Chapter One

Despite C. P. Snow

One of the first announcements by the new mayor of New York when he took office in early 1994 was that the city's considerable cultural budget (US$89 million, about double that of the Australia Council) should be redirected to its major cultural institutions - the opera companies, the ballet companies, the New York Philharmonic, the big art museums. These, said the mayor, are what attract the tourists and we need the tourist dollar. In Australia at various times, there are similar views put forward by one or another political party. The Federal Coalition has not seen a role for national funding of community arts, Art and Working Life, multicultural arts and so on, and in the 70s oversaw an expansion of funding to some major arts companies with a concomitant narrowing of support to the rest of the arts spectrum. For different reasons, the Australia Council's doctrine of "funding for success" prospectively concentrates the available funds on a smaller number of grant recipients.

If all or the great part of the funding to a country's artistic institutions goes to the best opera company, the best orchestra, a major theatre company, a major gallery, in the interests of having the best example of each as the national flagship (this idea in a less extreme version has had some currency in the past), would we have a dynamic artistic life? Indeed, would these companies be able to produce the goods under those circumstances?

In 1980-82, I lived in the twin cities Minneapolis/St Paul (combined population about 2 million). Although they were adjoined - only by the road signs would you know you were leaving one and entering the other - they were of quite different character. Minneapolis seemed more lively and prosperous - the dominant twin, as it were, although there was reputed to be great wealth in St Paul. The Minneapolis downtown was bright in a somewhat low-key mid-Western way, full of fine new architecture. St Paul's downtown by contrast seemed gloomy and depressing. St Paul had a reputation of political conservatism, Minneapolis of liberalism.

The reason for introducing these far away cities here is that their local means of funding the arts were quite different. The New York example notwithstanding, much of American arts funding comes from private sources. In Minneapolis, each arts organisation had to act independently in seeking private funds. In St Paul, on the other hand, the major arts organisations mounted a combined fund-raising drive, and distributed largesse to themselves from the resulting funding pool. While this in itself seems a worthy and useful concept, it had a consequence that arts organisations that were not members of the combined drive were to a degree excluded from private funding support in St Paul. And it was not so easy to be admitted to this charmed circle It was not necessarily in the interests of the in-group to admit more organisations since this was not likely to increase the income proportionately but did require that the pool be split into more shares.

Both cities had some fine cultural institutions. But it was Minneapolis which had by far the liveliest, most diverse and innovative arts life. St Paul's arts activities were confined more to the members of the fund-raising alliance. Now of course there is a chicken and egg issue here which extends beyond arts funding mechanisms to the entire ambience of the two cities - their relative wealth, ethnic make-up, physical layout and so on.. But on the other hand, perhaps that does not matter. Whatever the reason for the St Paul funding arrangements as they stood,

one wonders what its cultural life would have been like if there had been a more open system encouraging of diversity.

Is there any basis for deciding such issues? Could an argument, substantiated by pertinent evidence or credible theory be put to the St. Paul arts institutions that they should abandon their joint fund-raising campaign in order to enliven the city's cultural life and attract more interest in the arts from the populace? Could there be just as credible an argument put to the major arts institutions in Minneapolis that if they joined forces in a funding drive, they would raise more money for less effort, with no damage to the well-being of the smaller arts organisations nor the overall vitality of the city's arts activity?

There is an excellent chance that these questions were never posed nor addressed in those two cities. If, perhaps, they were, it would be very easy to find other cities where the artistic life grew like Topsy around the energies and proclivities of a few movers and shakers. The decisions that collectively resulted in the two distinct artistic cultures probably were of the order of "What will I paint today?" and "How can I find some dancers for my piece?" and "This leaking slum warehouse is a write-off. Does anyone want to turn it into a theatre?" and "Would it help us to attract some major industries to town if we had a better orchestra?" and "It's so boring raising money. Wonder if we can get a combined effort going with the art museum?"

Probably we can do better. The world is not without theories, nor examples of successful artists and artistic institutions, and some of them must be relevant to creating the best possible context for artistic development.

At the time a few decades ago when the contemporary cultural establishments of Minneapolis and St Paul were finding their feet, the circumstances probably were relatively stable compared with those in 1995. Of course, even in those days, the phrase "in a rapidly changing world" helped spin out every sixth sentence. Perhaps I have a different view of the speed of change now because I have had to pay closer attention, and to a wider slice of life, in order to attempt this book. However, it seems to me that change now is almost inconceivably rapid. My instinct in this situation is to search below the surface for some fundamentals that can survive cultural change and will be pertinent to any situation that might arrive by 2010. It happens that I have been drawn to certain theories in that supposed enemy of the arts, science.

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C.P. Snow's assertion in 1959 that the educated world was split into two non-communicating camps, arts and science, with quite contrary world-views, is probably still tacitly accepted by many of us. Our stereotypes of scientist as socially inept boffin lost in dealings with the inanimate world, and artist as a dreamer in the world of human affairs and emotions might be strong enough to defend themselves against our contrary knowledge of actual scientists and artists.

Or even by the increasing marriage of arts and technology. Now the most conservative art forms take advantage of new technologies, even if only to make a more efficient or elaborate presentation of old messages: ballet, opera and theatre companies use wonderfully sophisticated computer-controlled lighting and stage machinery, writers use the compositional and editorial flexibility of word-processing, musicians the improved standard of traditional instrument production or recording technologies, visual artists the special capabilities of new paints and plastics, and so on.

But the connections are stronger even than this, especially in music. Since World War 2, the modernist mainstream of "classical" composers was strongly

committed to a scientific paradigm of composition based on various number theories. And then there are the current new forms arising from new technologies: computer graphics, fractals, computer-synthesised and controlled sound, interactive forms, community literature on the Internet...

So while C. P. Snow's perception of thirty years ago was that we in the artistic realm must have an aversion to science, in actuality we now more and more cross the border, some on a raiding party to bring back scientific loot which we can put to our own purposes - and some to live and work in a multiculture of art and science.

This is not a one-way traffic. There are many scientists working in the communications aspects of computer and media development, for instance, whose conceptions begin with some aspect of the expressive needs of humankind. In any case, artists and scientists of whatever persuasion share the experience of invention; there is much that binds them.

The objective of this book is to attempt to anticipate some of the influences on the arts over the years to 2010, and to indicate some of the issues likely to arise from them. This necessarily involves prediction, which is to say, it requires some hypotheses about chains of cause and effect in arts production, from past to present and running into the future.

To form these hypotheses, it would be possible to extrapolate the current trends from one's knowledge of the arts and their world, and offer intuitions about where they will take us. Probably, this would be the normal and acceptable approach. It is consistent with the method of the arts themselves. It will be a basis for much of this book.

