Chapter 6

Review of Evolution and Beyond

Introduction

We have a rational explanation of life and as a consequence of this we have also discovered the meaning of life, or lack of it as some would say. We are part of the Evolutionary process for creating more efficient ways of organising the material of the universe. Everything else is a means towards this end.

This is a somewhat pyrrhic victory for rationality because the meaning provided is more of an explanation than a purpose. In fact, by accepting this explanation it removes many of the purposes which mankind has created to encourage or motivate our conscious minds to participate enthusiastically in the life process. Let us remain purposeless for a while longer and savour with our left brains the rational sense of it all.

In brief we have speculated on the origin of life which arose out of a new class of molecules called supra-molecules. These complex molecules had the ability to self-replicate their structure. We went on to analyse evolution, the process which took supra-molecules and turned them into us and the myriad of other life forms we see today. Evolution comprises heredity, selection and variation and results in adaptation. Behaviour is seen as just another adaptation, a strategy for survival just as much as a leg is. Different types of behaviour occupy different positions on the behavioural spectrum which ranges from reflexive/instinctive up to flexible, acquired behaviour. Behaviours are driven by genes, some directly others indirectly according to where they reside on this spectrum. The silent right brain is the seat of genetic drives which motivate and control us. The left brain is the location of rationality and language through which we can create more effective and powerful strategies. The mind is our mental model, the neuronal representation of reality through which we as humans devise and evaluate our acquired behaviour. We have left and right brain models and thus two minds or we may look on these as two distinct parts of a single mind. Our bodies, our behaviours and our mind(s) are designed by and devoted to perpetuating the evolutionary system. Everything we do is based upon this principle. This is the meaning of life.

It is instructive to watch some everyday scenes from this perspective. Television gives a good opportunity to watch human activities from a suitably dispassionate viewpoint. Whether you are watching the news or a socialising ‘soap’, it is remarkably easy to interpret the activities with the view of life expressed in this book. It is uncanny how well it works but disconcerting if you are accustomed to relying on a more embroidered view of life.

We went on to see how humans can achieve at least freedom of thought in the left brain and perhaps freedom of action if we can transcend the genetic and evolutionary forces that influence us. We have the opportunity for freewill rather than remain tied to our genetic drives as slaves to evolution. However, achieving freedom and escaping the command of evolution requires more than just understanding. Understanding pain does not stop us feeling it but perhaps feeling pain can stop us from understanding it; likewise with understanding life. It does not stop us from living life but most surely the act of living stops us from understanding it, because our thoughts are biased or driven by evolutionary algorithms. Our

experience of and desire for love, pleasure, status, friends are so real that they defy acceptance of their explanation. This is because of our left-right brain dualism and that evolutionary truth would undermine our fundamental social rules. Even the strongest proponents of evolution can be seen to be in two minds about its implications.

Exercising our freewill by considering the implications of this rational view of life provides us with an opportunity to choose our future and potentially escape our evolutionary destiny. Whether we want to escape from this route is of course an important question. A lot depends on what the future holds and what the alternatives are. All scientific theories should enable predictions to be made from them, so our scientific account of life should lend itself to helping us see the future. What is becoming increasingly apparent is that the opportunity to see the future and change it may not be available for long.

We cannot even bury our heads in the sand because, as I have hinted and will expand upon, there is a revolution in evolution occurring right now. The old evolutionary mechanism which has been operating on the same basis for billions of years is starting to change in a radical way. In particular, we are coming to the end of one phase, bio-evolution. There are other processes that we are part of. We need to see how, as evolutionary products, we fit into this wider picture.

In summary, I have described where we came from, how and why. If we are to make choices then we need to turn from looking at the past towards a clearer understanding of the present and where we are headed - the future of life and evolution. Let us review the evolutionary progression so far to consolidate our understanding and then to see what the implications are for the future.

"In the beginning ..."

In the beginning there was energy - and that was all. This energy had certain in-built rules and it occupied space, but none of the complexity of our present universe existed. Everything else was to emerge from this energy with rules. As it was seen in chapter four, time is defined by the movement of matter (a form of energy) and therefore before matter exists there can be no time - there is no before.

Quite quickly after the big bang this energy started to become organised - self-organised. This happened according to inherent physical laws and universal constants. These may or may not themselves be changeable as we shall see. The patterns of energy packets that worked, that is to say were stable, appeared and remained in the form of subatomic particles and particular packets of energy. Some energy remained in its original form, at what we shall call the first complexity level. The patterns or packages of energy that worked better became more frequent in the first example of cosmic natural selection. Whether this process was a one-off or part of a continuous process depends on your view of what currently goes on in suns, black-holes and other primordial cosmic entities.

Atoms formed from subatomic particles and molecules from atoms. Natural selection of atoms and molecules occurred. Stable combinations of subatomic particles were selected, self-selected, to form atoms. Similarly, different combinations of atoms were produced by random collisions and only the stable ones of these molecular 'mutations' were selected, that is continued. Some atoms remained as atoms at the atomic complexity level, but could still participate, be used, in higher complexity levels.

The ability to form molecules emerged from the properties of the atoms, just as atoms formed from energy. These were amongst the earliest examples of emergent properties giving new complexity levels. Molecules self-organised, they evolved into self-replicating macromolecules or supra-molecules. This happened by the same chance processes that caused the formation of a water molecule, although due to the complexity of the structure, self-replicating molecules were much less likely to occur.

As soon as a new level of organisation appeared it gave the opportunity or possibility of it too being organised into a new complexity level. Each subsequent complexity level utilised the former. Self-replicating molecules were created using the same Evolutionary principles and methods as before but represented a big step because of the number of further possibilities for interactions which emerged from this.

This process continued as seen in table 2. This table illustrates how we have two types of evolutionary change: inter-complexity level change and intra-complexity level change. The latter involves the gradual unfolding of the many ways with which the new emergent properties at that level can be arranged. It results in diversity as seen in the periodic table for atoms, the range of chemicals, the variety of single cell organisms, the diversity of metazoan animal species, the range of societies and cultures, or the types of computer. I call this overall process Evolutionary Structural Emergence (ESE).

The Evolution of Evolution

Inter-complexity level change represents qualitative steps in organisation which are permitted by the emergent properties of the preceding level. It is shown by the transition from atoms to molecules, from molecules to supra-molecules, from supra-molecules to cells and so forth.

We normally associate evolution with the biological phase of complexity levels, cells and bodies. What I am suggesting here is that in an analogous way to how biological evolution takes place, there is a grander Evolution, denoted by a capital E, which encompasses the inter-complexity level changes. The Evolutionary mechanism has manifested itself in all these complexity levels giving rise to atoms, molecules, organisms, societies and computer systems. The biological level is one phase, just as vertebrates are one part of animal evolution.

The currency of this process is information. Information is the potential to use energy to organise matter. It is the sum of the rules which define how something will behave. It acts like a cosmic catalyst bringing about arrangements of matter, static and dynamic, which would not have occurred very easily otherwise. It has the ability to counteract the second law of thermodynamics and to reverse entropy flow, at least locally.

All these complexity levels have information. At the atomic and molecular level this information is integral to their components, a property of themselves. In self-replicating molecules and biological levels of evolution the information is to a large extent contained separately. It is abstracted from all molecules to be held by a specialised subset of them - DNA.

All levels contain the property of being able to organise matter, that is to say they contain information. They exist because they can and do organise matter, in fact they cannot stop doing it.

	Main Information Store	Complexity Level	Type of Evolution
1	Energy	Physical forces	Physical
2	Subatomic particles		
3	Atoms	Chemical bonds	
4	Molecules		Complex bonding
5	Self-replicating macromolecules	Chemical	
6	Cells / DNA	Biological	Genetic
7	Multi-cellular-tissues / Bodies		
8	Brains / Words	Human	Neuronal
9	Societies	Techno-Social	Digital - Electronic circuits / Light
10	Computer networks	Informational	Pure Information[5]

Table 2 To show the wider Evolutionary process and the overall progression through complexity levels

Let us continue our examination of the essence of Evolution and how it develops in the more familiar evolutionary arena of biology. DNA was adopted (or adapted) as the main repository for the information of an organism. This abstraction or separation of information from structure opened up numerous possibilities for new, more flexible arrangements. Cells became established as the standard unit for operational reasons. Single-celled organisms abounded until some utilised a new collective property that emerged from that level - multicellular organisms were now possible and could work sufficiently well to earn existence. These multicellular organisms took the form of bodies, again for operational reasons and to facilitate movement. Single-celled organisms still exist today because some of them, in particular contexts, are able to maintain their access to resources. Not all situations or supplies of resources favour a multicellular approach. Evolution can be viewed simply as the competition for available atoms and molecules within different environments and the different strategies used to gain advantage in doing this. A further emergent property came out of the multicellular strategy, enabling cell specialisation with the resultant possibilities for division of labours and

[5] It could be argued that all evolutionary levels are informational.

differentiation of function. Within each of these levels a variety of approaches led to diversification. And so the process continued until the early hominid stage.

The information of an organism determines how it is built (form) and how it behaves. Behaviour is seen as an expression of neuronal organisation. In order to get through the single-cell stage of reproduction, all this information has to be stored in the DNA of the egg and to a limited extent the egg cytoplasm. It is important to realise that it is not necessary to code total information for form and behaviour in the DNA. All that is required is sufficient in order to result in the end products of form and behaviour. Therefore the initial DNA information only needs to utilise and exploit, in a predictable and repeatable way, the properties that emerge as a cascade when DNA code is transcribed and translated. Another way of putting this is to say that the starting point and some of the rules are specified in the DNA and the rest occurs as a result of the chemicals, systems and structures which subsequently develop. This has the advantage that complex outcomes can be coded for by relatively simple starting points, as long as the emergent and epigenetic channels exist. This property of emergence, found here in the morphogenesis of each organism is analogous to that which gives rise to a succession of complexity levels.

Our conclusion at this stage is that what we thought of as biological evolution is part of a larger, universal Evolutionary process which itself appears to evolve. This is called Evolutionary Structural Emergence. The steps in this process occur by emergence, which in simple terms can be looked on as the expansion of possibilities of interactions or behaviours, as a consequence of new properties resulting from an increase in complexity. The currency of this process is information. This can reside in the entity itself, as in the case of atoms, or can be stored separately, as with DNA in organisms.

Evolutionary Drive

Let us look more closely at the driving force behind this process we call evolution. Why do things evolve? It is the outcome of two components - energy and information. Evolving structures are created by the use of energy under the direction of information. As indicated earlier, information is the potential to use energy to organise matter. Information drives evolution from within. An evolving body contains the rules which dictate what matter can do, how it will behave. Only some of the information in an evolving collection of matter at any one time is used to drive evolution, but there must be some information which causes evolution otherwise it would not happen. When people speculate on constructing living machines they often reach the same conclusion that there must be some ‘motivating’ force without which they are simply machines. It is one thing to create a machine capable of replication, it is quite another to create a machine which will be driven to replicate despite problems which arise from the outside.

Different information will cause matter to be organised in different ways. This information can exist in a wide variety of forms. In atomic and molecular evolution the informational drive is contained within the particles themselves. Random movements cause energetic collisions which result in specific interactions. The nature of these interactions is specified by physical and chemical rules (information) within the atoms and molecules themselves. The scope for evolution is limited since the permutations are somewhat restricted.

At the higher, biological complexity level the constructional possibilities become numerous. Consequently, the informational drive becomes more powerful. After all, in the end it is the information which is evolving and the more open ended the possibilities the greater is the chance of evolving more effective informational drives in the form of the most effective replication machines. The process is self-advancing. Also, we shall see that this informational drive gradually becomes more distinct as an entity in itself. In living systems the drive becomes essentially that of replication. Once replication is enabled and given certain necessary conditions, evolution will occur. For simplicity of reasoning growth is assumed to be part of replication. The question of evolutionary drive becomes one of replication drive. Evolution becomes a comparison of Relative Replication Rates (RRR). However, let us not forget that the RRR for an organism is simply the expression of its underlying information. It is this information which tells the organism what to do, how to interact with the world. In the simplest cases this behavioural information says gather resources and divide.

In self-replicating supra-molecules replication is a consequence of the molecular structure, that is the information created as a product of the pattern of atoms. Given fresh supplies of atoms this information will cause, or even force, the supra-molecules to replicate. Herein lies the key. The matter available for being organised is finite, at least locally. Taken together with the above unstoppable property, this inevitably leads to competition. It now becomes important how well these entities can reorganise matter. Again this manifests itself in a quite simple relationship - the better an organiser is at organising matter, the more there is of it. There is no need for an external judge in this competition. There are only so many sub-atomic particles, whether they group together to form oxygen atoms or magnesium atoms is determined by a form of atomic competition, the outcome of which is decided by the informational content of the subatomic particles themselves, the prevailing conditions and consequently the stability of the atoms.

At the single cell stage the drive comes from cell division. This in turn is a consequence of the information which controls cellular behaviour and consists of the rules which govern the acquisition of resources and mechanism of cell division. This cellular information drives the cell to take up molecules from outside, process them to a greater or lesser degree and then, when sufficient are in place, triggers the division mechanism. This obviously required a lot more information than self-replicating supra-molecules contained. In fact, so much information was required that a special molecule arose to store it. DNA became the repository for much of the information used to drive replication and hence evolution.

In asexually reproducing multicellular organisms the information only needed to become a little more elaborate to distinguish the cell division of growth from the cell division of a budding mechanism which gives rise to more individuals.

Sexual reproduction led to a more complicated situation. There is a reproductive component in the sense that a budding process, the production of germ cells, will result in new organisms. The sexual component exists in that to successfully produce offspring the germ cells must fuse with a germ cell from another individual. Sex is not so much about replication as a mechanism for speeding up the mixing of informational units so as to optimise the evolutionary process. Here we get a reminder that this information is not only the means to an end but represents the end in itself. Information produces replication which in turn enables evolution which creates better information - this is a cyclical process. In theory we could have sex without reproduction. This would require a mechanism for exchanging genetic information and distributing it around the body. New organisms would no longer be

needed. You would just modify the existing ones. This does not appear to have been possible although genetic engineering is heading in this direction.

