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Representation, Comprehension and Communication of Sets: The Role of Number. Pt. III

(Sect. 9–11 and Annexes)

Judge, A. J. N.: **Representation, comprehension and communication of sets: the role of number.** III (Sect. 9–11 and Annexes)
In: Intern. Classificat. 6 (1979) No. 2, p. 92–103
Examines the cognitive and other factors which tend in practice to limit the number of elements distinguished in a set, particularly for sets fundamental to social science and policy formation, such as: human needs, values, principles, problems. It is argued that the number of elements so distinguished influences significantly both the relationships perceived between the elements and the qualitative characteristics manifested by them, irrespective of the content of the set. Such effects are important in the case of the more abstract sets for which the ambiguity of verbal descriptors creates considerable problems of comprehension and communication, especially when the set of elements is used as the basis for the elaboration of a group of cooperating institutions. The representation of such sets in traditional symbol systems and in modern 2 and 3-dimensional forms, is reviewed both as a source of constraints on set formulation and as a guide to the formulation and comprehension of the more complex sets through which the problems of society can be better contained. (Author)
Part I in Intern. Classificat. 5 (1978) No. 3, p. 126–133; Part II in 6(1979) No. 1, p. 15–25.

9. Qualitative characteristics of sets

9.1. Characteristics of multi-term systems

The remarks of the previous section provide a context within which efforts at establishing the characteristics of multi-term systems can be considered as defined in Annex 1. This question cannot be explored here. It serves as an indication only therefore, that the results of J. G. Bennett's exercise are summarized in Annex 2. This suffers from the disadvantage of not establishing explicit links to the rich variety of cultural and mathematical material reviewed by von Franz in her study of the first four integers. Such material should be used to interpret and broaden the meanings, otherwise Bennett's (or any other) particular orientation is too easily assumed to exhaust the meaning associated with each system – thus subjecting the approach to the difficulties raised in the previous sections.

Bennett points out that "no one system taken alone can exemplify the organized complexity of real structures. We usually need to take more than one system into account in order to gain the insights needed for understanding any existing structure that we find. According to the aspect of structure that happens to be relevant to a given purpose, a system of one order may be more useful than another." ((45), vol. 3, p. 11–12).

Also (bearing in mind the limited value of label words for the system attributes identified in Annex 1): "The series of multi-term systems is a progression such that each system implies all the earlier ones and requires those that follow. We cannot understand the triad unless we already group the notions of universality and complementarity, and the dynamism of the triad is not realized without the activity of the tetrad. The later systems are not only more complex and more highly organized than the earlier ones; they embody an understanding of reality that is more comprehensive and practical. The progression is from abstractness to concreteness." ((45), vol. 3, p. 12).

But: "Not all structures exemplify all stages of the progression to the same degree. A given structure may exemplify one attribute strongly and others weakly.... One other general property of systems remains to be considered. This we shall refer to as term-adequacy. If the terms of a system cannot be clearly discerned in a given structure, the required characters will be lacking and the system in question is then inadequately represented." ((45), vol. 3, p. 13). Namely the set is weak in that attribute.

In the light of this argument, attempts should be made to explore a 3-term set re-interpreted as a 4-term system or more, particularly in the case of fundamental sets. In Bennett's study of systematics[61], he finds that: "for purposes of practical utility, the systems fall naturally in groups of four. The first four from the monad (1-term) to the tetrad (4-term) help us to see *how* structures work. The systems from pentad (5-term) to octad (8-term) show *why* they work and how they enter into the pattern of reality. The third group from the ennead (9-term) to the dodecad (12-term) is mainly concerned with the *harmony* of structures: that is, the conditions that enable them to fulfill thier destined purpose." ((45), vol. 3, p. 12)

9.2. Clarification of specific sets

Two procedures are outlined (in Annex 3) for the clarification of material on complete sets. Both procedures ensure that any given set is embedded in a context. In the first case, this is in relation to alternative (or more superficial) possibilities. In the second, it is in relation to more fundamental possibilities.

By such procedures the set is being tested and refined in a manner which should establish the constraints on its meaningfulness and communicability to those who – in contrast to its vigorous advocates – may be sensitive to other aspects of the context in which it is embedded[62]. The procedures necessarily highlight the extremely limited value of dependence on the univocal, unambiguous meaning of any words (in definitions) used to label such sets or their elements.

It should be stressed that, in contrast to the usual competitive preoccupation, the concern is not with

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establishing any particular set as the most valid. Rather it is to give some understanding of the probability that any such set will be advocated, perceived as valid, or widely comprehended and communicated. At the same time it supplies a context for elucidating the meaning underlying whatever marks (words, numbers, codes, etc.) are used to identify a set and its elements.

10. Representation of multi-term sets

10.1 The above sections have identified: the constraints on set formulation imposed by number: the importance for comprehensibility of representation in 3 dimensions; the impact of particular number choices on the consciousness of those exposed to such sets; the problems of comprehension and the role of memory; and the properties exemplied by sets of a given number of terms. These are brought into focus by the problems of representing and comprehending multi-term sets. The problems have been strongly emphasized. Even a brief perusal of Annex 2 makes it clear that a verbal explanation in linear text form dos not come near capturing the gestalt quality of most of the systems identified. Just as when the elements of a set are listed, the *sequential* presentation introduces the time dimension to an extent determined by the number of terms. Von Franz notes: "Detailed investigation revealed, however, that number, understood as a psycho-physical motion-pattern, is intimately connected with the problem of time" ((9), p. 235). The linear scanning required is not consistent with holistic comprehension of the single underlying concept. The manner in which the elements stand as "un-time-bound" aspects to the set as a whole is lost[63].

10.2 It is for such reasons that Bennett, in his presentation of the systems in Annex 2, relies heavily on 2-dimensional diagrams with a high degree of symmetry. And indeed many complex structures are open to comprehension if they have a high degree of symmetry (82). The emergence of symmetry in science is also frequently considered an indicator of the adequacy of a description. As Rudolf Arnheim notes: "In a broader sense, symmetry is but a special case of fittingness, the mutual completion obtained by the matching of things that add up to a well-organized whole" ((21), p. 64–65). Symmetry has the special merit of enabling the mind to regenerate constantly those aspects of a pattern which fade from comprehension when they are not the focus of attention[43]. It is in part for these reasons that asymmetric diagrams are seldom used for these purposes. Lack of symmetry limits the comprehensibility of conventional concept maps (83). Figs. 1–3 are thus interesting examples of "representational classification".

10.3 Given that symmetry is richer in 3 dimensions and that representation is then naturally more compact, the basic question still remains whether such packing of 3-dimensional structures should bear any isomorphic relationship to the manner in which concepts are "packed" in comprehension. Is it irrelevant that the geometry of such packing is fundamental to so many natural structures in the environment and to the design of artefacts? The argument may be made that concepts require an N-dimensional space as Rene Thom would seem to

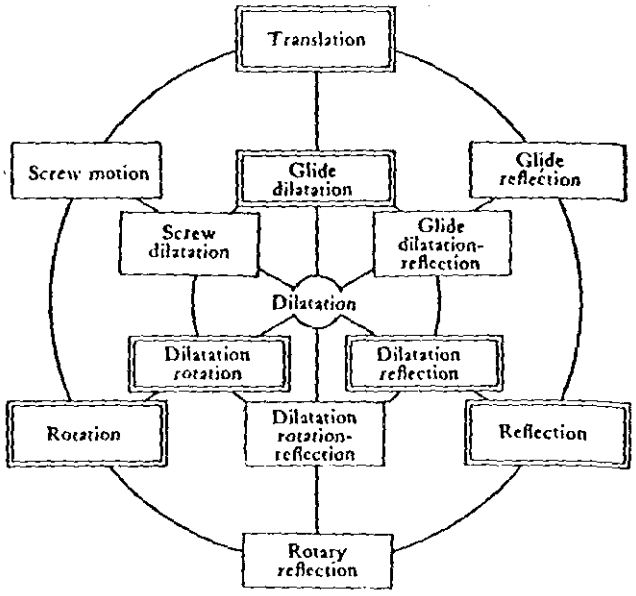

Fig. 1: Schema of positional space relations. The relations of the outer ring contain identity as their inner relation. The relations of the inner ring contain delatation. Dilatation itself is a purely inner relation. (Source: W. von Engelhardt, "Sinn und Begriff der Symmetrie". In: Studium Generale 6 (1953) No. 9, S. 524 reproduced by permission of Springer Verlag and W. von Engelhardt)

