

COMPUTER-AIDED VISUALIZATION OF PSYCHO-SOCIAL STRUCTURES

- peace as an evolving balance of conceptual and organizational relationships

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### Organizational complexity<sup>1,2</sup>

The number of organizations active in any given field or geographical area is increasing.<sup>3</sup> The growth in the number of independent organizations has been paralleled by a fragmentation within the larger ones -- leading to a proliferation of sub-commissions and sub-sections. Accompanying these trends is an uncharted growth in the variety of forms of organized activity. These trends of divergence have been partially compensated by an increase in the inter-connectedness of organizations and efforts at establishing bodies with coordinating or integrating functions -- but these trends of convergence also contribute significantly to the complexity. Furthermore, this static organizational structure provides a framework for forms of dynamic, temporary or ad hoc organizations which are difficult to track systematically but are nevertheless a key feature of organizational life -- particularly when organizations can be deliberately based on lags (or temporal "niches") in inter-organizational processes.

### Knowledge complexity<sup>4,5</sup>

The number of fields of knowledge is increasing. This growth has been paralleled by specialization or fragmentation within disciplines as they encompass a larger range of concepts. This leads to a proliferation of sub-specialities and sub-disciplines. Accompanying these trends is an uncharted growth in the variety of forms of organized conceptual activity and a multiplication of meanings associated with any given term. These trends have been partially compensated by increasing recognition of the interconnected or multidisciplinary nature of many areas of interest and there have been efforts at establishing integrative overviews of programs in each discipline and a general systems discipline. These relatively static features of the body of knowledge are accompanied by the formulation of unsubstantiated concepts as a basis for immediate action because dynamic features of the system ("lags") prevent the rapid location and integration of relevant tested knowledge existing elsewhere -- this increases complexity particularly when the existence of such temporal niches is deliberately exploited to generate false concepts. Much damage can be done before compensating processes can be brought to bear -- it is the "appearance of truth" rather than "truth" which is significant within the lag time.

### Problem complexity<sup>6</sup>

The number of recognized problems has risen rapidly, particularly with the advent of the environment issue. The growth in the number of problems has been paralleled by a recognition that each major problem needs to be broken down or fragmented into sub-problems. Accompanying these trends is an uncharted growth in the variety of problems. These trends of divergence have been partially compensated by a recognition of interlinkages between problems and efforts at locating the key or fundamental problem underlying a whole group. In the final stages, problems become "aggressively interactive" in that they do not remain docile and static but appear to have a momentum and initiative of their

own. They increase or decrease in importance and manner of interaction without it being possible to determine the original cause of the change. The environment becomes turbulent and new short-term problems are generated in the vortices.

#### Comparison of approaches to complexity

There are other features common to the three types of complexity noted above:

1. Interest in the entity -- organization, concept, or problem -- is not such as to generate a methodology which would encourage systematic data collection. Samples are collected in terms of predefined categories but there is no effort to determine how many of each entity there are. Basically confusion still reigns as to the nature of an organization, a concept and a problem.
2. The consequence of (1) is that there are no statistics on the entities in each case. It is not known how many organizations are currently in existence, although different agencies may have some such information to facilitate program activity in their own spheres. Similarly the number of concepts current in different sectors of society is unknown, as is the number of problems. The lack of statistics follows naturally from a lack of any systematic lists of each type of entity -- for example, there is no list of "world problems".
3. The consequence of (1) and (2) is that there is little understanding of the variety of entities within each type of complexity. Each sector of society perceives a limited range of relevant entities and rejects others as of little interest or significance.
4. As a result of (3), the typologies developed reflect the special interests of the sector of society within which they are generated and tend to be very crude, ignoring grey areas and hybrid entities.
5. In each case concern is primarily with the "relevant" entity conceived in isolation from its context. The interest in inter-organizational relationships has only recently started building up, relationships between concepts is confined to those within each particular discipline -- inter-disciplinary and general systems approaches are suspect. Recognition of significant relationships between problems is governed by agency or departmental short-term program priorities. It is therefore not possible to determine systematically whether a particular type of entity or relationship is not present in a given setting.

6. The absence of typologies and a picture of interrelationships means that it is not possible to build a picture of the ecological system in each case. It is not possible to look at the ecological system constituted by a particular community of organizations of different types.<sup>7</sup> Nor is it possible to look at the ecology of a particular conceptual milieu.<sup>8</sup> Again, the ecology of problems is fragmented into convenient administrative chunks by unintegrated mission-oriented agencies.<sup>2</sup>
7. In each case the deliberate structuring of the approach to the different types of complexity results in various forms of "exclusive relevance" or "apartheid". One can speak of: an organizational apartheid which ignores the developmental requirements of particular types of organizations;<sup>9</sup> a conceptual apartheid which ignores the significance of particular types of concept, and of a problem apartheid which ignores the significance of particular types of problems -- for each organization the only significant problems are the ones with which it is concerned.<sup>10</sup> There is no framework within which to consider all problems.
8. The exclusiveness noted in (7) occurs at a time when the hierarchical structures reinforcing it are recognized to be crumbling or at least suspect. Stable institutions, conceptual systems and problem environments are threatened with dissolution.<sup>2</sup> Non-hierarchical organizational structures are sought. Hierarchical classification of knowledge and rigid systems of categories are challenged, and simplistic groupings of problems are rejected.<sup>4</sup>
9. Despite the trend noted in (8), there is still, in each case, no "rational" method of locating the most significant entity in response to a given set of circumstances. The fundamental is embedded in detail, the general in the particular. A practitioner of one discipline cannot know and is unlikely to admit that the practitioners of another are better equipped to respond to a particular problem.<sup>11</sup> The key problem area, and the organizations to be responsible, must therefore be selected by a process of political barter.

#### Interaction between concepts, organizations and problems

Common features have been detected in the three types of complexity, but each type has nevertheless been treated as isolated from the others. This is not so. Organizational, conceptual and problem systems exist as aspects of one another. Change in one provokes change in the others, which therefore compounds the complexity.<sup>2</sup> These different interactions are not simultaneously recognized, since they are each the concern of different disciplines. New fields of knowledge are developed in response to new problems, and new organizations are established to facilitate regular activity with respect to new problems. But new

fields of knowledge result in the detection of new problems, or organizations may be created to further interest in particular concepts, etc.

