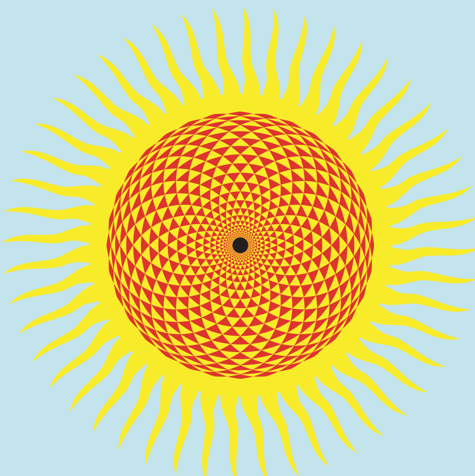
Work in Progress

Wholeness: The Union of All Opposites
Volume Two

The Unified Relationships Theory

Healing the Fragmented Mind in Cosmic Consciousness



Paul Hague

The Unified Relationships Theory

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Volume Two of

Wholeness: The Union of All Opposites

or

Semantic Principles of Natural Philosophy

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Part II

The Unified Relationships Theory

My mind seems to have become a kind of machine for grinding general laws out of large collections of data ... The loss of these tastes is a loss of happiness, and may possibly be injurious to the intellect, by enfeebling the emotional part of our nature.

Charles Darwin

Part I on Integral Relational Logic described how, by starting afresh at the very beginning, the Logos, arising directly from our Divine Source, can guide us to evolution's Omega Point, its glorious culmination after some fourteen billion years of outward development. As described on page 248 in Chapter 4, 'Transcending the Categories', having cognitively reached the Summit of the Mountain of All Knowledge, we can then return Home to Wholeness through a process of involution, as all forms and relationships dissolve into a seamless, borderless continuum, which is Nondual, Immortal Consciousness.

In a sense, there is then nothing more to do in life. We now know the innermost secrets of the Universe, what it is and that it is designed through the action of the Principle of Unity: Wholeness is the union of all opposites. As none of us is separate from the Divine, Nature, or any other for a single instant in our lives, we know that our True Nature is all-encompassing Consciousness, which includes the entire human race and, indeed, all sentient beings in its embrace. Thus, in Reality, there is no other. Since we live in a holographic Universe, all the thoughts, feelings, emotions, hopes, and fears of the entire species are contained within each and every one of us.

There is then nothing more to reach out for, to aspire to; as Wholeness, we are as complete as can possibly be. However, as well as being the entire Ocean of Consciousness, we are all also individual waves and currents on and beneath the surface of the Ocean. And as such, we continue to be living beings, following daily paths through life according to our lights, our unique propensities. Although we like to believe that we have a choice in how we act and behave, we don't really, for none of us is separate from any other or the Divine for a single instant. We are all participating in the great play of the Divine, as actors in a Cosmic Dance.

Nevertheless, the thought can arise that it would be nice if we could end the long-running war between science and religion and all the wars between the different religions so that we could live in love, peace, and harmony with each other and our environment. It is not in the power of either the Supreme Being or any of us to bring this miracle about collectively. It will happen or not, as the case may be. In the overall scheme of things, it really makes no difference what happens to the human race, one way or the other.

So let us proceed as if we had a choice in how we live our lives and see what happens. What we shall do in the remainder of this book is therefore to rebuild as much as we can of the world of learning within the Cosmic Context and coordinating framework of IRL, grounded on Love, the Divine Essence that we all share. Even though IRL takes us to the end of time, when there is no past and future, our emphasis will be evolutionary and involutionary, exploring as much as we can where we have come from and what our destiny is as a species. For the better we understand what is happening to humanity at the present time, the greater chance we have of living in harmony with the fundamental laws of the Universe.

Such a coherent synthesis of all knowledge can best be called the Unified Relationships Theory (URT), indicating that all beings in the Universe are related to all other beings in zero to many ways, some of which can be categorized, while others defy classification and must remain a mystery. This fully integrated, self-inclusive worldview is depicted in the notation of the Unified Modeling Language in Figure 1.47 on page 167. In essence, it shows that we human beings are never separate from the Divine, Nature, or each other for a single instant in our lives, contrary to what we are taught in religion, science, and business today.

Now, as the URT is entirely new, it cannot have become manifest as a rational body of knowledge from the past in the horizontal dimension of time. Indeed, as indicated by Section 'Laying down the foundations' in Chapter 1, 'Starting Afresh at the Very Beginning' on page 148, the URT has come into being through the creative power of Life arising directly from our Divine Source. We can therefore say that URT is a vital science, because *vital* derives from the Latin *vītālis*, from *vīta* 'life'. In contrast, modern science is dead, denying the existence of Life, believing that life is a property of the DNA molecule.[1] It is not surprising therefore that Charles Darwin wrote in his autobiography that "until his thirtieth year he had intensely enjoyed music and poetry and pictures, but that for many years afterwards he lost all taste for these interests."[2]

Both E. F. Schumacher, in *Small is Beautiful*, and Erich Fromm, in *To Have or To Be?* quote from Darwin's autobiography. Fromm used Darwin's experiences to demonstrate "the consequences and the human tragedy of a purely scientific, alienated intellect. … the separation from reason and heart is almost complete."[3] In Schumacher's case, he used Darwin's experiences to illustrate the distinction that G. N. M. Tyrell made between 'divergent' and 'convergent' problems, ones that cannot be solved by logical reasoning and ones that can, which are clearly analogous to what Herbert A. Simon called nonprogrammed and programmed decisions, as we saw on page 18. This is how Schumacher made this distinction:

> Life is kept going by divergent problems that have to be 'lived' and are only solved in death. Convergent problems, on the other hand, are man's most useful invention; they do not, as such, exist in reality, but are created by a process of abstraction. When they have been solved, they can be written down and passed on to others without needing to reproduce the mental effort necessary to find it.[4]

Actually, the URT, as vital science, needs both heart and mind, both intuition and reason. It addresses both divergent and convergent problems. On the one hand, IRL is pure reason, and can theoretically be learnt by anyone going through a similar thought process, like a mathematical theorem or scientific theory. But it is important to note here that a theory is not a collection of words, mathematical symbols, and pictures laid out on paper or stored electronically. As David Bohm has pointed out, "*theory* derives from the Greek *theoria*, which has the same root as *theatre*, in a word meaning 'to view' or to 'make a spectacle'. Thus it might be said that a theory is primarily a form of *insight*."[5]

So to be able to see the Unified Relationships Theory requires deep self-inquiry, necessary to solve divergent problems, such as those encountered in human relationships, "in family life, economics, politics, education, and so forth".[6] What this means is that we can only find deep inner Peace and Stillness by passing through a psychological death, by starting afresh at the very beginning. And this has nothing to do with the intellect, about our belief systems. Anyone can become a buddha, for we are all, in Essence, Buddhas.

In *The Book of Secrets*, the first discourses that Osho gave in English in the 1970s, when he was called Bhagwan Shree Rajneesh, he made a clear distinction between our rational development and the spiritual quest. The former is unique to us, as individuals, whereas the goal of the spiritual quest is that which we all share, which is ever-present in all of us: the Divine. As Osho said, "it may not be possible for you to have a mind, a reasoning faculty, like Einstein. But you can become a buddha … because buddhahood is not to be developed in you, it is already there. It is concerned with the basic centre, the original centre." As he said, it is impossible for any of us to repeat the exact thought processes of another.

> Because to develop the head of Einstein needs the same growth, the same milieu, the same training as was given to him. It cannot be repeated, because it is unrepeatable. First you will need to have the same parents, because the training begins in the womb. It is difficult to find the same parents—impossible. How can you find the same parents, the same date of birth, the same home, the same associates, the same friends?[7]

What this means is that what each of understands by the Unified Relationships Theory or theory of everything must be unique to all of us. But if we are to live in Love and Peace by ending the war between science and religion, this means that scientists and medical practitioners need to acknowledge the role that Life, or God the Creator, plays in our creative, healing processes.

Despite these differences, there is one issue that we could all agree on: our minds create our reality. For the evidence for this is self-evident once we begin to know ourselves in the time-honoured manner. This means, that we need to collectively establish psychology as the primary science, replacing physics and biology.

Of course, if we want this to happen and it doesn't, then this must inevitably create an inner conflict within us, a lack of Peace. We all follow our own unique paths through life, and if we want anyone to be different than they are, including ourselves, this is a violent act of war. Evangelism can play no role in the Age of Light. Yet paradoxically, such a society cannot come into being by hiding.

The meaning of *life*

The first thing we need to do in developing a vital science brought into existence by Life is to examine the meaning of the word *life*. The word *biology* means 'the study or science of life', from the Greek *bios*, 'life'. But biologists do not study Life; they study *forms* of life. So maybe it would be better to call biology *biomorphology*, from the Greek *morphe* 'form'. Yet everything in the relativistic world of form has come into manifestation through the power of Life, from quarks, through cells and concepts, to galaxies. So we are all biomorphologists in a sense, whether we are geologists, psychologists, architects, historians, poets, or whatever.

So how can we distinguish biologists from all other students of life? Well, what biologists actually study is *self-reproducing* forms of life. So maybe biology should be called *autogenic biomorphology*, from the Greek *auto* 'self', and the PIE base **gen* 'produce', quite a mouthful. This PIE root has given rise to many English words, mainly through Latin. These include *generate*, *gender*, *genealogy*, *gene*, *genesis*, *genital*, *genetic*, *general*, *genitive*, *genus*, *kind*, and *nature* (from the Latin *nasci* 'to be born'). To the ancient Romans, *genius* meant 'guardian or guiding spirit of a person at birth', which captures the fact that our creative energies do not egoically belong to us as individuals; they are born naturally from the Divine. So we could say that the true biologists are theologians, literally meaning 'science or study of God'.

I am deliberately not using the term *autopoiesis* or its adjectival form *autopoietic* here, even though this derives from the Greek *poien* 'to make, do, produce, create', which is also the root of *poetry*. The reason for this is that Humberto Maturana and Francisco Varela coined *autopoiesis* in 1972 to mean:

> An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in space in which they (the components)

exist by specifying the topological domain of its realization as such a network.[8]

As the systems theorist, Fritjof Capra, tells us:

> Maurana and Varela began their essay on autopoiesis by characterizing their approach as 'mechanistic' to distinguish it from vitalist approaches to the nature of life: 'Our approach will be mechanistic: no forces or principles will be adduced which are not found in the physical universe.' However, the next sentence makes it immediately clear that the authors are not Cartesian mechanists but systems thinkers: 'Yet, our problem is the living organization and therefore our interest will not be in properties of components, but in the processes and relations between processes realized through components.'[9]

Thus systems theorists today are at pains to deny the role that the Divine plays through Life in living systems, which are often called 'self-organizing', an energy that in the URT is called the Logos, arising directly from our Divine Source. This nonphysical energy has been known throughout the ages as a vital principle underlying human experience, encapsulated in Henri Bergson's concept of *élan vital*,[10] normally translated as *vital impetus* or disparagingly as *vital force*. Yet this vital force is "the energy or spirit which animates living creatures", as my dictionary says.

The word *animate* derives from the Latin *animalis* 'having a soul', from *anima* 'breath, soul', which, of course, is the root of *animal*. These words are related to the Swedish *anda* 'breath, spirit', and *ande* 'spirit, soul', connected with *aniti* 'breathe' in Sanskrit. In turn, *spirit* derives from the Latin *spiritus* 'breath, spirit', from *spirare* 'breathe'. So the roots of our language clearly indicate that the ancients were well aware of the role that spirit, arising from the soul plays in breathing animals, such as human beings.