Sexual reproduction involved more complicated behaviour as did the search and competition for ever rarer resources. This elaboration of behaviour required the development of a nervous system. One consequence was that instead of the behavioural rules being held in the same molecules that exhibited the behaviour, it was now possible to concentrate the behaviour of the organism within the neural networks of its nervous system. We have the appearance of a specialised behavioural information store in an analogous way to how DNA serves as a general store for the organism's information.

It gets a bit more complicated than this since the nervous system is itself a product of DNA. Consequently, many of the behaviours held in the neural store are ultimately stored in DNA. The development of flexible behaviour simply extended this system to give a broader range of conditional responses according to the environmental context. The further development of acquired, flexible behaviour upset this relationship. Acquired, flexible behaviour brought tremendous advantages in terms of evolution. In essence, it allowed the information of an organism to be taken from other organisms or even created afresh and not to be dependent on either its own bodily structure or even the informational content of its DNA.

On the other hand, this same innovation could have been disastrous since the behaviour of the organism was no longer tied directly or indirectly to the informational drive now held in the DNA and expressed through the nervous system. The driving force had become uncoupled from the mechanism for its expression. The solution to this apparent mistake was to find mechanisms to ensure that the acquired, flexible behaviours were controlled by the informational content of the DNA in the organism. I call these mechanisms 'drives' because they fulfil the function of high level informational, behavioural motivators. These drives consist of neural mechanisms in the brain which cause all behaviours to be directed towards satisfying them. They are genetically determined and hence selectable in an evolutionary sense. In this way, our evolutionary drive has passed to replication, then to DNA, then to brain based behaviours and finally to brain behavioural drives which ensure the evolutionary objectives are met.

They represent such fundamental evolutionary requirements as hunger, thirst, the need to mate, the need to defend or attack, the need for territory. By prioritising these, the organism can benefit from the freedom and adaptability of flexible, acquired behaviour to achieve evolutionary goals. They have become the evolutionary drive which pushes forward the whole process in an organism which is capable of saying "why should I?"

Therefore, in response to the question, "What drives the evolutionary process?", the general answer is information since it is this which governs how matter behaves. Information can comprise the ability to organise matter, our definition of life. It is a feature of evolution that it is driven by information and that this information is made more effective by the very process it drives. This ability to self-adapt, to automatically improve is a simple but amazing feature of the evolutionary drive.

The information responsible for evolutionary behaviour is found to reside in increasingly specialised locations. In atoms and molecules it resides in the structure itself. In biological material this information manifests itself as the rules for replication. In simple cells it is found in the cellular components which contain the rules which control cell division. Ultimately the master copy resides in the DNA which acts as the central store for information. In more complicated organisms the

informational drive is found in particular brain based behaviours. This utilises a more specialised structure, the nervous system, which is responsible for processing the increased informational requirement of these organisms. Again, the long term storage medium remains in the DNA. Finally, the informational basis of the evolutionary drive is transferred to more general brain based behavioural drives which ensure that evolutionary objectives are met despite superficial behavioural freedom.

As we reach the end of the biological phase of the universal Evolution, human beings are faced with a question of whether something else, for example society or computer networks, is taking over the driving force of the wider Evolutionary process. A relevant analogy is that of a multicellular organism where individual cells serve a supporting role to the body as a whole rather than being the primary, evolving entity as in single celled organisms. Is Evolution moving on to another plane so that humans are left as a relatively stable component of a larger system? Is our position in the driving seat of evolution soon to be taken by a more advanced organised body?

Is Evolution Directional?

Most experts claim that evolution does not follow a particular direction - there is no overall progression in complexity. The argument is as follows. Evolution can proceed in all taxonomic directions, towards or away from complexity. It has no purpose, no goal. If a complicated organism does not need its adaptations to obtain its resources there is no reason why it should not evolve in the reverse direction, even crossing complexity levels. Adaptations usually incur a cost and therefore must earn their keep through advantage. It is also possible for alternative adaptations to be substituted giving sideways evolution. Complex and simple strategies are just different approaches to solving the problem of survival.

I am proposing that there is a progression in complexity which results from the evolutionary process. It arises as a function of an order-creating system starting from a state of total disorder. I have called this overall progression in complexity Evolutionary Structural Emergence. At the beginning of the universe this created an explosion in complexity development and an explosion is directional if it occurs within the confines of a gun or against a solid wall. Assuming that the universe started as energy which gave rise to simple subatomic particles, this meant that overall the emergence of complexity could only go one way. Together with there apparently being no limit to the level of complexity which is possible, this creates the evolutionary gun barrel which gives the impression of direction.

Consideration, through the fossil record, of the way the living world has changed from its beginnings to the present day clearly demonstrates that there is a progression. Interestingly enough this is also evident in the evolution of many complicated adaptations. For example, the mammalian eye did not suddenly appear. It evolved gradually. Each stage was an improvement over the previous one. It seems unreasonable to suggest that the evolution of the eye does not represent a progression just as it would be perverse to argue that today's complex life forms do not represent a progression from the first simple life forms.

There are several reasons why people do not like the idea of evolutionary progression. Firstly, progression implies purpose and this is the exact antithesis of the evolutionary process. Evolution has no way of knowing where it is going, it simply goes with what works. However, taking this one stage further it becomes a

matter of asking whether there is a progression in what works. Complexity provides alternative ways of solving problems. Complexity will inevitably arise in a sequence which starts with simplicity, although localised reversals are also possible. There is no sense of purpose, of aiming for a particular objective - it just happens. I suspect that in their eagerness to refute the idea of a divine guiding hand, evolutionists go to the other extreme and misinterpret the blindness of evolution as randomness. Indeed, mutations do occur randomly but Natural Selection ensures that the incorporation of those mutations into living systems is anything but random. It is like the way water collects together to form streams and rivers as it obeys gravity on its route to the sea. The movement of water molecules is random but nevertheless is channelled by the banks and river bed in a particular direction. It is not aiming for the sea, it is not seeking to collect together - it just blindly happens and as a result rivers emerge. More generally Evolutionary Structural Emergence is guided (confined) by the informational content of whatever phase it is in.

Secondly, opponents of the idea of evolutionary progression claim that life does not become better, simply more diverse. In support they point to the fact that some so-called primitive life forms are still alive today. This view makes the mistake of equating a progression in complexity with a progression in effectiveness. Even if there was no progression in effectiveness this does not stop there being a progression in complexity. However, I am taking the case for progression even further by claiming that this also occurs in terms of overall effectiveness. Life is about the ability to organise matter. Humans are more effective than amoebae at doing this. Evolution is almost synonymous with 'getting better', whether it is in the shape of an enzyme, the sequence of steps in a biochemical pathway, the design of the eye or the overall fitness of an organism type. Why can this not also occur for life as a whole? It is true that the variety of organism design reflects the diversity of niches, but this does not exclude the possibility that these are filled in a particular order. I do not want to pursue this further here, referring the reader to an earlier discussion on this matter, but would point out that this is easier to see in the wider Evolutionary process than the bio-evolutionary one.

The third reason for people rejecting the concept of an evolutionary progression is that of modesty. We do not want to suggest that we are better than other animal life. Once again this confuses effectiveness with complexity. The main reason for our modesty is in part, as referred to above, because we go to the other extreme in order to deny the religious argument which makes mankind the centre of the universe. Dialectically it is an easier case to argue from divine direction to no direction rather than to an alternative direction, one involving complexity. It may also result to some extent from our right brain social sense, which likes to emphasise the team rather than the individual. This factor should have no place in this argument but I include it as an example of the way right brain thinking can cloud left brain issues.

The conclusion is that there is an obvious evolutionary progression in complexity and probably one in effectiveness as measured by the ability to organise matter.

Behavioural Adaptations

All information systems exhibiting the properties of life are selected for their ability to organise matter. Each is successful in terms of its physical structure and how that structure is used - its behaviour. Adaptations are products of evolution.

These may consist of structural and or behavioural components, both of which are different expressions of information. The changing, through mutation and subsequent selection, of structural information leads to diversity of form, structural adaptations, each effective in particular environments. Likewise the changing through mutation and subsequent selection of behavioural information leads to diversity of behaviours. Initially behaviour was an integral part of structure but behavioural adaptation, in tandem with structural change, gave rise to the nervous system which undertook control and coordination functions. The nervous system became the new specialised tissue for storing and enacting behaviours, although it should be noted that since the information for making the nervous system was held in the DNA, in-built behaviours, such as instincts, were also specified there. This specialisation into nervous tissue of behavioural properties previously inherent in each part of that system represented a major enhancement in our ability to organise matter on a par with the specialisation of information storage into DNA.

The reflex of sensing followed by response gave rise to sensing followed by selective response. With the addition of memory this became a type of varied response and developed into the ability to learn and acquire new behaviour - flexible, acquired response. Finally, with the machinery for mental models, we saw the appearance of the reasoned response.

The appearance of memory and reasoned response represented another quantum leap. Information which was previously fixed in the DNA, only changeable by mutation gave rise to a system which allowed changes to the information to be acquired without mutation. Behavioural adaptations previously depending on mutations could now, for the first time, be freely adopted into or created in the nervous system of that individual. Flexible, acquired and reasoned behaviour became the bio-software of our bodies, as easy to change as the software on a computer.

Reactive behaviour moved onto proactive behaviour. This behavioural adaptation really seemed to be catching on and spreading. As it became more complex it still needed a purpose to control how it was used. These new organisms, with their interchangeable bio-software, may be amazing in their complexity but they are useless in evolutionary terms if they cannot multiply. The fundamental behavioural drives of mating and eating provided this purpose and were added to by more complex drives which were linked to the basic ones.

Memory developed into mental models which allowed complex behaviour to be coordinated, effects to be predicted and outcomes to be remembered for the future. Mental models allowed simulations and multi-factorial processing which permitted even more complex behaviours. Thought, reasoning, ideas and synthesised behavioural strategies created an information explosion in our new hominid animal.

Furthermore, it would appear that the better the model, the better the simulations and the more effective the predictions and subsequent actions. The mental models became so good, so detailed that we put ourselves into the model and as a result acquired self-awareness and consciousness. Perhaps this was also what necessitated purpose on a conscious, intellectual level. The focussing mechanism (is it located in the left or right brain?) of this mental model, the CPU, the part which switched conscious attention to different areas of the model, became ‘I’.

In addition, rational thought, an evolutionarily useful specialisation of part of the nervous system (left brain) because it helped us to predict events and solve complex problems, enabled non-evolutionary thoughts!

The Adaptability Adaptation

Both nervous systems and flexible, acquired behaviour arose from mutations in DNA. Together they created the adaptability adaptation. Derived from DNA this adaptation allowed for the first time, in any quantity, adaptation without mutation. Information used to organise matter still came from DNA but now additionally from the nervous system on its own. Previously the nervous system just added a way of expressing and operating behaviours which were also held in the DNA.

There are many successful strategies to cope with evolutionary change and competition. These include evolutionary adaptations, such as shells, camouflage, biochemical pathways (passive evolution), and real-time adaptive strategies such as movement, warm bloodedness (active evolution). However, even better than either of these is adaptability where, by use of artefacts and creative thought, solutions can be found immediately (in evolutionary terms) to any survival problem or advantage found in opportunity. Adaptability is better because it does not rely on evolutionary (mutational) change - the adaptive solution is created in the brain without recourse to DNA. There is a limit to adaptation of the body but not to adaptability. Successive adaptations can result in the ability to jump one or two metres high but only adaptability can create space rockets. The adaptability adaptation created the thinking, learning brain and as a consequence the potential for science and technology. These features of the adaptability adaptation are advantageous because they are faster and of greater scope than evolutionary change. In other words they bypass the bio-evolutionary process. If all change could occur by this method evolution would be obsolete. Life has moved from passive evolution to active evolution and finally to anti-evolution. The adaptability adaptation has become anti-evolutionary in the biological domain, whilst still part of Evolution, the universal process of change.

Social Evolution

Alongside the above innovation (are they causally related?) another behavioural development evolved. This represented the next complexity level and emerged from the existing level of separate bodies. It consisted of the evolution of the adaptation of individuals working together and was driven by the emergence of a collective set of rules (information) but relied on the selfish evolutionary principle that individuals could get more from working in a group than separately. It is analogous to the uni- to multicellular complexity level transition. This was the social adaptation. The strategy was used by organisms as diverse as ants and monkeys. The additional information needed for social behaviour was based in DNA and the nervous system. The impetus and drive for basic social behaviour originated in DNA through mutation, but was soon supplemented by acquired behavioural information held in the brain. Significantly, this acquired information did not depend on the genetic mechanism for transmission. When the two new adaptations, social behaviour and learning brains, came together it opened the way to amazing new properties and possibilities. It caused an information explosion that made the others seem like damp squibs.

Social behaviour encompassed the feature of collective effort being greater than the sum of the efforts of the individuals involved. In parallel to this process learning brains gave rise to thoughts, mental models, left brain thinking and synthetic social structures such as religion and politics. This opened up possibilities for

extensive tool-making. Together, the social strategy and learning brains, gave rise eventually, but very quickly in terms of evolutionary time, to science and technology.

This pair of activities held a vast new potential for organising matter many times that of the old, exclusively DNA-based system which had to rely on just structural and behavioural adaptations of their own bodies. Science could give rise to new behaviours based on a coherent and expanding scientific database of information and technology could give rise to new structures. Instead of evolving better legs over a long period of time through normal DNA-based means we invented cars almost instantaneously through technology. Left brain based science gave us an understanding of the world which enabled our thoughts and models to be more effective. Rather than relying on myth and magic we relied on objective information. It is not just a move from DNA to brain based behaviour, since this had already occurred. It is the combination of brain based learning ability within a collective strategy that proved so powerful.

Tools and rational thought could truly be called the extended phenotypes. Richard Dawkins uses this phrase in a slightly different way in his excellent book of the same name. Tools extend or enhance many of our phenotypic traits. I have already mentioned cars, or vehicles in general, extending our capacity for movement but other examples are telescopes extending our eyes, guns magnifying our hitting power and houses assisting our skin. Likewise science extends our information base from the immediate and pragmatic to a body of knowledge which is consistent, accurate, and accumulating. It also extends our thoughts beyond the evolutionary process itself. In this way machines free the body and rational thought frees the mind from their genetic limitations. The phenotype is no longer restricted by the genotype.