It is useful to distinguish an integrative interaction whereby, for example, inter-conceptual integration legitimates and eventually leads to inter-organizational integration. Similarly, a disintegrative interaction exists whereby, for example, decrease in inter-organization coordination leads to a decrease in the perceived inter-linking of problems. These interrelationships may be represented by Figure 1. The source of change is therefore very much a "chicken-and-the-egg" question.

In order to derive some measure of aspects of complexity in each case and the manner in which each aspect of the complexity is related to others, the following can be distinguished:

- number or population of entities
- variety, diversity or number of species of entities
- fragmentation or extent of within-species diversification
- interconnectedness, or decentralized inter-entity links or cooperation
- order, centralization or presence of hierarchies of dominance
- competition between entities.

#### Individual in relationship to complexity

Up to this point, it has been convenient to avoid reference to the individual, but clearly organizations and concepts are the productions of individuals, and problems are detected by individuals, and it is in terms of the individuals's powers of comprehension that complexity is defined. In addition, complexity experienced personally by individuals bears a close resemblance to that noted for organizations, concepts, and problems.

It is possible to speak of an increase in the number of roles (or equivalent psychological states) activated by or accessible to an individual. This growth is paralleled by a fragmentation and specialization of traditional roles. Accompanying these trends is an uncharted growth in the variety of possible roles and life-styles. These atomizing and complexifying trends are partially counter-balanced by efforts at formulating unifying philosophies or more integrated and mature life-styles.

The individual psycho-system may therefore be added to Figure 1 to give Figure 2.<sup>10</sup> The integrative and disintegrative interactions may also be added. The question of personal identity, perceived complexity,

Subject to 6 conditions of complexity (see Table 1)

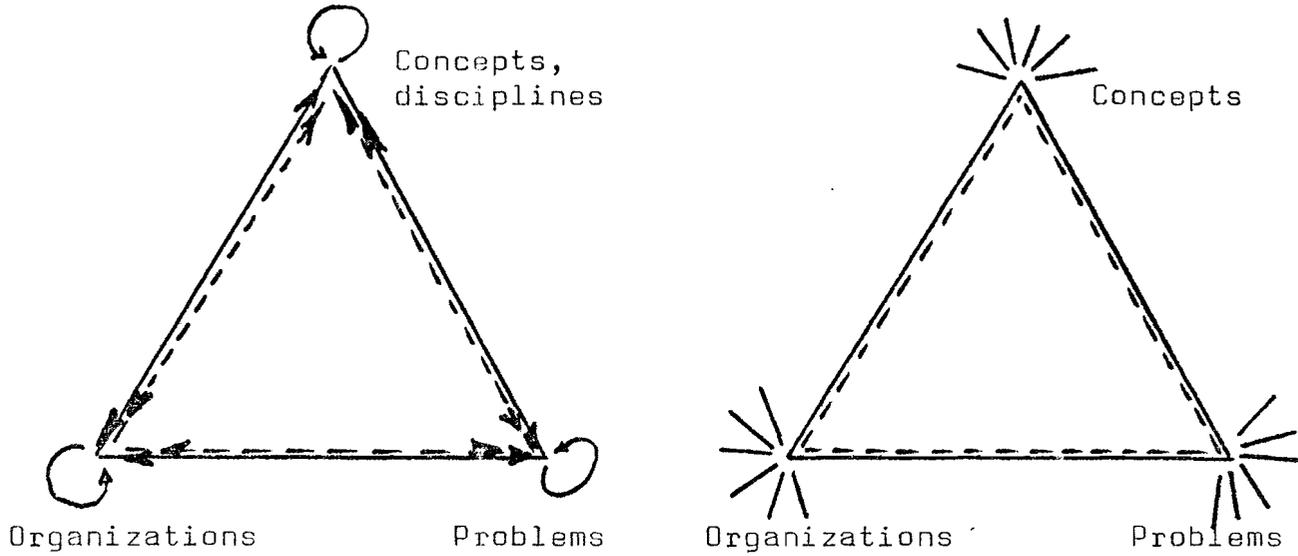


Figure 1. Indication of interrelationship between three types of psycho-social entity

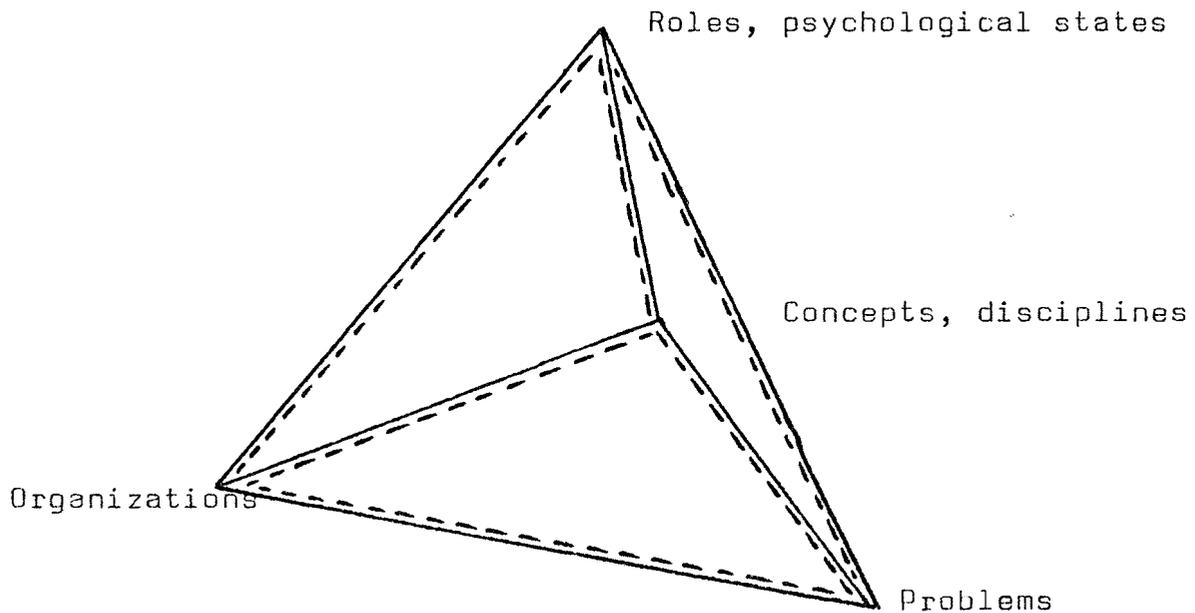


Figure 2. Indication of interrelationship between four types of psycho-social entity