We can also see these etymological relationships in other languages. For instance, in the Old Testament, the Hebrew words *nephesh* 'breath; life, life force, soul' and *rûah* 'breath, wind; spirit, mind, heart' are translated as 'soul' and 'spirit', respectively. Similarly, in the New Testament, the Greek words *psyche* 'breath, spirit; life, soul; heart, mind' and *pnuema* 'wind, breath' are also translated as 'soul' and 'spirit', respectively. As *The Strongest Strong's Exhaustive Concordance of the Bible* tells us, all these words denote 'the immaterial part of the inner person that can respond to God'.

And in the East, Atman, "the real immortal self of human beings, known in the West as the soul" derives from Sanskrit *ātman* 'breath, spirit; soul, essence, self'. Also in Sanskrit, *prana* means 'breath, vital life', from verbal root *prā* 'to fill', from PIE base **pelə-* 'to fill', also root of *fill*, *plenty*, and *plus*. Similarly, *qi* (*ch'i*), a central concept in Taoism and Chinese medicine, denotes "the vital energy, the life force, the cosmic spirit that pervades and enlivens all things", literally 'air, breath, gas'.

Anyone who has been close to someone peacefully dying can see why the ancients made this association between life, spirit, and breath. For as the breath slows and eventually stops, spirit ceases to enliven the body. It is perhaps natural that our forebears took this anthropocentric view of life and death. However, in the URT, we can see that all structures in the Universe, including the physical universe of mass, space, and time, arise from our Divine Source and return there at the end of their lifespans. This includes, of course, Western civilization, the global economy, and *Homo sapiens sapiens*. The human race is not immortal, anymore than any other structure is. To deny this is to deny life, for life and death are just sides of the same coin. So if we are to face the imminent death of capitalism and the eventual death of humanity with equanimity, we can only do so through a psychological, egoless death before our bodies return to the Immortal Ground of Being that we all share.

This is perhaps the most important reason why we urgently need to unify reason and mysticism. Yet there is almost no scientist today who is ready to make peace possible by ending the war between science and religion, despite many of them writing books on the subject. This is well illustrated by Fritjof's best-selling *The Tao of Physics: An exploration of the parallels between modern physics and Eastern mysticism*. He writes:

> Once these parallels between Western science and Eastern mysticism are accepted, a number of questions will arise concerning their implications. Is modern science, with all its sophisticated machinery, merely rediscovering ancient wisdom, known to the Eastern sages for thousands of years? Should physicists, therefore, abandon the scientific method and begin to meditate? Or can there be a mutual influence between science and mysticism; perhaps even a synthesis?[11]

He goes on to say:

> I think all these questions have to be answered in the negative. I see science and mysticism as two complementary manifestations of the human mind; of its rational and intuitive faculties. The modern physicist experiences the world through an extreme specialization of the rational mind; the mystic through an extreme specialization of the intuitive mind. The two approaches are entirely different and involve far more than a certain view of the physical world.[12]

By admitting Life, as the origin of all energy in the Universe, into science, science and theology merge into a single discipline of study. Philosophy, as a separate discipline also ceases to exist, for as Bertrand Russell said, “Philosophy, as I shall understand the word, is something intermediate between theology and science. … between theology and science there is a No Man's Land, exposed to attack from both sides; this No Man's Land is philosophy.”[13] But why should theology and science attack philosophy and vice versa? Why not create a coherent body of knowledge in which there are no longer any wars? enabling us to Live in Love and Peace.

That coherent body of knowledge is the Unified Relationships Theory, whose framework is Integral Relational Logic (IRL), described in Part I. As the URT is not science, philosophy, or theology, in the sense that these words are used today, we can call it *panosophy*. This means that panosophers are scientists, philosophers, and theologians all rolled into one. And when they take this learning out into the practical world of everyday affairs, they are also business people. In effect, as panosophy cannot be classified—as it is transcultural and transdisciplinary—panosophers are unlabelled, without any particular identity in the world. They are mavericks, from the name of Samuel A. Maverick, a nineteenth century Texas rancher, who did not brand his cattle. Panosophers are thus also mystics, studying the innermost secrets and mysteries of the Universe, which are invisible to the categorizing mind.

Seven pillars of unwisdom and wisdom

What we need to do now is show how we can build this coherent body of knowledge on the gnostic foundation, metaphysical framework or skeleton, and cosmic context provided by IRL. As the URT shows that all beings in the Universe are related to all other beings, this means that we need to make some radical changes to the way that we view our lives today. For Western civilization is based on the assumption that we human beings are separate from God, Nature, and each other. As a consequence, what is taught in the schools and universities of Europe, America, and all other countries that have been influenced by this European tradition is based on seven pillars of unwisdom, a term coined by Arthur Koestler to highlight the absurdities and limitations of the biological, behavioural, mechanistic, and quantitative sciences.[14] Koestler identified four such pillars, which we extend in the all-inclusive URT to seven: misconceptions of God, Universe, Life, humanity, money, justice, and reason.

The first pillar of unwisdom arises from our separation from God; the next three arise because we see Nature as other; and the fifth and sixth pillars support our notion that we are separate from each other. These six pillars of unwisdom are encapsulated in Western reason by Aristotle's Law of Contradiction, which is the seventh pillar of unwisdom, lying at the heart of mathematical proof and deductive logic.

Pillars of unwisdom

Separation from God

1. God is other: there is a great gulf between the Creator and created that can never be bridged. Each of us has our own personal God, with whom we can have a relationship and conversations. Human beings are created in the image of God. God does not exist.

Separation from Nature

2. The physical universe is the primary reality and all phenomena in the Universe can be explained in terms of the laws of physics, including Consciousness, which arises from the brain as an epiphenomenon. It is the task of science to master and control Nature, viewed as an objective reality, for the egoic benefit of certain groups of human beings alone.
3. Life is a property of the DNA molecule and first emerged on Earth some 3.5 billion years ago. Consequently, evolution is a process that has come about solely by purposeless transformations of the DNA molecule, aided by natural selection, without divine intervention. Human learning is not biological and is therefore not an evolutionary process.

4. Human beings are biochemical machines and nothing but machines. Physical and psychological disorders can therefore only be cured through either mainstream or alternative medication, not through spiritual, subtle, or mental healing energies. It is also possible for computer scientists to create artificial intelligence, artificial consciousness, and even artificial life.

Separation from each other

5. Technological development can drive economic growth indefinitely, and money is a commodity with value that can be bought and sold. We can understand everything that is happening in business through econometric, financial, and management accounting models. If we are to survive as individuals, we must selfishly compete with our fellow human beings for the precious resources of our beautiful planet Earth, including the money supply, which must be limited to hold its value.
6. Individual human beings have the free will to decide their destiny and how they behave. So people can be blamed for what are called immoral, antisocial, or criminal activities, and can claim credit for what society regards as praiseworthy. Such a divisive society is characterized by individuals adopting litigious and vengeful attitudes, on the one hand, and, on the other, seeking recognition through prizes and awards.

Logical implications

7. For reason to be valid, it must reject paradoxes and self-contradictions, a principle encapsulated in Aristotle's Law of Contradiction, which underlies mathematics and deductive logic. Thus, to see both sides of a situation is a two-faced sign of weakness, of indecisiveness; a dualistic view that inevitably leads to war.

It is by demolishing these pillars of unwisdom, and rebuilding the entire world of learning on the seven pillars of wisdom that we could make peace possible. In summary, these are:

Pillars of wisdom

Union with God

1. Every one of us is in union with the Divine at every instant of our lives. There is only one absolute Whole, which provides the overall context for all of us as individuals. God has no image, for Wholeness is the union of all opposites, including form and formlessness.

Union with Nature

2. Consciousness is all there is, the only Reality. Everything in the relativistic world of form, including the physical universe and ourselves, is an illusion, an appearance in or abstraction from Consciousness, with no permanent existence; this is called *maya* in the East. We are thus all an integral part of Nature, inseparable from anything else in the world of form.
3. Evolution, from the most recent big bang fourteen billion years ago, through the evolution of the species, to human learning, progresses accumulatively through the synergistic effect of

structure-forming relationships, the whole process being driven by the creative power of Life, whose origin is the Divine. The ultimate destiny of evolution is ineffable, nondual Wholeness, whence it began.

4. In essence, human beings are divine, cosmic creatures. Our true nature is thus Wholeness and the Truth, Love and Peace, Life and Freedom, Consciousness and Intelligence, and Stillness and Emptiness, capitalized words to denote Ultimate Reality, the Absolute, and God. The power of Life, alone, is quite capable of restoring us to health, wholeness, and holiness.

Union with each other

5. All growth processes in the Universe are limited, following an S-shape. To trade in financial products is, like buying and selling kilograms and metres, an absurdity. We can best see what is happening in business today by integrating all the semantic models developed by individual information systems architects working in separate enterprises. We can only survive as a species, and thereby realize our fullest potential, if we learn to cooperate with each other synergistically.
6. We human beings are the products of some fourteen billion years of evolution, which has been brought about through the power of Life, acting in the timeless, constantly refreshing the blind, mechanistic evolutionary processes that take place in the horizontal dimension of time. There is thus no doership or ownership, no separate entity who can be said to do or own anything. What we call 'justice' is thus an egoic concept, which arises because of our inability to see our personal lives in the context of the Whole.

Logical implications

7. The Universe is inherently paradoxical, a situation that we need to incorporate in a hologenetic, noninferential, self-reflective science of reason that truly reflects the world we live in. To see both our own and the other person's perspective is a sign of intelligence, leading to peace and harmony in personal and group relationships.

Overview

As the Unified Relationships Theory is the result of integrating all knowledge in all cultures and disciplines at all times, past, present, and future, it would fill all the bookshelves in the world if it were written out in full. So to keep this part within reasonable proportions, we shall just focus attention on the most critical issues facing humanity today: our health, well-being, and whatever we can do to prolong our survival as long as possible, recognizing that *Homo sapiens sapiens* is not immortal, and that one day our species will become extinct.

Having created the foundation, framework, and context for the URT in Part I using reasoning of the utmost abstraction, the approach we shall take here is to refine these concepts, making them ever more specialized to particular domains of discourse. Remember that we are looking at the Totality of Existence in terms of the abstract concepts of structure, form, relationships, and meaning; it is meaningful structure-forming relationships that make the world go round. So what might look like separate domains from a specialist perspective, display similar underlying patterns when looked at from a generalist point of view, where *generalize* has the same root as *generate*. Furthermore, as we see on page 1069 in Chapter 13, 'The Prospects for Humanity', using the concepts of pædomorphosis and gerontomorphosis, such an evolutionary approach is rejuvenating, freeing us of the past that keeps us in the dark about what is happening to humanity at the present time.

We saw in Part I that IRL emerged to explain why scientists and technologists are driving the pace of scientific discovery and technological invention at exponential rates of accelerating change. However, as egalitarian IRL treats time and causality in exactly the same way as all other concepts, it does not explicitly solve the business management and modelling problem described in Section 'The central information systems modelling problem' on page 16. We rectify this situation in Chapter 5, 'An Integral Science of Causality' on page 483 by setting this particular problem within a broad view causality and spontaneity, which can explain why everything that happens in Universe happens in the way that it does.

With the basic principles of causality established, we can then look at evolution as a whole, which is vitally important for an understanding of what is causing the pace of evolutionary change to accelerate exponentially. For the changes that we are experiencing today are the just latest manifestations of some fourteen billion years of evolution since the most recent big bang, which we look at in Chapter 6, 'A Holistic Theory of Evolution' on page 521, providing a timeline based on a diminishing exponential series in mathematics. We can thus see that we are now living at the most momentous time in evolutionary history as evolution passes through its accumulation point, in systems theory terms.