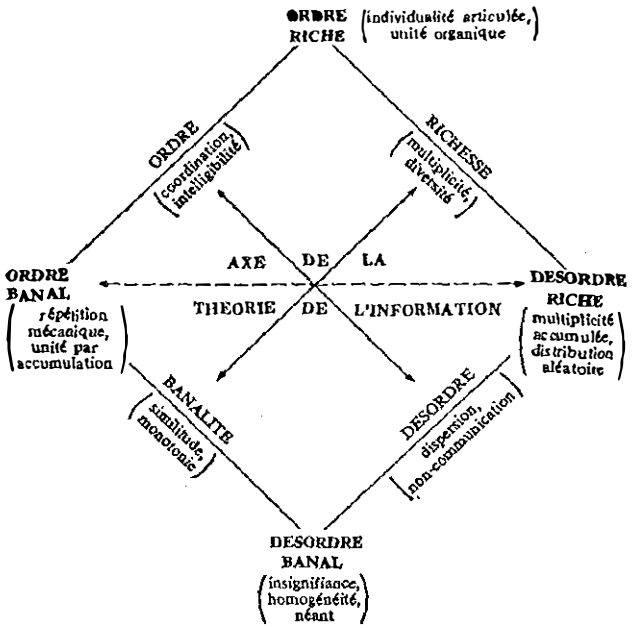

Fig. 2: Schema used to interrelate information of different qualities of order in experimental music. (Reproduced with permission from: Henri Pousseur: Fragments theoretiques I sur la musique experimentale. Bruxelles: Ed. de l'Institut de Sociologie de l'Universite Libre de Bruxelles.

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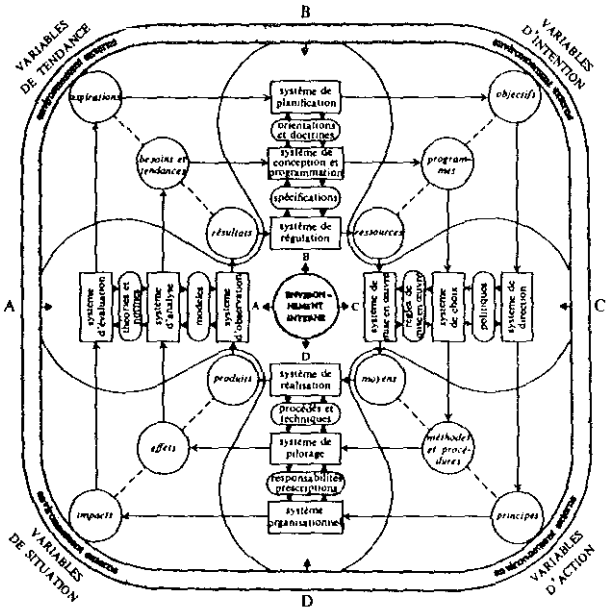

Fig. 3: Interrelationship of 4 activities at 3 levels in an organization resulting in 12 sub-systems linked by imput-out variables and by control variables. (Reproduced with permission from: Bernard Walliser: Systèmes et Modèles; introduction critique à l'analyse des systèmes, Paris: Editions du Seuil 1977, p. 115.

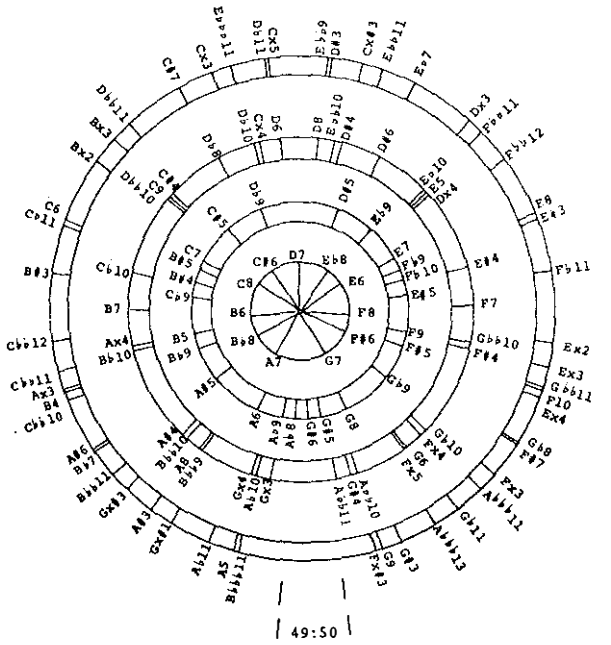

Fig. 4: Emergence and classification of tones governed by some integer ratios (deduced from Platonic texts) and their representation in concentric mandala form. (Reprinted by special arrangement with Shambhala Publications, Inc., 1123 Spruce Street, Boulder, Colorado 80302 U S A, from: "Myth of Invariance" by E. G. McClain, p. 168. Copyright 1978 by Shambhala Publications, Inc.)

imply (see above). And yet he himself recognizes isomorphism between natural and social systems[30]. And it is those very same natural systems requiring an "infinite-dimensional space" which are so elegantly and symmetrically ordered (to one perception) in relatively simple *3-dimensional* arrays (84) (131). Agreed, the N-dimensional space is required to order *transformations* and conflicts between such structures. But it would seem to be highly probable (particularly in the light of the ordering role of number) that there be a certain degree of isomorphism with "concept packing", at least in 3 dimensions and if only with regard to the iconicity of representations[31,64] (The very interesting question, of whether Thom's N-dimensional space can reflect the transformations and conflicts between such structures, namely the social dynamics of ideas and the organizations based upon them, is not an immediate concern here.)

10.4 Bennett, in presenting his schema (see Annex 2), makes use of several different 2 and 3-dimensional diagrams to symbolize a system of a given number of terms. He does this to bring out different qualitative aspects of the system in question. This suggests a much more general approach to the problem of representation using work in graph theory (see Annex 4)

10.5 Although the graph theory convention of points and lines may only be meaningfully representative to a segment of the population in western cultures[65], it is possible that symmetric patterns and solids are much more widely acceptable. Whatever the case, such structures may be used to order or classify the elements of a meaningful representation which could (and does traditionally) employ other forms and media, e.g. animation[66], dance[67], drama, ritual, music ((90)–(95)). Part of the general inability to perceive such underlying structures lies in the widespread "visual illiteracy" discussed by Arnheim ((21), p. 294–315) – although "structural illiteracy" draws attention to an even more neglected aspects of it. (It is likely that there is a whole series of unrecognized configurative classificatory "handicaps" equivalent to such "hidden" disabilities as dyslexia, discalcula, arhythmy, etc).

10.6 There is also good ground for arguing with Fuller (1) that ideal forms such as polyhedra conceal a basic design problem which must be solved to obtain a more complete representation in concrete reality. He does this by generating dynamically stable "tensegrity structures" each based directly on a given polyhedral form[68] (96). In this design problem and its solution may well lie the clue to the limited utility of ideal forms for representation, comprehension and (above all) effective implementation. For this reason, the author has explored the possibility of using tensegrity structures as a basis for new approaches to the representation of concept and problem complexes, and the creation of new kinds of organization (97, 102). Clearly this is relevant to the representation of the sets of interest here (98, 99, 101).

10.7 The above procedures result in the generation of a multitude of symbols which may be enrichened in various ways (e.g. colour coding, etc). The question arises as to whether this multiplicity is not undermining the original objective of representing and communicating the governing central concepts – particularly since it is what already characterizes the representations of sets of various kinds. However, in remarking on the apparent

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divergencies of representation between traditional cultures, von Franz states: "In this field, too, knowledge of the part played by the psychic unconscious in the formation of the concept is lacking. Of the archetypes of the collective unconscious we know that they – like a crystal lattice in the mother liquid – form structural dispositions in the unconscious, invariable in themselves, although their pictorial and representational appearance in human consciousness exhibits variations. Behind these variations lies a basic archetypal pattern that can be descriptively reconstructed." ((9), p. 31–2). Tucci effectively makes the same point in explaining how different users benefit from different kinds of mandalas to arrive at the same understanding: "Hence, as the ritual is adapted to individual adepts, the mandalas are very great in number. In some of the Tantras of the Yogatantra class they can be counted in hundreds" ((38), p. 80). There is a great deal to be said for adapting symbols and representations to the user, rather than imposing a "standard" pattern.