	<u>Organizations</u>	<u>Concepts</u>	<u>Problems</u>	<u>Roles</u>	<u>Maximum</u>	<u>Minimum</u>
Number/ Population	Increase	Increase	Increase	Increase	Information overload	Insufficient stimuli
	Decrease	Decrease	Decrease	Decrease		
Variety/ Diversity	Increase	Increase	Increase	Increase	Complexity	Immaturity
	Decrease	Decrease	Decrease	Decrease		
Fragmentation within species	Increase	Increase	Increase	Increase	Inability to coordinate action	Lack of specialized ability
	Decrease	Decrease	Decrease	Decrease		
Inter- connectedness	Increase	Increase	Increase	Increase	Inability to act	Spastic action
	Decrease	Decrease	Decrease	Decrease		
Order/Central- ization	Increase	Increase	Increase	Increase	Overthrown by revolt	Revolt
	Decrease	Decrease	Decrease	Decrease		
Competition	Increase	Increase	Increase	Increase	Elimination	Perpetuation of weak variants
	Decrease	Decrease	Decrease	Decrease		

Table 1. Interactions between conditions of psycho-social complexity for different groups of entities  
(not completed)

Table 2. Limits in variation of Table 1 measures of complexity for an entity in an ecological niche

fragmentation of the personality, and the ability to create stable psycho-social relationships (essential to peace) are all intimately related. R. D. Laing suggests that a firm sense of one's own autonomous identity is required in order that one may be related as one human being to another -- otherwise any and every relationship threatens the individual with loss of identity. Furthermore, the changes in the relationship between the different aspects of a person's relationships to himself affect his inter-personal relationships.<sup>12</sup> Marcuse suggests that psychological problems therefore turn into political problems, private disorder reflects more directly the disorder of the whole, and the cure of personal disorder depends more directly than before on the cure of general disorder.<sup>13</sup> Lawrence S. Kubie argues that unless the individual can free himself from internal tyranny he will restrict the freedom of his society to change.<sup>14</sup> Donald Schon notes that change in organizations has its impact on the person, because beliefs, values and the sense of self have their being in social systems.<sup>2</sup> Measures of complexity for the person can be envisaged and added to Table 1.

Table 1 provides a crude overview of the complexity with which society and the individual are faced. Increases or decreases in any measure cause changes in other parts of the system. It is doubtful whether universal agreement could be obtained on the interrelationships, even if more cells were introduced into the Table.

Since it is man who is directly or indirectly the major cause of change in the psycho-social environment, his individual actions may be considered the origin of the dynamic of the system. Faced with the different features of complexity noted above, he responds in a manner to ensure himself an adequate behavioural niche.<sup>15</sup> Some idea of the limits by which he is bounded is given in Table 2. His relationship to these limits may be modified by changes in his environment to the other measures noted in Table 1.

In carving out and developing an adequate behavioural niche in response to a changing environment and his own developmental needs, it may be assumed that each person adapts the condition of his own psycho-social system. These responses may be creative responses which modify the measures of complexity in his environment due to the formation of new organizations or concepts. It is not known why a given individual finds a given niche satisfactory, whereas another is motivated to seek a "better" one and will refuse to adapt to the existing environment. The dynamics of change would seem to originate in the individual's rejection of the conditions represented by a particular combination of measures of complexity such as those mentioned above. Some combinations of such measures may represent states in which identity is threatened for the personality type in question. Complexity may constitute a direct threat to identity.<sup>12</sup>

It is possible that there are different strategies by which an individual can reinforce his identity as he develops. But basically, unless the individual can be placed in a more commanding position with respect to the information to which he is continuously exposed, he will adapt or redefine himself and his habitat in such a way as to eliminate consideration of all information outside certain tolerance limits -- for with a threat to the stability of his environment it no longer provides an anchor for personal identity and a system of values.<sup>2</sup> He will set up his own "doll's house" model of relevant actors in his psycho-social environment.

### Approach to complexity

Some idea of complexity in the psycho-social system has been given above. It is assumed here that the only useful collective decisions to promote peace must be made on the basis of some means of ordering complexity in a systematic manner -- or else run the risk of using simplistic models inadequate to the situations, on other than a short-term basis, and possibly counter-productive.

The task to be tackled parallels that in the case of natural environment systems described by David Pimentel in which there is a multiplicity of inter-specific "food chains", together with many branches and cross-connections among food chains making a structure of interactions called "food webs". The complexity of these food webs is such that no one has yet worked out the complete pattern of food relationships and interactions in any natural community. The relationships between 50 species in a given community results in a diagram "so full of lines that it is difficult to follow" and this only represents one quarter of the 210 known species in a "simple" community.<sup>16</sup> In such a situation a simplistic model used as a guide to the use of pesticides could be disastrous.

The approach advocated to penetrate complexity is to develop uses of an existing device which could handle and display the multiplicity of relationships in a manner to facilitate understanding. This is described in the next section.

In describing the device it is unnecessary to distinguish between the different types of entity or relationships making up the complexity. In each case the device is handling entities and relationships. Categorization of these features should be left to the user and not limit the flexibility with which data can be handled.

The advantages of this sort of approach have been argued elsewhere. Whether attention is focussed on organizations, concepts or problems, or even the components of natural eco-system, it is possible to distinguish relatively invariant continuing entities but only to the extent and in the field in which they each maintain two types of relationships -- internal ones to various sub-systems and structures and external ones which link them, either as a whole or via a sub-system, to their surrounds. The entity is in fact a pattern of relationships, 'subject to change but recognizably extended in time.

This way of regarding the objects of our attention helps to resolve the dichotomy between the individual and society and many other pseudo-problems resulting from the tendency, built into language, to regard entities as "things", rather than systematically related sequences of events.<sup>8,17</sup>

This "loose" approach can be achieved by handling the entities and relationships as networks which can be processed and represented using graph theory techniques.<sup>18</sup> In effect, a non-quantitative topological structure of the psycho-social system is built up, to which dynamic and quantitative significance can be added as and when appropriate data becomes available.

