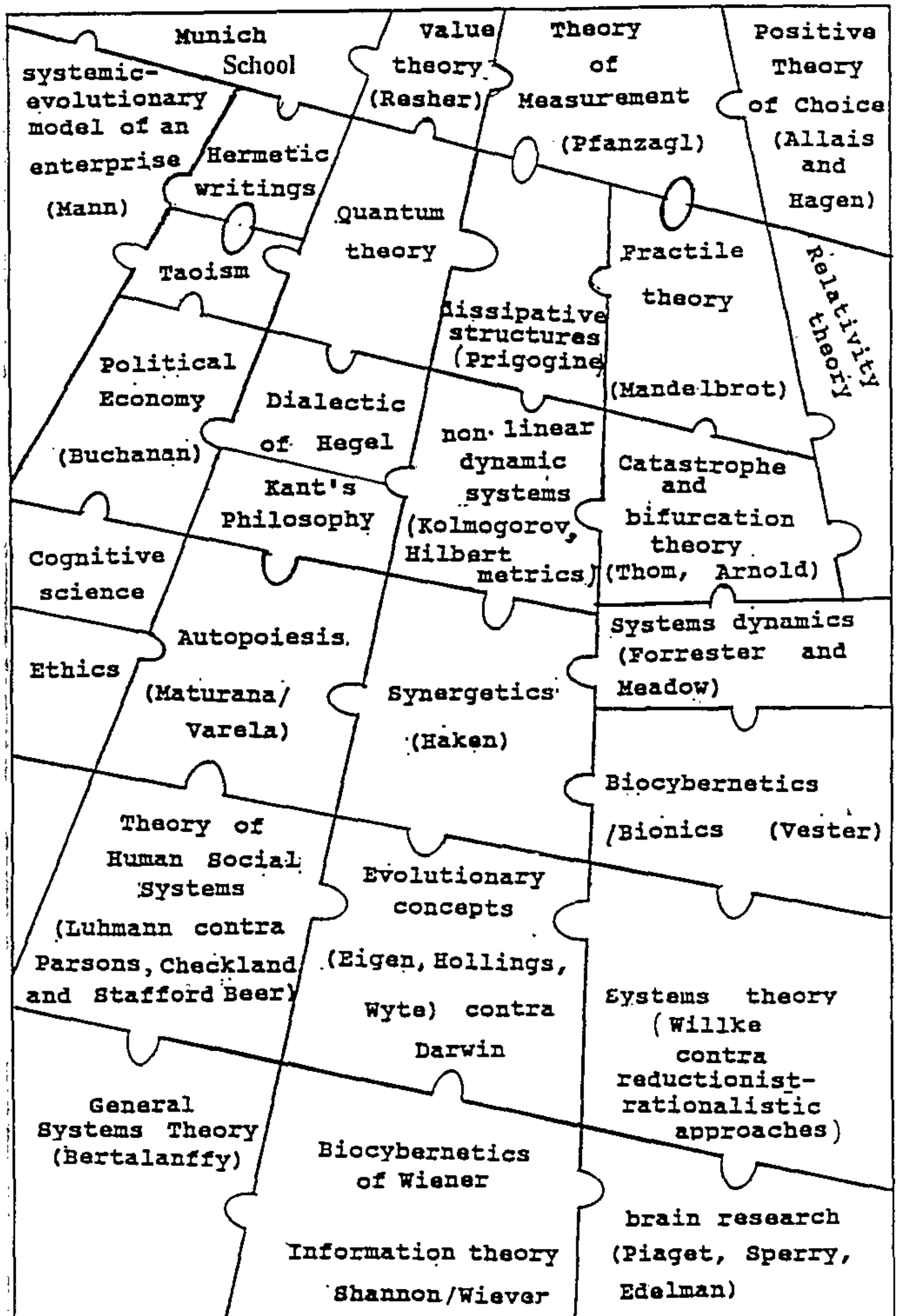

Figure 1: The Theory of sustainable systems as a jigsaw-puzzle of significance
source: Marzen, (1994)

network by such approaches. The simultaneous use of these rationalities can help put together a jigsaw puzzle of significant scientific and non-scientific concepts within a functional-structural whole (Fig.1).