But the point is that these divergent forms, and those arising from the procedures above, are *generated by rules governed by numbers.* The variations emerge from a general pattern or number field which we are slowly coming to understand (e.g. von Franz has a chapter on "Archetypes and numbers as 'fields' of unfolding rhythmical sequences" in which she grapples with the question).

11. Implications

11.1 The purpose of this paper is to demonstrate the importance of number in the complete sets fundamental to social science and policy formulation. It is fairly obvious that formulation of a 2-term set of concepts (values, problems, etc.) establishes a dynamic for the advocates of each term, or those involved in any institutionalization of the dyad – namely a dynamic having any or all such aspects as: active/passive, right/wrong, we/they, dominant/subordinate, conflict, complementarity. For example:

> "By the very nature of scientific logic which is binary, intellectuals tend to form bi-polar structures with two opposed camps rallied under two paradigmatic banners. The polarization often takes place even within each of the two poles which then divide themselves into subpoles, and so on, and so forth" (49).

It is equally, obvious that promulgation of a 1-term set (e.g. *the* problem, *the* value, *the* method, etc) gives rise to another kind of dynamic. It is however less obvious what kinds of dynamics tend to arise from sets with a larger number of terms. Yet sets with larger numbers are frequently produced and usually it is considered convenient to ignore how the elements of the set interact at the conceptual level or through organizations (departments, progranunes, laws, information systems, etc) on implementation. This paper implies that, like it or not, *certain interaction qualities are built in by the choice of the number of set elements.* If ignored, they will erode or completely undermine the effectiveness of any action based upon them. They define the problem to which the initiative is vulnerable and by which it will be counteracted, or nullified.

11.2 Implicit sets of a given number of terms usually engender particular *styles of debate.* For example: 1-term, promulgation and propaganda; 2-term, pro and con argument as in some legal, parliamentary and scholarly arenas; 3-term, mediatory and reconciliatory debate. Given that issues currently exceed the capabilities of such forms of debate or are exacerbated by them, other higher-term forms may be envisaged to contain and facilitate the interactions between a greater number of distinct viewpoints. This would also be relevant to the interactions within *interdisciplinary teams* and the design of the classification systems which serve them (98). A sense of *issue configuration* would stabilize understanding of the complete sets of "logically incompatible" problems which such teams are increasingly obliged to confront. This could lead to the emergence of methods based, on a *non-dualistic complementarity.* A need for an improved approach is becoming evident (132), even in unexpected places: "The mosaic theory of intelligence has focused attention on collection, the gathering together of as many pieces as possible for the analyst to work with. A more psychologically oriented view would direct our concern to problems of analysis, and especially to the importance of mental models that determine what we collect and how we perceive and interpret the collected data. . . there are important implications for the management of intelligence resources" (133).

11.3 *Research on complete sets* is required to clarify their nature and variety. Complementary approaches include: research on number, as advocated by von Franz; research on symbols in traditional cultures, of any well-ordered sets and their elements; and research on modern sets elaborated in scholarly and action-oriented texts. This should lead to better understanding of: (a) how sets can be formed and their elements classified, (b) how the relationships between their elements can be rendered comprehensible, (c) how the nature and value of higher term sets can be demonstrated, and (d) the nature of the totality, they are intended to encompass. It is in the East that qualities and attributes have been so carefully distinguished and ordered, whereas sophisticated number-based frameworks have been elaborated in the West. This research should bring out the points of contact. An excellent point of departure would be the problems of "classifying" tones in music as explored in two complementary studies by a philosopher (134) and a musicologist (135) faced with the challenge of the alternative patterning possibilities within the Rg Veda: "Rg Vedic man, like his Greek counterparts, knew *himself* to be the organizer of the (musical) scale, and he cherished the multitude of possibilities open to him too much to freeze himself into one dogmatic posture. His language keeps alive that "openness" to alternatives, yet it avoids entrapment in anarchy." (134, p. 31) This appears to amount to a degree of order beyond that attained in classification today; the flexibility and the challenge to musical creativity are illustrated by Fig. 4. It is perhaps no accident that P A Heelan's work on the logic of changing classificatory frameworks (139) cites the Rg Vedic example and is considered of fundamental importance by these two authors[84].

11.4 It is not recognized, when advocating or imposing the use of particular sets (e.g. of values, needs, etc), that these effectively compete as *functional substitutes in traditional societies* for other sets of qualities represented by hierarchies of gods or spiritual beings governing those qualities (or some of them). The fundamental sets society now attempts to generate are indeed designed to

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perform many of the regulatory functions previously ascribed to supernatural beings or potencies. Given the relative rapidity with which such sets are now formulated – compared to the long cultural refinement of a pantheon – it is not surprising if they are viewed as superficial, "bloodless" and unrelated to the cultural refinement of the traditional sets. These are so meaningfully represented (with nested levels of interpretation) through richly decorated beings and memorable tales exemplifying their relationships – to the point that the quality and its representation are difficult to distinguish in a particular culture. The lack of success of public information programmes of national and international agencies, in substituting modern intellectualized versions (of somewhat ersatz quality) using product marketing techniques, is understandable. The new versions lack credibility and durability even if the traditional versions are destroyed by the process[69,70].

11.5 Comprehension of the qualitative characteristics encompassed by higher-term sets has been shown to be no easy matter despite their vital importance for a more adequate grasp of our current social crisis[71]. Problems of *classification, comprehension, memory aids and representation need to be considered together.* There is every indication that conventional methods do not have an adequate degree of complexity to embody, and reflect for comprehension, the complexity of multi-term systems[72,73]. Research is required: (a) on the generation of *iconic symbol sets of high mnemonic value,* (b) on the consequence of disposing them in configurations so that the pattern of relationships may be comprehended as a whole, and (c) on any paradigm shift or change of awareness which this may facilitate. There is no reason why this should not include an investigation of the traditional memory technique and its intimate relationship to classification systems[74]. To what extent were traditional symbol ssystems, or associated numbers, successfully used for their powerful mnemonic value?

11.6 Intriguing lines of investigation emerge from recognition of the intimate relationship between brain operation and classification. Varela notes: "the contents of our reality are truly a reflection of the recursive biological and cognitive computations, in contradistinction to the more commonsense view that our knowledge is a map of the out-there. From this point of view, there is more a construction than a map. These are tantalizing possibilities for a cross-connection between epistemology and science, for the design of knowledge representation systems, and for management and societal problems." (106)[75]. This is related to current investigations of the transformation of the categories of conscious experience associated with shifts in characteristic EEG frequencies. For example, it is suggested that: "the felt shift and the reorganization of conscious experience is a multi-level phenomenon, involving a reorganization of concepts, a choice of principles consistent with these concepts. . . as well as the appropriate reorganization of all lower levels of the hierarchy consistent with these changes . . . . The transformation, then, is not merely a reorganization, but at a deeper level is a re-creation" (107)[76]. EEG data may even provide a link between characteristic frequencies (1 – 3, 4 – 7, 8 – 12 Hz), the preferences mentioned in Part 1 for sets of a given number of elements, the ability to comprehend them, as well as the quality of that comprehension. A better understanding of the conventional separation of subject and object can be obtained by exploring, as does R. Fischer, ecstatic and meditative states in which "the separateness of object and subject gradually disappears and their interaction becomes the principal content of the experience. . . meaning is "meaningful" only at that level of arousal at which it is experienced, and every experience has its state-bound meaning" (136). Relevant to the "concept triangle" question (see Part II and Fig. 5), Fischer in a section on "sign-symbol-meaning transformations", discusses evidence of the transformation of sign to symbol in the visual realm "where the constancies of space and time are replaced by geometric-ornamental-rhythmic structures", namely hallucinatory form constants. These are visible metaphors, otherwise uncommunicable, within a structure of symbolic logic and language whose non-visual equivalents also govern the order of poetic and musical rhythm in such experiences. Once again the importance of number becomes apparent. This question is set in a wider framework in studies initiated by Erich Jantsch (137, 138), to which the argument of this paper links at points too numerous to mention here.