To bring this big picture closer to home, in Chapter 7, 'The Growth of Structure' on page 571, we then look at how structures evolve, particularly at the S-shape of the growth or learning curve, which applies to us both as individuals and as a society. The Internet is a prime example of the growth of structure over the past couple of decades, so we shall look at how this has naturally come about, tracing the growth of structure of computers, programs, systems modelling, data, and conceptual modelling. There then follows a study of the key concepts of energy, synergy, and entropy from the perspective of the URT. We can perhaps note that globalization, which has become a derogatory term in recent years, is also arising through the natural convergent powers of evolution. But, it has got a bad name because we still believe that we must fight each other for the finite money supply, causing severe psychological and ecological damage.

Chapter 8, 'Limits of Technology' on page 619, shows that it is false to assume that technological development can drive economic growth indefinitely, for we human beings are not machines and nothing but machines. Most particularly, it is not possible for a computer to program itself without human, that is, divine intervention. There is thus no such thing as artificial intelligence, consciousness, or life; we human beings have a far greater potential for growth and development than computers will ever have.

Chapter 9, 'An Evolutionary Cul-de-Sac' on page 643, we look at how Western civilization has reached a dead-end in its development, with nowhere else to develop, and some of the things we need to do to disperse the blocks and barriers that prevent humanity from realizing its fullest potential as a species. We focus attention particularly on the evolution of scientific method, of mathematics and logic, and of science based on physics and lifeless biology.

Chapter 5
An Integral Science of Causality

Knowledge is power.

Francis Bacon

Although Integral Relational Logic emerged to explain why scientists and technologists are driving the pace of change in society at exponential rates of acceleration, IRL, in itself, does not address this issue directly for three main reasons.

First, studying causality inevitably involves time. But time is a concept treated in exactly the same way as all other concepts in egalitarian IRL. For we cannot be consistent in our thinking if we treat time any differently from any other concept, as explained on page 142 in Chapter 1, 'Starting Afresh at the Very Beginning'. So, IRL, as such, cannot tell us anything about causality, not even what caused it to come into existence.

Secondly, faced with the imminent death of the global economy and the human race, the mystical became of paramount importance. Having consciously reached the Omega point of evolution at the end of time in the spring of 1982, my top priority was to find a way of dealing with this awesome vision with equanimity.

Thirdly, inspired by David Bohm, I realized that before I could be of any use to humanity in its moment of crisis, I needed to heal my fragmented, split mind in Wholeness, healing the deep schism between reason and mysticism, which many cognoscenti say is impossible.

Based on this exquisite sense of Wholeness, it is thus the first task of the Unified Relationships Theory to develop a holistic science of causality that can explain why events happen in the Universe, wherever this is possible, not the least, what is causing us human beings to behave as we do. Although such a holistic science has been gestating for thirty years, this chapter is one of the last to be written, for some of the reasons explained above. So without losing touch with mystical Love, Intelligence, and Consciousness, we now need climb down from the summit of the mountain of all knowledge and start afresh at the very beginning once again, this time looking at the Universe from a causal perspective in the two dimensions of time.

For as Brian Greene has said, the essence of the much sought-for theory of everything, which Einstein called a 'unified field theory', is "a theory capable of describing nature's forces within a single, all-encompassing, coherent framework."[1] Of course, physicists can never solve the ultimate problem in science because they only recognize physical causes, not psychospiritual ones, which are of primary importance. It is not until we have developed a comprehensive model of the psychodynamics of society as a whole that we can fully understand the dynamics of the physical universe, including the way that the brain and the DNA molecule function.

So what is causality? Well, dictionaries define *causality* as the relationship between cause and effect, the principle that everything has a cause. *Cause* itself derives from Old French *cause* 'matter, thing', from Latin *causa* 'cause, reason, motive; interest; law-suit; case (different root)', from *causare* 'to cause' and *causari* 'to give as a reason', related to the conjunction *because* 'by cause, for the reason that'. Other causal meanings derive from *causātiōn-em* 'excuse, pretext', root of *causation* 'the action of causing, the operation of causal energy'. Another Latin word whose root was *causa* was *causārius* 'sickly, diseased'.

We can thus see that the history of causality has been concerned at least with providing scientific explanations why events happen in the way that they do, with finding legal and ethical reasons and justification for people's actions, and with discovering the aetiology of disease from the observed or felt symptoms. *Aetiology* 'assignment of a cause, study of causation' derives from Greek *aitia* 'cause, reason'. However, how people have interpreted the supposed relationship between causes and effects over the ages has varied widely with whatever worldview and personal prejudices have informed their explanations.

But today, Integral Relational Logic, as the universal science of reason that shows how all beings in the Universe are related to each other, can, in principle, provide an integral explanation for all causal effects, so far as this is possible.

In studying causality in this integral manner, we should not forget that our minds create our reality. So the URT is first and foremost a science of the inner, and, as such, places psychology as the primary specialist science, before physics and biology. In putting Western thought back on its feet in this way, we obviously shall make radical changes to the concepts of energy and life, as they are understood by materialistic science today.

The second of these changes is much simpler than the first, even if neither is particularly easy given the way that we have been culturally conditioned over the millennia. Figure 5.1, another way of depicting the two dimensions of time in Figure 4.11 in Chapter 4, 'Transcending the Categories' on page 272 , illustrates the holistic principles involved in this transformational exercise. The metaphysical, coordinating framework is IRL, which shows that that the all-inclusive Cosmic Context for all our lives is Consciousness and that the secure Gnostic Foundation that we all share is Love, our Divine Essence. The vertical line in this diagram thus represents the transcendent and immanent aspects of the Immortal Absolute or Divine Cosmos, a seamless continuum with no borders or divisions anywhere. We can then see that all structures and relationships in the relativistic world of form arise from Ultimate Reality as abstractions from or appearances in Consciousness, which is essentially an Eastern worldview. The simplest way to explain this in Western terms is that Life—arising directly from our Divine Source in the vertical dimension of time, like a fountain—is the Ultimate Cause of everything that exists in the manifest world.

The situation gets somewhat more complicated when we look at the way that structures interact with each other in the relativistic world of form in apparently causal, acausal, and spontaneous relationships. Over the years, many different words have been defined in English to denote causal relationships. In human terms, these include *wish*, *want*, *desire*, *covet*, *like*, *will*, *hanker*, *pine*, *hope*, *longing*, *yearning*, and *craving*. More generally, these are just some of the words that denote causation: *energy*, *force*, *might*, *potency*, *power*, *strength*, and *action*. So how can we make sense of all this confusion?

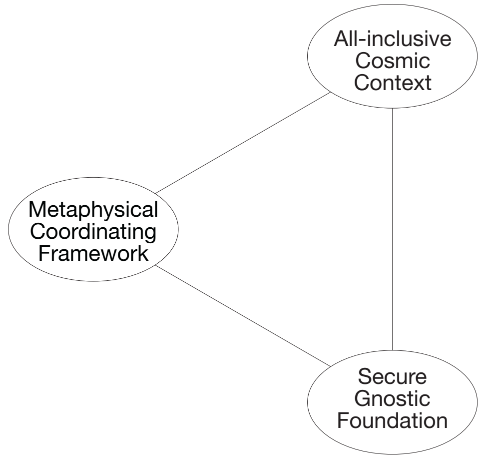


Figure 5.1: *Holistic context, framework, and foundation*

Well, in general, as nothing exists in the Universe except meaningful structure-forming relationships and their opposite–chaotic confusion–structures are causal, as David Bohm told me when I met him for the first time in November 1980.[2] During the previous summer, following the idea that data in all its forms is energetic, Figure 5.2 shows the relationships of some key concepts in my mind at that time. As I was to write a couple of years later, when I first attempted to write the book you are reading now, "Because of the emphasis on materialism in science and society today, the bond between matter and energy was so strong in my mind that I could not break it and link energy with structure."[3]

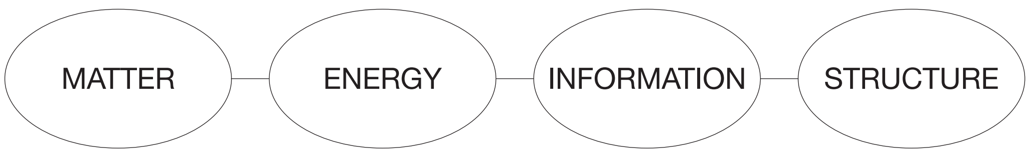


Figure 5.2: *Association of causal concepts in 1980*

Even though I was well familiar with the synergy of structure from my job as an information systems architect in business, I could not see that structure is the unifying causal principle in the Universe, whether structures are nonphysical or physical, as illustrated in Figure 5.3. However, after this major breakthrough, I was able to continue building a coherent model of all knowledge in the Universe with renewed confidence. The major task then was to learn David Bohm's theory of the Implicate Order in order to develop a holistic science of causality, as this chapter begins to outline.

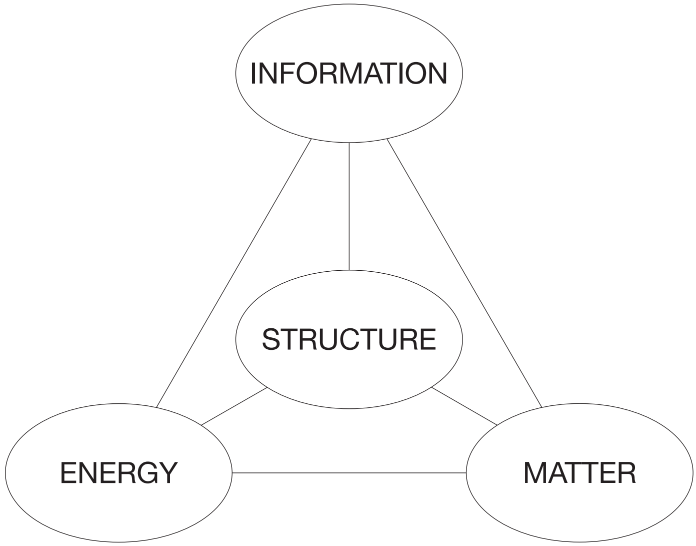


Figure 5.3: *Association of causal concepts after David Bohm meeting*

Now the primary purpose of developing such a holistic science is to use the concept of structural energy to enable us to intelligently and synergistically adapt to the most momentous turning point in evolution's fourteen billion-year history, which we outline in systems theory terms in Section 'A systems perspective' in Chapter 6, 'A Holistic Theory of Evolution' on page 559. As we now live in an Information Age or Knowledge Society, we can best begin this self-inquiry by exploring some key aspects of the meaning of information, free of all previous energetic concepts of causality. For we cannot adapt to the unprecedented rate of evolutionary change that we are currently experiencing by holding on tenaciously to the status quo. The only viable way forward for humanity is Total Liberation, releasing the mystical core of Being from the thick, billowing clouds of unknowing.

What this means is that if we are to coherently understand causality in all its manifestations, we need to undergo a profound transformation of consciousness, as I have experienced during the thirty or more years that I have been studying the meaning of information as an information systems architect. In my case, this total transformation has led my fragmented mind to be healed in Wholeness, enabling individual consciousness to expand and deepen to such an extent that it has become coterminous with Consciousness itself. As Ramesh S. Balsekar tells us, the Buddhists have a wonderful metaphor to describe this awakening process.