The plurality of scientific concepts calls for a generalised science within the framework of sustainable development. A generalised methodology can be proposed, made up of Haken's synergetics (Rosser, 1992) which shows similarities to dissipative structures of Prigogine, Catastrophe theory of Thom/Arnold, Biocybernetics of Vester, Information theory of Shannon and Wiever, ergodic systems theory, Kolmogorov measure, Hilbert metrics, etc. (Marzen, 1994). According to synergetics, the behaviour of complex systems can only be understood if one analyses the inter-linking structure of a few key order parameters or neurons. This is the way in which Neural Networks might be created, in contrast to the status quo characterised by the behavioural adoption of an already existing structure and its further optimization in a "laissez-faire" interaction of neurons.

Synergetics assumes that the human mind works as a functional whole which can recognise incomplete pictures within the framework of significance (useful or useless pattern). These pictures are created by the interaction of key factors at the highest level while all other parameters at lower levels are "slaved" (Haken,1990). The behaviour of the focal system may show a tendency to chaotic or catastrophic behaviour when faced with irreversible phenomena based on positive feedback. The introduction of negative feedback can bring the system to balance (in accord with Vester's biocybernetics (1992)).

Finally global analysis (systemic-evolutionary and biocybernetic-taoistic consideration of reality) results in a set of several optimal scenarios or several optimal alternatives based on negative feedbacks. Which scenario to choose depends on its relative importance. Sustainable systems cannot select within contexts of preferences because of their reflexion property. This involves the assumption that sustainable systems do not necessarily select the best option, but rather the most compatible scenario or alternative which will not lead to destruction of other systems. Reflexion excludes the selfish property which is incorporated in the optimization of preferences based on the dominance principle of Social Darwinism. This is a process of higher cognition, not of altruism. Rather it is an action of common sense which allows all members of a community to become better off as an ideal of Political Economy (Buchanan, 1986, pp.270).

3. Conclusion: The mental model of MCDM may be useless for sustainable development

We can show that multiple-criteria decision models cannot lead to sustainable development:

- The weltanschauung of MCDM implies beliefs in a static, predictable and understandable world. This is in contrast to the philosophy of sustainable systems which assumes a complex, dynamic, unpredictable world.

- There is no awareness that criteria and alternatives might be involved in an inter-linking social structure which appears as a feedback hierarchy. Further there is no awareness of relationships within the social structure in the form of feedbacks which can have different intensities, relative importance and dynamics. Consequently the behaviour of the focal system cannot be recognised.

- The optimization of preferences is based on the dominance principle which selects the best (fittest) action measured against several criteria. There is no awareness of the consequences of the selected alternative for the social network. The optimization of preferences for one group leads generally to conflict and social injustice, e.g. majority rule leads to suppression of minority rights. It is in contrast to the order principle of nature which, is not Darwinian selection, but co-evolution (Eigen, Wyte, Hollings, Luhmann, Willke, Marzen) and love in the form of symbiosis, partnerships, and cooperation as incorporated in autopoietic structures (Maturana, 1992). Real consensus is impossible within dominance structures. Maturana argues that real consensus is only possible within contexts of love, since it requires harmony and cooperation. Love is thus regarded as a constituent principle of autopoiesis and, in general, of sustainable systems.

- The mental model of metric scales assumes preferential independence between criteria and alternatives, and the existence of a linear preference function. This model contradicts the representation of sustainable systems as a network hierarchy with a recursive structure.

- The context of preferences is a bipolar notion. Therefore value functions based on preferences need to cover the whole range of IR (e.g. the S-shaped value function in Tversky/Kahnemann, 1979).

- The analysis of complex systems, in particular dynamic systems, shows that only positive numbers can be assigned to information (entropy). It seems doubtful if information can be involved within preferential structures such as attractiveness and desirability.

