

Aesthetics as an aid to understanding complex systems and decision judgement in operating complex systems

Carole McKenzie and Kim James

Psi International Ltd, UK

This paper argues that fundamental questions in relation to organizations seen as complex, evolving systems, operating in far-from-equilibrium conditions are not capable of being resolved by mensuration and, in the absence of this, that a reliable decision procedure is capable of being developed by using aesthetics as defined by Henri Laborit in the foreword to *Biologie et structure*. A brief description is given of a methodology developed by Psi International at the French Institute for training Public Services employees, Dijon, France.

“Quality is practical, and factories and airlines and hospital labs must be practical. But it is also moral and aesthetic. And it is also perceptual and subjective.”
(Peters, 1989: 83)

We start with this quotation from Tom Peters for several reasons. The entities which he names, factories, airlines and hospital labs all function within a complex system - the environment today. He draws attention to the human factors which underlie these organizations, he correctly links the concept of quality with morals, aesthetics and perception and the subjectivity of the human being who operates within these organizations. For quality to succeed these subjective and perceptual elements must be understood. We start by saying that Peters repeats himself when he draws attention to aesthetics, perception and the subjectivity of the human being. In our approach aesthetics is a perceptual phenomenon and it is necessarily subjective.

Complexity is a dominant phenomenon in the relations which make up our present mode of existence. Dominant in the sense that we as humans have to understand the world we live in and, in an effort to maintain our balanced state, we categorize some phenomena as complex. Complexity is not merely complicated. We are using a definition of complexity which corresponds to that given in a sentence by Sir Arthur Eddington (Eddington, 1928: 275), namely that “a complex System is one which contains at least one element which is not open to measurement.” A system in which all the elements can be measured and accorded a scale may be complicated, but it should not be considered complex in a modern sense. We are, however, anchored in the past

in our thinking. Assuming that the ways that education has taught us are the only valid ways of understanding lead us into error if we are not careful. We have been using a cybernetic methodology since the late 1960s in a study of aesthetics as a ‘tool for thought’.

Systems theory is what it says; it is an attempt to discover what features are common to all systems, from atoms to the galaxies of the Universe. A useful example of a complex system is the operation of the human element of systems. Complex systems form a sort of exoskeleton for humans as a species. Without these systems which we have developed we would be defenceless in our environment. The unit you choose for describing the organization of the environment depends on the level you choose to describe. Gibson draws attention to the fact that there are no special proper units in terms of which the environment can be analyzed once and for all. Instead there are subordinate and super-ordinate units.

“There are forms within forms both up and down the scale... Units are nested within larger units. Things are components of other things. They would constitute a hierarchy except that this hierarchy is not categorical but full of transitions and overlaps.” (Gibson, 1979: 9)

Lissack rightly comments that, “What we find when we search is a function of how we look” (Lissack, 1996). As the problem becomes more complex, purely in terms of how many small problems are concatenated to produce the apparent overall, global, problem the more people and managers in particular tend to operate on gut feeling to choose a solution. Increasing the alternatives reduces the tendency to compare alternatives, one by one, on their capacity to provide solutions, which might, or might not, add up to a solution to the overall, and it increases the tendency to evaluate the alternatives as a whole: The tendency is to use intuition to find a solution which will be applicable in a generalizing fashion. If the thinking pattern of the manager is not able to operate on a rich fitness landscape it becomes a matter of pure chance whether the solution chosen is correct or not. It is therefore necessary to educate the perceptual capacity of the manager to increase his or her ability to perceive a rich fitness landscape. In this case it is necessary to find a method of increasing the perceptual abilities of the manager.

In linear problem solving - the 'fact analysis' domain - particular beliefs and behaviors may play little or no part in the solution of the problem. Increasingly as complexity increases, as the problem becomes a question of intuition (gut feeling) then the beliefs and behavior of the person becomes increasingly important. Global solutions demand powerful inputs of creativity. Different companies have different capacities to absorb new information in a continuous flow. The ones whose structure and organization have the capacity to adjust rapidly to information in a pro-active fashion will be those who prosper and survive. Paraphrasing Cohen and Levinthal (1990), "This ability depends upon the expertise of the people who stand at the interface with the environment and those who act as facilitators of the spread of knowledge across the boundaries between sub-units within the organization. It is a prime role and responsibility of these 'gatekeepers' to monitor the environment and translate the information into a form understandable to the people within the organization."