We have just taken an enormous Evolutionary step. In other organisms a social strategy could be simply looked on as another adaptation, another behavioural variation which enabled better chances of survival through collective and or cooperative living for those individuals who possessed the relevant mutations. However, as this approach developed in humans with their learning brains, we can see the full impact of this emerging complexity level, the society. The proposal is that a society represents a higher Evolutionary unit than the individual in the overall Evolutionary progression, just as molecules were to atoms and living organisms were to molecules. If societies are units of evolution it follows that they should compete, that they have an information base, a hereditary mechanism, a source of variation and so forth. We are undergoing and witnessing a transition phase from one complexity level to another. As with the other transitions, the earlier levels still exist and are incorporated into the higher level.

However, we are leaving the familiarity of bio-evolution and embarking on a different type of Evolution, Socio-Evolution. We need to explore this area to make sure that it qualifies as an Evolutionary entity, to check the translation of terminology and concepts which accompany this transition. In particular, we need to ask what is evolving, what is being selected, where information is stored, what provides the drives and what will happen to bio-evolution.

What is Evolving?

As previously discussed, it is information which is evolving in the Evolutionary process. Whether it involves atoms, molecules, organisms or societies, it is the rules which govern the behaviour of that entity which are (self-) selected. In

biological times it was the organism which was most effective at gaining resources to make more of itself, to organise more matter, which was selected. In social times the situation is very much the same with the productivity of a society generally determining its dominance. However, whereas the effectiveness of an organism is determined by its genes, the effectiveness of a society depends on the acquired rules of that society.

The transition from uni- to multicellular biological levels involves two essentially DNA-based information systems. The individual to society step initially appears to describe the move from a DNA-based individual to an acquired information base entity. However, it could be argued that the relevant information, even in the individual, is of an acquired nature, thus indicating that we are observing a single to collective acquired information base transition. However, there are undoubtedly genes and probably genetic drives for initiating and promoting social behaviour.

Therefore on the one hand a social strategy is underpinned by genes, and on the other the success of one human society versus another is based on learned behaviour. Socialising is tied to genes in origin and in purpose but the content (or rules) of society is synthesised, not by the genes but by the acquired information mechanism. Just as individually acquired behaviour is not genetically created even though it is motivated by genetic drives and also uses cells which are products of genes, so a basic society is directed by genes and relies on gene based individuals but comprises a social system and structure which has emerged on top of the genes.

Imagine two societies of different types; let us use capitalist and communist ones, which comprise genetically identical individuals. They all have the necessary genetic drive for social behaviour but differ in the non-genetic, acquired social strategy used to run that society. They compete by waging war, either violently or economically or philosophically. One wins. One social strategy triumphs over the other. For the most part, the individuals of the vanquished society can be reused. They can take on the social strategy of the victors. This is not unlike the recycling of atoms and molecules in earlier types of evolution. DNA-based evolutionary units (cells) can also be recycled in this way but the increased complexity over the next level down makes the process seem quite extreme as individual organisms are broken down to molecules. A society is recycled by breaking it down into its individual components (people) and rebuilding the social infrastructure according to the pattern of the dominant society.

The above is an example of the acquired social strategy. The outcome of competition between the social strategies has not depended on DNA, nor on Relative Replication Rates. This also means that the usual evolutionary mechanism of natural selection based on differential fecundity in a birth-death cycle of individuals is not being employed. Interestingly it does depend on the relative productivity, both economic and technological, of each society. Once again we are back to our definition of the ability to organise matter as the fundamental criterion of evolution. In practice population size remains an important factor in determining the power of a society but it is not hard to see that we are moving more to a situation where it is power to organise matter that is important. In the past this was closely correlated with the number of people. In the modern world it is increasingly to do with the strength of a society's economy and technology. It is also to do with the complexity of a society.

This is an example where an understanding of life might help us to develop a better, less harmful strategy to life. Our current view, including that inherent in democracy, is that numbers count; the bigger the country's population the more clout

it has, the more people in favour of something the more justified it is. Even in developed countries where populations have stabilised there is a tendency to encourage growth by immigration. However, if we were to strive for economic and technological strength and effective complexity rather than strength through growth in population we would have a way of competing and indeed 'progressing' without all the problems that overpopulation causes.

What is being selected?

At the highest level we can talk of the social strategy being selected as opposed to individuals. In bio-evolution the selection of individuals can be expressed as selection of adaptations or even as the selection for the genes responsible for those adaptations. Richard Dawkins writes of selfish genes being the fundamental unit of evolution. From the perspective given in this book we can see that genes and proteins, genotypes and phenotypes represent different formats of information. Therefore ultimately we come down to the selection of information. In bio-evolution the mechanism depends on the genetic format for transmission through generations and the protein format for competitive comparisons within generations, whereas Social Evolution uses brain based acquired information.

Therefore in general terms it is the information base held in a society (social rules or social information) which is being changed as opposed to information held in the DNA. That is to say, information is evolving but now it is that held in our brains rather than that in our DNA. Although the mode and means of evolution has changed the basic principles and outcome remain exactly the same. The ability to organise matter is increased. Societies are a new and potentially better way of doing this organising. More than this, we have the emergence of the collective information of society. This information, although generated in the brain, is held in a variety of media, organic and inorganic. It does not depend on the existence of any one individual - it exists at a supra-individual level in the same way as a body is a collection of cells. It would be appropriate to call it a 'body of knowledge'.

Is bio-evolution still going on?

The answer is yes - for most animal and plant species, except only minimally (in the natural form) for those that have been domesticated or adapted for farming. Bio-evolution also continues in humans. However, it was a more prevalent feature of earlier types of society than our current one and is beginning to die out, or at least is being stabilised.

Consider the cell machinery, that is to say mitochondria, ribosomes, Golgi apparatus, nuclear membrane, endoplasmic reticulum, mitotic machinery, and so on. These cellular components are in principle still open to evolution, further refinement, further adaptation, but have been very stable. The greater change has occurred in cell form (single) or overall body structure and behaviour. The standard components remain standard.

So too with society, individuals continue to evolve to some extent but since the chief determinant of success is social strategy, which can be acquired, there is no point, no evolutionary pressure, to develop the old evolutionary changes, that is new bodily structures or new gene based behaviours. The new traits can be acquired without changing the DNA. The speed with which these changes can occur is a

major reason why Social Evolution is becoming dominant and DNA-based evolution is becoming marginalised. Having said that, it is possible that selection for DNA-based changes will continue to further enhance the socialising process. This could take the form of stronger needs or drives to act collectively as well as refinements of gene based abilities which are necessary in a social way of life.

Furthermore, whether the multitude of social roles which exist in the form of doctors, car mechanics, musicians, social workers, computer engineers and so on relies on underlying genetic differences or simply reflect differences in acquired information remains to be seen. It raises the question as to whether one general purpose genotype can be trained to become any of a range of sociotypes or the diversity of sociotypes reflects an underlying polymorphism of specialised genetic traits?

To some extent biological variety in the ability to be a functioning member of society is being unified or overlaid by educating, training and conditioning people in terms of their acquired behaviour. In modern societies, the ability to acquire and process information using the brain and the ability to work in groups have been given a very high priority. Education both formal and informal and cooperativeness are highly valued, more than other behavioural traits and most physical traits such as strength. The biological differences are becoming obsolete as we instil socially desirable behaviours.

Any drastic changes in the genotypes required for specific sociotypes will soon be implemented eugenically. Eugenics is a social mechanism for creating socially desirable types. There are already many subliminal, and some not so subliminal, eugenic practices and pressures present in our societies. Even the basic biological act of choosing a mate is tremendously influenced by factors such as class, friends, fashion, culture and so on. These are preferences given to (imposed on) us from society rather than pure individually derived ones. We can even see how our motivational genetic drives are being replaced by socio-politically correct constraints laid down by society. Incidentally, the fact that this can occur gives us some hope that we can overcome our genetic drives with rational alternatives if we choose to.

Genetic engineering is a powerful eugenic tool. As such it heralds the imminent demise of bio-evolution in humans and several other species for that matter. This involves jumping ahead a bit in our story but it warrants discussion at this point. Genetic engineering is a capability obtained through rational thought, science and technology. In principle it allows us to modify and replace any section of DNA in any species. Eventually this will enable us to change any gene based structure or behaviour. This has already started to happen. The Genome Project being undertaken by scientists from many countries represents the first stage, the descriptive phase, in a familiar progression from human understanding to human control. What has been the province of DNA and chance mutation for billions of years is now coming under our control. This in itself indicates the magnitude of the transition we are going through. We have not fully comprehended the situation since we are used to evolution being associated with long periods of time. The new time scale for the impending changes is dramatically faster. Likewise decisions about these issues need to recognise this.

Some people choose not to have children. It is an interesting thought that this may be an outcome of social forces. Society promotes reproduction in socially useful genotypes but suppresses it in others. It also follows that those outside of the influence of society will not be suppressed in this way. Is this why it is the middle classes which have fewer children than those in the higher or lower classes? On the other hand the arrival of genetic engineering means that we may well not need to wait

for bio-evolution to effect the fine tuning of the human phenotype and sociotype mentioned earlier. We can design the required type(s) of socially desirable human being at the same pace as acquired socio-evolution evolves the structure of society. As mentioned above, whether we will go for a general purpose model or a range of specialised ones is yet to be seen and inevitably raises Orwellian overtones. Besides this ominous eugenic approach, genetic engineering will allow us to mop up defects and disease. This is obviously less controversial and, after the maximising of our food resources by genetically optimising other species, eugenics against disease will be how we start down this path into general human eugenics. In essence, what genetic engineering means is that the brain, mind and society can take over the evolutionary decision making from natural selection of bio-evolution. This new artificial selection will be faster - we have yet to see whether it proves more effective.

Therefore this new system of Social Evolution not only controls its own operation, remarkably it has been able to take control of its predecessor, bio-evolution as well. There is a certain irony in this. We have depended on a DNA information base for our existence and development for billions of years. Now that we understand it and are taking control of it, it is becoming redundant in deference to the acquired behavioural information base. On the other hand, taking control in this way could only happen because we moved from limited, slow, DNA-based information to unlimited, fast, learned information. The ability to control DNA unsurprisingly meant developing an informational mechanism which superseded it. For the purposes of organising matter the information carrying capacity of DNA has reached its maximum and bio-evolution is too slow. It is no longer the best medium. Those that live by the evolutionary sword of competition shall also become extinct by it.

The Techno-Society

"Nam et ipsa scientia potestas est - Knowledge itself is power"

Our new nervous system not only gave rise to the social strategy but also to another variant - rational thought. These two new components, the social strategy and rational thought worked synergistically. Each on its own would achieve very limited success. Social, non-rational animals represent a new level of complexity but not a revolutionary one. Whether they remain DNA-based, as with other social animals, or start to use acquired information as in primitive humans, they might well find a niche but remain very much one of a variety of strategies. Alternatively, a rational, non-social animal might be theoretically possible but is severely limited in what it can achieve as an individual. In fact this combination is unlikely to be found since rationality is probably dependent on collective, social living.

However, put rational thought and the social strategy together and things start to happen - we have science and the collective application of the information it provides in terms of technology giving us the Techno-Society. This society is drawing clear of all other societies which exist on this planet. This has all been taking place in the last couple of hundred years or so, an evolutionary blink of the eye compared to other changes. Other aspects of society such as religion, politics, fashion, culture continue to be necessary to a greater or lesser degree as the social machinery. They are increased or diminished according to whether they enhance or hinder the scientific and technological approach.

The increased organising ability of the Techno-Society is expressed as power in many forms. We talk of particular countries (or societies) as super powers in the world. At the moment the American and Japanese versions seem to be the most powerful, albeit in slightly differing ways. Consequently, the rest of us adopt their methods - the social and economic philosophy of America and the manufacturing methods of Japan. Competition between widely differing styles of society has in recent years effectively become competition between different Techno-Societies. Other societies are scrambling, frenetically to convert. China is seen by many to be the superpower of the future. The case for this view largely derives from the vast population within the Chinese social organisational unit. It will be interesting to see whether this method of qualifying as a world power is becoming outdated or technological supremacy is becoming more important. In other words is total informational complexity becoming more important than biological biomass? Alternatively if China is responsive to new ideas it could have the best of both worlds.

Unlike in bio-evolution where extinction is the price of failure, only the society type disappears in competition between societies. The individuals can change and take on the strategy of the successful society, as we have recently witnessed with East and West Germany, Russia and USA. The societies themselves might not like the disruption and loss of heritage this entails but they cannot stop it. In the cases where societies are so primitive in a technological sense that the competition is too great, the results can be quite devastating. Here the very individuals may be threatened, either because the gap is too great to bridge, even by acquisition (note the similarity with the irreversibility of cell differentiation in morphogenesis) or possibly because the underlying genetically based social determinants are significantly different. The Techno-Society may have taken only a couple of hundred years to develop but the conversion of all other societies is only taking a few tens of years. The pace of change is increasing (and along with it our concern for the implications).

In summary evolution appears to have changed dramatically from individual bio-evolution to collective Social Evolution. And yet underneath, it is the same process because information is the currency of evolution - DNA and acquired information, or knowledge, are just particular working versions of it. We as individuals are still necessary to the Social Evolutionary system, but only as cells are necessary in a body. We are like differentiated cells, the components of the larger body, in this case called society. Our brains, themselves a product of DNA, developed a separate means of propagating information which is replacing the role of DNA.

DNA is the information base of individuals. Even their acquired behaviour, rational thought, scientific investigations are, through their right brains, driven by and hence tied to their genes. At the level of societies, scientific information is not tied to drives or genes. It is contained by the Techno-Society, the unit in which it is expressed. The individual is the unit in which most DNA information is expressed, whereas society, with both animate and inanimate components, is the unit in which collective, acquired, scientific information is expressed. It is this information, society's knowledge, which is proving so powerful in the process of organising matter, more powerful than the old replicative DNA-based system. The society is subsuming the individual.

The Too Successful Society

Whilst the above title is in a sense a contradiction in evolutionary terms, it is used to introduce the concept of adaptations going too far. In bio-evolution, adaptations are only selected if they are successful. Therefore too successful can only happen in as much as it would be possible for the adaptation to make the species too inflexible or specialised and thus vulnerable to a sudden and large adverse change in the environment.