It can be concluded that these are serious objections which do not allow to use conventional multicriteria methods for sustainable development. We need new approaches for decision making based on generalised knowledge within the framework of systemic-evolutionary and biocybernetic-taoistic consideration of reality.

4. Sustainable systems use the concept of relative importance

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 hierarchical feedback structure can be related to the invariance of the hierarchical feedback structure itself. We know that sustainable systems can make structural change (metamorphosis) within context of meaning (Luhmann, 1971) 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 (e.g. soliton waves theory) which preserve the volume of phase space. 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 (Rosser, 1992).

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. The bipolar concept of preferences cannot be used within network structures because the metrics involve logarithms. Further this value scale does not change linearly with the physical value of the stimuli (e.g. information of neurons or dimension of criteria).

The measurement scales involved in hierarchical feedback structures can only be ratio scales of relative importance, because of the fractile character of sustainable systems and consequently the need to preserve self-similar structures in rays.

5. Saaty's AHP can be enlarged and used for sustainable development

In general complex systems can be roughly represented by a network structure of a few key factors, e.g. criteria, holons (organisational units) or neurons. This is the highest level of complexity, which can be expended in further hierarchical levels such as sub-criteria, sub-holons or neurons at lower levels, all combined in a hierarchical feedback structure similar to the metaphor of Russian dolls.

This is how the Analytic Hierarchy Process structures complex problems by use of the so-called Supermatrix and Superhierarchy (Saaty, 1991, pp.10). Further it is well known that the AHP of Saaty estimates the impact scores of the alternatives using the Perron-Frobenius eigen-vector.

The Perron-Frobenius Theorem says that if A is a non-negative square matrix, some power of which is positive, then there exists an x_0 such that $A^n x / \| A^n x \|$ converges to x_0 for all $x \geq 0$. There are many classical proofs of this theorem, all depending on a connection between positivity of a matrix and properties of its eigenvalues. A more modern proof, due to Garett Birkhoff, is based on the observation that every linear transformation with a positive matrix, may be viewed as a contraction mapping on the non-negative orthant. This observation turns the Perron-Frobenius theorem into a special case of the Banach contraction mapping theorem. Furthermore, it applies equally to linear transformations which are positive in a much more general sense, for example the representation of fractile structures as positive matrices similar to rays.

The metric which Birkhoff used to show that positive linear transformations correspond to contraction mappings is known as Hilbert's projective metric. The metric used by Birkkhoff was invented by Hilbert for different purposes in non-Euclidean geometry. In the case of R_+^m Hilbert's metric d(x,y), i.e. the distance between x and y, can be viewed as a metric on rays because $d(\lambda x, \mu y) = d(x,y)$ for $\lambda, \mu > 0$ (Kohlberg and Pratt, 1982, p.199). Thus the Perron-Frobenius eigenvector cannot be separated from the Hilbert matrix, which requires the existence of a ratio scale for relative importance invariant up to rays.

The fact that sustainable systems should have an autopoietic structure, which has the ability to reproduce itself in self-similar fractile structures invariant up to rays, has been confirmed by Chaos and Fractile theory (Fig.2). Fractile structures make it possible to implement the subsidiarity principles as developed in the EC and to stimulate the synergy between systems units (Turnheim, 1993, p.337). Examples of fractiles are self-similar standing orders, statutes, forms of business governance, etc. Thus if we consider a strategic holding as having a fractile structure, and go deeply inside it, we shall always find self-similar sub-structures (Fig.2). This representation is symbolic and does not reflect the real internal structure of sustainable systems, which may be flexible, diversified, feedback hierarchical similar to the structure of the universe (Vester, 1992). Therefore, we can accept that the way the AHP models complex decision situations as complete or incomplete feedback hierarchies (Saaty, 1990, pp.12) is significant. Further, we shall consider each attempt to adjust the AHP to the foundations of the Theory of Preferences and the conventional Utility theory as obsolete. Mathematically the preservation of phase space through self-similar structures can be seen as a recursive structure of non-negative square matrices converging in direction (Fig.2). The view of the AHP that constituent parts of complex systems such as neurons, holons or in general key criteria of different fields, may exchange their information through a pairwise comparison is plausible.