> First, mountains and rivers are seen as mountains and rivers. An individual identified subject is seeing an object. This is total involvement. This is what the ordinary person does.
>
> Second, mountains and rivers are no longer seen as mountains and rivers. Objects are seen as the mirrored objectivization of the subject. They are perceived as illusory objects in Consciousness and therefore unreal.
>
> Finally, mountains and rivers are once more seen as mountains and rivers. That is, on being awakened, they are known as Consciousness itself, manifesting as mountains and rivers. Subject and objects are not seen as being separate.[4]

What this means is that if we are to intelligently manage our business affairs with full consciousness of what we are doing, we now need to take the mystical into rational, systemic science and the business world, into the Information Age we live in today. To do this, we can most simply remind ourselves that **Being** rather than **Object** is the most abstract concept in IRL, the superclass for all other classes of concept, as we saw on page 167 in Chapter 1, 'Starting Afresh at the Very Beginning'. In the beginning, beings are just data patterns prior to interpretation by a knowing being, which we can look at as structures of forms and relationships, as we saw on page 180 in Chapter 2, 'Building Relationships', like mathematical graphs in Figure 1.14 on page 76 in Chapter 1, 'Starting Afresh at the Very Beginning'.

So following the first section on the meaning of information and of meaning, itself, we then explore a little the psychology of information as it affects our behaviour. Having then established the general principle that meaningful, structure-forming relationships are causal, whether they be physical or nonphysical, we can then use this as a framework to study the history of the science of causality.

There are really only two perspectives that we need to look at here. First is Aristotle's science of causality, which laid down the basic principles that were followed until Kepler's *New Astronomy* in 1609, as we see on page 929 in Chapter 11, 'The Evolution of the Mind'. (In a later edition of this book, we shall study the psychodynamics of society during the past three hundred years through the eyes of structuralism and semiotics, obviously closely connected with Integral Relational Logic and the first couple of sections in this chapter.)

This leads us to the modern view of causality, which we explore through the concepts of energy, synergy, and entropy, leaving the paradoxical, acausal effects of quantum physics to Section 'The surface of things' in Chapter 9, 'An Evolutionary Cul-de-Sac' on page 692. In effect, scientific materialism took over studies of causality, denying the existence of nonphysical causes, which have been experienced by human beings for millennia. If we are to understand why scientists and technologists are driving evolutionary change exponentially, we need to overturn this misconception with the utmost urgency.

But let us not forget that nothing that might be written about causality in this chapter or elsewhere is real in an absolute sense. For the entire world of form is merely an abstraction from Consciousness, the delightful play of the Divine, called *lila* in the East.

The meaning of information

Today, we live in an Information Society, identified as such in 1979 by the social scientist Daniel Bell, who first called today's predominant economic mode a 'post-industrial society'. This is how he defined information and knowledge at the time:

> By information I mean data processing in the broadest sense; the storage, retrieval, and processing of data becomes the essential resource for all economic and social exchanges. … By knowledge, I mean an organized set of statements of facts or ideas, presenting a reasoned judgment or an experimental result, which is transmitted to others through some communication medium in some systematic form.[5]

As what was ARPANET then has now spread into people's homes as the Internet, giving millions instant access to all the world's knowledge, this is even more obvious now than it was then, when I began investigating the meaning of information in order to develop a comprehensive model of the psychodynamics of society.

Yet even though we are deluged by information everyday from the Internet, television, newspapers, magazines, books, and, of course, each other and our natural surroundings, we take information for granted without giving it a second thought. So as information plays a central role in all our lives, if we are to intelligently manage our business affairs with full consciousness of what we are doing, we need to investigate further this mysterious being called information. So what is it and what is meaning?

Well, we saw on page 159 in Chapter 1, 'Starting Afresh at the Very Beginning' that information is data with meaning, data being 'that which is given', the 'raw' substance of the Universe prior to interpretation by a knowing being, for *substance* literally means 'standing under', from Latin *substantia* 'being, essential, matter', from the present participle of *substāre* 'to be present, to stand or be under', from *sub-* 'under' and *stāre* 'to stand'. In turn, information is that which informs, from Latin *informāre* 'to give form to, shape, fashion, form an idea of, describe', from *forma* 'form, figure, shape, mould, sort, kind', of uncertain origin, but perhaps an alteration through metathesis of Greek *morphē* 'form, shape'.

The basic meaning of *meaning* is 'intention, purpose', a verbal noun deriving from *mean*, from Old English *mǣnan* 'to tell of, to intend, signify', with various cognate Old Germanic words meaning 'mean, make known, have in mind, hold an opinion', from Proto-German **mainjain*. There is some disagreement between the etymological dictionaries about the original PIE base of *mean*. Some say that the PIE base is **mei-no-* 'opinion, intention', also root of *moan* 'complain'. An alternative base is **men-* 'to think', also root of *mind*, *mental*, *memory*, *mention*, *mania*, *music*, and *money*. The association of *meaning* with *interpretation* came about from the sense that in communications, we intend to convey a certain sense when using some word, sentence, or significant action. Conversely, we interpret what is being communicated as meaning, not necessarily what the communicator intended.

We can best see the association between meaning and purpose from the oft-asked question, "What is the meaning of life?" In other words, "Why are we here?", "Where are we all heading?", and "What is our ultimate destiny as a species?" These questions have puzzled humanity for thousands of years and we can see that few have found satisfactory answers to these fundamental questions of existence through such comedies as *The Hitchhiker's Guide to the Galaxy*—originally a radio series, then a book by Douglas Adams, then a TV series and film—and Monty Python's *The Meaning of Life*. For we like to laugh at that which we don't know as a relief from the fear of the unknown.

In Adams' novel and film, "Many millions of years ago, a race of hyperintelligent, pandimensional beings got so fed up with the constant bickering about the meaning of life that they commissioned two of their brightest and best to design and build a stupendous supercomputer to calculate the answer to Life, the Universe, and Everything."[6] With infinite majesty and calm, after seven and half million years of computation, the computer, called Deep Thought, gave this simple answer: "forty-two". But the people did not understand the answer because they did not actually know what the question was. As Deep Thought said, "Once you know what the question actually is, you'll know what the answer means."[7]

In a not dissimilar fashion, the *What is Enlightenment?* magazine asked Vijai Shankar, an Advaita sage, former medical practitioner, and founder of the Academy of Absolute Understanding, for his answer to the most important spiritual questions of our time, the magazine's motto at the time. The reply was intended for the Spring/Summer 2001 issue, whose theme was "Can enlightenment save the world?", specifically asking a number of teachers of nonduality, "Does the world need to be saved?"[8] This was Vijai's reply, which was not published:

> A question is merely a question. There is no such thing as a spiritual question. The rudiments of a question are to be questioned. If a question can be answered then it can no longer remain as a question. Which means it is not real, and that which is not real how can it be important? An answer too, if it is an answer should remain as such, which cannot be questioned. Find that one question which cannot be answered and that answer which cannot be questioned.[9]

The solution to this apparently intractable puzzle is readily available to anyone who becomes aware of self-reflective Intelligence, the Witness that can see everything, when the observer and observed become one. To illustrate this point, here are four stanzas from Eric Idle's jolly 'Galaxy Song' in Monty Python's 'The Meaning of Life'.

Just remember that you're standing on a planet that's evolving
And revolving at nine hundred miles an hour
That's orbiting at nineteen miles a second, so it's reckoned
A sun that is the source of all our power

The sun and you and me, and all the stars that we can see
Are moving at a million miles a day

In an outer spiral arm, at forty thousand miles an hour
Of the galaxy we call the 'Milky Way'

Our galaxy itself contains a hundred billion stars
It's a hundred thousand light-years side-to-side
It bulges in the middle, sixteen thousand light-years thick
But out by us it's just three thousand light-years wide

We're thirty thousand light-years from galactic central point
We go round every two hundred million years
And our galaxy is only one of millions of billions
In this amazing and expanding universe

The first line of the second stanza here says that we can see the Sun and the stars. But then in the next two stanzas, there are a number of observations about the galaxy of which we are a part. Now who is the observer here? Clearly not direct eyesight. What is actually happening, as we saw in Subsection 'Maps and territories' in Chapter 1, 'Starting Afresh at the Very Beginning' on page 71, is that the mind creates a model of the physical universe, enabling us to see the relationship of our Sun to the rest of the Milky Way Galaxy, and, in turn, our galaxy's relationship to the other galaxies in the physical universe.[10]

By taking this expansion of consciousness to its ultimate conclusion, like an out-of-body, near-death experience, we can view the Totality of Existence as a coherent whole with self-reflective Intelligence and see with the Cosmic Light that enlightens the Cosmos that Consciousness is the Universe, not the physical universe. In other words, there are extraterrestrial beings living on Earth in human form who do not belong anywhere on the planet for they are Divine, Cosmic beings, able to stand outside themselves in Wholeness. And this tells us that we are not alone and that there is, indeed, intelligent life on Earth, despite the final stanza of the song.

So remember, when you're feeling very small and insecure
How amazingly unlikely is your birth
And pray that there's intelligent life somewhere up in space
Because there's bugger all down here on Earth

So what does this Holoramic perspective really tell us about the meaning of life? Well, by the Principle of Unity, all structures that emerge from the Immortal, Formless Ground of Being are born to die, or, in the case of human beings and the other animals, conceived to die. But before this happens, structures evolve to their fullest extent, fulfilling their particular potential, whether this be as a species, civilization, galaxy, microbe, or whatever, schematically illustrated by the life and death curve in Figure 5.4. It is pertinent to note that materialistic, mechanistic science has no explanation for the creative processes depicted in the left-hand side of this curve, investigated further in Subsection 'The growth curve' in Chapter 6, 'A Holistic Theory of Evolution' on page 538, focusing its attention on the right-hand side, as described in Section 'Energy, synergy, and entropy' on page 507.

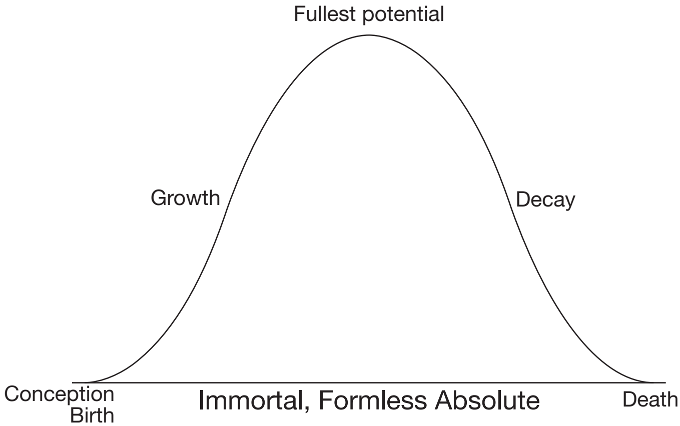


Figure 5.4: *Schematic of life and death of structures*

Now we are the first species to become aware of the inevitable mortality of structures, leading to great consternation in the human population for tens of thousands of years. To overcome any suffering that might arise from the fear of death, mystics like Shakyamuni Buddha have discovered that if we pass through a psychological death of the sense of a separate ego before the death of our bodies, we can live in the bliss of complete union with the Divine. This ontogenetic process of *samsāra* 'journeying' culminates in *Nirvāna* 'extinction', *Moksha* 'liberation', *Kaivalya* 'Absolute Consciousness', and *Satchidananda* 'the bliss of Absolute Consciousness', depicted in the small bell curve in Figure 4.13 on page 275 in Chapter 4, 'Transcending the Categories'.

However, humanity faces a quite unprecedented situation today. Evolution is currently passing through its accumulation point in systems theory terms, the most momentous turning point in some fourteen billion years of evolution, outlined in Section 'A systems perspective' in Chapter 6, 'A Holistic Theory of Evolution' on page 559, leading to the end times of the human race, foreseen by visionaries of all ages. But very few are yet aware of this evolutionary inevitability, mostly following the outward path labelled 'Western civilization' in Figure 4.13, accelerating away from Reality with every year that passes. So if humanity is to deal with any suffering that might arise from the imminent death of *Homo sapiens sapiens*, the entire species needs to pass through a phylogenetic psychological death, not only of the individual ego, but also of identification with humanity, the Earth, and the galaxy, galaxy of galaxies, and physical universe of which we appear to be a part.