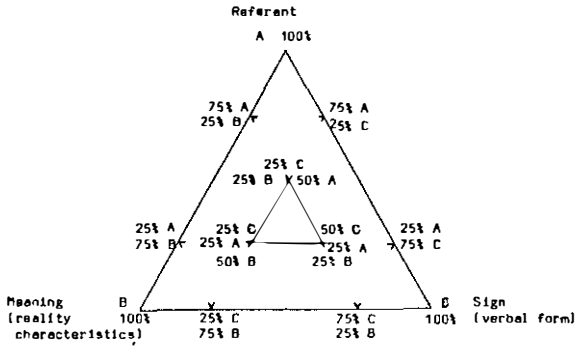

Fig. 5: Convergence of concept triangle elements: Diagram indicating a particular condition of "adulteration" of the absolute distinction between the pure elements of the concept triangle. (Such diagrams are used to indicate the variety of equilibrium conditions of 3 elements in physical chemistry.) Such a presentation may be used to clarify the nature of other kinds of "blurring" of distinctions between the three elements.

11.7 This paper attempts to show the basic role of number and configuration in overcoming limitations to man's ability to perceive (and denote through classification schemes) the patterns which affect him and in which he is embedded. Biologist Gregory Bateson's central thesis is: "The pattern which connects is a metapattern. It is a pattern of patterns. It is that metapattern which defines the vast generalization that indeed it is patterns which connect" (112, p. 11). He asks: "How is logic, the classical procedure for making chains of ideas, related to an outside world of things an creatures, parts and wholes? Do ideas really occur in chains, or is this lineal structure imposed upon them by scholars and philosophers? How is this world of logic, which

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eschews "circular argument", related to a world in which circular trains of causation are the rule rather than the exception? . . . we shall see as every schoolboy ought to know that logic is precisely unable to deal with recursive circuits without generating paradox, and that quantities are precisely not the stuff of complex communicating systems" (p. 20). And: "as of 1979, there is no conventional way of explaining or even describing the phenomena of biological organization and human interaction". It is through study of *number-governed qualitative configurations* that responses to Kelley's related questions should be sought: "And the ultimate question is, *what nature of pattern or system of patterns will enable the human mind to retain familiarity with the maximum number of patterns*? And what is the maximum number of patterns the human mind can hold if the patterns are of this type? What other attributes of patterns are conducive to greater retention by the mind?" (41). Finally, how is this related to the level of awareness or maturity of the observer? (107)[77,78]

11.8 The ability of the mind to retain elements of information long enough for it to form memorable patterns with other elements (e.g. of the set) can be enhanced by the use of *mnemonic aids.* Whilst these may be viewed with disdain by those familiar with the subject matter, it must be recognized that classification schemes are not memorable to the uninitiated (e.g. the public, its representatives and those from other disciplines) who ultimately determine through the democratic process whehter resources will be allocated to the maters ordered by such schemes. The same applies with regard to any argument presented in a linear sequence in an article or book. There is a strong case for interrelating the points made in a *non-linear* presentation. This goes beyond the seminal mnemonic serial structure described by Neelemeghan (63)[79]. Furthermore, in view of the increasing resistance to written arguments of any length there is a case for investigating the possibility for their partial replacement by mnemonically structured diagrams which may provide the detailed pattern for dramatized portrayal necessary for communication to a wider audience. Three dimensional centred mnemonic structures may offer possibilities for memory reinforcement and comprehension beyond those of the two dimensional variety.

11.9 In considering contemporary efforts in the West to allocate qualities and attributes to multi-term systems[80] one is particularly struck by the "bloodless" nature of the resulting categories (however innovative the exercise, such as in the case of Bennett). Such frameworks are generally conceived as mutually exclusive, the advocates of each ignoring the others in favour of their own particular slant on reality. There is much misplaced confidence in the ability of words to label qualitative concepts without ambiguity[81]. It is not recognized and that, as such, each constitutes a representational aspect of a more subtle and more comprehensive framework (cf. Rene Thom's approach). In fact, however apparently distorted or inadequate the attempt, its degree of "distortion" identifies the location of its advocates in relation to other perspectives, challenges, and problems of comprehension. Such relationships are governed by numbers indicative of qualitative distinctions.

11.10 It is to be hoped that this paper has demonstrated the importance of a new approach to representation and the possibilities for it. It may indeed be argued that Johan Galtung's emphasis (56) on the need to switch from the conventioinal "facts-theory" to a "facts-theory-value" (i.e. from 2-term to 3-term) approach, should be extented to "facts-theory-value-*representation*" (4-term), or beyond[82]. The dynamics resulting form facts-theory are too well-known, but the difficulties are not eliminated by his 3-term suggestion. Basically, if insights cannot be meaningfully represented, they are incomprehensible and therefore irrelevant to the period in which they are formulated.

11.11 Finally in the words of Bennett: "For a long time, men have looked for ways of getting beyond the dyad: but mankind as a whole remains bound by sentiments of exclusion and contradiction. Meanwhile the progress of science and technology is leading us towards structured notions of greater and greater complexity. The same is true of nearly all branches of life: psychology and sociology, art, history and religion; all are moving away from naive expectations of simple unstructured solutions to human problems and towards the recognition that we and the world in which we live are an organized complexity that can be understood – even to the limited extent that we do understand – only by discerning the structures that bind us together". ((45), vol. 3, p. 74–5). Or in the words of Bateson: "Break the pattern which connects the items of learning and you necessarily destroy all quality". (112, p. 8) Unrelated set elements break patterns.

Annex 1

Clarification of terminology

The definitions given below are those of J. G. Bennett ((45), vol. 3, p. 10–11) and are given as a basis for his elaboration of a multi-term sequence in Annex 2. In the main part of this article "set" has been used to signify what Bennett defines as "system", although the two terms have been used interchangeably.

"1. A *system* is a set of independent but mutually relevant *terms.* The relevance of the terms requires them to be *compatible.* No one term of the system can be understood without reference to all the others.
2. The *order* of a system is given by the number of terms. . . .
3. In systems, there are no fixed meanings attributable to the term, which depend upon the structure of the system as a whole, so the various *connectivities* are common to all systems of the same order.
4. Every system exemplifies modes of connectedness that are typical of the number of terms. Thus there are zero connectivities in a monad (one-term), one in a dyad (two-term) . . . If the connectivities are distinguished according to direction, the number is doubled. All the connectivities are significant and must be taken into account if the structure represented by the system is to be understood.
5. Each order of system is associated with a particular mode of experiencing the world, called the *systemic attribute.* . . .
6. The mutual relevance of all the terms of a system requires that they should be of the same logical type and make contributions to the systemic attribute of

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one and the same kind. This we shall indicate by a common *designation*. . . .

7. The independence of the terms of a system requires that each should have a distinctive character. An important part of the study of systems consists in identifying the term *characters* of systems of a given order . . . .
8. The mutual relevance of terms of a complex system can be found, to a first approximation, by taking all the terms in pairs. These are called the *first-order connectivities* . . . Connectivities of a higher order can be studied as sub-systems from the tetrad (4-term) onwards . . ."

Annex 2

Example of an elaboration of a number-based sequence of systems

The series below was developed by J. G. Bennett (45) to replace the Aristotelian and Kantian categories, with their dualistic characteristic. His definitions of systematic features are given in Annex 1. The characteristics given here summarize the extensive descriptions of Bennett (vol. 1, p. 31–48, vol. 3, p. 14–75).

Comprehension of the systems proceeds in a definite sequence, given their order of emergence into awareness and the minimum number of terms required to exemplify their attributes. Only 12 systems are identified here, although systems of any number of terms may be considered in order to encompass whatever degree of concreteness one is capable of grasping. The limitation is one of understanding.

A particular system never exhausts the possibility of description and comprehension for, whatever number of terms is reached, some degree of abstraction remains and additional terms must be admitted in order to move towards a greater concreteness. Growth in understanding requires recognition of the representational power of successive systems and a deepening appreciation of their significance. *As implied here and as stressed in the main text, Bennett's word labels and comments are only indicative and do not encompass or exhaust the meanings to which they refer.* Their indicative power may be severely eroded by irrelevant polysemantic associations and increasingly so for the 3-term case and above. Conversely the richness of meaning in a given case is indicated by the symbol complexes which cultures produce to exemplify such systems. The symbols may facilitate a better intuitive grasp of each system *as a whole*, in contrast to the fragmented comprehension resulting from the following descriptions presented as linear text.