However, it is *science* that is devoted to the systematic study of cause and effect. Acknowledging that, it seems perverse to exlude the possibility that science might offer some insights into this predictive exercise.

There are other reasons for bringing science into the picture. It is scientific innovation which has brought about such rapid and radical change. We can hardly look to the future without taking into account at least the direct effect of these innovations on the arts. The precepts of science are not usually brought into a discussion of the arts (except those arts in which scientific innovation is integral, notably at present, aspects of computer-generated art), but the differences, even the dissonance between the artistic and scientific world views can stimulate a different sort of insight and speculation. Finally, at the same time that the sciences have been changing our world, they themselves have been changing. An important aspect of this change is that it has brought about the emergence of new types of understanding of social and cultural phenomena. The science of "complex adaptive systems" may have the potential for new types of explanation of the cultural phenomena we see around us, new and different approaches to supporting their development and predicting where they are taking us. It also can tell us that often, prediction of future behaviours of complex adaptive systems is, in principle as well as in practice, impossible.

This chapter gives a brief exposition of certain scientific concepts which then are used where appropriate throughout the book in an examination of the arts world. I am not a scientist, and so the account no doubt is flawed. On the other hand, if the book had been written by a scientist, it might be comparably lacking on the artistic side. This approach has been adopted in the face of warnings from scientist friends. Foolhardy, I have pressed on, buoyed by the opinion of Murray Gell-Mann, particle physicist, namer of the quark, and Nobel Prize-winner, that in this age of ever-increasing specialisation and growing danger to the planet, there is

a need for some people to take "a crude look at the whole". I acknowledge that the following may not be quite what Murray Gell-Mann had in mind.

Causality at fundamental and higher levels.

Science can be perceived as a multi-tiered structure. The laws of causality at the base of the structure are the most fundamental because they encompass in principle the phenomena and laws of sciences at higher levels, and are more general than them. So, for instance, the laws of the physics of elementary particles are more fundamental than those of biology because there is no aspect of biology which is independent of the behaviour of elementary particles. The specific laws of biology only apply in special conditions - obviously enough, the behaviour of living things.

Says Murray Gell-Mann: "One of the great challenges of contemporary science is to trace the mix of simplicity and complexity, regularity and randomness, order and disorder up the ladder from elementary particle physics and cosmology to the realm of complex adaptive systems. We also need to understand how the simplicity, regularity, and order of the early universe gave rise over time to the intermediate conditions between order and disorder that have prevailed in many places in later epochs, making possible, among other things, the existence of complex adaptive systems such as living organisms." (Murray Gell-Mann: *The Quark and the Jaguar. Adventures in the Simple and the Complex.*. New York: W.H.Freeman, 1994. pp.119-120)

Every last, minute aspect of a stroke of an artist's brush can be described in principle as functions of the states and interactions of elementary particles. But this would not be sufficient to account for it, any more than the phenomenon of thought can be fully accounted for by a description of the activity of the brain. Why this artist chose to apply pigment of this colour, in this shape, at this precise place, with this tool and this exact gesture, cannot efficiently be explained in terms of electrons and photons; nor can the history of the artistic tradition which has conditioned the brush stroke and to whose survival it contributes, and its relationship to the larger culture and society. Such an explanation must work at a less fundamental, more contextual level.

Causality is a mixture of certainty and chance.

The laws of physics are quantum mechanical: i.e. determined by the "mechanics" of the behaviour of elementary particles regarded as quantized packets of energy. Whereas, with complete relevant information, we are able to predict with effective accuracy the specifics of cause and effect in our deterministic everyday world of large objects (e.g. the path of one billiard ball when hit by another), quantum mechanics can predict only *probabilities* of particle behaviour (e.g. the probability that the radio-active nucleus of a specific atom will disintegrate at a specified moment in time).

The consequences of this indeterminacy can be felt in our everyday world. "A law of geology, biology, or human psychology may stem from one or more amplified quantum events, each of which could have turned out differently." The amplification is not of the quantum event itself, but grows through its chain of consequences. "The amplifications can occur through a variety of mechanisms, including the phenomenon of chaos, which introduces, in certain situations," outcomes which are disproportionately large when compared to the cause... "(Q)uantum mechanics...teaches us that chance plays a fundamental role in the description of nature." (Ibid. p.134)

Gell-Mann calls these chance events that lead on over time to significant regularities, "frozen accidents". "...many characteristics of a given part of the

universe at a given time are related to one another through their common origin in some past incident." (Ibid. p.227 ff)

Thus, a special concept of history is brought into science. Things are what they are not only because of the eternal and ubiquitous operation of fundamental laws, but also because of particular chance events with consequences so amplified as to constitute a significant, continuing pattern and thus a law in a segment of the universe. This phenomenon can take place at the particle level, or the classical domain of heavy objects, or the biological or societal level.

The QWERTY typewriter keyboard is a sort of frozen accident. It was designed at the inception of mass production of the mechanical typewriter to present a level of awkwardness in operation that would limit the speed of typists and so prevent jamming of the mechanism. Now we have computerised word-processing and there is no possibility that a typist can outrun the ability of the machine. But we are still frozen into the now relatively dysfunctional QWERTY design because the manufacturers need to serve the existing skills of the work force. Economist Brian Arthur calls this "lock-in". (M. Mitchell Wardrop: *Complexity*.*The Emerging Science at the Edge of Order and Chaos.*Touchstone, New York, 1992. pp.34-5) The *lock-in* phenomenon will recur in a number of scenarios throughout this book.

It is a principle at work in the Australian government's 1994 *Creative Nation* arts policy statement. *Creative Nation* assigned substantial funding to the development of multimedia production. The economic rationale is, in part, to gain foreign exchange through export of multimedia. The proponents of the scheme argue that we are now in the early developmental period of multimedia as a global commodity, and that Australia can gain "first-mover advantage" if it can move now to win some of this market (see Chapter Six). Australia would take the opportunity to lock itself in to the perceptions of multimedia purchasers as an important source of this product. It need not have chosen to do this, nor need the multimedia market need to regard Australia as an important source; things could be otherwise. But if it were successful, this would be a sort of frozen accident. Gell-Mann offers as other examples of such frozen accidents the resemblance of automobiles of a particular model, or the appearance on coins of the head of a particular monarch (Gell-Mann. p.228) In other circumstances, Edward VIII would not have abdicated, George VI would not have been crowned, and Elizabeth II's head would not be on our coins.