#### Description of interactive graphic display technique

The suggestion has been made above that structuring the relationship between entities could best be accomplished using graph theory methods.

(This topic is discussed separately in the paper on: Use of interactive graphic display techniques. See page 89 )

#### Graphics and communication

In order to understand the value of interactive computer graphics, a few basic principles of communication should be considered. Languages are used to convey thoughts. Languages may be gestural, verbal, written, notational, or graphic. The effectiveness of a language depends upon its ability to retain and transfer meaning and this in turn depends upon the complexity of the language. One can conceive of a spectrum of "language and medium" from primitive gestures through to sophisticated computer environments. At each point in the spectrum there are disadvantages and advantages for communication. An attempt has been made to list these out in Figures 3 and 4.<sup>24</sup> These should be considered as very tentative schemas only.

These Figures suggest that most of the advantages of the early portions of the spectrum are combined together in the later portions where interactive graphics is used in various ways. The question is why do graphics help to convey more information than words. One reason is that as concepts become more complex, they do not lend themselves to easy encapsulation in words and phrases. Often an explanation in simple words, whilst theoretically possible, can be achieved only at the price of such prolixity as to defeat the ends of the explanation. Many objects, processes, or abstractions can be portrayed for discussion using a few simple graphical symbols much more easily than they can be described verbally (cf. the classic example of the spiral staircase). The other pressure is of course that many subtle invariants and relationships currently displayed in statistical tables, are

Figure 3A: Comparison of different methods of communicating concepts

<u>Method</u>	<u>Advantages</u>	<u>Disadvantages</u>
Gesture	direct and to the point; dramatic impact	no abstraction possible
Speech	personalized, subtle, poetic, imageful, analogy-full, adjusted to audience	no permanent record, meanings and models shift from phrase to phrase
Writing	permanent record; words weighed and compared in context; document forms an intelligible whole	meaning of words undefined or differ between documents; definitions become concretized and language dependent; com- plexity of abstractions limited by syntax of language; problem of jargon
Image	provides context in physical terms; involv- ing, highly complex, high information content, high interrelationship	superficial and unstructured
Maths	handles very complex abstractions and re- lations and a multipli- city of dimensions	loss of intuitive apprecia- tion of the concepts involved; impenetrable without lengthy initiation; system of nota- tion becomes more complex than the concepts described; impersonal
Diagram (exhibit charts)	structured to make a specific point	over-simplification; exage- ration of some features at expense of others; processes only displayed statically
Artistic mobiles	complex, new and un- predictable relation- ships	experience primarily in- communicable
Diagram (flow charts/ graphs)	portray all detectable inter-relationships in precise manner; panoramic view of system	visually complex to the point of impenetrability; processes still conveyed statically; difficult to modify

<u>Method</u>	<u>Advantages</u>	<u>Disadvantages</u>
Interactive graphics (alphascope)	precise messages; responsive; contents can be oriented to suit user	no structured overview; bounded by language mode of program; processes conveyed as a sequence of isolated messages (or as a game experience)
Psychedelic environment	very subtle and complex imagery and relationships; process oriented; integration of visual and audio; psychologically involving	no scientific content; no significant invariants; experience primarily incommunicable
Interactive graphics (structured image)	greater user selectivity and control on content and form of presentation; complex abstractions held on display; processes displayed as flows; dynamic; enhanced creativity; 2-4 dimensions.	highly structured without the subtle relationships characteristic of arts; user still centred "outside" the structure "looking in"
Computer graphics art	generation of new and unpredictable dynamic imagery	no scientific or "real world" predictive value
Interactive graphics (multi-terminal)	teams working simultaneously on same ideas; access to each others "semantic space"; interactive thinking	fundamental distinction remains between artistic use of the display or surface volume and scientific interest in structure and data base; still only reflects a portion of the subtleties of all invariants and processes known to psychologists, diplomats, etc.
Interactive graphics (coloured & image)	higher information content; visually more intriguing; closer to artistic media; more powerful presentation of processes	
Interactive graphics (3D - helmet)	user psychologically centred within the structure	
Interactive ideograph (hypothetical)	continuous gradation and interaction between scientifically structured and aesthetically structured display; enhanced creativity; reflects subtleties of psychologists, diplomats, etc. able to convert to and from a "field theory"	still only a scaffolding for disciplined thought
	<u>Representation of structures</u>	





ignored unless they can be represented in meaningful graphical form.

Some current interactive graphics uses include, for example, calculation and analysis of electronic circuits, design of aerodynamic shapes and other mechanical pieces, design of optical systems and plasma chambers, simulation of prototype aircraft and rocket flight, visualization of complex molecules in 3 dimensions, air traffic control, chemical plant control, factory design and space allocation, project control, primary, secondary and university education and educational simulations.

In every case above there is some notion of geometry and space, but the geometry is always the three-dimensional conventional space. There is no reason why "non-physical spaces" should not be displayed instead -- and this is the domain of topology. The argument has been developed by Dean Brown and Joan Lewis.<sup>25</sup>

It is useful to introduce C. S. Peirce's term "iconic", namely "a diagram ought to be as iconic as possible, that is, it should represent (logical) relations be visible relations analogous to them".<sup>26</sup> Iconics is therefore connected with the degree to which features of the graphics display contribute towards, or facilitate understanding. Patrick Meredith makes similar points in discussing the uses of "semantic matrices".<sup>27</sup> He contends that grammarians have attended exclusively to the linear arrangement of words in sentences but that this conventional grammar must now be regarded as a particular case of a very much more extensive "geometrical syntax", just as Aristotelian logic turned out to be a special case of a much wider system of symbolic logic -- and that in the spatial arrangements of entities, their geometric relations should be correlated with the logical relations between them. He gives the periodic table of chemical elements as an example of the richness of the field to be explored. The power of this two-dimensional visual display in generating systematic references concerning relations between its constituents indicates the latent potentiality of the nascent geometrical syntax.

There is however a question of "iconicity for whom". A well-known survey by Anne Rowe (The Making of the Scientist) found a high correlation between (1) visual imagery and experimental inclination, (2) non-visual imagery and preference for theoretical science. Many theoretical scientists prefer not to use visual imagery -- which may explain their difficulty in communicating with other sectors of society. Don Fabun draws attention to the possibility that non-Americans may not find the display of concepts and their relations by grids or network structures very meaningful. Europeans, and particularly Orientals, are inclined to attach importance to areas. There does not seem to be much extensive work on this question cross-culturally or with respect to different personality types. And yet, it may strongly influence the

manner in which concepts are communicated, particularly if certain personality types tend to be associated with certain disciplines.