1-term representation and comprehension ("Wholeness")

Systemic attribute: universality. Term designation: totality. Term character: diversity in unity.

Any situation to which we direct our attention is a monad, but some exemplify the systemic attribute of universality more strongly than others. The monadic character of the universe as a totality is present in all its parts. Wholeness is universal and omnipresent but relative; it may be transformed into identity. The combination of confused immediacy and the expectation of finding an organized structure gives the monad a progressive character; it is what it is, but it holds the promise of being more than it appears to be.

Aspects of wholeness: unity, coherence, togetherness, completeness, order, organization.

2-term representation and comprehension ("Polarity")

Systemic attribute: complementarity. Term designation: poles. Term characters: positive, negative. Connectivity: force.

Any pair of terms between which both connection and disjunction are recognized, although few pairs stand in more than weak opposition to one another or with more than insignificant connection. Through polarity, everything is in a state of strain which polarity itself can do nothing to relieve. If gives rise to force which may be transformed into direction. It can neither show how oppositions arise nor how they may be resolved. Its closure is not that of completeness.

Aspects of polarity: active/passive; pleasant/unpleasant, like/dislike, etc.

3-term representation and comprehension ("Relatedness")

Systemic attribute: dynamism. Term designation: impulses. Term characters: 1, affirmation; 2, receptivity; 3, reconciliation. Connectivities (1st order): acts (1–2, generation, 2–3, consent; 3–1, decision). Connectivities (2nd order): actions (1–2–3, expansion; 1–3–2, interaction; 3–2–1, freedom; 2–1–3, concentration; 2–3–1, identitiy; 3–1–2, order).

Every dynamic structure has the form of a triad and the three independent impulses found are those to which all relationships are reducible. Such relatedness may be transformed into interaction. The triad shows how acts enter into the structure of the world and resolve contradictions.

4-term representation and comprehension ("Subsistence")

Systemic attribute: activity. Term designation: source. Term characters: motivational (1, ground; 2, goal); operational (3, direction; 4, instrument). Connectivities (1st order): interplays

Subsistence is the limitation of existence within a framework and may be transformed into maintenance. The tetrad specifies an event. It is the form of all activities that lead to a change of order and as such is inherently inflexible. Its very nature is to be an activity of transformation. Its lack of central emphasis allows activity to be studied as ordered diversity, but prevents the association of the activity with a particular entity. Indeed it does not allow for the existence of separate entities.

5-term representation and comprehension ("Potentiality")

Systemic attribute; significance. Subsidiary attributes: potentiality and meaning. Term designation: limit. Term characters: 1, intrinsic; internal limits (2, lower; 3, upper); external limits (4, upper; 5, lower). Connectivities (1st order); mutualities (10 dyads). Connectivities: (2nd order): 10 triads. Connectivities (3rd order); 5 tetrads.

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Meaning and potentiality must be added to activity, if the significance of a structure for itself (and for the totality that contains it) is to be specified. Only then does a structure become a bounded significant entity. Such entities have limits of significant connectedness with the outer world and limits of connectedness with their inner range of meaningful potentialities. Everything that exists has potentialities for actualization that outstrip the relationships that it can sustain within any concrete situation.

6-term representation and comprehension ("Repetition")
Systemic attribute: coalescence. Subsidiary attributes: recurrence, progress and self-realization, independence, form of events. Term designation: law (governing the coalescence of events). Term characters: 1, order; 2, expansion; 3, identity; 4, freedom; 5, concentration; 6, interaction. Connectivities (1st order): steps.

Coalescence is understood as the property of structure, whereby significance acquires depth and enrichment and yet retains the unique character associated with a particular event. The hexad, as progressive cyclicity, is the system most appropriate for sutdying structures in a step-by-step process of realizing their significance as events. It expresses the two-fold character of creation and counter-creation and also the movement of the entire process towards a goal. Although potential energy can be stored up indefinitely, it can only renew itself through the repetitive two-fold action of a disturbing and a restoring force. Success in action requires a balance between attention to what actually is and what potentially might be; events continue to transform themselves even when their actualization is completed. However the hexad does tend to emphasize the separateness and isolation of such events from one another.

7-term representation and comprehension ("Structure")

Systemic attribute: transformation. Subsidiary attributes: structure, history. Term designation: state. Term characters: 1, initiation; 2, involvement; 3, separation; 4, harmonization; 5, insight; 6, renunciation; 7, completion. Connectivities (1st order): intervals. Connectivities (2nd order): harmonies.

A structure is a self-regulating system capable of relatively independent existence. Such a system is no longer closed and changes in the environment accompany changes in the entity. A transformational superstructure is therefore provided by the heptad to reconcile the self-realization requirement of the well-defined entity (namely the acquisition of new properties that were previously neither potential nor possible) and the dissolution of identity required for integration as a part within a whole. A heptadic system is required whenever there is change involving a real gain or loss in significance. By such transformation, significant events are integrated into the stream of universal history.

8-term representation and comprehension ("Individuality")

Systemic attribute: completedness, organized totalities. Term designation: element. Term characters: active (1, summit; 3, atom; 5, base; 7, totality); structural (2, states; 4, functions; 6, necessities; 8, ideals). Connectivities (1st order): components (dyads). Connectivities (2nd order): initiations (triads). Connectivities (3rd order): fields (tetrads). Connectivities (4th order): significant substructures (pentads).

Individuality (whether actualized or potential) is the source of initiative residing in organized structures; it may be transformed into endurance, and is also a unique centre of conscious subjective experience. The octad is able to represent organized structures and historical processes ranging in scale from unity to totality. Its value is classificatory, interpretative, heuristic and predictive. It is however only applicable to structures organized in depth.

9-term representation and comprehension ("Pattern")
Systemic attribute: harmonization. Term designation: sources (3), steps (6).

Experience would lose all coherence if there were not always active sources of order residing in the patterns of organized structures. The ideal completion of the octad does not take into account the uncertainty and hazard encountered in actual experience. The ennead permits the representation of everyday working structures (disturbed by unpredictable environmental factors) in which harmony is established and maintained. The harmonization is dynamic and indeterminate.

10-term representation and comprehension ("Creativity")
Systemic attribute: integrative complementarity.

In all experience there is evidence of a creative (pattern generating) activity that is not only the source of order but also the vehicle of disorder – a polarity exemplified by the decad. At this level several sets of processes are able to compensate for one another's defects and produce an overall harmony that reacts on, and sustains, the individual structures.

11-term representation and comprehension ("Domination")

Systemic attribute: synergism

This is the highest form of relatedness and is the power, subject only to the law of necessity, that reconciles order and disorder through the agency of creativity. It provides the conditions for mutual completion of structures of different kinds.

12-term representation and comprehension ("Autocracy")

Systemic attribute: perfection.

The dodecad is significant as a master pattern for understanding all total structures of the universe, because it is the first system in which the main elements of experience can all be represented. It combines dynamism and diversity, or relativity and relatedness. It is the culmination of the transformations whereby the structure of existence is first disordered, then corrected, then redeemed and finally perfected. Autocracy is the primary affirmation by which all possible experience is brought into existence whether as potential pattern or as the actual process of the universe. It is the element that acts without dominating, wills without reacting, and unifies all possibilities.

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Annex 3

Clarification of specific sets

1. Eliciting subordinate sets: relating distinctions

If a set is named (e.g. "development"), the question may be asked in how many ways possible elements may be distinguished by subdividing the set.

2-level distinction: The set may, for example, be split into *2 subsets*, but in how many ways may this be done in a particular case? Depending on the level at which the distinction is made, there may be 1, 2, 3, 4, or N recognized 2-level distinctions; namely the most fundamental, and successively less fundamental levels of distinction. Clearly these are not unrelated, since the less fundamental distinctions are regrouped in distinctions at more fundamental levels. For example, at the level at which only 4 distinctions can be recognized, the regrouping would tend to bear a relationship to the level at which only 8 distinctions are made (by regrouping pairs of distinctions). On initial examination of all such 2-level distinctions, there would tend to be some confusion as to the level to which they should be allocated in order that the most fundamental should not be embedded in a set of less fundamental distinctions. The probability of any particular 2-level distinction being advocated as most fundamental is likely to be higher, the greater the number of possible distinctions at that level. (Namely it is less likely that the more fundamental 2-level distinctions would be recognized.)