If this could happen, the Information Age we live in today would mark the transition period between the end of the mental-egoic period (me-epoch) and the beginning of the age of universal spirituality (us-epoch), fulfilling Pierre Teilhard de Chardin's prophesy, outlined on page 523 in Chapter 6, 'A Holistic Theory of Evolution'. We explore the possibilities of this liberating process happening at a global scale in the last couple of chapters of Part III, 'Our Evolutionary Story': Chapter 13, 'The Prospects for Humanity' on page 1027 and Chapter

14, 'The Age of Light' on page 1131. But first, we need to go right back to basics, to become as conscious as possible of what we mean by the meaning of information. For this can help us understand the meaning of life, an understanding that has eluded humanity throughout its history.

Now as we saw from the root of *information* on page 488, the purpose of information is to inform, to give form to. And as forms are ubiquitous, it is not surprising that their study, called morphology, from Greek *morphē* 'form, shape, figure, appearance; beauty, grace', appears in a wide variety of disciplines, such as linguistics, biology, and even folktales.[11] Appropriately enough, in linguistics, the basic unit of meaning is the morpheme, composed of phonemes and graphemes, the smallest distinctive units of sounds and signs in written language.

For instance, let us take the letter *a*, which generally denotes an open or near open vowel sound, like /æ/, as in *cat*, and /ɑː/, as in *father*. A word like *bath* can be pronounced with either sound depending on where one is brought up. In other European languages, *a* is more rounded, pronounced as /a/ or /aː/, as in French *patte* or *gare*, respectively. However, because of the Great Vowel Shift between 1450 and 1750,[12] *a* can also be pronounced as a diphthong /eɪ/, as in *name*.

Figure 5.5 shows the relationship of these vowels to all the major vowels in the notation of the International Phonetic Alphabet (IPA). You can see that vowels have three basic attributes with domains of values 'open to close', 'front to back', and 'rounded or unrounded', once more illustrating the way that we all use IRL to organize our ideas. A fourth attribute—short and long—is denoted by postfixing 'ː' to the basic sign. Other attributes, such as stress and tone, are denoted with diacritics on the basic signs.

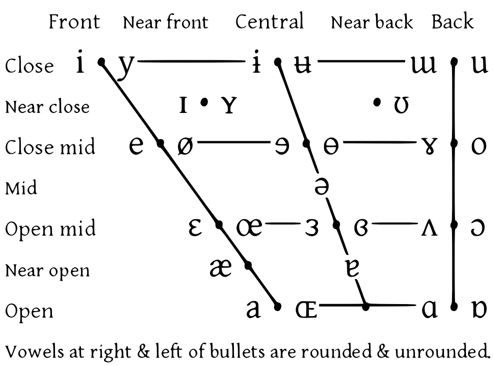


Figure 5.5: *Vowel signs in International Phonetic Alphabet*

One other key point to note about letters is that when we read them, we take in the entire sign as a whole. The word *gestalt*, from the German *Gestalt* 'form, shape, pattern', represents this sense of wholeness very well, for it denotes "a shape, configuration, or structure that as an object of perception forms a specific whole or unity incapable of expression simply in terms of its parts," or "a physical, biological, psychological, or symbolic configuration or pattern of elements so unified as a whole that its properties cannot be derived from a simple summation of its parts", to give another dictionary definition.[13]

This emphasis on the wholeness of forms led Max Wertheimer (1880–1943), Wolfgang Köhler (1887–1697), and Kurt Koffka (1886–1941) to found a school of gestalt psychology in the early twentieth century. Wertheimer emphasized that the Gestalt is perceptually primary, defining the parts of which it was composed, rather than being a secondary quality that emerges from those parts,[14] a notion not unlike Aurobindo's concept of Supermind: "The Supermind is the Vast; it starts from unity, not division, it is primarily comprehensive, differentiation is only its secondary act."[15] In the words of *Encyclopædia Britannica*:

> Gestalt theory originated in Austria and Germany as a reaction against the associationist and structural schools' atomistic orientation (an approach which fragmented experience into distinct and unrelated elements). Gestalt studies made use instead of phenomenology. This method, with a tradition going back to Johann Wolfgang von Goethe, involves nothing more than the description of direct psychological experience, with no restrictions on what is permissible in the description. Gestalt psychology was in part an attempt to add a humanistic dimension to what was considered a sterile approach to the scientific study of mental life. Gestalt psychology further sought to encompass the qualities of form, meaning, and value that prevailing psychologists had either ignored or presumed to fall outside the boundaries of science.[16]

Then in the 1940s, Frederick S. Perls (1893–1970), better known as Fritz Perls, and his wife Laura (1905–1990) turned this emphasis on the perception of phenomena inwards, founding Gestalt therapy, "a humanistic method of psychotherapy that takes a holistic approach to human experience by stressing individual responsibility and awareness of present psychological and physical needs".[17] Perls and his family lived in South Africa from 1933 to 1946 and were much influenced by the holistic evolution of Jan Smuts,[18] focusing particular attention on how human beings could realize their fullest potential. For as Perls wrote in 1969, "Unfortunately in our time the average person uses only 10 to 15 percent of his potential; a person who uses 25 percent is already called a genius." Continuing, he said that people, as representatives of a social mores, spend more time in telling others what to do than in listening to their needs. Seeing therapy through the gestalt concept of growth, Perls said, "I now consider that neurosis is not a sickness but one of several symptoms of growth stagnation,"[19] a critical life-and-death issue we look at in more detail in Chapter 13, 'The Prospects for Humanity' on page 1027.

In the meantime, let us return to the basic units of language and look at how designers of typographic fonts view letters. To design glyphs, they need to analyze signs into segments of curves and lines and then put them together in an aesthetic and functional manner, as illustrated in Figure 5.6. Here, the familiar Times letter *a* is formed by the space between two closed curves, consisting of nodes and the arcs between them, like the mathematical graph of Figure 1.13 on page 75.

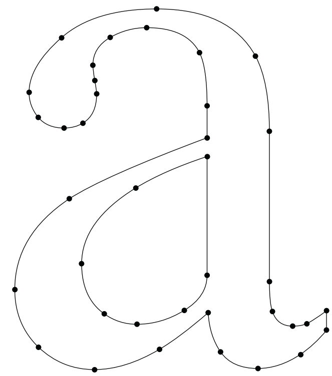


Figure 5.6: *Times letter* a

This example of designing fonts by analysis and synthesis is typical of all creative processes in both the arts and sciences. It also marks the difference between holistic and reductionist science. In the latter, researchers focus more attention on analysis, without always considering the connections between the constituents, throwing the interesting relationships away. Indeed, because evolution has been more divergent than convergent during the thousands of years in which the mind has been evolving, we all act rather like reductionist scientists, becoming identified with a religion, nation, political ideology, specialism, occupation, sex, or whatever, to the exclusion of other members of these classes.

We can overcome this fragmentation by noting that what holds for the humble letter *a* holds for every other structure in the manifest world of form, including the Totality of Existence, which, when viewed as a Whole, is Formless. For when we see, feel, and sense the Absolute as a seamless, borderless continuum, the notion that we are separate from the Divine, Nature, and each other disappears completely. Wholeness is all-inclusive, with nothing left out. Furthermore, as we always need a context for interpretation, Wholeness provides the overall Cosmic Context for determining the meaning of all data patterns in experience, with no division between science and mysticism, for instance.

Returning to our journey towards Wholeness through a holistic science of causality based on the notion of the meaning of information, we now need to look at words, consisting of one or more morphemes. For instance, the words *cat* and *act* consist of three letters in sequence, conveying different meanings, representing different concepts in the meaning triangle in Figure 1.32 on page 126. In contrast *tca* is not a word in the English language and conveys no meaning other than as a set of initials. So meaning is inextricably connected with order.

This association between meaning and order becomes even clearer when we look at sentences as strings of words, like "The cat sat on the mat." Even putting these words into alphabetical order as "cat mat on sat the the" conveys no direct meaning. We can extend this meaningful ordering principle to paragraphs, sections, chapters, books, and every book that has ever been written or ever will be written in any language whatsoever. Integral Relational

Logic and the Unified Relationships Theory show how we can bring all this knowledge into universal order and hence discover the elusive meaning of life on this planet.

The psychology of information

However, as the words, formulae, and figures in this book are a product of a lifetime of study, courageously questioning the assumptions and preconceptions of Western civilization and its Eastern counterparts, it is uncertain how meaningful the signs and symbols in this book might be. One key issue in developing a holistic science of causality is that physics is widely regarded as the primary science and that all human behaviour can ultimately be explained in terms of the supposedly inviolate laws of physics within materialistic, mechanistic science. However, it is obvious to anyone who has inquired deeply into the causes of human behaviour that psychology is the primary, specialist science, on which the so-called natural sciences could be built.

We can help put Western civilization back on its feet by further exploring the meaning of information from a psychological perspective. We can simply begin here with an example I used in 1981, when writing a working paper called 'The Information Society': a railway timetable. Today most timetables, whether they be for railways, buses, aircraft, or ferries, are available in electronic form. But at that time, railway timetables were still printed, just as they had been since George Bradshaw (1801–1853) first published his famous timetables in 1839, often referred to as a 'Bradshaw', as a generic name for any railway timetable in the literature.[20]

So how does the printing provide us with information about train times? Well, this information consists of particles of ink, which are made up of molecules and atoms, which in turn consist of a variety of sub-atomic particles, with attributes like charm and strange, where particles of matter can have attributes with integral fractions of spin and electric charge, as we see from Figure 9.9, 'Part of standard model of fundamental particles and interactions' on page 693. We have moved into the mysterious realm of quantum physics, which clearly cannot answer our question. Information is not in the material of the ink.

Where then is it? Well, we saw on page 492 that the meaning of information derives from the shape, form, and order of the particles of ink on the page. These forms consist of a letters, numbers, and other signs that are laid out on the page in such a way that they provide us with the information that we seek. A random sprinkling of ink would not provide us with any information, even though the mass of the ink might be the same as in the railway timetable.

We are thus faced with the essential problem of information. It is not a material thing and so materialistic science can tell us nothing directly about the Information Society we live in today. Information is a property of the material of the ink, in the timetable example, but also, in some senses, independent of it, for we can also store exactly the same information in electronic form. While we can hold the timetable in our hand, we perceive the information it contains in our mind. Information is thus a conceptual property of the material, not a physical one. Of course, matter is also a concept in the mind, but we don't usually think of it in this way. Matter is something apparently solid outside us, not something that we envisage. So while information is intangible, the concept of information is somewhat impalpable, which is why scientists who are not fully engaged in self-inquiry don't know what information is or where it ultimately comes from.

The basic point about a railway timetable is that we use the information that it provides us with to take action, to decide on which train best meets our need. As such, the meaning of information can be said to be causal. Let us take another simple example. When driving a car towards a busy crossroads, if we see the traffic lights ahead change from green to amber to red, we slow down and stop. For we know from visualization, if not experience, that to proceed would be dangerous as other drivers, cyclists, or pedestrians are about to pass through the intersection. We are thereby reminded that we are not alone in the world; we need to give and take if society, as a whole, is to run smoothly. As we do not always act as individuals in this socially aware manner, to enforce this systemic principle, governing authorities have made it illegal to jump the lights at red.