Progress in understanding is made through the development of mental models or symbolic notations that permit a simple representation of a mass of complexities not previously understood. There is nothing new in the use of models to represent psycho-social abstractions. Jay Forrester, making this same point with respect to social systems, argues however that every person in his private life and in his community life uses models for decision-making. The mental image of the world around one, carried in each individual's head, is a model. One does not have a family, a business, a city, a government, or a country in his head. He has only selected concepts and relationships which he uses to represent the real system. But when the pieces of the system have been assembled, the mind is nearly useless for anticipating the dynamic behaviour that the system implies. Here the computer is ideal. It will trace the interactions of any specified set of relationships. The mental model is fuzzy. It is incomplete. It is imprecisely stated. Furthermore, even within one individual, the mental model changes with time and with the flow of conversation. Even as a single topic is being discussed, each participant in a conversation is using a different mental model through which to interpret the subject. And it is not surprising that consensus leads to actions which produce unintended results. Fundamental assumptions differ but are never brought out into the open.<sup>28</sup>

These structured models have to be applied to any serially ordered data in card files, computer printout or reference books to make sense of that data. Is there any reason why these invisible structural models should not be visible to clarify differences and build a more comprehensive visible model? The greater the complexity, however, the more difficult it is to use mental models. For example, in discussing his examination of an electronic circuit diagram, Ivan Sutherland writes:

"Unfortunately, my abstract model tends to fade out when I get a circuit that is a little bit too complex. I can't remember what is happening in one place long enough to see what is going to happen somewhere else. My model evaporates. If I could somehow represent that abstract model in the computer to see a circuit in animation, my abstraction wouldn't evaporate. I could take the vague notion that "fades out at the edges" and solidify it. I could analyze bigger circuits. In all fields there are such abstractions. We haven't yet made any use of the computer's capability to "firm up" these abstractions. The scientist of today is limited by his pencil and paper and mind. He can draw abstractions, or he can think about them. If he draws them, they will be static, and if he just visualizes them they won't have very good mathematical properties and will fade out. With a computer, we could give him a great deal more. We could give him drawings that move, drawings

in three or four dimensions which he can rotate, and drawings with great mathematical accuracy. We could let him work with them in a way that he has never been able to do before. I think that really big gains in the substa scientific areas are going to come when somebody invents new abstractions which can only be represented in computer graphical form."<sup>29</sup>

The primary function of visual representation is to facilitate understanding. To understand a concept is to apprehend correctly all the relations which determine its structure. This means not only grasping the fact that certain relations hold between certain entities but also seeing that the nature of the entities permits those relations to hold and that the global character of the concept determines their occurrence.

#### Use of information

The implication to this point has been that what is required is more powerful research insight into the different types of organized complexity. This is in fact totally insufficient. Research information systems are used by research workers and tend to be of little significance, directly or indirectly, to non-research areas -- particularly in the social sciences. How exclusive should an information system be?

A means needs to be found of making the type of information discussed here directly accessible to the following information users:

- research workers
- education of students, briefing of diplomats, etc.
- policy-making
- program management.<sup>30</sup>

Non-research needs tend to be viewed with a certain contempt by research workers, but this is merely the counterpart to the contempt in which research conclusions are held by those involved in day-by-day decision-making.<sup>31</sup> This antipathy arises from the tendency of research workers to focus on problems which decision-makers consider irrelevant and to publish their results in an incomprehensible form, and the tendency of decision-makers to use techniques and models which research workers consider antiquated and to focus on symptoms rather than causes of problems.

But even a sophisticated alliance between research and decision-making is totally insufficient. Students must be educated about the psychosocial system -- and this education should be based on the same data used for research and decision-making and not on antiquated simplifications.

Educating students is educating the (relatively) powerless. Even this complex of users is inadequate to break the dangerous situation now predicted for the very near future (if not in many ways already a reality), namely that the politician, working in tandem with his technological advisors and program designers, is increasingly in a position to put forward interpretations of urban or world "reality", programs to deal with it and evaluations of those programs as implemented, based on knowledge either unavailable to those who might challenge him or unavailable at the time that a challenge might be most effective.<sup>32</sup>

In other words, it would be extremely irresponsible to create a sophisticated tool for a system which will use it to strengthen its own position at the expense of its environment. As Herman Kahn points out, we now face the sinister situation in which the world is becoming so complex and changing so rapidly and dangerously and the need for anticipating problems is so great, that we may be tempted to sacrifice (or may not be able to afford) democratic political processes.<sup>33</sup> Faced with this threat, it might be better to suppress initiatives to produce such a weapon against the powerless and to bank on the protective advantages of complexity. This is the dilemma: either one opts for inaction in the belief that the misuse of science and technology will breed its own compensating mechanisms and possibly the decay of the system -- or else one banks on the advantages which would accrue from a wider availability of such a tool.

In terms of the second option, there are three other necessary sets of users:

- public information on system modifications
- public monitoring of system modifications including privacy protection and participative action
- use by the individual to de-fragment himself.

The first two deal with means of updating weak links in the democratic process. The third concerns private use by the individual to straighten out or order his own mental models of his environment. There may be others.