In Social Evolution things are happening so fast that the normal test of time does not occur as it did with bio-evolution. To some extent this is a problem which arises out of the interface of two differently evolving systems - the biological and the technical. More significantly however, there is the issue of speed with which a new behaviour is adopted in relation to the speed with which it is tested. In bio-evolution a mutation occurs and only becomes widespread if it remains advantageous. It is continually tested as it becomes more frequent through the process of Natural Selection. To put it another way, it can only become more frequent because it is successful. With Techno-Social Evolution an idea can be generated and whilst it must be good to become widely adopted, the full test of its true advantage may not come until after it is widespread. For example, a nuclear strategy may work because of its advantages in the short term but be disastrous in the long term due to the disadvantages of nuclear waste taking longer to have their effect.

Technology and society are like mind and body. The more flexible mind can push the physical capabilities of the body too far. Similarly, innovative technology can dominate society such that the relationship becomes unbalanced. If perfectly rational, technological developments are not introduced in a way which is sensitive to the society that receives them, the outcome is imbalance and disruption. The mutual dependence of technology and society as an integrated system should be considered, otherwise a destabilising situation arises which is counter-productive.

Our world is going through this phase at the moment. The ecological movement is highlighting the problems created by the insensitive application of technology. It is trying to say that technology is pushing society, or at least the individuals in it, too hard too fast. As mentioned above, the worrying point for us is that in this rapidly developing system the old fashioned, bio-evolutionary checks and bounds can react too slowly if left to themselves. An unstable situation can and is arising. In tune with the way we acquired this new strategy, society needs to acquire new and artificially imposed regulations in order to restore balance. We need to create a rational ‘Artificial Selection’ to supplement Natural Selection. We are attempting this with our governing bodies and committees but unless we recognise what is really going on, our actions will be confused and reactive rather than informed and proactive. Of course it may also be that we are simply old-fashioned evolutionary mechanisms which find it difficult to tolerate the new ways!

DNA is Dead - Long Live the Word

Where is the information stored in this new phase of Evolution? What is the mechanism by which this Techno-Social Evolution proceeds? How does it compare to the old one? The new information base is in memory – currently within the human brain. Initially it was acquired or learnt afresh within the structure of the neuronal networks of each individual in each generation. It supplemented neuronal

information held as a consequence of genetically determined neural morphology. This informational resource arose and was retained because it enhanced the process of organising matter. Later, with the development of language, this newly acquired information could itself be inherited and passed between generations. Language, words, both written and verbal, were to become the hereditary mechanism of this new information base.

Memory has become the store for the new information. Lest you should think that memory is intangible compared to DNA and proteins remember that the material basis of memory is known at the gross level. It involves electrical pulses, chemicals and brain cells. If this does not help, then consideration of the operation of a computer which uses transistors and electrical pulses to do comparable informational tasks will remove any vestiges of mystery. This body of information is of course supplemented by more enduring external memory banks in the form of books and their modern equivalents.

The essential role of organising matter formerly involved reproducing biologically. Now the major way we organise matter is through technology. This represents quite a change. A society can do through technology what organic life could only do through replication. We can design a new machine and build it. Admittedly we do often make multiple copies, we replicate our designs, but this is now an optional rather than an essential part of the process. By doing so we are organising matter and increasing complexity, the criteria of life. Life in this context is referring to organic and supra-organic life in the form of societies. The information we use to do this technological organising resides in our brains and our libraries. The working medium is the word. Words are the modern version of the genetic code. Words are used in our thoughts and stored in our brain based memories or in books and the like. Thinking and memory are today's equivalents of proteins and DNA respectively. An interesting difference with the new system is that variants, new ideas, are generated as thoughts in our brains and are then passed into our memory banks, the reverse of that found in the organic system - a 'lamarkable' development. Non-verbal thinking probably also plays a role, but I shall concentrate on the verbal format involving words since it is this type of thought expressed through language that underlies the scientific and technological breakthrough.

We can now see that it was not DNA per se but the information it contained which was important. This information can be transferred to other DNA molecules in the form of copies during replication since the information lay in the spatial pattern of the DNA, the sequence of bases. The fact that that two different sequences of DNA can contain exactly the same types of atoms and the same energy but different information is a nice illustration of how information is expressed. In essence it is less to do with energy and components than the spatial arrangement of matter. That is why organising matter creates more information and creating more information involves organising more matter.

It is curious why DNA is the universal biological information store, notwithstanding certain RNA viruses, prions and other minor hereditary alternatives. It is not only universal but its mode of use is incredibly conserved. Other forms of storing information would do as well, providing they could interface with a system which uses the information to organise matter. There is no theoretical reason why another macromolecule or molecular system could not fulfil the same function, although biochemists do not seem to have provided us with many alternatives. Unlike DNA, there are other media which can be used for memory in the current phase of evolution. Likewise the word is also an arbitrary code and we have many different languages, whereas the genetic code is almost universal. However, we are

seeing that English is becoming the dominant working language and it could be argued that science is the de facto universal code of the Techno-Society. As in the case of DNA information only being usable in a cell context so our mental information is entirely context dependent. The equations used for deriving profound physical laws could be placed in my brain and a physicist's brain but they would only be information in theirs. Also one drawback of language is the ambiguity compared to the genetic code, but it has to be acknowledged that language is dealing with considerably more intangible information than that used to produce enzymes.

To sum up, the genetic code based on DNA is being superseded by words held in memory (both human and computer based). The old type of evolution is being phased out but two of its last functions, which may well be assisted by genetic technology, are to improve the genetically based core ability to acquire and process information as well as our genetic drive for socialising. The new phase of Evolution is selecting in particular for information to be used in the Techno-Society and effective social strategies to support this.

The Gene as an Idea

How is this new information structured and how does it arise? Bio-evolution uses genes, mutations and natural selection. Socio-Evolution uses ideas, thinking and science. Ideas act as informational units, thinking generates change and science provides the mechanism of selection in the Techno-Society.

Just like genes, ideas confer advantage to for the system they are used in. If they work well the system will benefit and that idea will be more prominent. We cannot say they will become more numerous as would be the case in bio-evolution. An effective idea could spread within the system but also could become more deeply integrated into the system in terms of its organising ability.

As with the DNA system which contains enormous amounts of apparently redundant DNA, so society contains its share of informational detritus. If this 'excess' DNA acts as a mutational breeding ground, perhaps the information surplus in society also provides a source of new ideas. On the other hand if the surplus DNA is true waste, that is it is produced by the multiplication of 'pre-phenotypic selection' genetic units in a micro-world of the nucleus, so information outside of the scientific domain, where selection occurs, is prone to proliferation without purpose.

Unlike genes, ideas do not require survival of the units which carry them. The way ideas spread would be like an organism being able to patch in a new successful mutant gene instantaneously. This indeed may become possible with genetic engineering and could replace the normal method of patching in successful genes - reproduction and sex. Ideas can be transferred or acquired between individuals and the nearest current DNA equivalent is viruses. Therefore information in ideas is no longer tied to a physical entity, although it still requires a material substance to hold it. The information is free to move - quickly.

Ideas are mutated by thinking and discussion. Out of these new ideas, the effective ones, in a technical sense, are selected by the scientific method. The implementation of these ideas is driven by market forces. This is why market forces must be allowed an appropriate degree of freedom to be expressed. This concept also applies to non-scientific ideas whose selection is by various social mechanisms. These can be looked on as housekeeping functions making up the supportive infrastructure of the social organism.

Menes and Methods

New genes arise through mutation whereas ideas are created in the mental models of our minds. This creative step is often attributed with mystical significance and high importance by some people. In fact, the mechanism could be like the generation of DNA mutations and simply consist of a process of random associations which are then filtered by our mental models. It is this filtering or internal selection which is the vital step as it picks out useful ideas from the randomly generated noise, just as natural selection does with mutations. This internal selection is a preliminary to the external, society wide selection process.

This process identifies ideas that work or, in the case of scientific ideas, those that are consistent. One interesting development in this sphere is that of induction, deduction and logical inference. These are potentially very powerful strategies. They imply that given a certain information base it is possible for this to grow without additional input. The consequential information is contained within the starting facts and can simply be unfolded, unlike our present science which, despite what we would like to pretend, is much more serendipitous and dependent on trial and error. Mathematics is an area where you could imagine this happening. At the moment our rationality is not good enough to do this in more than very small steps but if it could be extended by a new improved reasoning system the implications would be considerable.

Once generated, ideas are selected within the society as a whole as discussed earlier. Richard Dawkins talks of such ideas as replicators and calls them memes. He gives examples such as tunes, catch phrases as well as more purposeful ideas like religion. They jump easily from brain to brain and Dawkins gives the impression that they operate like selfish genes. In Social Evolution these memes are selected for their effect or usefulness to individuals in a society. They have no absolute value or function in themselves but can be used as mechanisms. For example, fashion memes are arbitrary and ephemeral but serve a persistent role in group identification. In general, they are used to synthesise and dynamically maintain the fabric of society.

I would now like to restrict our consideration to the Techno-Society where ideas are sifted by the scientific method. This process is very different to the one above. It produces ideas which have external reference, absolute value and long term validity. This represents another of those quantum steps where relative values become absolute values - chance social change has become directed social change. The meme based changes are not important in themselves except in so much as what they enable, whereas scientific ideas have direction and a context. It is almost the reverse situation to that which we had before. Their content and consistency is more important than what they enable. If Dawkins will excuse me directing a mutation at his meme I would like to call these ideas menes - because in the rational, scientific context they mean something. In common parlance menes are scientific facts.

The other non-scientific ideas have no absoluteness or truth about them. I could say they are a means to an end but that would be confusing. They are the fabric and fuel of society enabling it to function as a cooperative group. As such I shall call them senes - they set the scene.

Menes are kept because they pass the test of the scientific method. It is the latter which has taken over from the Natural Selection of bio-evolution and likewise provides the ratchet mechanism for a progression from disorder to order, from ignorance to understanding. Occasionally, of course the menes turn out to be false (that is senes). In which case it is necessary to throw them out and start again. This

happens in science. It is the fact that it can and does happen that makes science so powerful.

Eventually menes are tested as to their usefulness. This is done through technology. If successful the menes are turned into a technological idea, which I shall call a tene, and are utilised in the process of organising matter. On the other hand, all scientifically valid bits of information are kept, even if currently of no use, because of their potential use in generating further menes which will be applicable in the future. The natural selection of tenes is the market economy, the buying power or energy transferral potential of individuals. Collective, artificial selection has been tried for tenes in the form of communism but it has not proved effective.

The equivalent of the scientific method in the non-scientific, social domain, that is the natural selector of senes, is social authority. Depending on the magnitude of the sene this can take the form of governmental institutions or the dominant fashion group or simply the leader of any group or gang. When these hierarchies of social structures are democratic, the ultimate selection criteria are based on collective social opinion. This can be subjective, changeable and sometimes cruel but despite this, and perhaps because of it, it is usually a very effective process. Senes used to be more important than menes but in modern societies senes are increasingly selected for their ability to support the dominant mene/tene based technological approach. For example, capitalism and communism both use science but the former has more energy to assign to it and is better able to exploit it technologically.

Put all the menes, senes and tenes together and you have the informational substance of a Techno-Society. This is used to synthesise the behavioural and structural form of the society in a comparable way to how DNA information is used to create these attributes within an individual organism.

Finally, it is worth reminding ourselves that all this selection of senes, menes and tenes results in the competition and selection of whole societies. I have been using the term society in its most general sense to represent the collective behaviour of a group of human beings. This raises the question as to what is the optimum group size. The technique of working as a group is valid whether we are talking of a handful of people, a district, a town, a club, a religion, a nation, multinational companies and so forth. Each size of group is maintained because collectively it provides extra benefits to its members. The types of benefits are determined by the type and size of group. It is usually when the types of benefits and types of groups get mixed up that inter/intra group competition tries to reorganise the boundaries. There is a continual shuffling of the criteria and size of different groups through political, social and commercial mechanisms. Undoubtedly new types of group will appear as our societies develop. The development of the Internet for the exchange of information provides opportunities for groups to be defined less by geography and more by their interest or information content.

Socio-Evolutionary Drives

In bio-evolution it is the innate tendency to replicate which creates the pressure for evolution to work. Replication, within the context of finite resources along with hereditable variation, leads to competition and selection. Thus replication can be seen as the main driving force of bio-evolution. Ever since supra-molecules, self-replication has been an in-built feature of life. As life became more complex and behavioural methods more sophisticated, the mechanism for self-replication has

become more indirect. Eventually with humans, in order to allow acquired behaviour we had the development of genetically based drives which kept the flexible behaviour directed towards replication serving tasks.

Initially it was mutations and probably the creation of a genetically based social drive which led to social living. We have previously discussed the advantages to individuals of living in groups. From this view, society is simply another behavioural strategy based on genetic drives and representing the old bio-evolutionary principles. In other words, it is the desires and aspirations of individuals for material goods, status and power which collectively provide the pressure for selection and hence the drive for Social Evolution. Once again it is ultimately the genetic make-up of individuals which shapes the society. Indeed this fairly describes the operation of primitive societies.

However, what I am proposing is that the society takes on an existence of its own. This idea says that although societies were developed by individuals for the old selfish, genetic and bio-evolutionary reasons, on another level a collective social strategy is being formed. Society is an emergent property of individuals. It is part of the wider Evolutionary process.

A society runs according to a set of rules. In humans the ability for acquired behaviour means that they can create those rules, but the existence of genetic drives gives overall direction to this process. Therefore the acquired social rules are directed to the overall genetic and evolutionary objectives. They are genetically driven but not genetically determined. These rules exist in our brains rather than our genes. This raises the possibility that other rules can be acquired or imposed providing they can overrule our genetic drives. I am proposing that society as an entity can achieve this by developing a collective set of rules which can be acquired by its individual members. This could happen as part of the formal educational and political processes or more informally through social interaction. In the modern world, television provides a very effective method of transmitting these collective values. If the rules are not obeyed voluntarily the government together with the legal system provide a very powerful means of imposing them.

Obviously this process would start off with rules which were compatible with those which satisfied genetic drives, but eventually, as the society became established, it is possible for a separate agenda to be introduced. The acquired values and rules of society start to overrule those innate ones from the individual. For example, years ago the sexes probably looked for certain raw attributes in each other. Today these are considerably supplemented by various social criteria which must be met in order for attraction to develop.