It can be assumed that between neurons (criteria or holons) of different fields there is an exchange of information, energy and matter which can have different intensities, dynamics and relative importance.

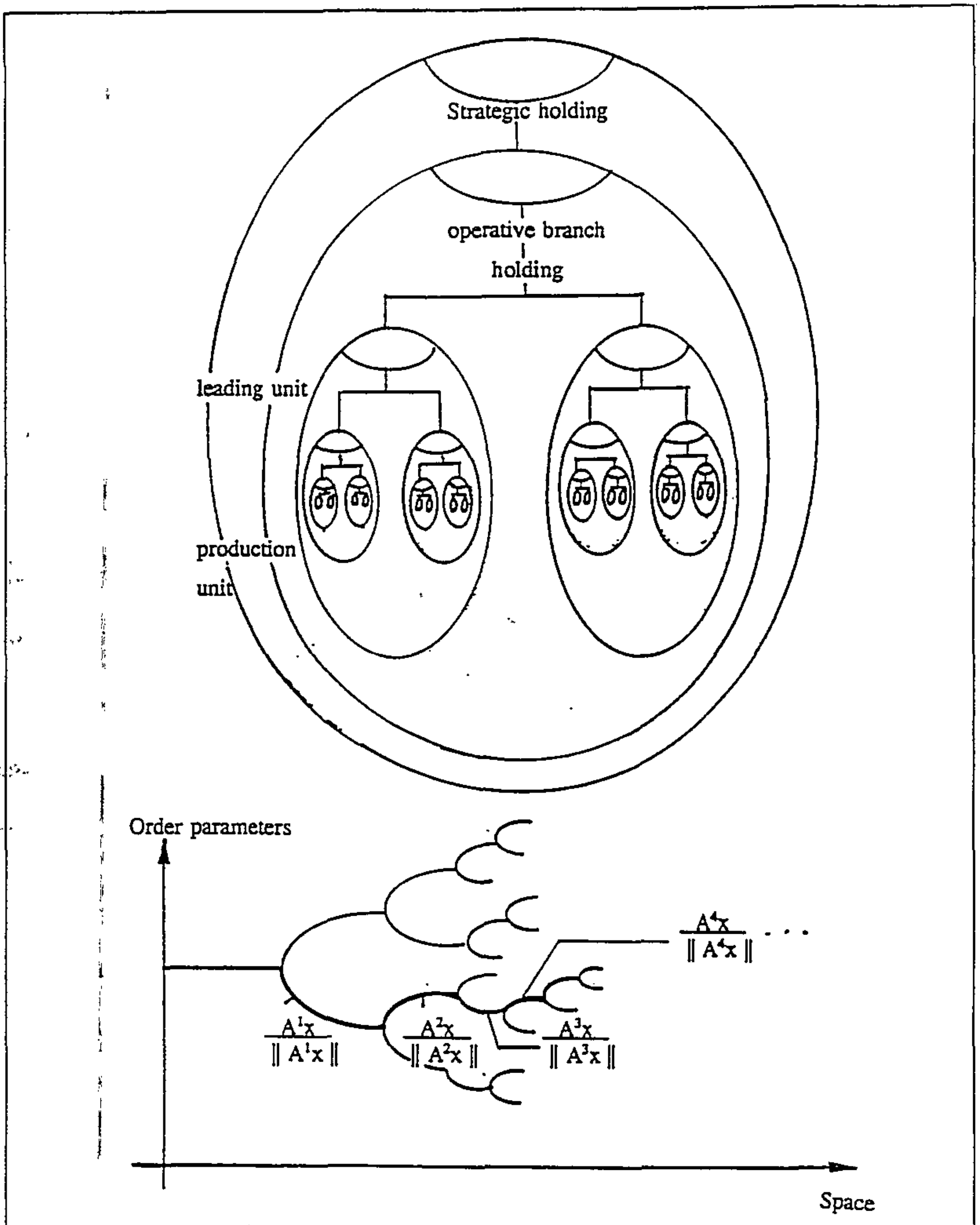

Figure 2: The fractile structure of sustainable systems

For two neurons with probabilities of information p and q, according to Shannon and Wiever (1940). the information is $H = -(p \log p + q \log q)$, $q = (1 - p)$ (p and q are objective probabilities).