These seven uses should, ideally, be interrelated (see Figure 4) via a common data base and the much discussed data networks. Each requires different techniques of data presentation, filtering and manipulation for which the visual display unit is ideally suited. Insights and problems detected in one use should affect the priorities of other uses. The current tendency is however to build separate information systems of different levels of sophistication for each use, so that they are quickly out of phase, incompatible and in many cases inadequate and

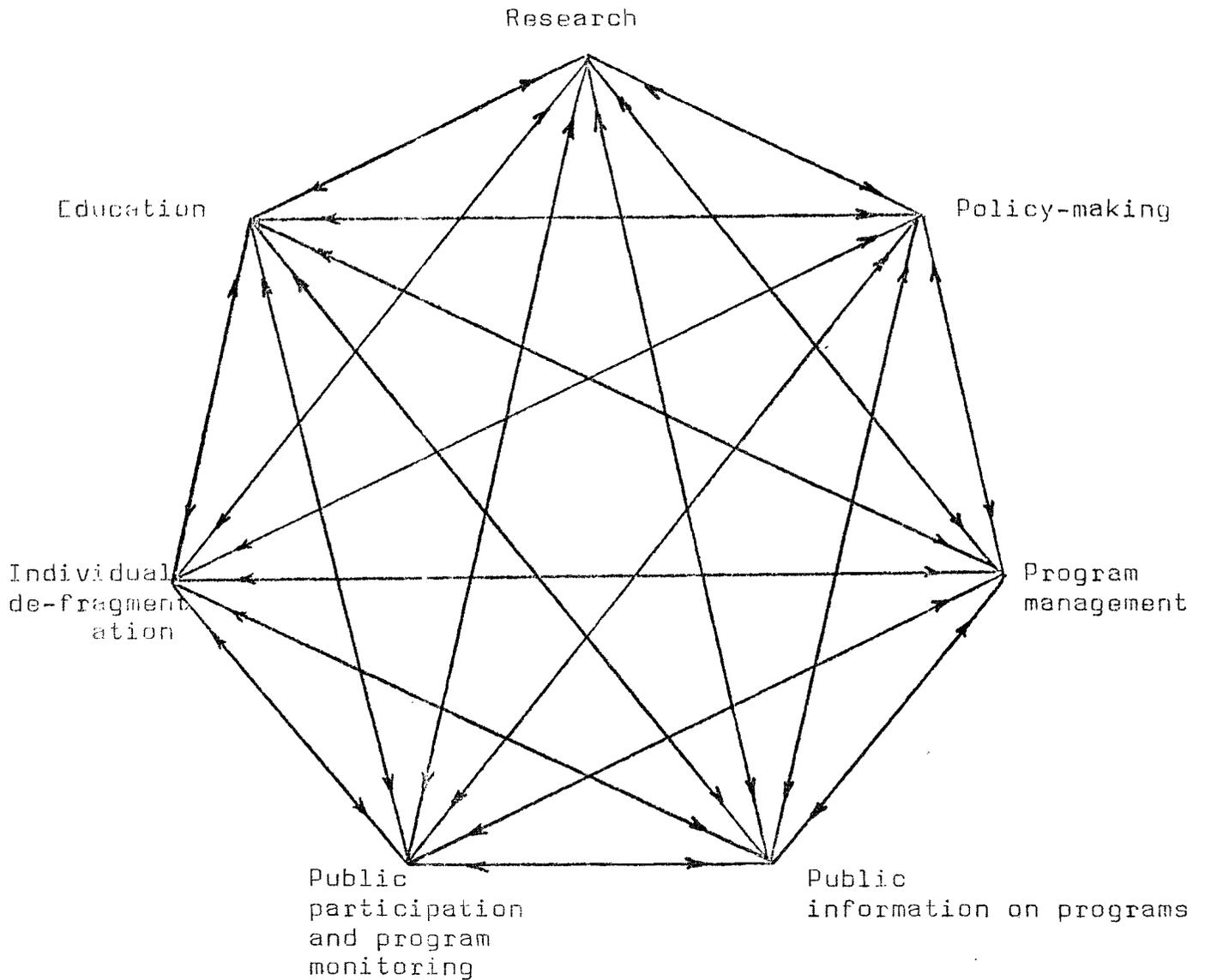


Figure 4. Interrelationship between different uses of information, which should ideally be based on a common data-base to avoid spastic change in society

useless. In such circumstances, developments in each area do not reinforce and counter-balance one another, rather the psycho-social system evolves in leaps and starts. Information systems constitute the nervous system of planetary society. The fragmented approach to their design and use would seem to lead directly to social crises analogous to those found in the case of certain disorders of the nervous system, as though the psycho-social system was some organizational dinosaur suffering from spastic paralysis and aphasia.<sup>34</sup> Integrated and harmonious development can only be achieved if the information system is designed for multipurpose use -- and especially by those with resource problems, as in the developing countries and in the decayed areas of developed countries.

If the different systems cannot be interrelated, it would be preferable as a strategy to make the visual display technique available only as an idea clarification and concept integration aid, and block its systematic use for the penetration of organized complexity. (This may be easy since most organizations have a natural horror of having their detailed structure exposed to others -- despite their own interest in that of others.)

#### Relevance to peace

The interactive graphics technique provides a means of handling complexity. The question now is: in what way does this contribute specifically to the knowledge and value requirements for peace. To some "complexity" is a guarantee of peace. Johan Galtung suggests a general formula for peace based on increasing the world entropy, i.e. increasing the disorder, messiness, randomness, and unpredictability by avoiding the clear-cut, the simplistic blue-print and excessive order.<sup>35</sup> There is a distinction however between a degree of complexity which produces overload, and irrational and uncoordinated responses, and that which requires many known relationships to be taken into account. Complexity may provide peaceful behavioural niches which act as protective bulkheads. Without a clearer picture, however, it is impossible to determine whether the protection is adequate or equivalent to sheltering in dense dry undergrowth from an approaching bush fire.

The problem is how to lower the degree of complexity, but at the same time to beware of simplistic proposals for change by those who believe they have an adequate model of the complexity.

The notion of a peaceful society has come to resemble the mythical, calm "stable state" noted by Donald Schon which is to be reached after a time of troubles.<sup>2</sup> He suggests that belief in it is a belief in the unchangeability, the constancy of central aspects of our lives, or belief that we can attain such a constancy. This belief is institutionalized in every social domain, in spite of acceptance and approval of change and dynamism. It is a bulwark against the threat of uncertainty

and instability. Given the reality of change, the belief is only maintained through tactics of which we are largely unconscious so that our responses are spasmodic responses of desperation and largely destructive. He is concerned with developing institutional structures and ways of knowing for the process of change itself i.e. "beyond the stable state". Current proposals to institutionalize stability are generally efforts at restoring the institutional status quo ante which is identified as the best approximation to the stable state.