Three levels of causality

The "classical domain" of the physical science of heavy objects has been successful in limiting and revealing a deterministic world of *linear* cause and effect. It is a presentation of the world somewhat akin to a coarse-grained photograph, serviceable in showing the large regularities but not fine enough to catch the indeterminacy at the particle level. This is the science that gave us the industrial revolution. An engineer designs backwards from the desired outcome, a top-down process depending on linear chains of causality in which detail is deduced from the the description of the intended result. Classical science is reassuring to our everyday perceptions of the physical world. The universe does not pull the chair from under us just as we sit. The car will be where we left it. (But not the car-keys. Car-keys are to causality what khaki is to military concealment. Are the soldiers hidden or is there no-one out there?)

Because of the success of classical science, there has been an attempt to translate its methods and certainties to sciences at a less fundamental level: biology, evolution, ecology, or the sciences which attempt to explain human or

social behaviour (including the behaviour of cultures). Thus classical economic theory assumes that in deciding upon their strategies, people/agents in an economic system are perfectly rational and perfectly predictable, infinitely smart and capable of of perceiving instantly a course of action which will lead to an optimal result.

Economist Brian Arthur points out the fallacy of this approach through an analogy to chess. (Wardrop p.150) In the perfect chess game, two omniscient agents would work backwards in their minds from a checkmate, time and again, considering all the possible moves, to find the optimal move to open. But this is absurd, because the total number of possible moves in chess is 10 multiplied by itself 120 times: more moves than there are elementary particles in the universe. Chess is an open system which is effectively infinite. Chess players cannot work in this way.

Economics deals with a much more complex environment than chess. Imperfectly smart economic agents must deal with an infinite number of possibilities. There are enormously skilled chess players who have found means to win: calculating the possibilities a few moves ahead, using heuristic guides to the best strategies in a given situation. Like the chess players, the agents in an economy succeed on the basis of experience and learning about that small part of the economic universe known to them. Analogous conditions apply in any sector of human society or culture.

At the level of biology or culture, the new *sciences of complexity*, of *complex adaptive systems*, come into play. They search for regularity but acknowledge chance, predict probabilities as well as certainties, and identify circumstances in which prediction is inherently impossible. The work on complex adaptive systems is of special pertinence to speculation about cause and effect in the arts.

Complex adaptive systems.

"...at certain times and places in the universe the conditions are propitious for the evolution of complex adaptive systems. Those are systems" such as living cells, human beings, ecologies, economies, art forms, "...that take in information - in the form of a data stream - and find perceived regularities in that stream, treating the rest of the material as random. Those regularities are compressed into a schema, which is employed to describe the world, predict its future to some extent, and to prescribe behaviour for the complex adaptive system itself. The schema can undergo changes that produce many variants, which compete with one another. How they fare in that competition depends on selection pressures, representing the feedback from the real world. Those pressures may reflect the accuracy of the descriptions and predictions or the extent to which the prescriptions lead to survival of the system....(T)he response to the pressures can be imperfect. Thus the process of adaptation of the schemata leads only approximately to "adaptive" results for the systems. "Maladaptive" schemata can occur as well." (Gell-Mann. pp.368-9)

To make this definition more transparent, let us invent an example. For a bacterium, the data stream could be the temperature, humidity and chemical composition of its immediate environment. The perceived regularities could include, for instance, the continuing occurrence of those chemicals which, through evolution, are identified as its food. Says the bacterium: "The world includes these chemicals which are my food. Because it always has, it always will. I plan to go on eating them." So it does, and prospers and multiplies. Then suddenly the data stream changes. The environment includes a new chemical, penicillin. The bacterium and all its children are, for the purposes of living, as the generals might

say, deselected. That is, all except one, a somewhat sickly freak with a chance mutation that allows it to go on living with penicillin. "The family's gone. It's up to me now", says the freak, in that terse way bacteria have. So the "adapted" bacterium founds a new dynasty.

On the human side, the adaptation was not biological but followed upon research, the discovery and use of penicillin. A further adaptation will be required with the appearance of the new, resistant strain of the bacterium.

The bacterial adaptation was a step in evolution, made possible by a *chance mutation.* The human adaptation was a result of a *purposive response* to a challenge from the environment. Both the bacteria and the humans performed as adaptive systems registering and responding to the other's behaviour, the one through adaptation/evolution dependent on chance, and the other through adaptation dependent upon learning. Note that there is a strong parallel between the processes of *adaptation*, *evolution* and *learning.* All are defining characteristics of complex adaptive systems.

Computer scientist John Holland postulates that complex adaptive systems of complex adaptive systems (e.g. a cultural system and its human members or a forest and its constituent species), share certain characteristics (Wardop, p.145). It will be argued that such characteristics are clearly displayed by the arts or cultural sector of a society.

- Each complex adaptive system is a network of many self-organising "agents" acting in parallel The environment for these agents results from their interactions with other agents in the system. There is no central control; control is highly dispersed among the agents and results from their competition or cooperation.

- Each system has many levels of organisation, with agents at one level serving as building blocks for a higher level. Chemicals combine to form a cell, cells to form a tissue, tissues to form an organ, organs associate to form a whole organism, a group of organisms will form an ecosystem. Such systems are constantly revising and rearranging themselves, learning, evolving, adapting in response to their experience and their environment.

- All complex systems anticipate the future, through their internal models and in the case of of humans in social systems, through the foresight of habit or creative thinking. These predictions are the building blocks of behaviour.

- "Complex adaptive systems typically have many niches, each one of which can be exploited by an agent adapted to fill that niche. Thus the economic world has a place for computer programmers, plumbers, steel mills...just as the rain forest has a place for tree sloths and butterflies. Moreover, the very act of filling one niche opens up more niches... So new opportunities are always being created by the system. And that, in turn, means that it's essentially meaningless to talk about a complex adaptive system being in equilibrium: the system can never get there. It's always unfolding, always in transition...And by the same token...there's no point in imagining that the agents in the system can ever "optimise" their fitness, or their utility, or whatever. The space of possibilities is too vast; they have no practical way of finding the optimum. The most they can ever do is to change and improve themselves relative to what the other agents are doing. In short, complex adaptive systems are characterised by *perpetual novelty*."

The arts and the arts world as complex adaptive systems

Applying these characteristics to a speculation about the arts world, it is quite clear that it is comprised of independent, self-organising artists and arts

companies, acting in parallel without central control, cooperating and competing with each other and with the surrounding natural and social forces to produce a sort of cultural ecology. Forms of central control can arise, as for instance in authoritarian regimes, but perhaps it can be argued that these are a superposition on the arts system in which control otherwise is dispersed among all its participants. At the policy level, in due course it will be demonstrated that central control tends to act against the best development of the arts.