This also helps to explain some of today's non-selfish social behaviour. People actually want to behave socially rather than simply because it is in their own selfish best interests to cooperate. Sometimes they will even give significantly more than they get in terms of their social balance sheet. Why is this? It is partly that people have to believe how they behave; they have to believe in cooperation in order to come across as genuine to others. In doing this they occasionally exceed the required amount of altruism. However, in other cases I believe it is not that people are rising above their genetic interests to a higher independent moral plane, but that society is promoting socially useful behaviour as part of its evolutionary program. More generally the fact that we are in the transition from gene focussed individuals to society facing citizens means that currently human behaviour is a product of both systems. We should remember this when we interpret human behaviour. On the whole most of the interpretations given earlier rely on the genetically based argument

but the view of our future given in subsequent pages assumes the increased dominance of factors derived from the level of societies.

The subjugation of individual genetic drives by society can be seen in the way these drives still operate even if uncoupled from reproduction. In developed societies people are as ambitious as ever but whereas in previous times their achievements were cashed in for offspring, today they are exchanged for quality of life, which usually includes increased consumption. Another apt example is the way we continue to have active sex drives but use contraception to avoid the biological consequences. The goal of having sex is a strong motivation for expending large amounts of energy on various productive and wealth creating activities. The fact that social pressures remove the final product of these direct and indirect sexual efforts, having children, seems rather blatant but has its humorous side. We have discussed why not all sex needs to lead to offspring and that it could also serve a socialising function. This is exactly my point.

The proposal of society as another organisational body can be seen as part of a well established and ongoing emergent progression. It is not so much an escape from evolution as the next stage in the overall Evolutionary process. Atoms join together into molecules according to their own set of rules, to satisfy their own electron shells. Once joined together the collection of atoms, the molecule, has its own behaviour. The molecule consists of nothing but atoms and yet it has a collective identity, a collective set of rules, molecular information. Its collective chemical properties rely on the same electron shells of the atoms but together they constrain the individual atoms and allow new behaviours. Bodies are made up of cells. These cells probably have no sense of the body as a whole. They operate as individual cells and yet as a group they have the properties of the whole body. The drive to divide, make proteins and metabolise resides in each cell but the exact way in which it carries out these activities is moulded by its 'corporate' context. Likewise, human society consists of individuals but collectively there emerges other capabilities. Whilst its abilities are partially determined by the rules held within individuals, just as molecules depend on atomic rules and bodies depend on cell rules, another set of rules emerges as a product of the new organisational body, the new complexity level. These new rules can dominate the old ones.

Therefore in the past and to some extent the present, individual self-interest and ultimately genetic drives lay beneath the social strategy, but society is taking on an identity of its own. That is to say, controlled selfishness and the paranoia of being cheated may have initially permitted the advantages of cooperative behaviour but gradually individual genetically based social drives are being replaced with supra-individual social drives. We are in a transition phase. With the aid of our political and legal systems, these socially correct, supra-individual social drives will become effective in themselves and enable society to rely less on genetic drives. This in turn will make the society more productive as the need for personal incentives and temptations to cheat get less. There is however, a cost in terms of individual freedom.

Ingredients of Social Evolution

In an earlier chapter we saw that bio-evolution required reproduction (multiplication) and heredity. From these came competition, selection and mutation

(variation). Let us see whether Social Evolution has these ingredients and hence qualifies as a true evolutionary system.

As discussed above, in bio-evolution reproduction gives rise to population growth and this, within a context of finite resources, leads to competition. Also the existence of a life death cycle provides a mechanism for allowing successful variants to become more widespread and hence selected. The addition of sex assists this process by providing a faster method of combining variants.

Reproduction (of societies) does not appear to be a necessary property of Social Evolution in the same way as it is for the units of bio-evolution, except that in less advanced societies the pressures produced by population growth do in practice provide pressure to adopt effective social strategies. A Techno-Society can grow in power or organising ability without multiplying. It is not, as is the case in bio-evolution, a matter of more power enabling more people. Neither is it a case of more people resulting in more power, although some societies are still trying this strategy which has worked so well in the past. It can even be the case that in more advanced societies too many people can reduce power. Birth rates tend to level off in developed countries and it is tempting to infer that as society becomes a discrete entity it behaves like a biological body which limits the total number of cells.

As indicated in chapter four, it is in principle possible for life, in the widest sense, to increase in power by growth alone rather than growth through multiplication. Multiplication is the form of growth which has been favoured up until now in bio-evolution. Growth on its own has been flawed for a number of reasons including the accumulation of damage, functional complexities, problems with movement, difficulty of implementing improvements (variants) and resources being locked up in old growth. Reproduction is a multiplication strategy to overcome the imperfections of biological systems.

The Techno-Society can by its very nature grow without reproduction. As a side effect death is no longer required as an in-built characteristic of the system. Growth is generically a more fundamental expression of life, that is to say the ability to organise matter, than is the more specialised reproductive form. That is why a better label for our fundamental units of life would be organisers rather than replicators.

In bio-evolution reproduction serves two purposes. Firstly, the existence of a life-cycle and the generation of offspring provide a mechanism for allowing successful variants to become more widespread and thus selected. In a Techno-Society changes can be acquired and are not tied to bodies containing genes. The birth-reproduction-death cycle is not necessary in order to spread new ideas. The second purpose for (effect of) reproduction in bio-evolution is that it is this innate tendency to multiply which creates the pressure for evolution to work. In complex organisms this innate tendency was converted into genetic drives which are implemented in a variety of ways by acquired behaviour. As discussed in the previous section on Socio-Evolutionary drives, initially it is the desires and aspirations of individuals for material goods, status and power which collectively provide the pressure for competition, selection and therefore Socio-Evolution to take place. These genetic drives are gradually being replaced by a collective society based drive.

As for the creation of evolutionary pressure to drive the process, there remains the drive to organise matter within a context of limited resources. The development of societies and the individuals which make up those societies can provide that pressure in other ways than demand by increased numbers of people. It is clear that societies compete in terms of manufacturing, financial and service industries. This

competition becomes more subtle as societies consolidate and societies form supra-societies. As a result of competition selection can take place. With bio-evolution Natural Selection (or Relative Replication Rates) is the selective judge. With Techno-Social evolution there are a variety of mechanisms depending on the type of information. Menes (rational ideas) are selected by the scientific method, Tenes (technological ideas) are selected by the market economy and Senes (social infrastructure ideas) are selected by Politics or politics.

It is the tenes which determine the technological organisation of matter and in some ways menes and senes provide secondary support to this. This is why the market economy, the purchasing power of consumers, is so important for Evolution. This method of selection has so far proved to be the most effective in selecting and driving Evolutionary (technological) improvement. It is fascinating to observe how political and business leaders of economically successful countries and businesses instinctively know that productivity and productive environments are what it is all about, despite probably never having looked at it from an evolutionary perspective, of never realising that they are part of a single process which underlies the development of the whole universe - the ever increasing ability to organise matter. How much more successful they could be if they saw their role in terms of the raw Evolutionary process, rather than as a political or business derivative of it.

Variants of Techno-Social information can arise either rationally or randomly and can be acquired rather than rely on mutation. However, acquired Techno-Social information need not be so very different to the situation found with sexual reproduction, which provides a mechanism for collecting genetic variants together from the whole population without having to wait for all the mutations to occur in a particular genotype. Sex is a way of acquiring new genetic information. If the sexual mechanism allowed for new combinations of genes in the participants rather than rely on the production of new offspring, the process would be even closer.

Apart from speed of acquisition, the real difference in mechanism between Techno-Social Evolution and bio-evolution lies in the mechanism of heredity. As seen earlier, when we discussed the principles of evolution, heredity of information appeared to be a necessary component of an evolutionary system. A mechanism for Techno-Social heredity needs to pass on the collective body of knowledge of a society. In practice, this is achieved on the one hand by the social and cultural mores of a society and on the other by the accumulated scientific and technological knowledge stored in our brains and libraries.

For many social rules this might seem a somewhat fluid arrangement compared to a DNA-based mechanism, but history shows it can be sufficiently stable to permit Social Evolution in a real sense. Much of the variability in detail could be viewed as analogous to the variability of gene expression within an organism and that the underlying fundamentals are more constant. With respect to the rational rules of scientific and technological information the heredity mechanism works well and results in the accumulation of knowledge with little or no degradation as it gets passed on.

I said that heredity was a necessary component of evolution as a process. Heredity is really shorthand for faithful transmission of information between generations. Therefore, approaching the issue of heredity from a different direction, we could say that it is the ability to transfer information accurately which is important. Now that behavioural information is uncoupled from reproduction its association with individuals and life cycles is diminished. The accuracy of transferral is dependent on the effectiveness of the means of communication. This is why the rate of Social Evolution is increasing as our methods of communication improve.

Even the need for accuracy can be called into question. The overall objective or outcome of evolution, depending on your degree of teleology, is to produce better ways of organising matter. With bio-evolution this was very much related to life cycles, reproductive success and gene pool fluidity (the speed with which variants could spread through the population). With Techno-Social Evolution the method of transferral means the ideas pool is much less viscous than the gene pool. Consequently there is a sense in which inaccuracy of transferral, that is change or the 'mutation rate' of ideas, can be greater. The system will evolve faster.

Therefore, with the social equivalents of heredity (or transmission), variation, competition, selection and growth instead of multiplication we have the basic ingredients of an evolving social system. Finally, when comparing bio-evolution and Social Evolution we should remember that it is information which is being processed and the ability to organise matter, that is create this information, which is being tested, selected and evolved. This helps us to see the various mechanisms as alternative ways of achieving the same outcome and biology and society as different organisational levels in this process.

Social Identity

Genes define the identity and relationship of bio-evolutionary organisms. What defines human social groupings? A group is basically a collection of individuals who cooperate and provide mutual support. How do we form these groups?

Originally cooperation with other individuals was restricted to family members. It made perfect evolutionary sense for an organism to help those who were genetically related. Giving assistance to a child is perhaps the primary example but the same principle can be applied to some degree to other relatives. There was a common purpose stemming from a common gene pool.

The same arguments could be applied to tribes; cooperation within them and rivalry between them would have resulted from a high degree of genetic commonality, especially in times of limited travel and small, self-contained communities. It is possible to continue this line of reasoning to propose that the justification for cooperation within whole countries is because of an individual's greater genetic identity with one country versus another.

The alternative explanation is that whilst genetic similarity may underlie familial support, this becomes too tenuous as the group size increases. Participation in larger groups may simply be a function of cooperation providing better chances of survival for individuals whether or not they are related to other members of the group. This is the social explanation. Support of an individual for one group or another becomes support for the social system they are benefiting from. It is more to do with selfish cooperation than selfish genes. Although there are probably genes which promote social behaviour, the competition is between which type of acquired social behaviour is being used rather than between different types of social behaviour promoting genes, except perhaps in the early evolution of this strategy.

In other words, it is evolutionarily better to be a member of a group than an individual for various reasons other than genetic commonality. In humans one group can be better than another according to which set of rules they create or acquire. Differences in these rules can inhibit movement between groups for practical reasons. Sometimes the cultural gulfs can result in almost distinct social species, despite the

apparent relative ease of transferring acquired behaviour compared to sexual exchange. In these cases there is a total inability to exchange informational material whether it is in the form of senes, menes, tenes or genes.

Additionally, individuals must earn their place in a group, they must justify why they should be allowed to share the benefits of that group. This also makes the transferral between groups difficult. Therefore it makes sense for an individual to support the group they are a member of. They do this in order to secure their own position and thus the potential for their genes in the future but not because of the shared genes reasons given earlier.

Football teams and multinational companies are good examples of the social explanation. Football teams may be named after the local town but the players, the manager, the staff, the owners and even some of the supporters can come from widely differing parts of the country or in many cases the world. Likewise multinational companies are supported by groups and individuals from disparate geographical and political locations. It is associating with the identity of that group which seems to be important. This has little to do with genetic identity, although as has already been acknowledged, it may have a lot to do with personal genes. Also, the very fact that this tendency is so widespread and people become so committed to these groups suggests that the need to be in a group is genetically based and an expression of the socialising genes proposed earlier.

This group identity becomes a virtual organism which exists in terms of images and perceptions in the mental models of all its members. It also has a real presence in the form of organisational structures and buildings. I contend that this social body can subjugate the individuals within it and that as individuals we become as one cell is in a whole body. We continue our individual lives instinctively lending support to those collective organisations we participate in, but remain oblivious to the overall perspective and objectives. We are an integral part of the whole but our influence, certainly as individuals and possibly as human beings, is diminishing. The group or society is a continuation of the progression from atoms, molecules, cells and organisms. It becomes the next organisational unit of information which carries out the unifying property of organising matter, of generating complexity, of creating information.

Features of Techno-Social Evolution

All is none

One possible problem which arises out of this new Evolution is that if new strategies can be acquired it would appear that relative advantage disappears since everyone can adopt that approach. In reality this is no different to bio-evolution where mutations arise, give advantage, become selected as the norm and cease to provide any relative advantage. Eyes are an advantage but not if everyone has them, except in an absolute sense. They are maintained because a change which removed them would be a disadvantage. Therefore bio-evolution and acquired Social Evolution are the same except the latter involves a different medium and is much, much faster. It is not a problem that it is faster, in fact it can be an advantage. What we need to remember is that in bio-evolution genes are being selected but in Socio-Evolution it is ideas (menes/tenes/senes) which are being selected. Genetic

information is tied to a physical being whereas acquired information can transfer between physical bodies.

However, the speed with which ideas can be acquired followed by the relative advantages being cancelled out does lead to complications. I suspect some of these arise because Social Evolution overlaps with bio-evolution. In addition, societies which were the first to adopt and or develop an idea are keenly aware that when other, competitor societies catch up they will have lost their advantage. They cannot stand still but must move onto the next idea as soon as possible. They use a number of tactics to slow the acquisition process in others. One formal method of doing this is the patent and copyright system. As already indicated, society relies on individuals and sub-groups to generate and develop ideas. They do it for personal advantage. Why should they bother if there is no reward and everyone just copies it? This becomes an increasing problem in the information society where the copying of ideas becomes much easier. An example would be the ease with which computer software can be copied and the way it bears no relation to the effort required to create it in the first place. To get over this problem society artificially bestows reward and a head start in the form of patents and copyright. This provides the best of both worlds - easily transferable ideas but retaining incentive for individuals to generate new ideas. Secrecy is a less productive alternative.