Quantum and Relativity theories (Capra, 1982) imply that probability must become more important in evaluation theory. In classical physics, probability is used when the details involved in an event are unknown. For example, in the case of throwing a dice, we can predict the outcome if we know the exact symmetry of the dice and the composition of the surface on which it falls. These mechanical details are called local variables. In subatomic physics, local variables are represented by connections between spatially separated events through signals - particles and a network of particles - that respect the usual laws of spatial separation. But beyond this local connections other, non-local connections have recently emerged: they are instantaneous connections to the universe as a whole and cannot be predicted in a precise mathematical way. This is in accord with Prigogine's theory of dissipative structures and the Haken's Synergetics (Marzen, 1994).

The laws of atomic physics are statistical laws, according to which the probabilities for atomic events (e.g. that an electron has one or another energy state, orbit, spin rotation, etc.) are determined by the dynamics of the whole system. Whereas in classical physics the properties and behaviour of the parts determine those of the whole, the situation is reversed in quantum physics: it is the whole that determines the behaviour of the parts. Bell's theorem, based on the Einstein - Podolsky -Rosen experiment (EPR), was a shattering blow to Newtonian physics since it showed that the conception of reality as consisting of separable units, joined by local connections, is incompatible with quantum theory (Bohr, 1958, p.20).

Bell's theorem demonstrates that the universe is fundamentally interconnected, interdependent and inseparable (Capra, 1983, p.346). Capra examines the EPR experiment and Bell's theorem, which involve the observation of two electrons which spin in opposite directions as they move apart, but maintain total spin of zero. The paradoxical aspect of the EPR experiment arises from the fact that the observer is free to choose the axis of measurement. Once the observer has chosen a definite axis and has performed the measurement, this act will give both particles a definite axis of rotation.

The crucial point is that we can choose our axis of measurement at the last minute, when the electrons are already far apart. At the instant we perform our measurement on particle 1, particle 2 may be thousands of miles away, yet it will acquire a definite spin along the chosen axis. How does particle 2 (or another observer) know which axes we have chosen? There is no time for it to receive that information by any conventional signal. Here the fundamental assumption of the inseparability of objective and subjective probability arises, which is analogous to the duality of nature. Subjective probability is dependent on the observer's weltanschauung, culture and education, and expresses the relative importance which he attaches to the existence of non-local connections.

Measurement in a dynamic network of particles (neurons, systems units) should consider the availability of both objective and subjective probabilities. This was acknowledged by Pfanzagl (1968) and can also be found in the Shannon and Wiever's equation as shown above and interpreted in Fig.3.

If we can create such a function for relative importance of stimuli which represents the Power law, the logarithm of their values must lie on a straight line. There may be three important states of relative importance of information when it is exchanged in a pairwise comparison of stimuli, e.g. neurons/criteria: increasing, decreasing, or a relative importance moving around a max threshold value (Fig.3). The log of objective probability in Shannon's equation shown above, makes the value of information subjective since it refers to the ability of human beings to restrict intuitively the importance of physical values to a satisfactory level. We can replace it by subjective probability if we know how to determine psychological values to physical entities. In Fig.4 we show how to create such a function expressing a ratio scale over relative importance.

The decision maker is asked to place on a vertical bar the positions of weak, demonstrated and absolute importance of i over j in relation to the given optical unit which is associated with equal importance of i over j. This procedure can be repeated several times until the value function satisfies the Power law, e.g.