It is apparent that there are multiple levels of organisation within the arts world, each serving as the building block for a higher level. For instance, works of art, art styles and forms, the operation in society of the arts sector, conceptually form such a system. Artists of various disciplines, along with managers and administrators form the various departments which together form a theatre company; it and other theatre companies form one strand of a city's artistic life, which together with other strands... The whole of a culture can be seen as single system, containing a cascade of sub-systems. An arts policy which does not adequately recognise this structure risks skewing the relationships against the best possible outcome. An approach which says that only the individual artist matters, only the individual artist should make funding decisions or receive funding, ignores the other levels of the hierarchy that deliver art to its audience. An approach which hands over most authority to the money-makers and is dismissive of the artist has obvious consequences for the nature and quality of art. An arts-centred approach which ignores the relationship of the arts world to the larger culture might have the consequence, for instance, that the arts find themselves at the periphery of its concerns. It is also implicit that in the system there will be a naturally occurring change and fluidity. Any equilibrium will be short-lived, as noted below.

As all complex adaptive systems anticipate the future through internal biological structures or cultural assumptions, so for instance we might speculate that in humans there is a genetic structure to support the development of language (as per the theories of Noam Chomsky), a motivation towards beauty connected to reproduction and biological fitness, and the complex adaptive system's survival need to perceive and predict pattern, and that together these are building blocks for the production of narrative. Perhaps another way of conceiving this proposition is that we can observe empirically the ubiquitous human drive towards creative production as evidence of a hierarchy of internal structures in humans individually and collectively: an essence of being which *is* pattern, *desires* pattern, and therefore *expects and creates* pattern into the future. Stripped down to serve as the basis of a political argument, this observation says that the arts are indeed fundamental.

The arts certainly can be observed, especially in the West, as searching always for new niches to fill, constantly reinventing themselves, finding novel solutions to aesthetic problems. As one possible perspective on this process, let us consider the following. Artistic processes and works might be thought of as the events through which a society regards itself and its environment. Since the world and society are always in flux, there are always new things to regard. Where change is rapid, it may invite new means of regard, and new styles or forms of art arise.

In an oral culture, the intention of arts performance may be to recreate a story, song or dance exactly in its traditional form, perhaps against the chaos of failed memory. Even here, a level of novelty is unavoidable because the natural and societal context is constantly changing - and in any case the wishes of the participants can never completely overwhelm the intrusions of chance.

In the West, many aspects of the arts are captured in some sort of recorded form such as print, sound or film recording, or visual arts media of extended longevity. With the record secure, artists and society are freed to the intentional pursuit of novelty. Even in traditional set pieces, we look for new interpretation. Static historic art works - the paintings of Rembrandt or Van Gogh - are kept fresh by successive reinterpretations. The world of art is very sensitive to pressures of opinion and social change. It is very much contrary to the Western ethos to freeze the arts into immobility, into exact repetition of a small number of traditional theatre works, into viewing only of a set of approved masterworks by dead artists. We have seen innovation suppressed in various 20C autocracies, in our view to the detriment of the artistic creativity. But even in those instances, novelty persists within the permissable limits of expression. Prokofiev and Shostakovich were composers each with a very distinctive voice that rose above the social realist instructions of their political masters.

On this construction, it would be counterproductive for policy-makers to prescribe a precise shape for the arts world, however well-meaning and idealised, because even if through some extraordinary epiphany the vision is the one that leads to the best possible configuration of all the forces on April 10, by April 11 it may be ever so slightly wrong and by June is a dead weight against the responses to new circumstances. Of course, this does not mean there is no role for policy contemplation and decisions. (One role is to stand against such prescriptions!)

This brief commentary demonstrates that there is a comfortable fit between the concepts of complex adaptive systems and observable characteristics of the arts world. It also shows that from these concepts can be drawn hypotheses for the formulation of productive arts policies.

Evolution and coevolution, biological and cultural

It is interesting that the Government's main advisory body for the development of the "communications highway" has advocated a "managed evolutionary" approach, because while it believed itself capable of predicting the overall direction of development, it could not anticipate the detail of evolving technologies and patterns of public usage. (Chapter Six)

The processes of evolution are an extremely important facet of the application of the theory of complex adaptive systems to the arts and arts policy formulation. Cultural evolution is presented as an analogy to biological evolution.

Like the bacterium whose biography entertained us, biological species evolve within an ecology consisting of the physicochemical environment and other complex adaptive systems. A frog evolves a long, swift and sticky tongue to catch flies. To survive, the fly has to evolve a new defence. If it can find an extra turn of speed, taste more ghastly, or grow a sting, the fly could win the round. The frog will need another food source, or its own successful counter-mutation. There could be a *co-evolutionary* ratcheting up of the skills of this pair until, perhaps, there is a temporary equilibrium with stable frog and fly numbers.

While these pairings are interesting, species of course coevolve with a very large number of other species in the same ecological system, all, as complex adaptive systems, searching for those regularities of behaviour of the other complex adaptive systems that are pertinent to their own survival and well-being, and through chance mutations, adapting to fill any niches of opportunity.

Human culture as a complex adaptive system contains within it identifiable complex adaptive subsystems such as government, economies, arts sectors, all interacting, and driven by interacting human beings, themselves complex adaptive systems. Gell-Mann presents the notion of *cultural evolution* as a phenomenon

influenced, obviously, by the biological adaptation and evolution of other systems in its ecological context, but itself dependent on learning and invention.

It is important to note that some scientists involved in this work expect to find some universality in theories of the behaviour of complex adaptive systems at all these hierarchical levels from the biological to the sociocultural and, with the necessary qualifications, in their speculations they range freely among them.

Biological evolution "often exhibits the phenomenon of *punctuated equilibrium*, in which species...stay relatively unchanged...for long periods of time and then undergo comparatively rapid change over a brief period". (Gell-Mann. p238) The punctuations can be caused by alterations in the physicochemical environment, or by a drift of small biological changes in a species which carry it towards "an unstable situation in which fairly small genetic changes can radically alter the phenotype." (Ibid p239). If this happens at the same time for a number of species, there can be major changes in the ecological community with extinction events and the creation of new ecological niches. *Gateway or breakthrough events* are particularly dramatic punctuations responsible for very significant change in the phenotype and the opening up of new possibilities, "sometimes involving higher levels or organisation or higher types of function." (Ibid p.240).

Gell-Mann notes that human creative thinking, which he sees as the highest achievement of evolution, also proceeds in small increments to or punctuations of what has been already been conceived, but sometimes with a gateway event in which a major new conceptual structure appears and causes a shift in the paradigms of the particular discipline or the broader culture. (Ibid p.260)

Designer Harry Williamson (we all have a passing familiarity with his design for the $100 note) offers a perception of the recent development of design in Australia. This could be interpreted as a succession of small increments leading to a gateway event. There was a slow development in Australian design over its colonial and commonwealth history, accelerated in the 1980s with the inception of the design program of the Australia Council. This set out to identify examples of good Australian design, raise public consciousness of its value, and connect industry with talented designers. There was some progress in increasing the use of high quality Australian design in graphics and manufactures. The gateway or breakthrough was a consequence of the government's moves to create a more efficient industry and an export culture through, among other things, the lowering of tariff barriers. Australian industry had to find a means of survival against cheaper imports. It began to look to exporting. When serving only a domestic market, it had been happy to license or "adapt" foreign designs for its products. But it could hardly export these designs back to their sources and so had to invest in its own. Design activity became integrated into the front line of some Australian manufacturing.