The problem of peace is therefore not so much one of producing a new formula for combining existing organizational building blocks. This could only result in another unsuccessful compromise in a long series. There is no evidence that the insight is available to design a peaceful society in which systematic violence is absent. There have been many proposals, but there is no evidence. We have no reason to assume that political societies will prove to be regulable at any level which we would regard as acceptable. Many species have perished in ecological traps of their own devising. We may already have passed the point of no return on the road to some such abyss.<sup>8</sup> As an example, a test experiment could be envisaged in which a "peaceful community" is designed and set into operation with all the resources and disciplinary skills available -- there is a high probability of failure within one generation or at least the introduction of rules which do violence to the original values in terms of which the community was designed. As evidence for this one may note the failure rate of communes, the second generation problem of kibbutzim, the urban disaster constituted by "planned" communities, and the difficulties associated with harmonizing relations in an isolated group of people over time periods exceeding a few days. The probability of failure increases with the diversity of psychological types, interests and cultures represented. Proposers benefit from the fact that by definition they cannot produce evidence for the success of their proposal and it is probable that they will not be there when it bears its fruits.

One reason why it is difficult to design a society is that the model used is by definition not sufficiently complex or detailed to take account of all the loose ends which will emerge and cause friction leading to violence. It is difficult to build up a picture of the dynamic interactive effects of sub-sections of the model. Most difficult of all is taking into account the individual as a developing, creative, and as such essentially unpredictable, entity for which we know our models are inadequate.

For the above reasons, it seems useful to suggest that peace is an ecological problem, namely a problem of harmonizing the interrelationships in society between a developing individual and his evolving environment. It is instructive to use the insights concerning the less ambiguous natural environment ecology (with respect to which we are objective), to draw attention to problems and opportunities in

connection with the psycho-social environment ecology within which we are thoroughly embedded.

Peace is here conceived less as a state and more as a very complex evolving set of relationships in which the latter bear some harmonious relationship to one another. The two key questions are: evolving to what, and what is harmonious. As in the case of the natural environment, there is no immediate answer to these questions -- there is insufficient understanding of the relationships and the nature of psycho-social development. Simplistic proposals for change and control may be assumed to bear the same relationship to the failure of the psycho-social eco-system as do pesticides to the failure of the natural eco-system. The psycho-social system will resist "redesign" but it is as yet impossible to say when the resistance is beneficial and when it is unfortunate and to be overcome.

The general problem of psycho-social ecology may be considered in terms of the different types of ecology mentioned in an earlier section, namely:

- organizational ecology i.e. the harmonious evolving inter-relationships between organizational units
- conceptual ecology i.e. the harmonious evolving inter-relationships between theoretical formulations, value and belief systems
- problem ecology i.e. the harmonious evolving inter-relationship between problems
- psycho-ecology or psycho-dynamics i.e. the harmonious evolving inter-relationships within a person's psyche.

### Knowledge

A major theme of this paper is that it is not more knowledge of the same type that is needed, but new types of knowledge. Much of the complexity and information overload is due to excessive production of unintegrated knowledge. It is useful to think of researchers producing knowledge which decays rapidly into pellets of information unless revived -- knowledge is integration of unrelated bits of information; documents represent fossilized knowledge, which can be reprocessed. What is required is knowledge which will help to reduce the decay rate dramatically and to "revivify" information. The remark of a Fortune editorial that "because our strength is derived from the fragmented mode of our knowledge and action, we are relatively helpless when we try to deal intelligently with such unities as a city, an estuary's ecology or "the quality of life" (Fortune, February 1970, p. 92) is applicable to the psycho-social system as a whole.

The "hidden dimension" which must be faced is that of the degree of integration of the knowledge used across conventional discipline boundaries and across boundaries between various modes of thought and action (e.g. research, policy-making, education, etc.). Just as

translations between natural languages is theoretically impossible but practically feasible to a satisfactory degree, so the attitude towards the interrelation of knowledge arising from different disciplinary perspectives should be viewed as partially feasible in practice, even if no theoretical framework can legitimate it.

Clearly, the momentum of the knowledge producers and their organizational settings makes dramatic change almost impossible. The solution advocated here is therefore the provision of a device for them which is structured to facilitate integration of information and enhances creativity and production of more integrative knowledge. In contrast, existing information systems encourage fragmentation and the generation of vast quantities of indigestible information.

With such a device, much vital existing information on isolated entities and processes in the psycho-social system can be "hooked together" in a manner which facilitates understanding by many disciplines simultaneously, and can highlight significant areas for research and action. Such an approach is vital to avoid clumsy spastic approaches to rectifying current problems. War and violence are the ultimate processes in a spastic society.

Our difficulty is that our mental models of psycho-social structure are based on patterns of relationships which are too intimately identified and associated with (visible) physical and behavioural structures which do not develop naturally and continually but can however (almost literally) be labelled. Means are required to increase reliance on more subtle and dynamic patterns of relationships for which more sophisticated methods of display are required.

### Conclusion

The world crisis may be viewed as the closing of an ecological trap, in the multiple sense elaborated here, and as a failure of communication between governments and governed, between disciplines, between organizations, between generations, and between psychological states. It is not a matter of improving the technical means by which new information is generated or transferred from A to B, indeed it is this which is setting the pace. It is in the processes of interpretation, integration and comprehension that the problem lies.<sup>8</sup> It is useless to step up the bombardment of the human organism by pellets of information and unrelated, "useful" but mutually antagonistic concepts unless the pellets are so organized as to be capable of faster assimilation.<sup>27</sup>

This integration must extend to the systems of interpretation by which alone communications have meaning and enable human beings to influence one another -- it is in this domain that coherence and continuity have almost completely been lost. But in order to re-integrate what is being so explosively torn apart, it is necessary to look at the psycho-social system in its currently fragmented state -- this poses much subtler problems of communication for which the device described here may be of major significance.

Each entity in the psycho-social system must be "recognized" as it is currently fragmented, because in this state each fragment has its own relations with other parts of the system which we must necessarily comprehend. They have emerged into existence as relative invariants, for some other part of the system, in response to system conditions which must be understood before attempting any premature integration back into "natural wholes" -- and before using models which assume the existence of such integrated wholes or which deny the significance of some entities or relationships. In particular it may be an advantage to attack the myth of society as a unified whole and the myth of man the individual -- before establishing well-founded bases for any such beliefs.

To clarify the two myths, a new "Origin of Species"<sup>43</sup> is required to show how and in what way each psycho-social system species arose and how it relates to other species. The only unity to be hoped for at this stage is an eco-systemic unity -- not some utopian community of man.