To ensure that traffic moves as smoothly and safely as possible, traffic regulators have also designed a variety of control systems at different levels of complexity. At the simplest level, the lights pass through a cycle of states—most commonly four—at regular intervals. However, sensors, either buried in the road or over-roadway ones, can detect the presence of vehicles about to pass through the intersection. Using appropriate algorithms, a computer can then minimize drivers' waiting times at slack times and optimize the flow at busier times.[21]

Although as human beings we can see and feel ourselves as Divine beings living in the vertical dimension of time in the Eternal Now, as drivers, in this instance, we act essentially as machines, like a thermostat that turns an oven off and on again as the temperature rises above or drops below a set threshold in a cybernetic feedback mechanism. Using the fundamental principle of concept formation in IRL—noticing the essential differences and similarities in the data patterns of our experience—we can see that this mechanical process is essentially a three-step one:

1. We receive information.
2. We make a decision.
3. We take action.

This information-decision-action process is a common feature of information wherever it is used. To give a few simple examples that I used in the early 1980s before my mystical experiences had deepened to the extent they have reached today: if we hear on the radio that there is an airline strike, we may decide to postpone our journey or take an alternative route; if we see that it is raining, we decide to take an umbrella when going out; if we feel that it is cold, we put the fire on; and if we look at a chair, we know that it is not a banana and decide to sit on it, rather than eat it.

We use all our senses to receive information from a wide variety of sources, both inner and outer. At the superficial level, our senses can be considered communications channels. When we communicate with each other, our principal input and output channels are reading and listening and writing and talking, respectively. However, we also communicate with each other in more subtle ways. For instance, Desmond Morris illustrates how we can often use gesture to communicate information to each other.[22] These gestures have a major influence on our relationships with each other, which are often subconscious.

The action we take on receiving information need not therefore be physical or conscious. Neither need it be immediate. We could store information and delay our action to a more appropriate time. The most obvious example is the education system. Here, the information children receive from the cultures they are born into, both in and out of the classroom, serves to determine actions later in life. As a result, we have all been conditioned to behave in mechanistic ways that are inappropriate for our times, which we explore further in Chapter 13, 'The Prospects for Humanity' on page 1027.

These are all examples of actions arising from decisions in the mind. However, there really is no essential difference between a decision to walk and the reflex action of a knee on being tapped by a hammer. These actions just arise from different structures in the body-mind-spirit organism, which are also similar to the conditioned reflex of Pavlov's dog. In turn, what is the difference between the action of an animal deciding to mate when it sees the display characteristics of its partner; or birds deciding to migrate and then deciding the distance and direction in which they will travel; or the action of a plant deciding to grow when the sun's rays warm the soil?

We can consider all these to be examples of systems communicating information between and within themselves. So we are beginning to see that not only can any form or structure in the Universe be considered as information, but also that all these forms and structures are interrelating with each other, emphasizing the point that the entire Universe can be seen as an information system.

But what we are particularly concerned about at the moment is to look at the psychology of information, since such a study helps us understand the psychodynamics of society as a whole and hence the prospects for our future well-being and survival. Specifically, while meaning is evidently causal in general, what meaning we give to specific data patterns is obviously dependent on a whole host of psychological factors, not the least on how far we have developed up the various levels in the spectrum of consciousness illustrated in Figure 13.17 on page 1064. And, of course, if our lives are based on one or more of the seven pillars of unwisdom, then we are likely to interpret data patterns in a quite different manner from those who live by the seven pillars of wisdom, listed in Section 'Seven pillars of unwisdom and wisdom' on page 477.

The seven pillars of unwisdom are based on the assumption that we human beings are separate from each other, which can lead to gross distortions in the way we use information and communicate with each other. The moral philosopher Sissela Bok has deeply explored some of the central issues here in her classic books *Lying: Moral Choice in Public and Private Life* and *Secrets: On the Ethics of Concealment and Revelation*.[23] To set the scene, she begins *Lying* with these familiar questions:

- Should physicians lie to dying patients so as to delay the fear and anxiety which the truth might bring them?
- Should professors exaggerate the excellence of their students on recommendations in order to give them a better chance in a tight job market?
- Should parents conceal from children the fact that they were adopted?
- Should social scientists send investigators masquerading as patients in order to learn about racial and sexual biases in diagnosis and treatment?
- Should government lawyers lie to Congressmen who might otherwise oppose a much needed welfare bill?
- Should journalists lie to those from whom they seek information in order to expose corruption?[24]

As Bok says, we all have to grapple with such problems in our personal lives, a subject that had been little studied until she wrote her book. However, she doesn't mention that Western civilization is based on a collection of lies that are based on the false belief that we human beings are separate from the Divine, Nature, and each other. In scientific terms, these lies lead to the second to fourth pillars of unwisdom that underlie Western civilization: the belief that the physical universe is the Universe, that Life is a property of the DNA molecule, and that human beings are machines and nothing but machines.

It is not only science that is based on lies. Politicians, competing against other politicians and seeking to manipulate the public to their point of view through functionaries called 'spin doctors', are not renowned for telling the truth, often turning to the persuasive power of numbers. The way that statistics are sometimes used to bolster weak arguments is encapsulated in a phrase that Mark Twain attributed to Benjamin Disraeli (1804–1881): "There are three kinds of lies: lies, damned lies, and statistics."[25]

So as our scientific, medical, and political explanations about what is happening in the world today are often based on lies, how can we possibly answer moral questions until we have answered the more fundamental question "What is truth?", which has puzzled philosophers and religionists for millennia. For how can we answer this question if we are not actively engaged in the search for Truth, the Absolute Truth? And here, it is absolutely essential to be honest in our self-inquiries; otherwise we just fool ourselves.

In *Secrecy*, Bok points out that lying and secrecy intertwine and overlap. "Lies are part of the arsenal used to guard and to invade secrecy; and secrecy allows lies to go undiscovered and to build up." She continues:

> Lying and secrecy differ, however, in one important respect. Whereas I take lying to be *prima facie* wrong, with a negative presumption against it from the outset, secrecy need not be. Whereas every lie stands in need of justification, all secrets do not. Secrecy may accompany the most innocent as well as the most lethal acts; it is needed for human survival, yet it enhances every form of abuse. The same is true of efforts to uncover or invade secrets.[26]

We don't need to look in detail at the many concrete examples of secrets and lies that Bok examines in her books, for they are all examples of the general pattern of either-or issues, such as right or wrong and benefit or harm. And who can say what is right or wrong in any particular instance? For what might seem to be a misfortunate, unfavourable situation at any one moment could well turn out to be a blessing in disguise.

However, perhaps we can pause for a moment to consider the relationship of secret societies to the aim of this book to uncover the innermost secrets of the Universe, especially the Hidden Harmony: the Principle of Unity, *Wholeness is the union of all opposites*. The word *secret* derives from Latin *sēcrētus*, past participle of *sēcernere* 'to separate, divide off', from *sē* 'apart' and *cernere* 'to separate', also root of *secretary*, originally 'a person in someone else's confidence, sharing secret or private matters with them'.

We can see from the root of *secret* why it is so difficult to reveal the Hidden Harmony that underlies the Universe. Because of the first pillar of unwisdom, it is one of the most entrenched taboos in many cultures to say, "I am That," as Nisargadatta Maharaj did in a classic spiritual book of this name. So those who have sought to come into union with Reality, which is how Evelyn Underhill (1875–1941) defined a mystic,[27] have often needed to meet in secret.

One of the first secret societies was the Pythagorean Brotherhood in Croton in the 'front heel' of southern Italy, which Pythagoras of Samos (c580-c500 BCE) founded about 525 BCE. However, about 25 years later, those who resented the secrecy and elitism of this club attacked the brotherhood, and Pythagoras fled and died in Metapontum, in the 'arch' of Italy's foot.[28]

However, this mystical school was far from being the first in Ancient Greece. The most famous of the secret religious rites were the Eleusisian Mysteries, related to Demeter, the Mother Goddess of the Earth, who went to Eleusis in search of her daughter Persephone. There, she tried to make the son of the royal family immortal and eternally young, but was prevented from doing so by the queen's fear. After this, she revealed her true identity and commanded that a temple be built for her, a story with several variations.[29]

At the supposed time of these events, some 3,500 years ago, the analytical mind was beginning to take people away from their Immortal Ground of Being, leading some to attempt to return Home to the Divine through rituals and initiation ceremonies. But such a spiritual journey was not for everyone, so these rites had to be kept secret, the origin of *mystery*, which derives from Greek *mustērion* 'secret rite or doctrine', from *mustēs* 'one initiated', from *mūein* 'to close one's eyes'. It seems that this association of mystery with closing the eyes was not because the divine mysteries would be revealed in meditation, as in the East, but because only those already initiated were permitted to witness the secret rites. So seekers coming to initiation would need to keep their eyes shut during the ceremony.

Today, spiritual seekers of gnosis do not normally try to keep their activities secret, even though the level of intolerance towards them from fundamentalist theists and atheists is as high as it has ever been. However, there are still a multitude of secret societies in the world that have evolved from these ancient mystical schools. One such are the Freemasons, dramatized by Emanuel Schikaneder and Wolfgang Amadeus Mozart in *The Magic Flute* '*Die Zauberflöte*'. An initiation ceremony is depicted in the opera as a trial of fire and water, which Tamino and Pamina undergo, protected by the magic flute, before they are united. As Joseph Campbell eloquently describes in *The Hero with a Thousand Faces*, such a trial is recounted over and over again in the myths and folktales of all cultures and ages. For who knows what demons we might discover when we dive below the surface into the depths of the Cosmic Psyche?

We can see the effects of our ignorance of the sub- and unconscious energies that cause us to behave as we do in a multitude of different ways. For instance, still keeping to the theme of secrecy, what is it about information that if you give away or steal a nation's secret information, you can be called a traitor or a spy and either executed or given life imprisonment without parole? Such types of information gives nations power over others, which can be threatened by whistleblowers, such as Wikileaks. The armed services rely on information, which they call intelligence, to defend the nation, sadly corrupting a beautiful word. This so-called intelligence is not only documents. It could be the deployment of troops, the layout of the land, the location of factories, and so on. All these provide information to the military.

Similarly, organizations acquire and protect the information they think they possess in order to remain competitive and retain control of the businesses. A quotation attributed to Benjamin Disraeli illustrates this very well: "As a general rule, the most successful man in life is the man with the best information."[30] Then in 1996, James A. Mirrlees and William Vickrey were awarded the Nobel Prize for economics for saying much the same thing, the citation reading "for their fundamental contributions to the economic theory of incentives under asymmetric information".[31] And, of course, Francis Bacon is famous for saying, "Knowledge is power."

This brings us to the central issue of running businesses in today's Information Society: what role could or should money play in such a global, interconnected society? This was one of the first questions that I asked myself in the late 1970s as we entered the Information Age, as I described on page 11. And as we saw there, Daniel Bell pointed out that we have no economic theory of information.

We can see the reason for this from the example of the information in a railway timetable we used on page 495. Information, in essence, is not a physical object, giving it some rather strange properties in conventional economic terms. For instance, when I buy a loaf of bread, the object passes from the storekeeper to me in exchange for money. However, when a teacher gives pupils some information, nothing is exchanged. Both teachers and pupils have the information. As Tom Stonier has said, "Whereas material transactions can lead to competition, information transactions are much more likely to lead to cooperation—information is a resource which can be truly shared."[32]

But there seems to be very little motivation in the world today to cocreate a Sharing Economy on a global or even local scale. Rather, we attempt to make the intangible content of objects such as books, CDs, DVDs, and software behave like physical objects through intellectual property laws, such as copyright, trademark, and patent laws. Even human beings, like sports, film, and pop stars, are 'brands' today, to be marketed like soap powder. How far is this dehumanization of our species going to go before we all go stark raving mad?