"It is not easy to arrive at a conception of a whole which is constructed from parts belonging to different dimensions... This is due to the consecutive nature of the only methods available to us for conveying a clear three-dimensional concept (of the world) and results from the deficiencies of a temporal nature in the spoken word. For we lack the means of discussing, in its constituent parts, an image which possesses simultaneously a number of dimensions" (Klee, 1924: 17).

The cleavage between the aesthetic and the non-aesthetic domain of experience, no less than that between the scientific and the extra-scientific, is the cleavage between the metrical and the non-metrical rather than that between the concrete and the transcendental (Eddington, 1928: 275).

Throughout history the great visionaries have been those who have known how to use this science-in-movement, which is aesthetics. Einstein was guided throughout by a keen appreciation and reliance on the role of aesthetics in the discovery of new structures of relations. How can aesthetics help the searcher who wants the best solution?

Judgements made on moral grounds frequently lead to unsatisfactory results, which compound the problem. What is needed are solutions which are the best for everybody, all round - the elegant solution. The science of aesthetics is the science of providing elegant solutions. The dictionary definition is: "the theory of beauty in general and of the feelings that it gives rise to in us, origin Greek *aisthetikos*, that which has the faculty of feeling" (The Concise Oxford Dictionary).

The development of aesthetics as a philosophical study over the past two centuries has given rise to a definition of aesthetics as the material presentation of truth where beauty is the signifier of this truth. Hegel defined beauty as the material manifestation of the idea. From this we move to the classic position that aesthetic beauty is no more than the most successful expression of ideas which have already been formulated by religion, science or politics. Successful aesthetic expression according to this reasoning is a confirmation of current ideas and a source of illusion.

If we use these definitions of aesthetics we are led to a static position where art (any art, including the art of management) is a representation and any attempt to use it gives rise to a series of interpretations of interpretations, a sterile criticism which is no more than a projective test of the attitude of the author towards some ideal form of an *idée reçue*. It can under no circumstances be used as a tool for thought.

Our definition of aesthetics corresponds to that given by Henri Laborit: "the search for new structures." "Aesthetics (must be) ... understood as a search for structures, that is to say the set of relations existing between the elements of the whole of our knowledge ... the search for, discovery and the use of relations makes action efficient" (Laborit, 1968: 13). If we discard the old description of aesthetics as the standards of accepted established beauty and replace it with Henri Laborit's definition we have a truly creative tool rather than a cosmetic one. If we can learn to search for new structures as a natural part of our ability to perceive the information that is available to us, it can provide us with a tool for working in conditions where there is a lack of clarity and only too much ambiguity. If we can learn to use this collectively, where we build a collective reference which creates a rational framework with its own checks and balances, our work teams, both formal and informal, will provide a fertile ground for a creative company. If we do this we will not miss the opportunity, but will see the signal in the noise and create new opportunities for action.

The origin of structures of relations

This paper is concerned with the ability to understand all complex systems. However, since the human person in its interactions is the most complex systemic interaction known, by studying how human systems operate we shall be a fair way to understanding all complex systems. "Everything is made of atoms. That is the key hypothesis. The most important hypothesis in all of biology, for example, is that everything animals do, atoms do. *In other words, there is nothing that living things do that cannot be understood from the point of view that they are made of atoms acting according to the laws of physics*" (original

italics) (Feynman, 1991).

A complex system is not a complicated arrangement of material elements. It is a complex set of interrelationships between elements which have attributes. Alteration of one subset of relationships alters the relations between all the elements. The relations between the elements define the system. The dynamics of interactions and transformations, of relations, that a system can undergo, and still remain that system, are its organization. The organization of the system does not determine what the bits of the system must be made of, it only lays down the relations that these bits must have in order for it to exist as a specific system.