On the other hand this tendency is counter-balanced by the lower stability, viability and acceptability of the less fundamental distinctions. Over longer periods of time they are meaningful to fewer and are of less value to the ordering of perceptions, however vigorously the use of any particular one may be advocated.

In sorting out to which level each 2-level distinction belongs, reference may be made to the pattern of relations between the various distinctions at that level in the light of the underlying qualitative characteristics of the number associated with that level (see Annex 2, for example).

3-level distinction: The set may however be split into 3 subsets. As before, it is a question of the number of ways in which this may be done in a particular case. The argument above applies again.

N-level distinction: Clearly the argument may be generalized for N-level distinctions although, in the light of earlier arguments, N is unlikely to exceed about 10.

Now the procedure adopted to clarify the ordering at any particular N-level, effectively clarifies the nature of the most fundamental distinction for N = 2, 3, 4 . . . N. This in turn provides an ordered configuration of aspects which exemplify the nature of the original totality (i.e. N = 1) which was explored by subdivision.

2. Eliciting superordinate sets

In addition to proceeding by subdivision, clarification concerning a named set (e.g. development) may be sought by determining of what sets it may be considered to be a part. Note that many of the existent fundamental sets are identified or named by enumerating their elements. The name of the set, if any, derives from them in their *plurality* and not from any concept of the *singular* totality they constitute as a set (e.g. human value*s*, human right*s*, etc.)

2-level combination: The set may, for example, be paired with one other set to form a 2-element set. But in how many ways may this be done in a particular case, given that the pairing cannot be arbitrary but must be based on some aspect of the quality associated with the number 2 (see Annex 2, for example). Such combinations could be ordered and clarified as suggested by the previous section.

3-level combination: The set could be grouped with 2 other sets to form a 3-element set. As before it is a question of ordering the ways in which this may be done to clarify the many possible aspects of the superordinate set.

N-level combination: Again the argument may be generalized, although it is unlikely, as before, that the total in the resulting set would exceed about 10. In this procedure it may well be that particular combinations are not meaningful or useful. Clearly it becomes increasingly difficult, as N increases, to integrate the original set into a combination. But at any stage, a further procedure may be adopted to identify, for an N-level combination, what, successively, the elements of an N−1, N−2. . . .N−M combination are. This clarifies the aspects of the nature of the more fundamental superordinate sets (where N−M = 1) which may underly any given set. Again the qualitative characteristics of number (Annex 2) may be used as a guide.

Annex 4

Symbol generation

1. In a system with P terms, it should be possible to identify by analysis (with computer assistance and graphic output) configurations of the P terms (linked by Q relationships), *selected in order of their degree of symmetry* for a given value of P. Constraints on the maximum and minimum value of Q in each case could also be partially determined in terms of symmetry requirements. Tables of such configurations, *without* considering symmetry, have been produced by Frank Harary (124). The less symmetrical structures, for a given P value, should then prove to be those of less probable value in the representation of the central concept – although possibly of more value in representing an aspect of it. And indeed the "traditional" diagrams are those which are likely to be prominent in the results – although valuable new ones may well be discovered by this procedure.

2. The same procedure may now be applied for the representation of P-term systems in 3 dimensions. Here the symmetry constraints are more severe. This procedure should preferentially select the regular and semi-regular polyhedra (when P is even) or less well-known structures (when P is odd) (22), (23), (125).

3. The procedure may be made more powerful if, for a given P-term system the structure selected is based upon P equal to:

either – number of edges of the structure
or – number of sides of the structure
or – number of vertexes of the structure (as above)
or – number of axes of symmetry.

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For, in terms of representation, it may be as meaningful to associate an aspect of the P-term system with any such numerable features. The emphasis is on ordering structures in terms of probable iconicity, with the expectation that families of decreasing iconicity will be distinguished by the procedure for a given value of P. Such families may be more valuable for representing aspects of the central concept, although the highly asymmetric structures in any family probably reflect the various forms of *pre*-comprehension, *mis*-comprehension or *non*-comprehension of the concept. Information gaps of this kind in education have been modelled in graph theory terms (126–129).[83]

4. A variation on the procedure in 2 dimensions is to allow each term to be represented:

– by, the *same* simple shape (circle, square, etc) and to select symmetric configurations in which the relationships are represented either by the points of contact between shapes or from implicit symmetry features (see (22), (30), and (36) on net diagrams for example).

or by *different* simple shapes, each characterizing a different aspect.

This procedure should select out many well-known symbols (130).

5. Again this variation may be applied in 3 dimensions using simple solids instead of flat shapes. As mentioned earlier the possible configurations are then governed by well-known packing constraints (22), (23).

Notes:

61 *Systematics* 1963–1970 (Institute for Comparative Study of History, Philosophy and the Sciences, UK)

62 Only by viewing an N-term set as an N–1 term and an N+1 term system can its significance be established.

63 On this point, the relationship of *time* to the variety of *standing wave* configurations of sand particles vibrated on thin plates of metal merits attention (see ref. (78)).

64 René Thom, on the first page of his study, makes the point that: "recognition of the same object in the infinite multiplicity of its manifestations is, in itself, a problem (the classical philosophical problem of concept) which, it seems to me, the Gestalt psychologists alone have posed in a geometric framework accessible to scientific investigation" ((32), p. 1).
Rudolf Arnheim in discussing the same question, notes that Gestalt psychologists recognize a tendency to "good form" or "well organized structure" (88). L. L. Whyte sees all mental processes such as memory, classification, choice, and will as "displaying a movement toward greater three-dimensional spatial order, symmetry, or form". And such morphic processes "are directly responsible both for the existence of forms, and of brain-minds themselves generating forms and being responsive to forms." ((85), p. xvi)
Jean Piaget also makes points which could be interpreted to be in support of this position: "As a result, spatial structures, from the biological point of view, bridge the gap between logico-mathematical structures, the nature of which is still unknown, and those structures which are either hereditary or, as is sometimes the case, acquired by learning" ((86), p. 309). Also: " . . . cognitive functions are an extension of organic regulations and constitute a differentiated organ for regulating exchanges with the external world. The organ in question is only partially differentiated at the level of innate knowledge, but it becomes increasingly differentiated with logico-mathematical structures and social exchanges or exchanges inherent in any kind of experiment." ((86), p. 369).

65 I am indebeted to Colin Cherry (*On Human Communication*, 1968) for this insight (87).

66 It could be interesting to explore the possibilities of portraying each term in a multi-term system by a human or animal figure and animating their interaction on graphics devices to produce a cartoon effect, using a computer programme governed by the original structure. (Supposedly many folk tales are based on such structures)

67 Rudolf Arnheim notes ((88), p. 207–8) that: " . . . one must assume that structural characteristics of visual form are spontaneously related to similar characteristics in human behaviour. We have called this type of symbolism 'isomorphic' because this is the term used by gestalt psychologists to describe identity of structure in different media. . . . The gesture of a dancer. . . contain(s) structural features whose kinship with similarly structured mental features is immediately felt." Ritual dances are based on this insight and even have their modern advocates: Steiner's eurythmy. Gurdjieff's movements, Ichazo's Arica movements, and the like. The aim being to penetrate and express the more fundamental forms and to use them as a means of classifying experiences within a functional whole. It is no accident that Keith Critchlow in a book on design (22) incorporates Laban's use of the icosahedron for dance notation (89).

68 It is interesting that in order to solve the problem Fuller has effectively had to confront the constraints of the basic duality with which our culture is faced as it is reflected in material forms. The "primitive" structuring effects of the duality have to be bypassed within a larger whole which depends on them for its integrity. This requires many more elements than the ideal forms, thus conforming to Bennett's insight that a higher number of terms is required to provide a better approximation to reality. (Although the higher number is effectively reduced by the encoding properties of the underlying polyhedron in each case).

69 In terms of the status in society of fundamental sets, there would seem to be an amusing parallel between the role of temples to different deities in the Roman Empire and that of international agencies with respect to global society. Both the temples and the agencies each base their actions on well-defined sets of qualities.

70 Possibly only by anthropomorphizing the representation of "world problems" which society faces will their nature and interplay be communicable to an adequate degree – particularly in terms of how they are ordered or governed.