To see why it is virtually impossible to cocreate a peaceful society living in harmony with the fundamental laws of the Universe, we need to look specifically at the psychology of money, which is a form of information, whose meaning, and hence value, is determined primarily by people's sense of identity. The flora and fauna on Earth have been evolving for billions of years without the need for money because they do not feel separate from each other, their natural environment, and the Divine Cosmos. Neither did the human beings who first received the great gift of self-reflective, Divine Intelligence around 25,000 years ago, living in what the myths of many cultures have described as a 'Golden Age'.

As we see in Subsection 'Primitive economies' in Chapter 11, 'The Evolution of the Mind' on page 815, money emerged in human societies when the fragmented, split mind led people to believe that they were separate from each other (and the Divine), leading to a sense of mistrust as people sought to gain advantages over others. In the words of Mike Hussey, a late professor at the Open University in England, "Money is institutionalized mistrust."[33] To enable the exchange of goods in such a divisive environment, early forms of primitive money were simply objects, such as cowries and pigs. But as the Stone Age moved into the Iron Age in the first millennium BCE, people began to manufacture coins of both precious and base metals, their values also being determined by their shapes and marks inscribed on them, as we see in Section 'The birth of coinage' on page 849.

Then as Hellenic and Western civilizations moved further and further away from Reality—as did civilizations outside Europe—money became increasingly impalpable, until today most forms of money are a series of 0's and 1's in computers. As such, money could really be treated like the information in our railway timetable, shared with all in a win-win situation. But because people's sense of security and identity in life is based on money as an immortality symbol, we have reified money, turning it from a measuring unit, like kilograms and metres, into an object with value. So today, some 95 to 97% of business transactions by volume involve financial 'products', called 'instruments' by investment banks.

Consequently, the meaning of money has become the primary causal factor in society today, separating people and communities from each other. We even need permission from the banks for the basic necessities of life, such as housing and land on which to grow food. And because the primary purpose of joint-stock companies is to make money rather than produce products that we need for our health, well-being, and very existence, they use techniques of mass persuasion through the unconscious, as Vance Packard pointed out in his classic book *The Hidden Persuaders* in 1957. So today, advertising is a $300 billion industry in the USA, about 2% of that country's GDP.[34] The rest of the world spends another $200 billion a year, from which we can gather that the Americans are the most gullible people on Earth.

But it is not only business corporations that are attempting to manipulate our minds through techniques of persuasion. Politicians, through their oratorical skills, and religious leaders, often playing on people's fears, behave in very much the same way. As do teachers, parents, and our peers, all of whom are constantly attempting to get us to behave in a manner that they find acceptable. And the meaning of information, in the broadest sense, mostly drives this social dynamics rather than some physical force.

Moving from the ridiculous to the sublime, aestheticism provides another example of the way that structural energy can affect us as human beings. We can be deeply moved by all art forms, such as music, poetry, novels, paintings, and movies, which might not have any functional benefit, and architecture, which normally does. Even mathematics, science, and accountancy have great beauty for those engaged in such pursuits.

One further example is humour, which is another way in which our inner beings can be filled with laughter and happiness through meaningful structures. Arthur Koestler devoted Part I in *The Act of Creation* called 'The Jester' to this subject. Here is an example that John von Neumann, the designer of the stored-program computer, gave him:

> Two women meet while shopping at the supermarket in the Bronx. One looks cheerful, the other depressed. The cheerful one inquires:
>
> "What's eating you?"
>
> "Nothing's eating me."
>
> "Death in the family?"
>
> "No, God forbid!"
>
> "Worried about money?"
>
> "No … nothing like that."
>
> "Trouble with the kids?"

"Well, if you must know, it's my little Jimmy."

"What's wrong with him, then?"

"Nothing is wrong. His teacher said he must see a psychiatrist."

Pause. "Well, well, what's wrong with seeing a psychiatrist?"

"Nothing is wrong. The psychiatrist says that he's got an Oedipus complex."

Pause. "Well, well, Oedipus or Shmodoedipus, I wouldn't worry so long as he's a good boy and loves his mamma."[35]

Koestler points out that the humour in this example arises from the clash of opposites, which he calls bisociation, which pervades many creative activities, in harmony with the paradoxical Principle of Unity lying at the heart of the Universe. As he says, in this example:

> The cheerful woman's statement is ruled by the logic of common sense: if Jimmy is a good boy and loves his mamma there can't be much wrong. But in the context of Freudian psychiatry the relationship to the mother carries quite different associations.[36]

Of course, we not only respond and react to information that we receive from our external

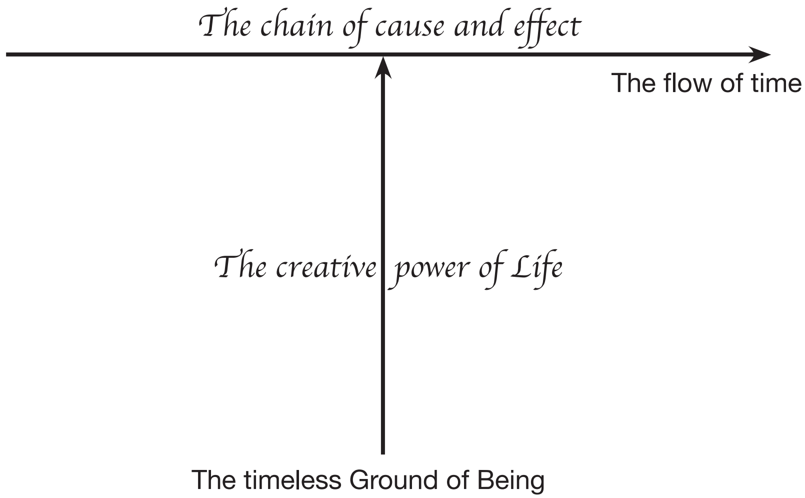


Figure 5.7: *Creativity and the chain of cause and effect*

world; forms and structures also originate within us. Sometimes, patterns mechanistically emerge in the horizontal dimension of time, just as computers can be programmed to generate quite complex patterns from simple seeds, as Richard Dawkins' program 'The Blind Watchmaker' illustrates. However, computers' ability to write evocative poetry, for instance, according to preset rules is extremely limited, indicating that our creativity arises predominantly in the vertical dimension of time, as illustrated in Figure 5.7.

Recognizing that the Ultimate Cause of our creativity is Life arising directly our Divine Source is absolutely essential if we are ever to live in love, peace, and harmony with each other. For as we saw in Subsection 'Concept of concept' in Chapter 1, 'Starting Afresh at the Very Beginning' on page 111, structures generally arise first as vague forms of inner visualization before they become articulated. And these visualizations are themselves causal, as we see in such phrases as 'the cause of human rights' and 'a good cause'.

In other words, causality is both a pull and push phenomenon, where the pull is some principle or ideal that people wish to pursue. But then, when we look at society as a whole, there is often a clash of wills, as one person's ideal is another's abhorrence. Such either-or conflicts often arise when considering ethical issues, such as the right of a woman to have an abortion versus the right of the unborn embryo or foetus to grow and develop, or the right of a human being to die peacefully when the pain of living becomes intolerable, called euthanasia, from Greek *eu* 'good, well' and *thanatos* 'death'.

As the creative power of Life is continuously pouring through us all, for millennia, societies have also wrestled with the problem of how to balance all this potential outpouring of energy with the need to maintain society in dynamic equilibrium. Totalitarian regimes have generally preferred stability to individual freedoms, the antidote supposedly being democracy, 'rule by the people'. But during the past century or two, democracies have only been able to maintain a modicum of order by stultifying people's natural intelligence from a very early age, teaching them the seven pillars of unwisdom. For if they did not, children would be able to see the absurdity of what they were being taught and the ruling authorities would no longer have power over the people.

With evolution currently passing through the most momentous turning point in its fourteen billion-year history, this tricky psychodynamic situation is as critical today as it has ever been. One paramount problem is the fourth pillar of unwisdom, the widespread belief that human beings are machines and nothing but machines and that therefore technological development can drive economic growth indefinitely. So politicians are doing their utmost to get as many people as possible to work in mechanistic economic systems, thus preventing them from realizing their fullest potential as Divine, Cosmic beings before *Homo sapiens sapiens* 'wise, wise human' inevitably becomes extinct.

For climate change and the many natural disasters since the beginning of the millennium remind us that the Earth is inherently unstable, only able to support today's complex technological society for a few more decades, at most. But because evolution has been more divergent than convergent, as human beings have learnt more and more about the world we live in, the mind has become fragmented, unable to see what is happening to humanity within the overall Cosmic Context that we all share.

The only viable solution to this problem is for all the divergent streams of evolution to converge in Wholeness, the Ultimate Final Cause of the Universe. This can happen when all the ethical and political conflicts that we witness in society today are brought into consciousness as the nondual union of all opposites, enabling us to return Home to the Immortal Ground of Being in the Eternal Now, as Figure 5.8 illustrates, reversing the upwards creative power of Life in Figure 5.7. But is evolution about to guide us towards its glorious culmination at its Omega point? Or are we going to continue rushing hither and thither, having little understanding of where we are all heading?

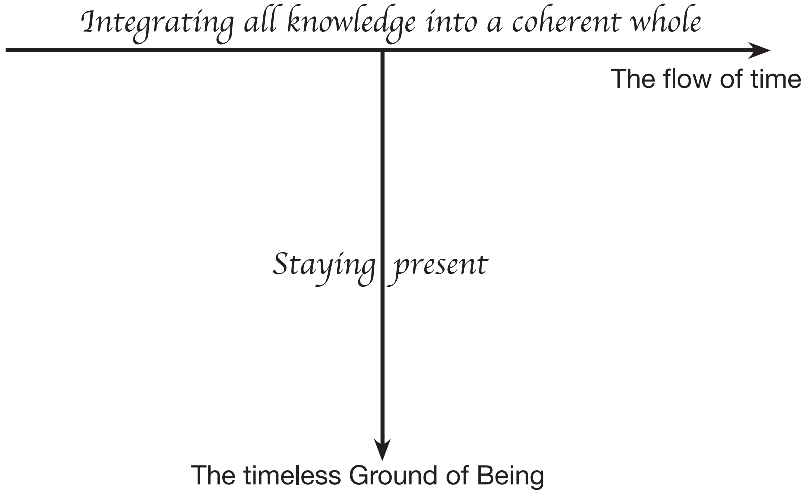


Figure 5.8: *Staying present in the Eternal Now*

Aristotle's four causes

As Aristotle was not a mystic, he rejected Heraclitus' Hidden Harmony—the fundamental design principle of the Universe—apparently not aware of the vertical dimension of time. Nevertheless, he was an astute observer of the world around him, laying down the foundations of a science of causality, which has many similarities with the holistic science being described in this chapter.