A systems approach is concerned with the relations between the elements which make up the system, not to the elements and how they work, or what materials they are made of. The actual relations that are present between the components of a real system in a real space are what we call its structure. "We are thus saying that what defines a machine organization are relations, and hence that the organization of a machine has no connection with materiality, that is with the properties of the components that define them as physical entities" (Varela, 1979: 19). It is this which allows us to study the systemic rules which govern things as distinct as an atom, a plant, an amoeba, a hedgehog, a car, an institution or a planetary system. Complex systems are additionally difficult because they are not end to end but nested.

The interweaving of the individual and society produces contradictions

"...there exist innumerable forces which interlace, an infinite number of parallelograms of forces giving a resultant, the historical happening. This in its turn can be regarded as the outcome of a force acting as a whole, without consciousness or will. For that which each individual wishes separately, is hindered by all the others, and the general upshot is something which no one in particular has willed" (Engels, 1941: 55).

In the management of human society there is a trend to emphasize certain traits, modes of connection, which have proved, in part, to favor the maintenance of stability. In the course of time these manners of regulating affairs restrict the desires of individuals to function differently. These desires are resisted by those whose own position feels threatened by any change. The individual exists in a bath of generalized aesthetic which keeps a set of norms of behavior and ways of solving problems in a fairly stable condition around the individual. In order for change to take place it has to occur in a surrounding of non-change.

Each individual develops according to their needs and these needs eventually conflict with the dominant paradigm. Because each person is an individual and hence unique it would be impossible for there not to be acute contradictions, at some time, between the efforts of the individual to solve their unique problem and the effort of society to reward previously tried and tested methods of so doing.

It is this contradiction which provides the motor for social change. How well the individual solves the problem for his or her self is largely an aesthetic one. If problems were merely arithmetic exercises life would be easy, one would feed the data into the computer and wait for the results to appear. Nothing is so simple. Every problem belongs to an individual with all the emotional investments which surround the problem. If these are not taken into account then disaster occurs, probably sooner rather than later.

Aesthetic development concerns the way in which the very complicated feelings and emotions, which are bound up with all the variations of personality and character, can be adjusted to the objective world. Aesthetic development concerns the precision with which these very complicated feelings and emotions are adjusted. In the absence of this complicated adjustment, arbitrary systems of thought are imposed, in spite of the evident natural facts, to solve problems of overwhelming complexity. These arbitrary systems are dogmatic and irrational in character, composed of simplistic logical and intellectual patterns. Recognition of one's own particular aesthetic is a tool which enables the person to make these fine adjustments. Because aesthetics is a lived experience unique to each individual the use of aesthetics starts with knowledge of Self and an understanding of one's own aesthetic.

Sir Herbert Read describes aesthetics as an "objectivated enjoyment of Self, it is a mode of perception, it is Empathetic". Empathetic - The power of imaginatively projecting one's own feelings into another, person or object, and in so doing understand the object of contemplation only taking note of what we can describe in words or calculate. In this perception the observer discovers that elements of feeling arise within his or her Self when examining concrete and objective reality (Read, 1943: 24). The infant child's identification of personal individual self with external objects is the first example of the achievement of the aesthetic judgement. In the infant this is categorized by child psychoanalysts as the child's internalization of the 'other' as possessing attributes of a self.

"The concept of the object is, primarily, nothing else than the concept of another ego. Thus in childhood the infant conceives external objects as beings which act freely and

arbitrarily. That is why the idea of the object is usually born out of the idea of another ego contraposed to one's own" (Feuerbach, 1943: 56).

In perceiving an object or an event the adult, in development from the infant, keeps this projection of their own identity onto the outside world and identifies this with his or her own sentiments. Sir Herbert Read gave the example of the spectator who discovers spirituality, aspiration and so on, in the spires and pointed arches of the Gothic cathedral and then contemplates these qualities in an objective or concrete form. In this way vaguely apprehended subjective feelings are seen as definite forms and colors. Read was writing in 1943 for a rather limited bourgeois audience, but we would say that the spectacle of a couple of first class football teams in a well played match is also a source of objectification of aesthetic values - beauty, harmony, symmetry, rhythm, fitness for purpose. Or a snooker championship, or dance routines, or a good film. The resonance is an aesthetic one on the part of the matter and the spectator. There is in fact practically no field of human activity which does not affect our aesthetic perception and yet it is ignored as a useful tool.