The "fitness" of complex adaptive systems

"*Fitness*" is a measure of the success of the adaptation of a complex adaptive system to the selection pressures emanating from its environment. In the arts, this notion of "fitness" has to do, for instance, with the fit between the artist or arts organisation and the cultural environment, and how the lack of fit might spur artistic development.

Gell-Mann provides us with the metaphor, a *fitness landscape*, expressed graphically. (Ibid. p.249ff) (BORROW OR ADAPT HIS GRAPH?) Evolution moves an organism across this landscape towards fitness at the bottom of depressions or *basins of attraction*. The deeper the basin, the greater the measure

of fitness. For the organism to achieve maximum fitness it must not become marooned in a shallow basin when there is a deeper one nearby. It needs to be jiggling around in a way which will give it the opportunity to bounce out of shallow basins and slide into deeper ones - but not jiggle so much that it cannot keep its place anywhere. There has to be an edge of disorder to the orderliness of a species. For an evolving species, random mutations are a sort of jiggling, as is the diversity resulting from sexual reproduction.

Analogies in the human creative process are the introduction of conceptually dissonant data into a problem to break open conceptual limitations to the approach (as in the use of scientific theory in this book about the arts) - or the sub-conscious synthesis of disparate concepts or images in the "incubation" phase of the creative process (e.g. the mind's work overnight when one goes to bed with a problem to solve). And again, there are analogies in cultural evolution.

The 1985 Tribe Report into the future development of Australian orchestras recommended that the ABC orchestras should be divested to local managements in order to maximise their opportunities to evolve towards excellence in performance and a distinctiveness in style. It did this in part because of their low standards at the time, and the poor ABC management. It foresaw that the ABC might respond to the criticism by improving support to the orchestras and raising their standards to a level which reduced the criticism to a low background murmur. While the improvement would be welcome, it would actually prove to be an obstacle to their optimum development. In effect, they would be stuck in a too shallow basin.

The Tribe Report caused major "jiggling" in the ABC and its orchestras. As a consequence, they did improve rather more than had been foreshadowed, and juddered their way down into basins of moderate depth. However, the name of the game in orchestral music is excellence. None achieved high international standard; none were down in the deepest basins of all, along with the Boston Symphony, the Berlin Philharmonic. This was noted by the Prime Minister, who mandated in his *Creative Nation* cultural strategy a change of ecology for the Sydney Symphony: divestment from the ABC to self-management, more funds, more players, international touring and the objective to achieve international quality. This introduces new selection pressures on the SSO, a new fitness landscape - potentially global rather than continental - with a demanding international audience to assess it against its own claims to excellence. It also, as it happens, will introduce funding pressures on the Government beyond those it had anticipated; its arts policies will be demonstrated to be caught in too shallow a basin to succeed in the world it wants to conquer.

A widely recognised international success for the Sydney Symphony could have many ramifications within its zone of influence. The fitness landscape for other Australian orchestras will change as they are compared with it, possibly unfavourably; there could be effects on their audiences and funding support, positive or negative. The SSO will have demonstrated certain modes of successful adaptation to the international environment, which are then available for emulation. The overseas stereotype of Australian orchestras, or music, or society, could be changed very positively with potential positive consequences for other Australian endeavours. New niches, new opportunities could open up in many directions, some of them quite unexpected.

The arts-world illustrations of scientific concepts given so far draw from past or present realities. Let us now instead ask some illustrative questions of the future. What is the fitness landscape for Australian arts in Asia? What alternative adaptations will confront us as we succeed in entering that realm? What

previously unforeseen niches might open for our arts if we are successful? What will be the selection pressures on the evolution of Australian art with the development of a global fitness landscape through electronic communications? What will be the effect of computer production of art on traditional art forms? What new niches for the arts are opened through computer simulation techniques devised for non-arts purposes? What of the "art" produced by "thinking" computers, themselves functioning as complex adaptive system? How will it change the arts landscape? Does it serve us to place such questions in a conceptual context of adaptation and evolution? In due course, we will take some of these issues further.

The edge of chaos.

We live our lives in a world which becomes manifestly more complicated. It seems to us in some ways to be newly chaotic: the world of work has changed and we cannot find our way around it successfully - perhaps we cannot find a job; land is being destroyed by salt or erosion, rivers are poisoned, species are dying. At the same time, pattern is found in more and more complex phenomena, which thereby in a sense are simplified. These patterns are utilised in various interventions into our ecological and cultural environments. We discover ways to create new strains of nourishing plants, and new ways to grow crops, but across the border from our implementation of these inventions is a chaotic territory of chance and unforeseen consequences, some of them disastrous.

The everyday impression of a world poised between order and disorder has been captured in a beautiful computational discovery dubbed the "edge of chaos". This phenomenon in its mathematical form is difficult and so far unexplained, but seems prospectively to be one key to a future understanding of complex adaptive systems such as human cultures. It may also offer a quite fundamental and illuminating insight into artistic structure.

Cellular automata, artificial life and the edge of chaos

Chris Langton, a scientist at the Santa Fe Institute, attempted to build an analogue on the computer of reproduction and evolution, a sort of "artificial life". He had succeeded in having a computer-programmed entity called a *cellular automaton,* a computer analogue of a living cell, reproduce itself.

In the course of his research, he came upon work by Stephen Wolfram of Caltech, claiming that all cellular automata fall into one of four classes. (Wardrop, p.225) Imagine these phenomena represented graphically on a computer screen. Begin with a network of cells, some living, some dead. In Class 1, the rules governing their interaction are such that no matter what pattern of living and dead cells you start with, within a very few operations of the rules, everything dies. The computer screen empties. In Class 2, the initial random pattern on the screen quickly coalesces into a stagnant pattern of static blobs, with perhaps a few other blobs periodically oscillating. In Class 3, the rules produce so much activity that the computer screen seems to be boiling. Nothing is stable or predictable. Class 4 is a phenomenon which seems unique to cellular automata: the rules produce "coherent structures that propagate, grow, split apart and recombine in a wonderfully complex way", without ever settling down. There was no explanation for Class 4 behaviour.