A common ecological framework is required for the massive existing programs of which the United Nations is a focal point namely disarmament, development, and environment -- but apart from inter-relating them the missing program, in the form of "psycho-cultural development" of the person, needs to be elaborated. One cannot expect someone suffering from physical starvation, structural violence, etc. to do much for himself, but nor can one expect someone suffering from mental and emotional starvation, fragmentation, etc. to want to do much for anyone else -- we do not know what "information vitamins" we are chronically deprived of in psycho-systemic terms. The crisis is a global and multidisciplinary one of "psycho-environmental evolution".

Three other problems of introducing change must be recognized. Stafford Beer has formulated Le Chatelier's Principle for the psycho-social system which he considers that would-be leaders and reformers of social systems often fail to appreciate: social systems do not need to respond to "progressive change" by defeat or violent reaction. They can simply adjust their internal equilibrium very slightly, "accepting" the change, and then offset and contain all its effects so that the macro-systemic characteristics remain the same. The other problem he notes is that most of the problems perceived as problems are in fact bogue problems generated by theories about social progress and the way society works.<sup>34</sup> A third problem is that people and organizations tend to create and detect problems to provide a necessary psycho-social tension to reinforce identity -- as such there may be a preference for problem solving activity rather than actually achieving a solution to the problem.

In the face of this confused, unstable situation in which organizations and concepts are increasingly inadequate to the tasks demanded of them, it is not some magic centrally developed policy on which society can depend. The systemic momentum and inertia are too great. People and

organizations must turn to the necessity of knitting together the elements of the organizational and conceptual networks in which they participate, in order to respond creatively to the problems they face. They must do so in terms of their growing eco-systemic sensitivity to their psycho-social environments. Society as a whole therefore depends on a global and multidisciplinary set of inter-dependent dynamic, self-compensating networks each responding rapidly to locally perceived problems. The networks need to be galvanized into a stabilized existence in which their maximum self-transformation potential is realized.

Identification should however be increasingly with the dynamic potential of people and organizations to reform networks and configurations of skills appropriate to each new emerging problem and less with a particular evolving network of relationships.<sup>47</sup>

A device such as that described here could constitute a vital catalyst to the processes required in this more sophisticated environment. Perhaps it will only be with such devices that man can "track" the daily changes in structures in such a psycho-social system and identify the relative invariants which provide the framework for evolving order. In value of a visualization approach to serve change agents at all levels is well summarized by Harold Lasswell:

"Why do we put so much emphasis on audio-visual means of portraying goal, trend, condition, projection, and alternative? Partly because so many valuable participants in decision-making have dramatizing imaginations....They are not enamoured of numbers or of analytic abstractions. They are at their best in deliberations that encourage contextuality by a varied repertory of means, and where an immediate sense of time, space, and figure is retained."<sup>48</sup>

Appendix on research and action possibilities

1. Require inventories of the resources of the psycho-social system: organizations, concepts, values, problems, roles, lifestyles and psychological states.
2. Require more sophisticated and comprehensive typologies and taxonomies of: organizations, concepts, values, problems, roles, lifestyles and psychological states with particular attention to grey areas and the points where such entities blur into processes or patterns of relationships.
3. Require attention to the functions performed by each type of entity as parts of an eco-system relating to many other parts of that system (to prevent organizational, conceptual or problem "apartheid") i.e. a focus on the relationships between entities.
4. Require a focus on "hooking together" sub-systems of the psycho-social system in a manner which makes the result useful to a wide variety of non-research bodies.
5. Require a focus on interdisciplinary relations equivalent to that on international relations -- in fact both are concerned with the balance between coordination and decentralization and the associated problems of territorial security, power and status. The problems of coordination between disciplines and modes of action increase in significance as the boundaries between nations decrease in significance. Specifically a systematic inventory of disciplines and inter-disciplinary bilateral or multilateral links is required. The significance and measure of inter-disciplinary integration should be as vital as that of international integration.
6. Require a focus on the "maturity" of psycho-social systems as a guide to the formulation of psycho-social indicators and measures of the quality of life. This is particularly important in the case of the individual -- no psycho-social system development can take place without corresponding maturation of the individuals psycho-social processes.
7. Require a focus on the application of cybernetics to psycho-social systems and the representations on displays of subtle relative invariants in dynamic systems.<sup>28</sup>
8. Require a focus on more powerful means of displaying complex eco-systems -- with particular regard to the iconicity of the display to persons with different techniques of visualizing relationships.

9. Require a focus on possible new types of organizations, concepts and problems likely to be significant in dynamic evolving psycho-social systems. In other words, what new forms of relatively invariant entities are probable vehicles for the evolution of the psycho-social systems.
10. Require a negative inventory of the entities which we need but do not have, or have but do not know, about i.e. need attention drawn to what is not known as a stimulus to research e.g. organizations needed, concepts needed, unresolved theoretical problems.
11. Require means of systematically assessing the non-representivity of a particular program in terms of the possible mix of knowledge skills, organizations, and problems appropriate to a program in the domain in question -- in the light of its known likely effects on other parts of the psycho-social system. In other words, how can the relevant factors or skills ignored be highlighted.
12. Require devices which
  - (i) catalyze integration of information, facilitate the generation of many more alternative integrative theories, and improves the learning and diffusion process.
  - (ii) assist the user to switch attention between system and sub-system, but particularly from the system to which he is in any way committed to any more comprehensive or alternative system.
  - (iii) reduce the cost of storing and displaying indirectly relevant links and structure closer to that of storing and displaying directly relevant links or structures.
  - (iv) display and "stabilize" the representation of complex eco-systemic structures and relationships in a variety of inter-convertible forms (e.g. networks, Venn diagrams, flow charts, etc.) to facilitate interactions between different types of user.
  - (v) permit artists to re-interpret eco-systemic structure displays into psychologically more meaningful and involving presentations which nevertheless retain the scientific interrelationships -- as a means of ensuring that sophisticated ideas "travel" further and benefit from the artist's skills as a communicator.
  - (vi) hold models and data in a way which permits people to "get inside" them so that they provide a meaningful thinking and creativity support system.
  - (vii) individuals can use to put their thoughts and beliefs on a topic in order and locate areas where more integrative concepts would be useful.

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