What is being responded to is the quality, the essence of the event or object. We are responding to Maturana's pure relations,

"If a living system enters into a cognitive interaction its internal state is changed in a manner relevant to its maintenance, and it enters into a new interaction without loss of its identity... The nervous system enlarges the domain of interactions of the organism by making its internal states also modifiable in a relevant manner by 'pure relations', not only by physical events. The sensors of an animal (say a cat) are modified by light, the animal is modified by a visible entity (a bird). The sensors change through physical interactions, the animal is modified by the interactions which hold between the relations between the activated sensors that absorbed the light quanta at the sensory surface... The nervous system expands the cognitive domain of the living system by making possible interactions with 'pure relations'" (Maturana, 1972: 16).

We are perceiving meaning that is beyond mere verbal description. Eddington draws attention to the crux of the matter; Aesthetics is our only way of dealing with that part of problems which is not open to measurement.

We tend to dismiss that which we can only feel, as being inferior to what we can talk about. Indeed our education is so highly geared to only taking note of what we can describe in words or calculate, that we tend to ignore a whole domain of information as be-

ing 'sloppy', 'soppy', 'childish', and so forth. In actual fact this is a mark of the straight jacketed mind. It has never been dismissed so lightly by top-flight business people, scientists and engineers.

Aesthetic development is an integral part of that perceptual faculty which we call intuition. The ability to respond to that part of problem-solving which is not yet open to measurement. Science looks for the underlying feature across separate events. Art seeks the maximum number of ways to express the single object or event. The intelligent person uses the two approaches simultaneously. The origin of the word art lies in the old Latin root *ars* which is linked to the making of form. Art is found in anything to which humans have given form, hence we can, and do, talk of the art of managing, the art of public speaking, the art of horsemanship. Meaning in all cases that the activity brings about a certain form which has attributes of 'fit', elegance, balance, efficiency and economy of energy. In all cases of our appreciation of a work of art proper, whether in architecture or the elegant solution of a complex problem of human relations, it is the appeal to our senses which enables us to make a value judgement. There is no genuine work of art, whether in business structure and procedure, or a painting by Rembrandt, which does not primarily appeal to our senses - our physical organs of perception.

The feature which distinguishes aesthetic consciousness is imagination, found most evidently in art. Imagination is the common factor in all the subjective aspects of art and the factor that reconciles diverse subjective aspects with the invariable laws of beauty: balance, harmony, symmetry, and rhythms. Composition is the sum total of all these properties whose purpose is to organize the physical elements which make up a coherent pattern.

"Imagination reveals itself in: the balance or reconciliation of opposite or discordant qualities; of sameness with difference; the individual with the representative; the sense of novelty; freshness with old and familiar objects, a more than usual state of emotion than usual order, judgement ever awake, steady self-possession with enthusiasm, feelings profound or vehement."

The above list is the work of the English poet Samuel Taylor Coleridge, (in Read, 1943) it could not be better put. Attempts to fully comprehend complexity and complex systems are impossible without these attributes. Imagination links the "more than usual states of emotion with more than usual order." It is the imaginative faculty which ensures that our minds are not satisfied with circumscribed activity, but ensures that we desire to create and go beyond the given. Imagination is the establishing of new relations between the

elements which have accumulated in our memory, our past experience. This is the predictive capacity in its human form. It consists in structuring in advance the world of tomorrow, and conforming our behavior to the bringing about of this new structure. It is this faculty which enabled Gibson to propose his theory of *Direct Perception* thirty years before the physical evidence was available. It gave Einstein the approach which enabled him to formulate the theories of relativity.

“In Einstein’s article of 1905 he said that all energy no matter what, has a mass. But it took him another two years of work to realize that the converse, although astonishing, was equally true: all mass, no matter what, must consist of energy. It was aesthetic reasons which led him to this conclusion. Why should one make a distinction between the object which has mass and that which it loses when energy is liberated? That would be to imagine without any real reason, two sorts of mass where one alone would suffice. Such a distinction would be in bad taste and indefensible in logic” (Hoffmann, 1972).