Langton eventually discovered a parameter governing these outcomes for cellular automata: the probability that any given "cell" would be alive in the next generation. With zero to 1 as the full sweep of this variable, a score of zero after one step left all cells dead, a score of 1.00 meant all were alive. In either of these cases, the result is the total stasis of Class 1. Small departures from these poles

produced a static or frozen Class 2 pattern. With a score of 0.50 there were equal numbers of live and dead cells, and the maximum turbulence and chaos of Class 3. However, *around the very precise value* of 0.273, he discovered very complex, dynamic but coherent Class 4 behaviour, a mix of chaos and order. The computer screen was filled with rich, dynamic, constantly changing pattern. Langton named this transition point the *edge of chaos*. (This is not the "chaos" of chaos theory.)

It was Langton's intuition that the edge of chaos is the point of emergence of life and mind - and that life and mind are not properties of matter per se, but of the organisation of matter, the *connections* between agents, as summarised in computation. At the edge of chaos, the components of a complex adaptive system never lock or freeze into place nor dissolve into turbulence, but are stable enough to store information and evanescent enough to transmit it. There are simulations and other tangible evidence that begin to demonstrate possible manifestations in the natural world. (Wardrop, p.313; Gell-Mann p.319)

Los Alamos physicist Doyne Farmer says (Wardrop, p.295) that accepting the edge of chaos is a phenomenon in the real world, we "will still have to explain how emergent systems *get* there, how they *keep* themselves there, and what they *do* there. Since the systems that are capable of the most complex, sophisticated responses will always have the edge in a competitive world, goes the argument, then frozen systems can always do better by loosening up a bit, and turbulent systems can always do better by getting themselves a little more organised, so if a system isn't on the edge of chaos already, you'd expect learning and evolution to push it in that direction. And if it is on the edge of chaos, then you'd expect learning and evolution to pull it back if ever it starts to drift away. In other words, you'd expect learning and evolution to make the edge of chaos stable, the natural place for complex, adaptive systems to be."

As to what these systems do at the edge of chaos, "the deceptively simple fact is that evolution is always coming up with things that are more complicated, more sophisticated, more *structured*, than the ones that came before." Perhaps learning and evolution do not only draw agents to the edge of chaos, but move them along it in the direction of greater and greater complexity. There is an upwards cascade, with building blocks at each successive higher level reorganising themselves, proliferating in new structures which can combine to emerge at a higher level yet. Some of these will be successful and some not. It is the successful ones which persist and form the basis for the next leap upwards.

The edge of chaos in the arts

As a computational phenomenon, the edge of chaos is very precise. It is not at all clear how such precision could be defined or demonstrated in the world of the arts. But at the least, like the scientists we can find illustrations by analogy or metaphor. I propose that the phenomenon of artistic style can be explained as an aspect of the edge of chaos. It must be emphasised that here we depart from science into free speculation.

The development of the tonal system in music over the nineteenth century might serve as an example. This account is a sort of caricature, intended to be comprehensible to non-musicians. The piano keyboard gives visual expression to the menu of sound pitches used as the ingredients in eighteenth and nineteenth century "tonal" music. If you play the white notes one at a time in succession from left to right (the notes being named *a - b - c - d - e - f - g - a - b - ...etc.*), you will hear a familiar "tune" which repeats itself, "higher" up, beginning after each set of seven notes. In that sense, there is a total of only seven white notes on the piano. It is loosely the case that a good deal of music from the mid-18C could be

translated to those white notes. When they are played together and in sequences according to the rules which govern that musical style, we hear music that is familiar to us in a particular way. Also, when this happens, a hierarchy of importance is established among the notes. There is one note which becomes a sort of centre of gravity, a "home" note. Other notes function as alternative, lesser centres of gravity.

Ah, but what about the black notes? Wedged into each set of seven white notes are five black notes. In this cartoon of musical history, let us regard the black notes as a sort of foreign territory. When the musical style called only for the use of white notes, an intruding black note would be heard quite clearly as "wrong!" - unpleasant, inappropriate, an injection of chaos into orderliness.

Imagine now that a composer, still working within the rules of this musical style, occasionally, in a little display of daring and originality, throws in a black note. Ooff! says the audience, shivering in pleasurable discomfort. Ooff again! Then it claps louder than usual at the end of the piece. The composer makes a note to be sure to throw some black sounds into the next piece.

Through repetition and experimentation, over the years all of the black notes are brought into play, the musical style changing to accommodate and regularise them. What previously was heard as orderly and familiar is now heard as boring and predictable. What previously was heard as ugly and chaotic is now heard as orderly and familiar. Here is the push towards complexity, pulling phenomena previously seen as chaotic or not susceptible to patterning into new conceptual hierarchies.

The musical style at any time, and perhaps especially in its most distinguished manifestations, might be heard to sit quite precisely on the edge of chaos. It takes particular sonic elements and combines them in a satisfying, ingenious, dynamic manner to produce an aural artifact of a quite specific tautness and character. If it does this in a routine way - i.e. the path is without surprise - we have a piece which seems like a Wolfram Class 2 phenomenon. Whether fast or slow, it might be heard as effectively static. If the piece breaks from style and leaps off into experimentation, it will be heard by listeners as chaotic, to a degree conditioned by their individual abilities to make sense of new ways of patterning sound.*[i]

By the early 20C, the precepts of the musical style had incorporated all the notes of the piano and spread democracy among them. While a musical work might be heard to have one note overall as its centre of gravity, within its progress the centre could shift temporarily to any of the twelve tones. While, as before, any simultaneous combination of tones could be heard as having its own centre of gravity, the permissable combinations had multiplied enormously. Melodies, harmonies and form had become much more complex. Composers, having observed the progress of this style through greater and greater complexity, began to wonder whether its possibilities were exhausted.

In 1914 the Viennese composer Arnold Schoenberg produced a theory for a new musical style in which all the twelve tones would be equal, none would be a centre of gravity, and dissonance would be "emancipated", i.e. dissonant sounds would have equal status with consonant sounds. This theory became the basis of much of the stylistic development in the classical music tradition over the remainder of the 20C. It took the late blooming phenomena of the preceding tonal system as the building blocks for what, in many aspects, was a radical reordering of the basis for musical structure. To the extent that it follows on these precepts, much of the subsequent evolution of music concerned itself with quite new parameters. The Schoenberg innovations could be seen as a phase transition to a

new, *emergent* musical phenomenon. "Emergence" will be explained in the next section.

If this is an example of the manifestation of the edge of chaos in the world of the mind, one is led into further speculation. If, as Langton believes, life emerges and exists on the edge of chaos, then we in every cell of our bodies live on the edge of chaos. If this is our fundamental being, then we should not be surprised to find it manifested in our thoughts and interactions. The clarity of the manifestation can be blurred in dealings with the larger world because of its complexity and because individuals' perceptions of what constitutes order and chaos vary so much. However, through the arts we can see the activity of a mind, living on the edge of chaos, ordering a world which is of its own creation. The primary interaction with the external environment is relatively simple: the environment is an audience of people with whom there is a tacit agreement about the vocabulary and syntax governing the world to which the artist will bring order. This conceptual structure, although now a given, was of course itself a creation of minds. There is a world created by a mind, and we can see it because we are party to this agreement.