Other complications arise because some people who have established an advantageous position in society will resist change fearing that they will lose out in the new system. This is an inevitable consequence of relying on individual gain as the driving force and will tend to slow the pace of evolution. When this is undesirable it will lead to the evolution of open or democratic or meritocratic social systems which reduce the opportunities for selfish, reactionary, or should we say individually focussed, behaviour.

Social Cheating

The use of a collective position of power to gain undue personal advantage is a form of cheating and breaks the terms of the social contract. This contract is a very delicate agreement which relies on the principle that working cooperatively will be more productive than working antagonistically or as individuals. In order to take advantage of this strategy there has to be an implicit understanding that the collective profits of cooperation will be shared out fairly, although not necessarily equally, amongst the participants. Not all of the profits are shared out directly since some resources are taken (taxed) in order to provide for collective, society level structures and organisations.

The greater the cooperation the greater the gain but also the greater the need for fairness of distribution. This leads to the social paradox whereby the most effective system appears to rely on ‘competitive cooperation’. Pure competition on its own is less productive because of the way resources are wasted in the competitive struggle. Pure cooperation avoids this but suffers from the lack of incentive to improve the way the system works. This may simply reflect the way social strategies are built on top of bio-evolutionary strategies. Genetically homogeneic ants do not seem to have a problem cooperating whereas humans do.

Human societies exploit the competitive energy of individuals but the price is the constant risk of social cheating, of going for extra individual gain within a collective enterprise. This is kept in check by a number of means. The original

biological methods consist of highly developed social senses to detect and prevent cheating (both in others and ourselves). It has even been suggested that much of the human brain is an elaborate mechanism for maintaining a tit-for-tat mechanism to prevent social cheating. In modern times societies have become so complex and large that these natural methods have had to be supplemented by our political and legal systems.

Power and the Glory

Another feature of social evolution is that it is driven by the desires of individuals, but not just in a material sense. Evolution requires resources and with bio-evolution we are used to the idea that these resources can include air, light, space and the like, as well as the more obvious supply of food. In Social Evolution we come across another resource which can be as sought after as any of these others – social power. Societies have institutions and organisational structures to help them run and hence the security and influence of an individual is affected by how they fit in to these. If society did not rely on the individual's drive for personal advantage, people would be like ants and carry out whichever role they happened to find themselves in. Society does not presently work this way and so position and consequently power in society is in demand as much as material resources. Social power, the power that derives from reaching a certain position in society, confers the ability to influence and control others. This magnifies the power of the individual. Also it can be seen from the way power is a function of social position, that it is a form of information.

Social Variants

Change within a society falls into two broad categories which I call subjective and objective. Subjective change is a means to an end. It is typified by fashion where the point is not the style itself but to establish a position in society in terms of wealth and status by getting people to either buy, copy or aspire to your ideas. Although this seems somewhat ephemeral and even wasteful of resources, it does help to identify socially adept people and establish them in key positions. The process also helps to generate important by-products in terms of improvements in the material and organisational structure of society.

The other type of change is objective and consists of scientific and technological innovations. In this case the new ideas and information are permanent rather than transient. They are true reflections of reality rather than fashionable ones and thus they have an enduring value in themselves. They accumulate and are used to increase the complexity, control and productivity of a society. In order to ensure these objective ideas match reality and are therefore worthy of adding to our body of knowledge, they are rigorously filtered by the scientific method. This body of knowledge also represents one of the discernible products of the social strategy.

Communications

Ideas, subjective and objective, are able to compete and spread to the extent that they can be transferred between brains. Therefore communication is an essential component of social evolution. One of the main ways of controlling social evolution is through controlling lines of communication. Control of society can be for benign reasons or for the interests of an elite ruling group. Unfortunately it is often difficult to differentiate between the two. A democratic mechanism of some sort appears to be the best way of avoiding such subversion of control by a minority. Also, a democratic mechanism of generating the rules of society tends to be more productive since it is more likely to allow the full expression of the underlying drive which is based on individual self-interest.

Over recent years it has been striking to observe how the move towards political democracy has been hastened by the introduction of two technical developments, two tenes which have undergone rapid selection. Television (including radio) and the Internet are having an enormous influence in avoiding imposed control of societies by promoting the effect of natural social forces. Both are methods of communication which transcend social boundaries. Television gave us a window on the world and the Internet allowed us to talk to this world.

Pace

Such global means of communication have also had an effect on the pace of change. In the days of DNA, large changes took thousands or millions of years to occur. Acquired behaviour allowed changes to happen much faster. The rate of change became dependent upon the speed and range of communication. This helps to explain why the pace of change seems to be increasing in the modern world. The development of trans-national, pan-world communications in the form of television, radio and the Internet means that ideas are instantly available all over the globe – in theory. These changes cannot be ignored lest we fall behind. Faster communications mean shorter advantage periods and have resulted in a frenetic pace of change within those societies who are trying to stay ahead. This is of course good news for the Evolutionary process although it can result in harsher conditions for some of the participants.

The Internet in particular is destined to have a great impact on not only the pace of Techno-Social Evolution, but also on its productivity. The interactive nature of the Internet means it is the first usable means of global interaction. It is becoming the nervous system of the world and will enable the same type of ‘advantages’ for the societies of the world as an organic nervous system permitted for us as individuals. Through communication the control and coordination of the members of society will promote efficiency but at the same time will inevitably impinge on individual freedoms. This is going to happen very fast.

Social Realities

Some people may feel that the characteristics or traits of a society are somewhat abstract. They are not. The same criticism can be directed at a body made up of cells. It could be said that a body is an artificial label, that there are no bodily functions and behaviours, only those of cells. This is clearly not the case and there

are supra-cellular characteristics. Actual manifestations of Techno-Social Evolution can be seen in the specialisations of individuals in specific roles, the creation of collective institutions and organisations, factories, office blocks, cities, the realisation of collective achievements such as flight. All these are real emergent properties of the new Techno-Social complexity level.

I will single out one of these products of society for particular mention. Science, the creation of a body of knowledge, is special amongst all of these for it is the informational abstraction of reality. As such it will continue long after the others which are necessary and temporary devices to enable the process to work. In fact, it sometimes seems that the scientific body of knowledge is the goal and everything else, including humans, merely a means to this end.

The progression in socialisation (living in groups) can easily be seen. We started as individuals who started to live in groups, then tribes followed by races, peoples or nations, depending on how you want to classify the higher order groups. Currently at the top level we have the emergence of various world organisations with the United Nations being the best known example. Within this we have countries or nations. This joining together of countries has reached a point which is very reminiscent of the state of countries one thousand years ago. These often consisted of islands of civilisation, or at least stability, interspersed with more anarchistic or barbarian populations. Just as years ago inhabitants of geographic areas coalesced into nations so we are watching the nations join up to form a world order – in a process we now call globalisation. Unfortunately from an organisational point of view one of the main reasons for creating groups is to compete against other groups. This throws doubt on the motivation to form a world order unless the benefits of doing so are significant and clear to see. An understanding of the Evolutionary process would help this to happen. Alternatively a world crisis or the discovery of malevolent alien life from space would serve the same purpose – an apparently fanciful idea but one that personally I would not rule out.

Society and Individual Freewill

For a moment it looked as though we might experience freewill. Up until now we have been secretly guided by our genetic drives - our capability for rational thinking has been contained by our more instinctive, non-rational thinking. However, the above discussion on social evolution suggests we are capable of suppressing, or at least supplanting, these drives. As always there is a catch. If we suppress these drives we might gain freewill and benefit from (pursue) less restricted left brain rational thought, but at the same time we would lose the driving force behind society. Is this what some might describe as the current malaise of Western society?

The compromise is that by understanding our primeval drives this helps us to operate more rationally and at the same time be less wasteful in society. This is one version of the objective outlined above which involves modulating individual drives so as to create a more efficient, less wasteful society. We are doing this anyhow, instinctively. I would suggest it might be better for several reasons if we did it consciously.

We are in a changeover period - a period of contradiction. We have individual drives designed for one purpose being borrowed for another, the building of society. Controlling individual drives is one thing but getting rid of them would require an alternative drive, a synthetic drive of some sort just as multicellular

organisms developed a special budding mechanism to replace the simpler cell division. A social or society promoting rational drive could serve this purpose.

However, freewill may lose out either way. We seem to be the components or engines of society. We are either driven by our genes or we become slaves to society. This is the irony I have been alluding to in terms of freewill. Just as we achieve the understanding to escape one master, our genes, we find ourselves soon to be controlled by another, the social pressure of society (and soon the computerised society).

The domination of the social complexity level over the individual level occurs through a number of mechanisms: government, religion, social pressure, pc (politically correct) behaviour, fashion. These are all ways in which individuals are forced, to a greater or lesser degree, to conform to the overall social imperatives. This is analogous to the way atoms collect together into molecules and in doing so their atomic properties are modified and restricted by their membership of the group, the molecule.

As an evolutionary system this change in design makes sense, but as human beings it seems a bit daunting. One of the aims of this book is to bring this possibility out in the open so we can see if this is what we want and to enable us to make a choice. Previously I have repeatedly made the point that life and the evolutionary processes were not so much wonderful and rare, rather that they were the inevitable, unstoppable consequence of the Big Bang. However, this time, thanks to our left brains I am saying, wait a minute we have reached one of Evolution's rare if not unique stops as it hurtles along to its terminus. We could get off, if only we could think for a moment and look through the window onto our world and see if we have come far enough. We shall revisit this issue in the final chapter.

Summary

Information has escaped from DNA and relocated within the brain. This information still requires individuals to carry it. Ironically, the body which contains this information used to be important because it was the expression of the information in DNA, but now it is important because its brain contains the social and scientific information of our societies. Just as many genotypically identical cells make up the body of a multicellular organism so many individuals, identical in their ability to contain, process and acquire information in their brains, act as the members of society.

The evolutionary battle is no longer about the survival of the fittest organisms but the fittest ideas and the fittest societies. Unlike the properties of successful organisms, successful ideas can be acquired. This increases the pace of the process. We have created larger and larger group sizes and are currently embarking upon the ultimate step (on this Earth) of globalisation, although the latter is at a very early and awkward stage. Social evolution is driven by the drives of individuals but gradually supra-individual organisation is occurring and eventually these drives will be replaced by supra-individual social drives. Through democracy the non-cooperative behaviour of the individual will be suppressed and the group, the society will be advanced.

We see that social evolution, like Evolution in general, is about information. By moving from DNA-based information to brain based information, by moving from information tied to a molecule to information which can be instantaneously

transferred, there has been a breakthrough. The Universe consists of information and energy (including matter). Our new ways of dealing with information are as far reaching, in terms of the consequences, as would be the discovery of fusion energy.

We have returned to where we started. Bio-evolution is just part of a larger Evolutionary progression. Physical atomic rules have been supplemented by molecular rules which in turn are added to by DNA rules followed by the rules of learned behaviour and finally social rules. This trend is accompanied by an increase in complexity due to a ratchet like mechanism for accumulating more powerful systems. Physical evolution gives rise to chemical evolution to biological evolution to techno-social evolution and eventually to pure informational evolution. All of these types of evolution are brought together by the underlying process of organising matter, of increasing complexity. It is this which unites them and it is more fundamental than whether it is done via atoms, cells, genes, words, individuals or societies. These formats of matter are simply ways in which the information necessary for doing this organising is stabilised and inherited or transferred. This progression in evolutionary methods, as opposed to overall objectives, is associated with an increase in complexity, an increase in control within the system (which is equivalent to a decrease in chance), an increase in organising ability and can be looked on as Evolution - the evolution of evolution.

Information revisited

Information is the common denominator of the universal process of Evolutionary Structural Emergence, of which bio-evolution is just a part. In chapter 4 we looked at how information present in energy, atoms and molecules gave rise to the information of supra-molecular structures and life in general. Now that we have followed the bio-evolutionary path through to humans and beyond, we should consolidate our views on information and the role it plays as part of the more complex systems.

Information was defined generally as that which determines the rules of interaction. When two or more entities interact information is what decides which outcome will occur from all possible outcomes. It dictates for example, that two hydrogen atoms rather than three can link to one oxygen to form a water molecule. It causes a honey bee to search for nectar in a particular rather than a random direction. In higher organisms it promotes the selection of more effective behavioural options. The use of information requires interactions to occur and energy to be involved. Overall it reduces the chance element of interactions and can be viewed as an increase in control.

More specifically information was defined as the spatial arrangement of matter (or packets of energy). This states that it is how an entity is built which determines its properties. I have called the spatial arrangement containing the information an infon. These properties are an expression of the informational content of the structure and are the accumulation of levels of spatial arrangement. For example, the information of a molecule is a product of how its constituent atoms are arranged but also some information is derived from the atoms themselves. Information is emergent and builds on previous levels of information. In some cases the latest information can be seen on its own as when different structures with different rules of interactions, different behaviours, are built from identical sub-units. This is illustrated by diamond and graphite where it is the pattern of the way carbon

atoms are linked together which causes their different properties or informational content.

Let us follow through the way information is used in different life forms. We will proceed from simple to complex life, but remember that it is the effective processing of information which is important rather than necessarily the amount or complexity of the information processing. Effectiveness is used here as the measure of the ability to survive in the competition for resources to make new informational units. Complexity provides more informational opportunities but also carries informational overheads. Notwithstanding this, I believe that in the end complexity will win over simplicity but even if both strategies survive, it is from complexity that innovative approaches will appear. As human beings we have a vested interest in this evolutionary domain since we have specialised in a strategy of complexity rather than of simplicity. Our future depends on not being (or being, depending on your view) upstaged by these innovations whereas that of a bacterium does not.

Starting with our passive cell, for example a bacterium, it behaves according to the molecular and structural information it contains. It secretes chemicals, exchanges molecules with its environment, grows and divides. We could almost describe it as a complex molecule.

A bacterium which has a flagellum and a means of sensing favourable chemicals can move towards resources. It has a behaviour in the specialised sense of additional activity and requires extra information to carry this out. The information resides mainly in the sensory structure within the bacterial membrane and its linkage to the motility structure, the flagellum, which results in the appropriate directional movement when a desirable chemical is detected. Actually, the whole system including the chemical is part of the information system. In practice we talk of the chemical acting as a trigger to the information contained in the bacterial structures. This is analogous to how the train timetable triggers the receiving informational system, the human, to catch the train. In order that subsequent copies of this bacterium have the advantages of this sensing mechanism, the information for creating it is stored in DNA. This informational trick has proved to be tremendously powerful and allows for the evolution of all sorts of similar behavioural mechanisms.