Imagining entails visioning and symbolizing, developing heightened perception and intuition. It enables self-discipline and effective team development as it reaches, and makes available, nonverbal processes. Such a technique is a powerful tool for the future. “There is (further) reason for optimism in the peculiar fact that progress in physics is often guided by judgments that can only be called aesthetic. This is very odd. Why should a physicist’s sense that one theory is more beautiful than another be a useful guide in scientific research? There are several possible reasons for this, but one of them is special to elementary particle physics: the beauty in our present theories may be ‘but a dream’ of the kind of beauty that awaits us in the final theory” (Weinberg, 1994: 12).

The appeal of the imaginative solution is a very subtle process, taking place below the level of normal conscious life. We are so aware of the difficulty of using words to describe a new idea that we use the words ‘imagine’, ‘visualize’ and ‘intuition’ when we seek to articulate such newness. When we speak of visualizing or imagining or using our intuition we are speaking about activities which are not verbal. We talk of ‘calling up’ images from the depths of our minds. These are forms of knowledge which are the precursors of verbal knowledge. There is a deep level of cognition where the images which we call up are formed in our preconscious. They are dependent upon our direct perception of the meaningfulness of our environment, the ‘affordances’, to use Gibson’s term.

Under normal circumstances people analyze and deduce from data. If we don’t have all the data we

go and get what appears to be necessary on the basis of that which we already have. We add up the figures and produce an answer which satisfies us. This is the area of ‘facts’. Unfortunately we do not have to look very far before we are confronted with problems that are not capable of being solved by linear logical sequential calculation. Nonlinear equations are the order of the day in a world which functions on discontinuities.

In order to cope with the rapidity of change and uncertainty of the information which is being received it is necessary to create as broad a range of *perceptual extero-receptors* at the interface with the environment interface and *proprio-receptors* within the organization to ensure the capacity for internal adaptation to meet the requirements of the environment/organization steady state. The obvious choice for this role of providing a central nervous system for the organization is the Human Resources department of the company. It is the people who drive a company forward or drag it down into decay. It is not the structure of the organization; people make the structure, and change it or defend it, in the latter case often blindly to the destruction of their own future rather than change. Human Resource departments have evolved within the company to resolve the internal contradictions between people and structures. They now have to make the evolutionary leap to become the perceptual organs and the central nervous system of the companies.

“In the beginning was the word”

Linear, logical and sequential words, dominate our education. Words are vital, spoken, written or conveyed in various symbolic shorthand. Words dominate our reasoning. The dominant communication process takes place through the spoken word. Words form our attitude to our world. Words have to be learnt and the rules have to be conformed to in order for us to convey meaning. The conformity of learning language brings acceptance of the symbols as being reality.

This is why an ‘aesthetic approach’ and the development of an aesthetic attitude is essential for all genuine understanding of complexity. It allows us to be ‘tuned in’, to be in a state of ‘information’ where we can pick up what works, what makes sense, what is a ‘good’ solution, an appropriate intervention. It is perceptual, functioning at the level of Gibson’s *Direct Perception of Meaning*.

Complexity cannot be understood outside a relativist culture where we can tolerate ambiguity, creativity (both in ourselves and others, since this is the source of much of the ambiguity), and where we can seek out structures in a continually changing environment. In our efforts to understand the complexities of a

chaotic world we admire intuition and imagination in problem solving. We admire creativity and we strongly desire to be creative ourselves.

About thirty years ago we were confronted with the problem of understanding the complexity of human interactions, a process which took us from the Royal College of Art, through the study of brain structure and function in the Department of Applied Biology at Brunel and on, most fruitfully, through the Cybernetics Division at Brunel under Gordon Pask. Our field of study at that time was the examination of the use of art in psychotherapeutic treatments within the British National Health Service. We presented the first results of this initial study at the symposium *Self-Steering and Cognition in Complex Systems* at the Vrije Universiteit, Brussels, Belgium, in May 1987 in a paper we called the "Art of Self-Steering". By using a process which can simulate the complexity of management experientially we have succeeded in creating a self-steering mechanism for the participants. Contrary to the simulations used in operations research and game theory, the exercise does not have as an aim the formulation by an observer of rules to apply to passive subjects, but the discovery by the participants themselves of a new paradigm for their thoughts.