If this hypothesis is correct, then we would expect to find evidence of life on the edge of chaos in all our dealings, but clearly apparent in works of art. It is especially clear in some forms of music because in music, content is form is style, and listeners with an understanding of a style can discern its order and know where chaos intercedes. But is this not evident in other ways in other art forms? In all forms, style creates expectations, and the particular art work goes on to satisfy or frustrate them.

The dynamic of grasping order from chaos is evident in art beyond considerations of style. "What's at *stake* in this scene?" says David Williamson. The scene is of interest because it establishes a conflict which we want to see resolved. The perfectly symmetrical visual pattern or art work can be boring; an asymmetrical art work which achieves a curious balance can be more satisfying because we must find the balance beyond the apparent irresolution.

Perhaps the experience of catharsis is somehow tied in with life on the edge of chaos. Catharsis, that tremendous release to well-being and aliveness, the surge of blood and gladness, comes with delivery from too long or too great an immersion in chaos and disorder. We have *that* experience at this time because such a resolution accords with a fundamental of our existence.** We reclaim our position on the edge. The organism rejoices. It is an experience less available to people who are quietly lost in routine. (Perhaps they have it when they escape from constraint to freedom.)

Even greater the experience of enlightenment, where a whole world thought to be in disorder is suddenly seen as One.

It is possible for a mind to create art in a style governed totally by private rules, for an audience consisting only of itself? There may even be artistic evolution within this private world. However, it is a prerequisite for the cultural significance of an art work that its rules must be understood and valued by people other than its creator. Cultural evolution depends not only upon the lone inventions of say, an artist, but on a participative audience that shares an agreement about the forms and rules of the culture and the boundary of chaos. We have attempted to conceive of artistic style in terms of the edge of chaos. The agreement within a cultural group about the rules of the style carries the concept beyond the internal structure of the art work and into the societal realm. A cultural group, defined by this agreement, becomes a complex adaptive system, dealing

with other complex adaptive systems and playing its role as an evolutionary force on the edge of chaos.

Emergence, phase transition and "bottom-up" self-organisation.

The property of emergence is evident in both the inanimate and animate world. It gives some explicit meaning to the saying "The whole is greater than the sum of its parts". Water has the characteristics of liquidity. Liquidity is not present in a single water molecule, but is present in a collection of water molecules. So liquidity is a new quality which *emerges* when a number of single water molecules are placed in conjunction. Solidity is an emergent property when the temperature of water is lowered to freezing point. Mind is an emergent property of brain. Schoenberg's musical style might be seen as emergent from the burgeoning complexities of late romantic music. The change from one state to the other is called a *phase transition*.

Through a computer simulation exercise, Craig Reynolds of the Symbolics Corporation in Los Angeles demonstrated how complex behaviour in complex adaptive systems could emerge from the operation of a small number of simple rules. (Wardrop, p241)

This simulation was designed to capture the essense of flocking behaviour in birds, herding behaviour in sheep, or schooling behaviour in fish. "Reynolds' basic idea was to place a large collection of autonomous, birdlike agents - "boids" - into an on-screen environment full of walls and obstacles."

Each "boid" followed three simple rules of behaviour:

- It tried to maintain a minimum distance from other objects in the environment, including other boids.
- It tried to match velocities with boids in its neighbourhood.
- It tried to move toward the perceived centre of the mass of boids in its neighbourhood.

The rules did not include the instruction, "Form a flock". Quite the opposite: they were entirely local, referring only to what an individual boid could see and do in its own vicinity. If a flock was to form at all, it would have to do so from the bottom up, as an emergent phenomenon. "And yet flocks did form, every time. Reynolds could start his simulation with boids scattered around the computer screen completely at random, and they would spontaneously collect themselves into a flock that could fly around obstacles in a very fluid and natural manner... In one of the rounds, a boid accidentally hit a pole, fluttered around for a moment as though stunned and lost - then darted forward to rejoin the flock as it moved on. Reynolds insisted that this last bit of business was proof that the behaviour of the boids was truly emergent. There was nothing in the rules of behaviour or in any of the other computer code that told that particular boid to behave that way." (Ibid. p242)

The flocking behaviour is, by definition, "*self-organising*". It emerges from the "*bottom up*".There is nothing in the relatively simple rules which could lead to an expectation of the actual outcome.

In his *autocatalytic set* experiments, Stuart Kauffman developed a simulation of the possible basis for the emergence of life through the "autocatalysis" of chemicals in the environment. This is yet another simulation in which order emerged, bottom up, from relative chaos. Kauffman showed that, given a sufficient level of environmental richness and complexity, through catalysis there could be a self-organisation of chemicals to produce basic chemical building blocks for living cells.

This idea of spontaneous emergence of self-organising viable entities from a sufficiently complex and diverse environment can be transferred to the explanation of social phenomena such as technologies, economies, culture. "(...S)ays Kauffman, once you have the interactions, it ought to be true in general that autocatalysis occurs whenever the conditions are right ...whether you're talking about molecules or economies. "Once you've accumulated a sufficient diversity of objects at the higher level, you go through a kind of autocatalytic phase transition - and get an enormous proliferation of things at that level." These proliferating entities then proceed to interact and produce autocatalytic sets at a still higher level. "So you get a hierarchical cascade from lower-order things to higher-order things..." (Ibid. p317).

Kauffman discovered in a subsequent experiment designed to simulate coevolution, that "when [the computer-simulated] species were given the ability to evolve their internal organisation, the ecosystem as a whole did indeed move toward the edge of chaos..." Further, "(f)rom the numerical simulations that we've done," says Kauffman, "it turns out that the maximum fitness is occurring right at the phase transition [to the edge of chaos]." (Ibid. p.312-3)

This seems to throw light on the question of which environment would be more propitious to the development of a vital arts culture: an environment of plentiful, diverse, small-scale arts activity, or a less diverse environment of a small number of excellent, large arts institutions. It might be a basis for our letter to Minneapolis or St Paul. "Evolution thrives in systems with a bottom-up organisation, which gives rise to flexibility. But at the same time, evolution has to channel the bottom-up approach in a way that doesn't destroy the organisation. There has to be a hierarchy of control - with information flowing from the bottom up as well as from the top down. The dynamics of complexity at the edge of chaos...seem to be ideal for this kind of behaviour." (Ibid. p. 294).