71 Interpreting Bennett's scheme (Annex 2), It can be very tentatively suggested that sets of the following numbers of terms are required to encounter these current issues: mediation, relationships (3-term); retraining, resource *renewal* (6-term); organizational systems (7-term); worker *individuality* and human development (8-term); environmental *processes* (9-term); social innovation and *creativity* (10-term). Each stage requires more subtle skills in organization and governance in order to tolerate the additional freedom (i.e. reduction in imposed order) it implies and demands; in fact the challenge to policy at this time seems to lie with the 11-term approach of balancing order and disorder, rather than attempting to eliminate the latter (100). But understanding, if there is any, in terms of such multi-term sets seems to be only instinctive or intuitive, aided by frantic "rational" (2-term) attempts to order the component elements in isolation from each other, and a "fire-fighting" response to problems arising from their interactions – when they can no longer be ignored.

72 Chinese philosophy, as exemplified by Lao Tzu and Chuang Tzu, is full of references to the attitude implied by the 12-term approach. This is also evident in the attitude advocated in Eastern martial arts, see Herrigel (103). It would be interesting to examine the Study of S. Boorman in this light (104). Clearly a strategy based on thinking in N+1 terms is bound to out-manoeuver one based on only N terms, as well as appearing unpredictable and disorderly to the latter.

73 Clearly Ashby's Law (105) concerning the necessary complexity for a *control* system also applies with regard to the complexity of a *representational* device. However there is the paradox that representations which are as complex as that which they represent are of questionable value.

74 Yates presentation (68) concerning *rotae* suggests the possibility of an approach intermediate between conventionally static classification schemes and computer-based mathematical models (e.g. of social systems), namely a memorable

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pattern of classification possiblities implying the complete range of relationships between a set of categories.

75 I am considerably indebted to Ira Einhorn for drawing my attention to references: (42), (106–107), (112).

76 Don (107) discusses a model of the brain put forward by Powers (108) and based on ten hierarchical levels of control: musculoskeletal intensity, sensation, configuration, transitions, sequence, relationships, control of patterned logical processes, principle, concepts. Again this bears comparison with a scheme such as Bennett's (Annex 2).

77 Recent work needs to be related to that of Zipf (109), used by Kelley (41), for despite revision by Mandelbrot (110), it is strongly critized by Rapoport (111). There may be a link in this context between Zipf's Principle of Least Effort and the Hamiltonian Least Action Principle (see note (38)).

78 Margalef (113) suggests that it is possible to measure the "maturity" of an eco-system as closely related in one respect to its diversity or complexity, and in another to the amount of information that can be maintained with a definite spending of potential energy. This is a question of patterning. A highly diversified community has the capacity for carrying a high amount of organization and information, and requires relatively little energy to maintain it. Conversely, the lower the maturity of the system, the less the energy required to disrupt it. Anything that keeps an eco-system oscillating (or "spastic") retains it in a state of low maturity. (Hence the danger of simplistic reorganization of organizational, conceptual or value systems.) A mature ecosystem has a maximum number of trophic levels of which, curiously in the light of this paper, the number rarely exceeds 7.

79 From Yates presentation (68), one may suspect that Giordano Bruno's "seals" served this purpose in relation to his own texts. A similar role may be ascribed to the lapidiary seals collected by Rziha (114) as reported by Ghyka (64)

80 Interesting examples, which have never been cross-linked, include Abellio (115), Buckminster Fuller (1), Haskell (116), Dodd (117), Lock Land (118), Langham (29), Young (25) and (26), Bennett (45). The Eastern equivalent which has attracted the most attention is the I Ching: see Needham (119), Blij (120), Gardner (121), Sung (122). The recently remarked link between the I Ching code and the genetic code raises many questions, see Schönberger in (123).

81 Bennett notes ((45), vol. 3, p. 25) that: "Many of the difficulties in the interpretation of natural phenomena arise from treating qualities as if they remain the same in passing from one system to another." (e.g. from a 2-term system to a 3-term system, the added third term modifies the qualities originally expressed by the other two terms)

82 Addition of "representation" as a *fourth* element is almost certainly insufficient simply as a passive pattern, at the best inviting to the attention. As with language in the West, it may simply classify experience without opening the observer to the action it suggests. Here lies a danger. Already with crude representations users of the flood of text information are overloaded to the point of blockage or effectively insulated from experience by suitable explanation and depiction. Some more iconic sophisticated representation may only reinforce the user's passivity, whereas appropriate representation may offer the user the visual configuration through which to *act* participatively and experientially (cf. the contrast between McLuhan's "hot" and "cool" media). "Activating potential" would thus seem to be a *fifth* element in the series and an appropriate constraint on representation. (I am indebted to Anthony G. E. Blake, for provoking these insights.).

83 See (128) "Both geometry and topology deal with the notion of space, but geometry's preoccupation with shapes and measure is replaced in topology by more abstract, less restrictive ideas of the qualities of things. . . (giving). . . a richer formalism to adapt as a tool for the contemplation of ideas. . ."

84 The fruitful area identified is the use of a non-Boolean (non-distributive) lattice structure of complementary or dialectically developing languages (perspectives, categories) which reflects the logic of quantum mechanics (140, 141). A developmental sequence may emerge either as the result of research *or* of comprehension (cf. programmed learning pathways) through stages which appear mutually incompatible for some period. From the diagrams used by Heelan and de Nicolas, both sequence and complementarity can simultaneously be represented by developmental pathways of polyhedral form which, in their examples, privilege a single vertex (e.g. in a cubic structure) as the "least upper bound element". Richer possibilities, corresponding to non-dualistic complementarity of multi-term sets, could well become comprehensible in the light of the full range of polyhedral structures – nesting polyhedral pathways to distinguish levels of co-existing incompatible perspectives (possibly linked by experiential or non-cumulative learning pathways, as might be represented by a circular chain of overlapping Venn circles) from levels at which complementarity is evident. Such polyhedral encirclement, of an unknown to be defined progressively without closure, could facilitate the relationships between viewpoints as discussed elsewhere (142).

References:

(We repeat the ones from Pt. I and II which are also cited in this Pt. III)

(1) Buckminster Fuller, R.: Synergetics: explorations in the geometry of thinking. New York: Macmillan 1975

(9) Franz, M.-L. v.: Number and time: reflections leading towards a unification of psychology and physics. London: Rider 1974.

(21) Arnheim, R.: Visual thinking. London: Faber 1970

(22) Critchlow, K.: Order in space: a design source book. London: Thames and Hudson 1969

(38) Tucci, G.: Theory and practice of the Mandala. London: Rider 1960

(41) Kelley, Jay Hilary: Entropy of knowledge. In: Philosophy of Science 36(1969) No. 2 (June)

(45) Bennett, J. G.: The dramatic universe. London: Hodder and Stoughton 1956–1966.4 vols.

(49) Mushakoji, Kinhide: Scientific revolution and inter-paradigmatic dialogues. Tokyo: United Nations University 1978.

(56) Galtung, J.: Methodology and ideology; essays. Copenhagen: Christian Ejlers 1977. p. 41–71

(63) Neelameghan, A.: Seminal mnemonics as a pattern for systems analysis. In: Libr. Science with a Slant to Documentation 7(1970) p. 353–364

(68) Yates, Frances A.: The art of memory. London: Routledge and Kegan Paul 1966. (page refs. to Penguin ed.)

(78) Waller, M. D.: Chladni Figures: a study in symmetry, London 1961

Correction: (80) Zeman, J.: Information and psychic activity. In: Progress in Brain Research 17. Amsterdam: Ed. Wiener-Schode 1965.

(82) Weyl, Hermann: Symmetry. Princeton University Press 1952. (See also note 33)

(83) Rolling, R.: The role of graphic display of concept relationships in indexing and retrieval vocabularies. In: P. Atherton (Ed.): Classification Research. Copenhagen: 1965. p. 295–325

(84) Stevens, Peter S.: Patterns in nature. London: Penguin 1974

(85) Whyte, L. L. (Ed.): Aspects of form. London: Lund Humphries 1968

(86) Piaget, J.: Biology and knowledge; an essay on the relations between organic regulations and cognitive processes. Edinburgh University Press 1971.

(87) Cherry, Colin: On human communication. Cambridge: MIT Press 1966.