Referring to previous chapters, behavioural information can be followed in a progression from such automatic behaviours as seen above, through conditional behaviours, acquired behaviours, flexible acquired behaviours to behaviour based on mental models. It can be seen that with respect to living matter a behaviour is really just a term to describe more elaborate, more abstracted properties of matter.

Whereas the bacterium relies on structural/molecular information stored in its DNA, the higher behaviours, as listed above, depend on another revolution in information storage. It is the information storage mechanism of the nervous system. Behaviours and responses are increasingly tied to how an organism is wired up rather than directly to its molecular, DNA-based properties. Once again however, we see that it is spatial arrangement, this time of neurons, which plays a vital role. The nervous system holds information by virtue of its pattern of interconnections, the three dimensional circuitry of nerve fibres. Thus information is contained in the neural circuitry which in the long term is less limited than atomic, molecular, structural (supra-molecular) or even DNA-based information. Prior to DNA, information was a product or property of the matter which contained it. DNA is unique because it contains the information for other molecules. In a similar way the nervous system acts as an innovative source of higher order interactions - behaviours of the whole system.

An advanced nervous system with a brain is truly an elaborate means of containing and utilising information. It enables many complex factors to be taken into consideration before a complex response is decided upon or evoked from the range of allowable behaviours. That is to say a brain has high informational content which can function in a rich informational context. In early prototypes the circuit diagram of the nervous system was probably entirely determined by the DNA. However, the expression of it in the form of a neuronal network opens up new areas of behaviours, new sources of information not available to proteins in other chemical or structural arrangements. Later, higher order nervous systems introduced innovative ways of storing and generating information over and above that of DNA. For example, the ability to acquire behaviour, to learn, opens up new horizons. No longer is it necessary to wait for the slow evolutionary DNA mechanism to generate the behavioural information.

If behaviour is laid down in the DNA-based, neuronal circuitry this gives great scope but ultimately it is limited in how complex the behaviours can be. The ability to acquire behaviours extends the repertoire. To refer to our computer analogy we have moved from ROM to re-programmable RAM to store information. Where does the information come from and how is it stored? The information comes from individual experience and that of others. It is then accumulated in a new information storage device - the memory. Memes or menes become the new informational unit superseding genes by virtue of their transferability and feature of being an instantly acquirable characteristic or trait. This is a big step because for the first time significant amounts of information are being created within – in the present rather than accumulated.

An even larger development in information utilisation came with human mental models. These are informational representations of reality in our brains, which may be accurate to a greater or lesser degree. This has required the development or evolution of a neuronal informational code as powerful as the genetic informational code to allow the brain to simulate events. It does this in order to generate appropriate behaviours. This is much more powerful than relying on a range of responses, whether in-built or acquired. The responses can be generated. The exact pattern of neurons underlying the responses can be created de novo.

Mental models allow reasoning and even rationality. They allow prediction and planning by separating the doing from the deciding. They require language as a means of transmitting information from one brain to another so as to reap the benefits of collective information usage. Language gave rise to writing as an informational medium. As we saw earlier, it is the spatial arrangement of photons dictated by the letters on the page that enable the information to be coded and sent via patterns of photons to the brain. The brain then converts them into another pattern, into an informational coding system in the neurons. This is a good example to use because it shows that it is the pattern rather than a substance or force which is transferred between page and eye. The information is the pattern. It can be seen as an elaboration of the use of vision generally as a sensory information mechanism. Photons from an organism's surroundings convey information rich patterns to its brain where this information can be processed.

Sound, the spatial distribution of air pressure, is used in language as an alternative method of coding information for transmission. There are other dynamic forms of information which I will not go into here, but can be thought of in terms of a computer analogy where information can be held either dynamically requiring energy to maintain it, as in the spatial arrangement of flip flop switches, or more stably for long term storage, as in magnetic sequences on a disk. So too with most

informational systems, the medium used for holding the spatial arrangement is often changed to stabilise information for storage purposes.

Language and writing opened up the path to science, technology and accumulated knowledge. These allowed the generation of information which is orders of magnitude greater than was possible before. The development of science as an information generating medium by the rational left brain should not be underestimated. It is at least as powerful as DNA and language as a mechanism for carrying, processing and expanding information.

Societies act as supra-individual information stores and processors which release the benefits of collective and cooperative information processing.

This brings us up to date and to the current improvement in information processing and generation - the utilisation of computers and information technology to enhance these activities. Computers have been used as an informational analogy but in reality they are an actual enhancement of our mental information processing system. The spatial arrangements of magnetic bits or patterns of photons (fibre-optics) enable such an elaboration to work by processing and storing information. Our appreciation of an overall Evolutionary process helps us to overcome a common block people have when trying to envisage non-living, non-organic computers taking over from human, biological evolution; biological evolution was but a phase of the overall Evolutionary process.

Let us recall at this point that the information in organic systems is used to exercise control, to organise matter, it could even be said to be the organising of matter – it determines the outcome of interactions. Since evolution selects organisms or systems which are more effective at doing this organising, the quality of the information determines evolutionary success and survival - not so much survival of the fittest but survival of the best informed. To put it another way, if information determines behaviour, in the sense of how matter controls other matter, then evolution will result in the development of ever more effective information systems, such as the simple but accurate information system of amoeba or the more elaborate and adaptive information systems of humans. The arrival of computers as the quintessential information processors heralds the end of the supremacy of the organic, ‘carbon’ based phase of the evolution of information and the arrival of the next - the ‘silicon’ phase. Life is the evolution of information. We are an elaboration of atomic and molecular information systems and in turn will be superseded by more advanced stages in this progression, such as computers. Organic evolution is but a step in the overall Evolutionary process of the Universe - the Evolution of information. Evolutionary Structural Emergence is the emergence of levels of information rich patterns.

Information Summarised

The universe started as energy and information. Information is what determines how energy was converted into matter and subsequently how these interacted or behaved. It is what restricts, or has the potential to restrict, all possible reactions and behaviours to particular ones in a given context. Information is held in the spatial pattern of an object’s components.

Early on, information consisted of the properties of matter which can be abstracted into the physical laws governing the behaviour of the fundamental component(s) of energy and matter.

However, since interactions gave rise to new spatial arrangements of energy / matter with new information this led to an open ended cascade of events where existing matter and energy created new permutations of matter and energy with new informational content in an unending progression - or Evolutionary sequence. I have called this process Evolutionary Structural Emergence. This progression which started with physics has moved through chemistry, biology and is currently entering the technology stage. In parallel it has passed through various types of information processing phases including atomic, molecular, structural, DNA, nervous system, thought and computer information systems.

The progression is an automatic unfolding of emergent properties in a series of complexity levels. Each step is determined by the information in the previous step, just as the morphogenesis of a specific body shape comes from the information in its genome or as molecules and chemistry unfold from the original set of atoms / elements and their properties and on a more abstract level, how mathematical laws and properties arise from an initial set of axioms. Of all the possible arrangements and relationships of matter which can develop, information is what determines what does develop. Information is what guided or restricted the universe where everything was possible to the actual world we have today. Information is what has enabled the selection of order, including us, from disorder.

Although part of an overall Evolutionary process, the biological phase represented a particularly significant step. From a world of atoms which passively respond to the information they contain, an extraordinary new combination of matter arose, the organism, which has control over matter - has the ability to organise and replicate patterns of matter. It could do this because of the information it contained. This information was then refined as part of the organic evolutionary process. The selection of more effective information systems is at the very heart of Evolution and in particular biological evolution, in the form of organisms. The evolutionary sequence proceeded from bacteria-like organisms which act in an almost chemical way according to a biochemical information system using DNA as its information base, through organisms with a nervous system as the information store and processor, to humans who use their brains, societies and more recently computers as elaborate information generators.

The properties of (the information of) individual components determine how they can come together into collections or spatial arrangements of components. From the very beginning it was the spatial arrangement of the components of energy, atoms, molecules or organisms which gave them their new properties or informational content. This continued up the chain all the way to writing which relies on the spatial arrangement of lines of ink to hold information and the data bytes of computers which rely on the spatial arrangement of magnetic 0s and 1s in sequences. This is why I describe the essence of life as the ability to organise matter (to increase complexity). It is this ability to create spatial arrangements of matter which is so important because it confers the ability to create information. Information is held in the spatial arrangement of matter; it is the spatial arrangement or pattern of the components. The ability of life to organise the spatial arrangement of matter gives it the power to create information, which ultimately determines what happens in this Universe. The biological method of doing this is just one step in a progression of emergent information levels, which together I call Evolution.

The information that allows life to organise matter, as it becomes more complex, allows it to generate information, including new information and this new information allows it to organise matter even more effectively. Information is the fuel of life and the subject of evolution. Evolution is the mechanism for selecting and

thus generating increasingly complex and/or effective informational systems. A living organism is an information system which at the minimum can replicate its information and at best increases it. A reformulation of our working definition of life, the ability to organise matter, would be the ability to recreate or generate information systems.

Biological evolution is now being surpassed by the next overall Evolutionary process, as organising power is linked to ever more pure sources of information based on science and technology.

The Future

The brain and its information containing, acquiring, creating capacity has lead to us escaping or out-growing bio-evolution and entering into Techno-Social Evolution. The DNA base has changed to a word base. What next?

Life is about the ability to organise matter, it is about information. Indeed, life can be described as an information processor. The latest and most powerful development of bio-evolution has been the human brain, the ultimate organic information processor. Therefore it is not surprising that we turn towards computers when we think of future developments. Perhaps it is no coincidence that computers are the favourite analogy when explaining brain function and vice versa. Computers have been invented to process information for humans. Currently they are only particularly good at processing certain types of information but their range is broadening.

We can see this development as part of a progression. Initially information was stored in atoms and molecules themselves. This information consisted of the properties of those structures and as such was invariant. With the appearance of life, DNA became a specialised molecule for the purposes of storing the informational content of the whole organism. The storage of information in DNA is digital rather than analogue in nature and therefore is less prone to degradation during copying. This is an important requirement of a system if it is to sustain an evolutionary process. The next step was for the brain to become the new medium of information storage. To some extent individual and social information held in the brain is analogue and susceptible to degradation, although the use of written material converts this to a more durable digital type of format. In addition, and more importantly, scientific information itself is already digital by nature since once proven it does not change simply as a function of time, although here we are talking of the content rather than the medium. The move towards information in computers obviously fulfils the digital storage requirement. Thus information has retained its non-degradable, digital properties from DNA through brains to computers.

On the one hand computers are just another way in which humans have used their brains and technology to extend their phenotype, their ability to organise matter. In this respect they are no different to other machines such as cars and lathes which enhance legs and hands. On the other hand, the skill they enhance happens to be that found in the central processing unit for information - the brain. This organising organ can also be viewed as simply another biological adaptation like eyes or legs. However, the fact that the brain specialises in information processing makes it unique. Therefore it is the fact that computers are enhancing this specialism which makes them different to the other machines which enhance the body.

By extrapolation of the trends found in the Evolutionary process, computers will become the dominant organising / informational unit and as such will supersede the current human organic variety of the brain. With the same irony that bio-evolution outmoded itself by creating the brain, so word based, acquired behaviour created the information processor – the computer. They too will take over from the system which created them. Cars and various other forms of transportation may replace our more natural forms of movement but we would not see this as a significant loss to our humanity. However, we are our brains and if their functions were usurped there is a real sense in which we would have lost something significant.

The statement that computers will replace human beings needs further clarification as there is often much confusion as to what this means in practice. First of all, I am not necessarily proposing that machines will replace our bodies, only that computers will replace much of our thinking capacity. Although as human beings we place much more significance on our minds, it will prove far harder to replace our bodies with machines than to create a computerised alternative to our brains. In other words it will be extremely difficult to devise a machine which can repair and maintain itself as well as our bodies are capable of. To devise one which can evolve as well is even harder. The apparent ease with which we heal a cut or our immune system keeps the body clean or cells replenish themselves belies the power these bodily functions bestow. I suspect the body is far better at its job than our brain is at carrying out its own function. This is perhaps not surprising since the body has been evolving for billions of years whereas the thinking brain has only been refined for a few millions of years at most and has probably been undergoing rapid change within this period.

Having said this I do not exclude the possibility of machines eventually replacing our bodies. The recently fashionable area of nano-technology which creates microscopic machines provides one signpost of things to come. It seems likely that bionic bodies will be produced where machines are integrated with the human body. In addition, we should remember that we do not necessarily have to create machines which copy every function of our bodies. The aim in the long term is not to create a humanoid machine but one which achieves the same objectives - to be self-maintaining and able to organise matter. We shall return to this important point when discussing the brain.

A far more likely development, at least initially, is that computers will replace our minds. I do not mean that a computer will be put in our heads instead of our brain, although it is likely that electronic chips will be implanted in order to facilitate information exchange between humans and computers. This is currently a weak link in the dual human / computer approach to information processing and unless it is overcome with something more effective than keyboards and current voice recognition we may find ourselves in the outdated model pile sooner rather than later. I suspect that despite computers and brains both using electricity, their operating systems will turn out to be irreconcilably incompatible.

Humans will not suddenly disappear but will exist alongside computers for a period of time. The handover will be relatively gradual. Even then it might not be a case of replacement but of computers taking over or extending the major role of our brains and leaving us behind in the process. We might remain as we are now but the informational control of the world will have passed to computers. This reminds me of the concept I call ‘mitochondrial man’. Mitochondria were once independent bacteria like organisms but now are microscopic, energy producing parts of every cell. They carry out their function oblivious to the overall functions of the cell as a whole. Likewise cells carry out their roles on one level whilst the next level up, the

body, exerts its power to fulfil a higher level role. Thus humans might at best continue to exist much as now but within tight constraints. They could be utilised to carry out various awkward or specialised tasks to which they are suited, as for example, cooks, cleaners and porters are necessary for a university to function. They fulfil a facilitating function but not the primary one of academics. So too mitochondrial man could provide necessary facilitating functions whilst the computer systems develop on a higher plane – and in overall control.