The training developed on the basis of this referential methodology aims at the introduction and use of aesthetics as a predictive and investigative capacity. This allows a new effective thought process in management which liberates and uses imagination, intuition and the power which arises from emotion. In a supportive framework, where all the elements of day to day reality can be simulated, the Graphic Referencing Technique (GRT - details can be found at <http://www.psy.co.uk/grt.html>) allows the use of elements previously considered as negative such as confrontation, conflict, ambiguity, indecision and error to be used as dynamic values.

These values then become the creative potential for a new paradigm where the complexities of situations and chaos become opportunities to obtain a higher perceptual ability in decision making. Both the necessity to pay attention to the least little detail and the consequences for the original ideal vision are brought into play. Aesthetics, whose subjects are Truth, Duality Values, Technique and Expression, is a generalizing function which corresponds to the need to work at the same time of the details and on the global plan. Participants achieve their own aesthetic and recognize the expression of their own values in the activity of managing. Through this they have an experience which assists management, both collectively and individually, to increase their perception of the total organization and advance the power and well-being

of any company.

The use of Graphic Referencing Techniques enables the interaction of a group of people to find creative solutions through the unrestricted exercise of imagination and the correlation of disparate elements. In essence GRT is a deep learning experience which enables managers to increase their potential by using the environment of change and chaos. Change, with all its ambiguities and possibilities is the lot of managers. The GRT experience teaches them to use the ambiguity and insecurity of change and turn it into a source for positive decision making.

Graphic reference: Basis and structure

The nature of intuition is very badly understood. We agree that it exists, but what it is, is less well agreed. It is well described in the literature of the history of science as playing an important part in the great discoveries of mathematics and physics. It is certain that it is strongly linked to imagination and visioning. Mankind is a creative animal but most creative thinking has to be acquired and maintained in spite of and against academic instruction

The start of creativity is the child's first scribble. Making marks and leaving traces is the earliest human activity in all countries, all races, all religions since mankind began

First things should come first

The importance of the spoken word cannot be denied. But the very act of learning to speak efficiently is an act of learning to do as someone else considers to be correct. In acquiring language we acquire knowledge at second-hand in the very act itself. We place no real importance on the learning to learn experience activity of the graphic act. Yet in this activity from its very start we teach ourselves at first hand.

A trace is a change in the surface of an area as the result of an event and which signifies that event. The fine view which we admire carries the traces of the multitude of events which brought it into being. To the eye of the geologist it signifies the volcanoes, earth movements, glaciations, soil erosions, to the historian it signifies different types of agriculture over history, settlements and battlefields, frontiers and movements of people and their activities. The traces left by events in time also indicate the possibilities of further events. To the town planner the traces indicate where his new development is likely to fit in most successfully.

Traces are nested one on another, the large traces of the landscape contain smaller changes. The traces which took place aeons ago contain those of historical time, the historical time contains the ploughed furrows

of last autumn and the hoof-prints of this morning's rider, each trace is made in time on the surface altered previously. The horse at a gallop leaves a trace in its hoof-print which differs from the same horse at a trot or a walk. The burglar is caught, at least in detective stories, by the print of his shoe in the flower-bed. The meaning of the whole contains a multitude of meanings nested one within the other.

The graphic trace

A graphic trace is a change in the surface layout of an area made by a human with an instrument such as a crayon, chalk, pencil, engraving tool, pen or a cursor. The essence of the action of bringing a graphic trace into existence is that it generates permanent information for the event. The sequence of trace making generates the pictorial event.

"A single drawing ... is in effect an operating system regulated by feedback ... the clearly sequential and cumulative nature of the traces, and the fact that a terminal product results, set drawings apart as a prime example of a regulated system in operation" (Beitel, 1970).

The trace constitutes perceptual information for the observer. All traces have a cause, and causality is registered in the change of the texture of the surface at a specific place as being of a different quality to the overall. Change is registered in the trace. The trace is a signifier of difference. We can make traces which are full of information for us without our being able to immediately put this into words. We can recognize the information in traces easily and then put the description into words. We have a tool for discovering meaning in our world and our part in this world at a level which eludes us if we try to logically 'reason it out'.