(88) Arnheim, R.: Gestalt psychology and artistic form. In: Whyte, L. L. (Ed.): Aspects of Form. London: Lund Humphries 1968, p. 202

(89) Laban, R.: Choreutics. London: Macdonald and Evans 1966. (Ed. by Lisa Ullmann)

(90) Bindel, E.: Die Zahlengrundlagen der Musik. Stuttgart 1950.

(91) Bindel, E.: Die geistigen Grundlagen der Zahlen. Stuttgart 1958.

(92) Attali, J.: Bruits: essai sur l'économie politique de la musique. Paris: Presses Universitaires de France 1977. (Demonstrates how the form of musical innovations heralds equivalent socio-political changes and how music may be used to reinforce the status quo.)

https://doi.org/10.5771/0943-7444-1979-2-92 https://www.inlibra.com/de/page/agb - Open Access -

(93) Ehrenzweig, A.: The hidden order of art; a study in the psychology of artistic imagination. Los Angeles: University of California Press 1967.
(94) Kepes, G. (Ed.): Structure in art and in science. New York: Braziller (Vision and ValueSeries, several volumes)
(95) Ghyka, M. C.: L'esthetique des proportions dans la nature et dans les arts. Paris: Editions de la NRF 1927. (see also ref. 64)
(96) Pugh, A.: An introduction to tensegrity. Los Angeles: University of California Press 1976.
(97) Judge, A. J. N.: Transcending duality through tensional integrity; from systems-versus-networks to tensegrity organization. In: Transnational Associations 30(1978) No. 5, p. 258–265
(98) Judge, A. J. N.: Groupware configurations of challenge and harmony; an alternative approach to "alternative organization". (Paper for a seminar on alternative organizations of the European Institute for Advanced Studies in Management. Brussels, June 1979)
(99) Judge, A. J. N.: Viable need patterns and their identification through constraints on representation in 3-dimensions. In: Lederer, K. (Ed.): Human needs; a contribution to the debate. Berlin: International Institute for Environment and Society (Wissenschaftszentrum) 1979.
(100) Judge, A. J. N.: Tensed networks. In: Transnational Associations 30(1978) No. 11, p. 480–485
(101) Judge, A. J. N.: Development; beyond "science" to "wisdom"; facilitating the emergence of configurative understanding in "Councils of the Wise" through computer conferencing dialogues. In: Transnational Associations 31 (1979) No. 7/8, p. 364–372
(102) Judge, A. J. N.: Organization and lifestyle design; characteristics of a nonverbal structural language. (Paper prepared for the Intern. Konf. Bedingungen des Lebens in der Zukunft und ihre Folgen für die Erziehung. Berlin, November 1978)
(103) Herrigel, E.: Zen in the art of archery. Pantheon 1953.
(104) Boorman, S.: The protracted game: a wei ch'i approach to Mao's revolutionary strategy. Oxford University Press 1971.
(105) Ashby, W. R.: Requisite variety and its implications for the control of complex systems. In: Cybernetica 1(1958) No. 2, p. 83
(106) Varela, F. J.: On being autonomous; the lessons of natural history for systems theory. In: G. J. Klir (Ed.): Applied General Systems Research. New York: Plenum Publ. 1978; p. 77–83, see also (42)
(107) Don, N. S.: The transformation of conscious experience and its EEG correlates. In: J. of Altered States of Consciousness 3(1977–78) No. 2, p. 147–168
(108) Powers, W. T.: Behavior; the control of perception. Chicago: Aldine 1973.
(109) Zipf, G. K.: Human behavior and the principle of least effort. An introduction to human ecology. Reading, Mass.: Addison-Wesley 1949.
(110) Mandelbrot, B.: An informational theory of the statistical structure of language. In: W. Jackson (Ed.): Communication Theory. New York: Academic 1953, p. 486–502
(111) Rapoport, Anatol: Comment: the stochastic and the "teleological" rationales of certain distributions and the so-called Principle of Least Effort. In: Behavioral Science 2(1957) p. 147–161
(112) Bateson, G.: Mind and nature; a necessary unity. New York: Dutton 1979.
(113) Margalef, R.: On certain unifying principles in ecology. In: A. S. Boughey (Ed.): Contemporary Readings in Ecology. Belmont: Dickenson 1969.
(114) Rziha, F.: Studien über Steinmetz-Zeichen. Wien 1883.
(115) Abellio, R.: La structure absolue. Paris: Gallimard 1965.
(116) Haskell, F.: Generalization of the structure of Mendeleev's periodic table. In: Full Circle. New York: Gordon and Breach 1972. p. 21–87
(117) Dodd, S. C.: The epicosm model for the material and mental universes. In: Progress in Cybernetics. New York: Gordon and Breach 1979.
(118) Lock Land, G. T.: Grow or die: the unifying principle of transformation. New York: Random House 1973.
(119) Needham, J.: The system of the Book of Changes. In: Science and Civilization in China; the fundamental ideas of Chinese science. Cambridge University Press 1956. Vol. 2
(120) Blij, F. v. d.: Combinatorial aspects of the hexagrams in the Chinese Book of Changes. In: Scripta Mathematica 28(1967) No. 1, p. 37–49
(121) Gardner, M.: The combinatorial basis of the I Ching. In: Scientific American (1974) Jan., p. 108–113
(122) Sung, Z. D.: The symbols of the Yi King; the symbols of Chinese logic of changes. New York: Paragon Reprint 1969.
(123) Schönberger, M.: Verborgener Schlüssel zum Leben. Weltformel I-Ging im genetischen Code. Frankfurt: Fischer Taschenbuch 1977.
(124) Harary, F.: Graph diagrams. In: Graph Theory. Reading: Addison-Wesley 1971, p. 213–234
(125) Pugh, A.: Polyhedra: a visual approach. Los Angeles: University of California Press 1976.
(126) Kingsley, E., Kopstein, F. F., Seidl, R. J.: Graph theory as a meta-language of communicable knowledge. In: M. D. Rubin (Ed.): Man in systems. New York: Gordon and Breach 1971, p. 43–69
(127) Kopstein, F. F., Hanreider, B. D.: The macro-structure of subject matter as a factor in instruction. Princeton: Educational Testing Service 1966. (Research Memo RM-66-25)
(128) Brown, D., Lewis, J.: The Process of conceptualization; some fundamental principles of learning useful in teaching with or without the participation of computers. Menlo Park: Stanford Research Institute. Educational Policy Research Center 1966?
(129) Judge, A. J. N.: Relationship between elements of knowledge. Brussels: Union of International Associations 1971. (Committee on Conceptual and Terminological Analysis. Working Paper No. 3)
(130) Hornung, C. P.: Handbook of designs and devices. New York: Dover Publications. (Contains 1800 geometric designs based on circle, triangle, square, scroll, cross, etc.)
(131) Pearce, P.: Structure in anture is a strategy for design Cambridge: MIT Press 1978.
(132) Judge, A. J. N.: Information mapping for development. In: Transational Asscoiations 31 (1979) No. 5, p. 185–192
(133) Heuer, Jr., R. J. (U.S. Central Intelligence Agency): Cognitive aspects of intelligence analysis. (Paper for the 20th Convention of the International Studies Association, March 1979)
(134) Nicolas, A. de: Meditations through the Rg Veda; four-dimensional man. Boulder: Shambhala 1978
(135) McClain, E. G.: The myth of invariance; the origins of the gods, mathematics and music from the Rg Veda to Plato. Boulder: Shambhala 1978
(136) Fischer, Roland: A cartography of the ecstatic and meditative states. In: Science 174(1971) p. 897–904
(137) Jantsch, E.: Design for evolution; self-organization and planning in the life of human systems. New York: Braziller 1975
(138) Jantsch, E., Waddington, C. (Eds.): Evolution and consciousness; human systems in transition. Reading; Mass.: Addison-Wesley 1976
(139) Heelan, P. A.: The logic of changing classificatory frameworks, In: Wojciechowski, J. A. (Ed.): Conceptual basis of the classification of knowledge. München: K. G. Saur 1974. p. 260–274
(140) Heelan, P. A.: Complementarity, context-dependence and quantum logic. In: Foundations of Physics 1(1970) p. 95–100
(141) Heelan, P. A.: Classical logic and quantum logic; their respective roles. In: Synthese 21 (1970) p. 2–33
(142) Judge, A. J. N.; Smith, D. H.: Interrelating viewpoints in complex meetings. In: Transnational Associations 30 (1978) No. 12, p. 542–548

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