The phenomenon of bottom-up, self-organising behaviour seems to be crucial to any policy for cultural evolution or development. It will be taken up in Chapter Three and will recur in a number of contexts throughout the book.

Summary of the argument of this chapter [OPTIONAL]

The exercise of prediction, unless it is a leap of intuition, is an attempt to discern a chain of cause and effect leading to an outcome significant enough, in this case, to warrant comment. Science is the discipline most concerned with demonstrating or theorising about cause and effect, and so in making predictions about arts futures, it is appropriate to look around for some relevant branch of science which might assist.

In everyday life we are inclined to think of cause and effect as rather cut and dried. We have the daily experience of moving objects around, and they respond as expected. We are pretty sure that the workings of the car and the CD player would be just as predictable, if only we knew what they were. However, contemporary science shows that cause and effect are not in nearly as certain a relationship as we generally suppose, especially when considering the behaviour of the fundamental particles of matter or of living beings, whether individually or in assocation with each other. A new science is evolving to capture the causal relationships in complex adaptive systems: entities such a biological beings, forests, economies - or art forms or cultures. These "systems" are obviously "complex". They are "adaptive" because they are in constant interplay with their environment, adapting as necessary for their well-being to the endless changes it presents. Their adaptation is through evolution of their basic structure, or through learning, so that a "fit" is created between them and their environment.

Complex adaptive systems can be conceived as games played by "agents", whether cells, plants, humans or arts organisations, against their environment. It is necessary to win at some level in order to be able to keep playing, But to win also is to learn, to use feedback from the environment to improve performance. Since the environment is always changing, this game never ceases, and complex adaptive systems are characterised by perpetual novelty.

Both evolution and learning are enhanced or transformed by the formation of "building blocks" - for instance in the former, new cellular structures or in the latter, new conceptual configurations - at ever higher hierarchical levels. So, to take the next step in learning an artistic discipline, we do not have to retrace our steps through the immense intellectual space between raw, undefined artistic materials and the elaborate constructions we have already been able to place on them, but can reshuffle the building blocks of higher order concepts already organised and understood, sometimes to emerge to a new hierarchical level. An artistic style can almost always be seen as building upon aspects of its direct predecessors.

Causality in complex adaptive systems must take account of multiple "agents" acting in parallel, without central control. The arts world as a complex adaptive system consists of a myriad of artists and arts organisations, each acting more or less independently but also interacting with the others, as well as the larger environment of the society, the nation and the natural world. There is no Master Organiser of the arts to control all this activity; that would be almost impossible. Development in the arts therefore is the outcome of the sum of the activity and invention of all of the participants. It is characteristically a "bottom-up" phenomenon, moving in small increments, becoming ever more complex, cumulatively preparing for an occasional "gateway event", a significant step in cultural evolution, sometimes introducing some "emergent" phenomenon not previously conceived - a new artistic style, for instance. For example, many in the popular music community anticipate the emergence of a new popular music style to attract the mass market, but almost by definition, cannot predict its sound.

Much of the research into complex adaptive systems uses computer simulations, a scientific tool capable for the first time of capturing the interactions of many causal agents, quickly processing millions of calculations in complex mathematical problems or compressing in time representations of the slow moving processes of biological evolution. (Many of these simulation processes have been adapted by artists for the production of art on computers.) The outcomes of some of these experiments are astonishing. One, of special interest to this study, reveals a curious and beautiful phenomenon at a very precise place between order and chaos as represented on the computer screen. Its discoverer hypothesises that the "edge of chaos" has real-world correlates, and is in fact the place where life and consciousness emerge. I conjecture that artistic works, as the products of the minds of beings living on the edge of chaos, are therefore themselves on the edge of chaos. This could be inferred from the phenomenon of artistic style: the ordering of the elements of an art form according to a specific set of rules to achieve a specific type of effect. The execution of an art work within a given style must achieve this order but, to maintain the interest of the audience - minds on the edge of chaos - must somehow dip into disorder, must tip off towards chaos but then reclaim the edge, in the process bringing a new order to the chaotic elements encountered.

In even more condensed summary, then, the concept of the arts as a system of complex adaptive systems draws our attention to an arts ecology of self-

organising, independent artists and arts bodies freely cooperating, competing and evolving new hierarchies of concepts and structures in a continuing and surprising way. The processes of cultural evolution and learning can be seen to be at play in deciding the course of development of arts and arts organisations. The theory of the edge of chaos has the potential to show a relatedness between fundamental aspects of human existence and its expression through works of art, and to explain the continuing evolution of art in ordering that which previously was disordered.

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In the next chapters these theories are applied in an illustrative way to the analysis of some aspects of arts activity, and so point to the types of outcome that might be expected from different types of intervention by arts policy makers. Many of the perceptions about the culture of the arts have been stimulated by the different world view of this scientific theory; others have arisen independently. *This book does not pretend in any way to be a piece of scientific work. It is a speculative exploration.* If it leads the reader into further speculation of his or her own, so much the better. Perhaps it could even provoke a real scientist to undertake a piece of real science. But we could not reliably predict that!

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* The 'meaning' of Western tonal music depends to a great extent on the regularisation *within* a style of this move from 'order' to 'chaos' to 'order'. Musical styles may be thought of as probability systems: that is, for a listener experienced in listening to a particular style of music, a statement of a musical phrase will arouse expectations for a subsequent musical statement with certain characteristics falling within the assumptions of the style. Thus a musical antecedent has a tendency to find completion in a certain type of consequent. According to one widely accepted theory, if its progress towards this resolution is deviated or otherwise inhibited, emotion will arise in the perceptive listener as though the musical tendency were his or her own. (See, for instance, Leonard B. Meyer: *Music, the Arts and Ideas*. University of Chicago Press, 1967) The listener experiences tension when the musical tendency is frustrated and gets pleasure from its resolution - or from faith in its future resolution. Here the chaos arises not from a temporary departure from style, but from surprising manipulation of materials within the style. Thus, perhaps, the invocation to artists in all genres: "Astonish me!"

** Santayana's explanation of the experience of beauty posits a sort of structural identity between the observer and the observed: "When our senses and imagination find what they crave, when the world so shapes itself or so molds the mind that the correspondence between them is perfect, then perception is pleasure... Beauty is a pledge of the possible conformity between the soul and nature." (George Santayana: *The Sense of Beauty*. Collier, New York 1961, p.182). Gardner Murphy seems to make the same point in a different way: "The order of the psychophysiological response to music may be the order of the orchestral production itself. The body may receive and maintain the esssential structure which is in the stimulus configuration, and music is 'sublime' or 'trivial' depending on the degree to which order is maintained." Gardner Murphy and Herbert Spohn: *Encounter with Reality*. Houghton-Mifflin, Boston, 1968, p. 238)