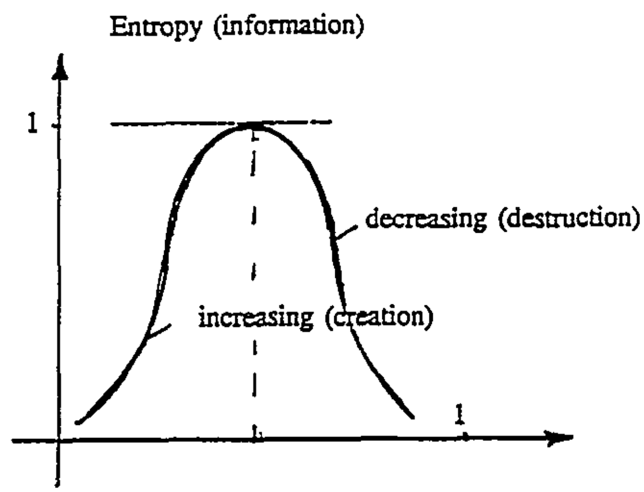

Figure 3: The duality principle in nature expressed by the unity of creation and destruction

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$$\left(\frac{S_1}{S_2}\right)^{0.7} = \frac{\mu(S_1)}{\mu(S_2)}$$

and yields a geometric sequence of sensory responses,
$\mu(S_n) = \mu(S_o).(1.35)^n \qquad 0 \leq n \leq 4.$

This value function represents a Hilbert metric since all values calculated by:

$$\log \frac{\mu(S_n)}{\mu(S_o)} = \log \frac{\max W_{ij}}{\min W_o}$$

satisfy the log-lin hypothesis (Fig.4). Once the value function over relative importance is created, the AHP can be used for further evaluation of the pairwise comparison of stimuli.

It can be argued that this is the real cardinal utility function in the Bernoulli sense, which implies that the neo-Bernoullian formulations (Allais and Hagen, 1979) involved in the axiomatic foundations of measurement scales, may be regarded as obsolete.