The handover of power could take place as follows. First computers will assist our thinking and decision-making processes very much in a supporting role. The next stage will entail computers and humans working in partnership. Computers will be so advanced and prevalent that many of our activities, large and small, will be impossible without them. This will be followed by a period when the activities of the world are so complex and integrated that many decisions will be made exclusively by computers. Humans will then find themselves in the supporting role rather than in control, perhaps doing some menial inputting and servicing of the machines. Up until this point we will be able to override the decisions of the computers but increasingly it will be too disruptive to the system, too complicated in knock-on effects, to exercise this power. Eventually our veto will be looked on as interference.

A simple example of this progression may be seen in the way computers are increasingly used in aeroplanes. At first they were not needed, with humans providing all the information processing functions. Then computers were used to assist in certain calculations. This was expanded until they could monitor the whole system and act as advisers to the human pilot. Still staying within current capabilities we see that computers can actually fly the aircraft in autopilot mode, although the human pilot can take over at any time. We are now hearing of aircraft systems which restrict what the pilot can do - all aircraft controls are routed through the computer system. The flight computer 'knows' that certain actions are dangerous and therefore does not permit them. Eventually we will have pilotless flight where the whole journey from take-off to landing is controlled by computer. Most pilots of modern aircraft would concede this possibility and in all likelihood this step has already been made in military or civil research programmes. It might be said that this is a trivial abdication of power since it is humans who are directing the overall aim of the activity. If we take it one stage further it is not inconceivable that computers will devise flight schedules to move people and resources to appropriate places. There comes a point when you have to ask who is controlling the process? The same sequence of steps can be imagined for the control of a nuclear power station.

The issues involved show some similarity with the 'calculators or spellcheckers in schools' debate. Antagonists say these devices are de-skilling our children whereas the protagonists claim that it is the overall task which is important, not the mechanics of getting there. If it really is a question of removing a time consuming part of the process then computers can be seen to be helping us. Of course this assumes that our reliance does not turn into dependence which could restrict us when our electronic aids are not available. However, if the choosing of the overall task is influenced by the computing process it starts to become an issue of who is supporting who.

Some people would agree that the future will involve team work between humans and computers but argue that no matter how sophisticated computers become they will merely play a secondary role to humans. I think the above examples help us to see how this view underestimates the power of computer systems. Their ability to deal with complex systems and to increase safety provide pragmatic reasons for

increasing their role. Extrapolation of the Evolutionary trend given in this book proffers a more theoretical view as to why they will inevitably take over.

What is the essential difference between a world in which computers support humans and one in which humans support computers? In practice they might not appear so very different. If humans are dominant they would probably use computers to increase their quality of life and to increase the time they had available for recreational pursuits such as sport and the Arts. If computers are dominant they would make humans redundant and hence force them to follow these same activities. The difference is one of choice and control. The view that computers merely support human objectives requires that humans retain the control and decision-making powers. The evolutionary retirement or subjugation view says that control and decision-making powers are given up to computers. An analogy, or indeed prior example, would be the way in today's world monkeys can have a good life but only as far as they are tolerated by humans, either in restricted areas of the jungle or in zoos. Evolutionary progression usually allows for the coexistence of earlier forms.

Control seems to be an abstract concept to distinguish the above alternative views. However, in the long term it has real implications. If we are superseded by computers in terms of control we will lose our ability to determine our future; by fulfilling a maintenance role our lives might become impossibly restricted. Eventually our activities might become a burden for the electronic world and we will be eradicated. It is only when we come across these limitations in the future and realise we are powerless to change them that we will know who or what has control and that it is too late. If freewill is what makes us human then we will have lost our humanity.

We discussed earlier how our potential freewill which arises from rational, acquired behaviour is restricted in practice by our genetic drives. We then saw that as we started to form cooperative groups the influence of genetic drives was being replaced or supplemented by social rules. These society induced constraints continue the denial of freewill. The rise of computers will be the final restriction on our freewill and this time it will be permanent. This is why I talked of the present time being a brief opportunity to examine our destiny and influence our fate. In the early phase of our transition to computers we will have the knowledge, the time and the resources, including the control of computing resources, to overcome the restrictions of genetics and society. We will be in a position to decide the future, to examine our purpose and possibly to devise a new one. However, as computers continue to become more influential this opportunity will be lost forever.

It may be that choosing an alternative destiny is part of the process of making us obsolete. That is to say we comply with the process by pursuing a purpose irrelevant to the main Evolutionary stream. After all what is the essential difference between achieving evolutionary freedom and being marginalised? We will examine the alternatives further in the final section of this book.

Therefore on balance, despite the superficial similarity of the powerful and the powerless interpretation of the future of humans, I favour the view that we will be superseded by computers, at least in the important Evolutionary criteria. As mentioned above this need not be unpleasant and will give us an opportunity to indulge the emotions of our right brain drives. Ironically, these were the very mechanisms which allowed us to become the dominant evolutionary organism. Once we were side-lined we would be kept entertained by endless opportunity to satiate these desires in a hedonistic retirement of the human race, or at least as long as we earn our keep by providing the basic housekeeping functions for the wired world. Of

course it is possible to accept such a fate as inevitable and part of a natural progression. I only ask whether our left brains can accept such a destiny.

Having examined the broad questions regarding this future Evolutionary transition let us briefly discuss some of the details which are sometimes used as reasons why this cannot happen.

"Computers are dumb - they can only do what they are programmed to do". This was a common battle cry of the "computers are only clever calculators" proponents. It used to be the dominant view, but as we witness the dramatic advancement in the capabilities of computers we hear it less and less. It could be argued that humans themselves start off by being quite dumb, in the form of newly born babies. The only difference is that babies are partially self-learning, whereas computers have to be totally taught (programmed). However, recent developments in software design mean that learning computers are starting to become a reality. The old binary logic is being replaced by more subtle evaluative processing systems. Our present computers are embryonic compared to those of the not too distant future. In comparison to how long it took to design a learning human infant, computers have barely passed the moment of conception in terms of their development. Their hardware is developing exponentially.

At this very moment computers are undergoing the 'social' transition. That is to say, just as humans collected into societies for greater productivity, so computers are being networked together to exchange and work cooperatively on information. As mentioned earlier, the development of the Internet can be seen as the nervous system of the world, or society's brain. Nodes are appearing around the northern hemisphere of the globe and eventually, I predict one of these (in the USA?) will expand to assume the role of world brain.

It is likely that the relative inflexibility of computer hardware will be overcome by concentrating on developments in the more flexible software. This has echoes of bio-evolution and the move to changes via the bio-software of acquired behaviour in our brains rather than relying on the more limited bio-hardware adaptations of our bodies. Thus a standard computer unit equivalent to a nerve cell may be developed and the advances will be in how these are networked together, the software they contain and what information is processed by this software.

Software will become self-modifying and self-written by computer. This is already possible to some extent. As this becomes more sophisticated and together with the above standard computer unit, we can see how the computer system can evolve. Indeed, current developments with genetic algorithm programming suggests that computing has a lot to gain by adopting and improving on the bio-evolutionary and genetic techniques which have been used to great effect in the organic world. As we have already noted, it is significant that digital rather than analogue information forms the basis of both computers and DNA.

Another criticism of the idea of computers replacing humans is to say that only humans can provide the drive to keep the whole technological progression rolling. Why should computers progress, that is evolve? Why should a computer do anything? The obvious answer is that a human has told or programmed it to and consequently the drive or motivation to do something comes from us. But if we are contemplating computers taking over control or even existing without us at some stage, our drive has to be transferred to, or at least controlled by, the computer. If humans are subjugated to an ancillary role rather than replaced they could still provide the basic drive but it would be the computer which decides how that drive is expressed. This is similar to the way in which our brain provides us with basic genetic drives but the higher levels of our primitive brain decide how to satisfy them.

However, whilst this layered approach may occur initially, I think it underestimates the power and potential of computers in the long term. There is no reason why this drive could not be replaced by a computer algorithm. People ascribe mystical qualities to the human drive to live and progress. I hope the forgoing sections of this book show that actually we rely on a number of fundamental rules and that our evolutionary explanation begins to suggest what these rules might be. Examples of the drives computers would need are those responsible for survival, innovation (mutation), acquisition and most importantly, the drive to generate information - in essence the computer would require evolutionary drives. How these drives are turned into activity and how they are prioritised will need careful thought. The sub-rules contained in our individual brains and those which allow us to live in societies are quite extensive and will require considerable and complex programming. The point remains however, that there is no reason why these cannot be written into the computer programs of the future. This would be the final humbling step to have the very essence of human drive and willpower translated into a few lines of computer code.

Another common mistake when considering the feasibility of making computers which are capable of replacing us is to suppose that they must mimic us. It is frequently stated that you cannot build a computer which can appreciate a joke or enjoy a Beethoven symphony. The simple response is that you do not need to. Much time is spent trying to get computers to walk, to see, to recognise human speech and so on. This is time well spent if its purpose is to assist humans in various activities but it is worrying that much artificial intelligence research is wasted on trying to simulate human abilities. Even worse, they attempt to emulate human sensory perceptions and responses without apparently realising that ninety nine percent of the human response lies in the context of the internal mental model, not in an optical system which can distinguish a bean from a button by light waves alone. Computers only have to acquire the essential evolutionary features from us. This is a far more straightforward task than creating a replica of a human. It is also a less anthropocentric one which acknowledges that we are just one possible format of an evolutionary device. However, this does require understanding what life is about and what its essential properties are.

The idea of computers being unable to express or feel emotions can be turned on its head. Anger, joy, sadness, love are simply strategies to get our somewhat ill-disciplined minds and bodies to do what they are supposed to. Although highly efficient in a biological domain they can be quite wasteful in an absolute sense. Therefore, how much more productive a system could be if these were no longer necessary and priorities could be established more rationally (although perhaps the improved system would need a random element to match the serendipity factor which arises out of the confusion of human affairs). The fact that many readers are now thinking, “but that would remove so much of what life is about”, is neither here nor there. Just because we are designed to appreciate these attributes does not make them better or preferable in other systems. That is my point, we are designed to favour them.

Conclusion

At the simplest level the issue as to whether computers will ever have the potential to replace the human mind can be viewed in the following way. If

electricity going around networks of neurons in our heads produces our essential being, then electricity going around large numbers of silicon chips is likely to be capable of producing something comparable or even better. This is the future. The dominant role of DNA will be ended and the universal computer network with its evolutionary software will rule the Earth. Inorganic life will have arrived again. We will be seen as the high point of organic life and bio-evolution but only as a transition phase in the wider Evolutionary process leading back to inorganic life. This is the reason I have used the title 'The Last Book'. We can now understand and write about what is going on, but very soon illiterate, intelligent electrical information systems will take over. Books represent the high point of human evolutionary achievement but a fossilised format in the world of the coming computerised information revolution.

With the start of organic life, a fully functional cell could not be produced de novo. Likewise, computers are still passing through this changeable time before settling on a usable unit. We will continue to facilitate this process. The pace of evolution is quickening with each complexity level and computers will pass rapidly through the single unit phase to the multi-unit networked computer stage. What started as electrons following orbital patterns around nuclei in atoms will again have reached a similar phase - information in the form of electrons flowing around silicon circuits in computers, although some people think that electrons will give way to fibre-optics and photons. Whether electrons or photons, the individual components are identical at the beginning and end but the informational content has changed and the complexity of organisation in which they operate is many orders of magnitude greater.

The organisation of matter, the amount of order, the complexity of matter and the control of the processes will all have increased as is indicated by the transition of the evolutionary medium through the different phases of gas, liquid, solid - gas after the big bang, liquid during organic evolution and solid in the silicon circuits of computers. Life on earth will have achieved the supreme organising ability - solid state life. That is to say there will be no moving parts, but an infinitely flexible information generating mechanism in the electron flow around its circuits. It will be a watershed in evolution - pure information.

We can now see why replication is not a fundamental characteristic of life in a true sense. Replication in general is only one specialised variant of growth. The ability to organise matter, our definition of life, can be achieved by growth alone, the ever expanding growth of a computer system. This is why a better label for our units of life would be organisers rather than replicators. The alternative and perhaps more fundamental definition of the life process is that it consists of the ability to generate and utilise information. Life is the ability to increase the informational content of matter. From this we can see that even material growth is not the only way to progress. Bodies reach a certain size and then stop growing. It becomes a matter of what those bodies do rather than just about their size. Our present Techno-Societies have stabilised in population size and yet are still obviously changing, becoming more complicated, and more powerful. It is possible to imagine that the computer population will stabilise with a fixed number of computers which are generating increased amounts of information. Individuals, reproduction and death are no longer necessary. They will evolve through informational units (infons) and menes - information is the fundamental Evolutionary currency. Complexity is the measure of the informational content of a system. Therefore life is about the ability to increase complexity.

Finally, what will become of the computerised world? The evolutionary drive will inevitably turn towards the heavens and start to organise that. The sun which has indirectly fuelled all of this will be brought into the system in a more efficient, direct way to act as the energy source. Alternatively we will discover the Eldorado of energy production - fusion energy. They will represent the ideal organising pair - the sun and planet Earth - energy and information, just as in the beginning.

The search will start for other usable, organisable sources of matter and link up with other planets which have life. Almost by necessity all significant forms of alien life will involve computer-like entities if they are engaged in the complexities of interstellar communication. A few signs of organic life will be heard but largely ignored until they have developed a bit further. The message sent could involve special codes only decipherable by advanced computer systems; humans would be oblivious to them in the same way as monkeys are to our radio messages. Also since birth-death life cycles will no longer be a problem, communication could take many years. By concentrating on the core of the Evolutionary process, information, computers will not encounter the difficulties we presently meet trying to transport matter around space. Physical travel indicates a very old-fashioned, human way of thinking - more advanced forms of life will communicate rather than travel.

And where no intelligent life - computerised life - is found some will be started or sown and revisited in 4-5 billion years when it has developed to maturity. These outposts might even be helpful enough to start signalling through space when they are nearly ready. Perhaps the simplest way for our information planet to do this would be to obtain some of those old bits of DNA and protein in the form of single cells from the museum's store room and broadcast them, shotgun fashion, throughout the galaxy. One or two of them might land on a suitable planet - and it would all start again enriching another corner of the universe with information.

Review of evolution and beyond