Creative thinking is dependent upon a paradigm which is creative. A paradigm is a world view. It is formed in experience and cannot be taught by didactic methods. It is the necessity to devise such a method which has brought about the Graphic Referencing Technique as the most efficient way of enabling people to achieve a new paradigm.

The Technique is a practical activity which simulates all the complex interactions found in social organizations of all types. It can show slow build-up progressions which suddenly break into new forms. It shows possibilities and probabilities. It demonstrates the build up of aggregations of power and shows how 'mergers' and 'takeovers' happen.

This can be done at the individual and the group level, or the two levels of interaction can be

merged. The technique gives the possibility of analyzing past interactions and altering sets of possibilities. In the exercise of Graphic referencing the participant learns through their own practical activity how each fact is enfolded within a network of other facts, and only an approach which is geared to recognizing the essential ambiguity that this creates is going to be efficient. This method enables a complex activity to be understood in a practical application. The practitioner achieves a self-referential reorganization of his or her thought toward a heightened efficiency of judgement in complex situations.

References

- Beitel, F. (1970). "Sketches toward a psychology of learning in art," in G. Pappas (ed.), *Concepts in art and education*, London, UK: Macmillan.
- Cohen, W. and Levinthal, D. (1990). "Absorptive capacity: A new perspective on learning and innovation," *Administrative Science Quarterly*, (March): 128-52.
- Eddington, A. S. (1928). *The nature of the physical world*, Cambridge, UK: Cambridge University Press.
- Engels, F. (1941) in G. V. Plekhanov, (ed.), *Fundamental problems of Marxism*, London, UK: Lawrence & Wishart.
- Feuerbach, L. (1941). *Werke. Vol II. 1907* in G. V. Plekhanov, (ed.), *Fundamental problems of Marxism*, London, UK: Lawrence & Wishart.
- Feynman, R. P. (1991). "Atoms in motion," in T. Ferris (ed.), *The world treasury of physics, astronomy and mathematics*, Boston, MA: Little, Brown and Company, pp. 3-17.
- Gibson, J. J. (1979). *The ecological approach to visual perception*, Boston, MA: Houghton Mifflin.
- Hoffman, B. (1972). *Albert Einstein: Creator and rebel*, Viking Press.
- Klee, P. (1964). *Theorie de l'art moderne*, Editions Gonthier. Bale.
- Laborit, H. (1968). *Biologie et Structure*, Paris: Gallimard.
- Lissack, M. (1996). "Chaos and complexity: Knowledge management?" <http://www.leader-values.com/Content/detail.asp?ContentDetailID=47>.
- Maturana, H. (1972). "The neurophysiology of cognition," unpublished research paper, Biological Computer laboratories University of Illinois.
- Peters, T. (1989). *Thriving on chaos*, London, UK: Pan Books.
- Read, H. G. (1943). *Education through art*, London, UK: Faber.
- Varela, F. J. (1979). *Principles of biological autonomy*, North Holland: Elsevier.
- Weinberg, S. (1994). *Dreams of a final theory: The scientist's search for the ultimate laws of nature*, Viking Press.

Carole McKenzie has an honours degree in Fine Art and a doctorate in Cybernetics. She is a trained family therapist and has a deep interest in the systemic theories of Chinese Traditional Medicine. She founded Psi International Limited in 1984 to apply cybernetic studies to industrial management. She devised the Graphic Referencing Technique to enable managers to understand complexity theories in practical appli-

cation. For the past twenty years she has worked as a consultant to Directors and Senior Managers in the IT industry. She has a deep interest in social enterprise projects in deprived areas in the UK and is a consultant to the Scarman Trust.

Kim James had a successful career as a sculptor in the 1950s and 1960s before turning to studying the psychology of creativity and obtaining a doctorate in Cybernetics. He worked for fifteen years as a consultant to the French National Institute for Training Psychiatric Personnel in Dijon, France. Since 2000 he has been working on the psychology of military motivation among ordinary soldiers.