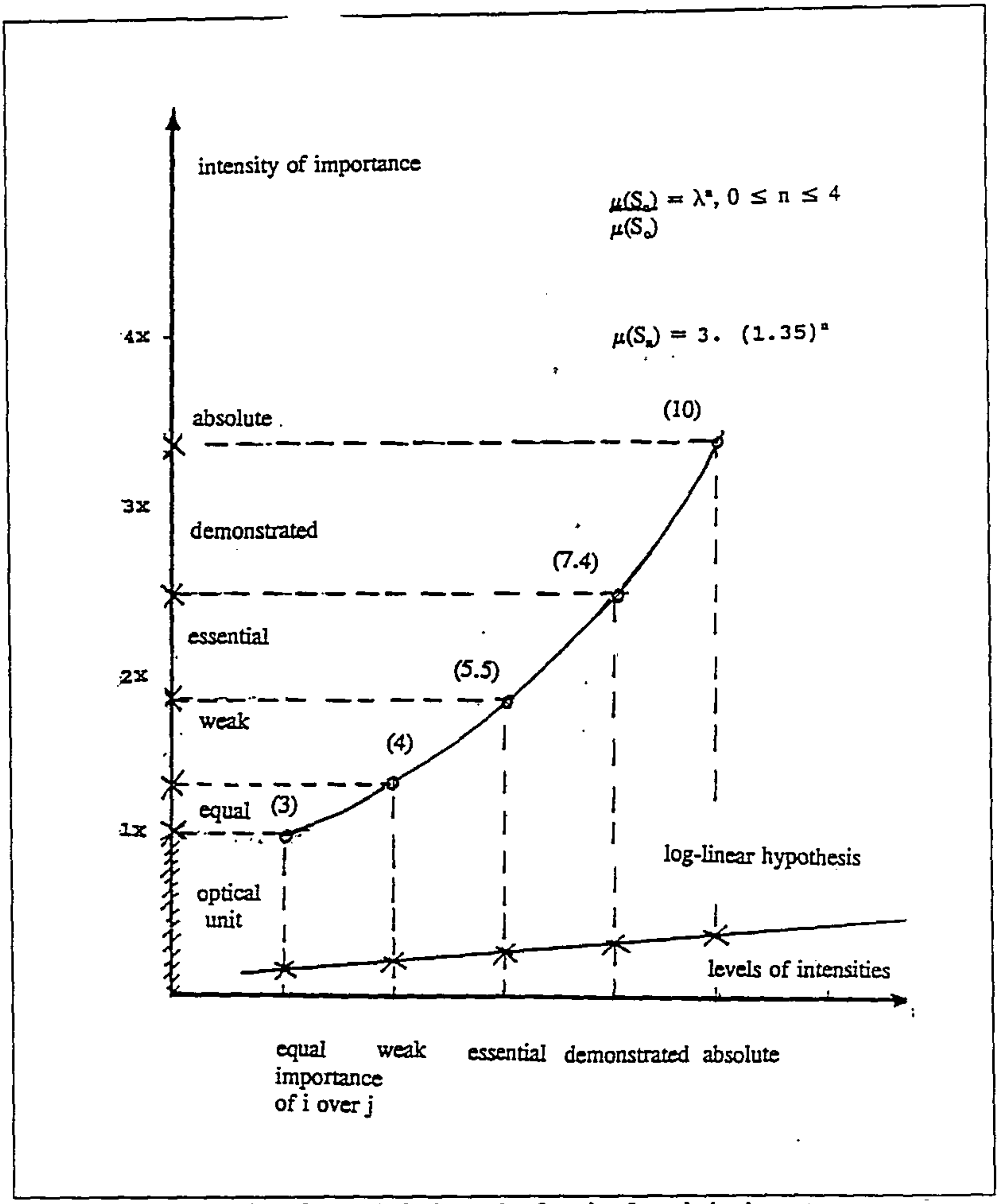

Figure 4: The creation of a psychological value function for relative importance

The reference point for a relative importance is that of zero importance, which matches with zero length, and makes sense since importance is a monopolar notion. In contrast, zero preference does not make sense since preference is a bipolar notion (Resher, 1969). Dyer's remarks on the AHP are founded on conventional Utility theory. However, our jigsaw-puzzle of contemporary scientific concepts (Fig.1) yields the awareness that Decision Analysis, Multiattribute Utility (MAUT) and Bayesian Decision theory may be insignificant for sustainable development (Marzen, 1994).

So Dyer's remarks on the AHP do not agree with the foundations of sustainable systems, and are not helpful in creating significant approaches which can handle complex decision situations.

5.2 The significance of Belton's remarks on the AHP

An essential assumption of Saaty's AHP is the differentiation between an ideal and distributive mode for pairwise comparison. The ideal mode is applied when physical values of alternatives/criteria are given. In this case the AHP uses direct ratios of physical values (Saaty, T.L., 1983, pp.11). This implies implicitly the assumption that a linear value function exists for the range of the intensities of relative importance. The Shannon/Wiever's information theory which uses log of physical stimuli, shows that the assumption above cannot be generally accepted. Therefore the requirement for one fundamental scale which preserves order and must converge along rays is evident (Fig.4).

However, Belton and Gier (1983) and Belton (1986) show examples of Saaty's distributive mode for one to nine scale of relative importance. The use of this scale leads to violation of the axiom of irrelevant alternatives and to a rank reversal. If one uses only one fundamental scale as already described Belton's most essential argument (Belton, 1983, p.229) that the AHP needs to normalise the ratio scale before lateral aggregation, by setting the highest intensity grade (value) to one, does not need to be valid. The Theory of Measurement (Roberts, 1979, p.83) says that in the case of one fundamental scale for all criteria or experts, the lateral aggregation of ratio scale values may be meaningful. In addition, self-similarity on rays is order preserving.

5.3 The significance of Lootsma's remarks on the AHP

Lootsma (1993, p.89) introduces the notion of a natural geometric scale for the quantification of verbal comparative judgements. He argues that the Power Law $\mu(S_1)/\mu(S_2) = (S_1/S_2)^{\beta}$ (Steven, 1957) which gives the relationship between the sensory and physical intensity ratios, clearly implies that a geometric sequence of stimulus intensities yields a geometric sequence of sensory responses, albeit with a different progression factor. For instance, for the ratio scale of relative importance (Fig.4) the progression factor $\lambda = 1.35$ is calculated as follows: $\mu(S_n)/\mu(S_o) = \lambda^n <=> 10/3 = \lambda^4$, $\lambda = \sqrt[4]{10/3} = 1.35, => \mu(S_n) = 3.(1.35)^n$. However, it can be argued that the geometric sequence can be produced if the decision maker has been questioning "a priori" identification of intensity levels. For instance, the values 3, 4.5, 5, 7.4 and 10 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. It seems that Lootsma is not aware of the fact that his natural geometric scale is not a measurement scale in the sense of the Theory of Measurement and psychophysics, since it does not match a physical stimuli, e.g. length. In addition, he does not describe what kind of manifestation (kind of questioning a decision maker) lies behind the natural geometric scale. Pfanzagl (1968) pointed out that the manifestation behind psychophysical scales in general might involve arithmetic or geometric middling operations which match equal physical distances with equal psychophysical sensations. Both arithmetic and geometric middling lead to the same type of scale. Validation of the middling operations can be expressed by the bisymmetry axiom, i.e. in our case 7.4 might be equal to (10 + 5.5)/2 or 4 might be equal to (5.5 + 3)/2, where 7.4 is the value of the demonstrated level, 10 and 5.5 are correspondingly the values of the absolute and essential levels, etc.

It can be argued that Lootsma's natural geometric scales do not respect both the bisymmetry axiom and the log-linear hypothesis. Further, the context of preferences cannot be expressed as a psychophysical sensation because zero preference in contrast to zero length, does not make sense. In addition, there is no reason to transform the AHP into a multiplicative structure by the use of the geometric mean aggregation rule. The meaningfulness of the eigen value approach is validated if one fundamental scale is used as already described.

In general, the comparison of the AHP with a conventional multi-criteria approach, such as the "weighted sum" is pointless. The AHP is a systemic approach which have the purpose of creating the view of "whole" and to identify in an analytic way, the relative importance of local and non-local information within and between systems units, in combined feedforward and feedbackward processes. The relative importance of scenarios or alternatives is a logical consequence of the mutual interaction in the network, and not a "cause-effect" action of isolated criteria. Conventional utility theory suggests that one definition of weight, is the value of a unit of the scale on which the criterion is measured (Belton and Gear, 1982, p.229). The number of scales is equal to the number of criteria. However, sustainable systems seem to accept only one fundamental scale of importance which can be simultaneously applied to all criteria combined in an inter-linking structure.

Lootsma's great contribution to Decision theory is the empirical proof of the existence of one fundamental psychological value function, based on psychophysics and expressed by the Power Law. This allows the construction of significant measurement scales, as cardinal utilities in the Bernoullian sense, and was confirmed by the experimental work of Allais and Hagen, Shannon and Wiever's information theory , dynamic systems theory (Hamiltonian systems, Kolmogorov measure, Hilbert metric), probability assessment according to Spetzler and Staël von Holstein, etc. (Marzen, 1994).

5.4 Conclusion: a new AHP (SHP)

Let us rename the Analytic Hierarchy Process of Saaty in a Systemic Hierarchy Process (SHP) which incorporates the systemic-evolutionary and biocybernetic/taoistic philosophy of sustainable systems. The SHP 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 SHP relevant for management (see Marzen, 1994 for more details):

- 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 the theory of sustainable systems.

- The dependence of irrelevant alternatives does not make sense in a global network analysis since alternative are generated as a consequence of the mutual interaction. The final analysis offers several optimal ways for taking actions. To choose depends on their relative importance. There are no irrelevant alternatives since all alternatives are optimal.

- 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 might be envisaged.

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