Aristotle's thoughts on causality are contained in both his *Metaphysics* and *Physics*, no doubt because the one third of his writings that have survived mostly resemble lectures rather than systemic works of literature. In Book V of *Metaphysics*, Aristotle begins with a number of definitions of Greek *arkhe* 'beginning, origin', saying that a common property of all beginnings is the first thing from which something either exists or comes into being or becomes known. Hence *phusis* 'nature' is a beginning, and so is element, understanding, choice, essence, and final cause.[37]

In Book II of *Physics*, Aristotle began his study of causality by separating mathematics from natural science. He said that mathematicians abstract properties, such as odd and even and straight and curved, which are conceptually separable from the world of change. Although he owned that mathematics could be applied to the natural sciences of optics, harmonics, and astronomy, for instance, it seems that he was keen to distinguish the abstract purity of geometry from natural science, which he regarded as "a single branch of knowledge [studying] the purpose or end of something and the way in which the purpose is achieved."[38]

Having defined the scope of natural science, Aristotle then identified four different types of cause—known today as material, formal, efficient, and final—saying, "These are more or less all the ways in which we use the word *cause*." Here is how he defined each of these types of cause:

> One way in which the word *cause* is used is for that from which a thing is made and continues to be made—for example, the bronze of a statue, the silver of a bowl, and the genera of which bronze and silver are species.
>
> A second way in which the word is used is for the form or pattern (i.e. the formula for what a thing is, both specifically and generically, and the terms which play a part in the formula). For example, the ratio 2:1, and number in general, cause the octave.
>
> A third way in which the word is used is for the original source of change or rest. For example, a deviser of a plan is a cause, a father causes a child, and in general a producer causes a product and a changer causes a change.
>
> A fourth way in which the word is used is for the end. This is what something is for, as health, for example, may be what walking is for. If asked, "Why is he walking?", we reply, "To get healthy", and in saying this we mean to explain the cause of his walking.[39]

Giving further examples of the sense of that from which things come, Aristotle included "letters (from which syllables come), matter (from which artefacts come), fire and so on (from which material bodies come), parts (from which wholes come), and premises (from which a conclusion comes)."[40]

David Bohm called on Aristotle's four causes to show that it is delusionary to view reality in terms of separate fragments rather than as an undivided flowing movement. In particular, he emphasized that the word *formal* in ancient Greek meant, in the first instance, "an inner *forming activity* which is the cause of the growth of things, and of the development and differentiation of their various forms". In contrast, in today's superficial society, *formal* tends to refer to an insignificant outward form, as in the terms *formal dress* and *a mere formality*. To avoid any confusion here, Bohm suggested that we use the term *formative cause* rather than *formal cause*, emphasizing "that what is involved is not a mere form imposed from without, but rather *an ordered and structured inner movement that is essential to what things are*".[41]

Now as the action of any formative cause must evidently have an end or product, formative cause always implies final cause. For instance, "it is not possible to refer to the inner movement from an acorn giving rise to an oak tree, without simultaneously referring to the oak tree that is going to result from this movement."[42] Of course, as this book is endeavouring to show, the ultimate Final Cause is Ineffable, Nondual Wholeness, brought about the formative cause of the Logos arising directly from our Divine Source.

Another word that we can associate with final cause is *design*. For instance, an architect can design a building or a software developer can design an information system. And when evolution has carried us to its glorious culmination at its Omega point, we can see how the Cosmos is designed, enabling us, if we wish, to design the infrastructure of a peaceful society living in harmony with the fundamental laws of the Universe. However, because what is happening to humanity at the present moment is unprecedented in the entire history of evolution, such a Utopian vision could only be realized when all the divergent streams of evolution have converged within a critical mass of people. Although the True Nature of all beings in the Universe is Wholeness, without such an experience, it is very difficult to visualize where humanity is actually heading. There is still a predominant focus on the relativistic world of form rather than on Absolute Formlessness.

From this perspective, we can then see that Aristotle's material and efficient causes are just special cases of the more general formative and final causes, which are inseparable two sides of the same coin. For matter and agents are structures, coming into being through the immanent power of the Logos, fulfilling their end purpose of becoming a star, elephant, or whatever.

Having defined four basic causes, Aristotle then went on to explore the relationship between cause, chance, and spontaneity,[43] which we leave until later in the book.

Energy, synergy, and entropy

While Reality is Wholeness, also called Consciousness, God, or Universe, we nevertheless live in the illusionary world of form, structure, and relationships. For practical purposes, it is therefore of interest to understand what has been causing the growth of structure to accelerate exponentially over the years. To do this, we need to use the archæology of language to make a fundamental change to the concept of energy as the physicists define it today, and thereby show how energy relates to synergy and entropy. This is such a confused subject that in 1996 the Scientific and Medical Network (SMN) in the UK devoted one of its Mystics and Scientists conferences trying to unravel the mysteries of energy in a conference called 'The Nature of Energy: Science and the Subtle'.[44]

Let us begin with the etymology of the words. *Energy* derives from *energeia* 'activity, efficacy, effect' from *energes* 'active, busy, working' from *en-* 'at' and *ergon* 'work'. Similarly, *synergy* derives from *sunergos* 'working together' from *sunergein* 'to cooperate' from *sun-* 'together' and *ergon* 'work'. In ancient Greece, a fellow-worker was called *sunerithos*. It is clear from this that *energy* and *synergy* originally referred to human activity and work. Aristotle seems to have had this meaning in mind when he said, "The energy of the mind is the essence of life." More generally, Aristotle, in attempting to find a causal explanation for the phenomena that he observed, made a clear distinction between *energeia* as an actuality and *dunamis* 'ability, power', from which we obtain *dynamics*, as a potentiality. But we do not need to go further into Aristotle's brave attempts to make sense of the world he lived in, using his four causes of material, formal, efficient, and final.

The Neo-Platonists then gave *energeia* a mystical meaning, as Chris Clarke, professor of applied mathematics in the UK, explained at the SMN conference. As he said, the idea of *energeia* was:

> A sort of potentiality for action as a seed of God which could then flow into God. And that became actually the dominant use of the word *energy* in the Middle Ages through the writings of Pseudo-Denys. Energy was part of a triple of *ousia*, *dunamis*, and *energeia*: being, power, energy. The being of God, the power which flowed out from God, the *energeia*, which was the return back to God, carrying the acts of God back to the One. And that was the basic concept of energy for five hundred years in late antiquity and the early Middle Ages.[45]

This conception of energy is reasonably close to providing us with an explanation for the accelerating pace of change that we are experiencing today. However, with the birth of science in the seventeenth century, the concept of energy took a marked turn of direction. "Energy became a numerically conserved quantity," in Chris's words, with these dimensions, encapsulated in Einstein's famous equation $E=mc^2$:

$$\frac{\text{mass} \times \text{distance} \times \text{distance}}{\text{time} \times \text{time}}$$

Similarly, force, power, and action came to have these dimensions, respectively, the first made clear by Newton's equation $F=ma$:

$$\frac{\text{energy}}{\text{distance}} \qquad \frac{\text{energy}}{\text{time}} \qquad \text{energy} \times \text{time}$$

At school, I was told, "Energy is the capacity to do work," which is something of a tautology for work has exactly the same dimensions as energy. Today, the physicists claim that all change in the Universe is caused by four basic forces: electromagnetic, gravitational, and the strong and weak nucleic forces. They claim that even human behaviour can potentially be explained in terms of these four forces, which they are trying to unify in some generalized concepts and equations. It is sometimes difficult to see why evolution should have taken the world of learning further and further from Reality and the Truth in this way. Nevertheless, it has happened and we must make the best of it, accepting and respecting those scientists who wish to hold on to these modern beliefs, taking people further and further away from the innocent wisdom of the ancients.

We can begin to take science out of the evolutionary cul-de-sac it finds itself in today by noting that with the URT we view the Universe in terms of structure, form, relationships, and meaning, more abstract concepts than the space, time, matter, and energy of the physicists. This means that meaningful structure-forming relationships must be causal and thus energetic. This includes the nucleic binding energies that can be explosively released in nuclear fission and fusion and Rupert Sheldrake's hypothesis of formative causation by morphogenetic fields, which Rupert denied were energetic.[46]

The word *synergy* best encapsulates the notion of relational energies. It is a word that has come into general use only in the past few decades. It did not appear in the *Concise Oxford Dictionary* of words in common usage until the sixth edition published in 1976 although the OED records its use as far back as 1660 to mean 'cooperation between people'. In modern scientific use, *synergy* has come to mean the 'combined or correlated action of a group of bodily organs, mental faculties, drugs, etc.,' first recorded in 1847.

For myself, I first came across the word *synergy* when visiting IBM Canada in 1979, when we exchanged ideas on how to build integrated databases, necessary if managers and professionals were to build effective decision support systems.[47] The eleventh edition of the *Concise Oxford English Dictionary*, published in 2004, defines *synergy* in this way: "interaction or co-operation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects". This is perhaps why synergy is a concept generally ignored by mathematicians. If you tear a greenback in half and give each half to someone else, what you give them is worth nothing. But if you join the two halves together again, the whole is worth one dollar. So 0+0=1!

The third of the words we need to look at in this section is *entropy*, which was coined by Rudolf Clausius in 1865 (actually *entropie* in German):

> I propose to name the quantity *S* the entropy of the system, after the Greek word *trope*, the transformation. I have deliberately chosen the word *entropy* to be as similar as possible to the word *energy*: the two quantities to be named by these words are so closely related in physical significance that a certain similarity in their names appears to be appropriate.[48]

Actually, *trope* in Greek had two meanings. As Jeremy H. Marshall of the Oxford English Dictionary Word and Language Service (OWLS) told me in a letter in 1993,[49] *trope* meant not only 'a turn or turning', but could also mean in many contexts 'change, transformation'. It was in this latter, more unusual, sense that Clausius coined *entropy*.

As Marshall said, the related verb *trepo* 'I turn' could be used both for 'turn around, change direction' and 'change one's mind' or 'go sour' (like wine). "The Greek root therefore has the same duality of meaning as the root of the English word *turn*, which may, for example, mean 'change direction' (as in 'turn into a side-road') or 'change form' (as in 'turn into a frog')." However, the Greek compound *entrope* did not have this latter meaning. It literally meant 'a turning inward', but only being metaphorically used in classical Greek to mean 'respect' or 'shame'. So *entropy*, as used in modern science, is not based directly on the Greek compound, but on a new formulation.

In this respect, *entropy* is rather unusual in science. The suffixes *-tropy* and *-tropic*, which derive from *trope*, generally mean 'turning, changing direction' rather than 'turning into, transformation'. For instance, *heliotropic* means 'turning towards the sun' and Stanislav

Grof's neologism *holotropic* means 'turning towards the whole'.[50] However, *holotropic* could also mean 'transformation of the whole'. Indeed this word beautifully denotes the transformation that we need to go through as a species if the children born in this millennium are to grow old enough to have children of their own.

But what did Clausius actually mean by *entropy*? Well, he wanted to measure how much of the energy of a machine was available for doing useful work and how much was unavailable, dissipated through friction, for instance. Entropy was a measure of the unavailability of a system's energy to do work, of its disorganization. This has given rise to the second law of thermodynamics, which states, "the entropy of an isolated system which is not in equilibrium will tend to increase over time, approaching a maximum value at equilibrium."[51]

This can be simply illustrated with hot and cold taps pouring water into a basin. The water is mixed, becoming tepid. But this lukewarm water cannot be unmixed to become hot and cold water again without an external source of energy. If the second law of thermodynamics applied to the Universe as a whole, viewed as a closed system, without anything outside it, such irreversible processes would lead to the 'heat death of the Universe' as its final state, with no available energy to do work or create anything.[52] This led Greg Hill and Kerry Thornley to describe the second law of thermodynamics as "perhaps the most pessimistic and amoral formulation in all human thought".[53]

Unifying growth and loss of structure

We are now at the heart of the dichotomy between science and spirituality. By the Principle of Unity, the opposite of the growth of structure, illustrated by the growth of the information technology industry in this chapter, is the loss of structure, encapsulated by the second law of thermodynamics. During the past 150 years, there have been multitudes of attempts to heal this deep split in our understanding of the world we live in. But because scientists are not generally mystics and mystics are not usually scientists, for the most part we are still living in utter confusion, unable to make sense of what is happening to our species at the present time.

At the core of this problem is Charles Darwin's book *On the Origin of Species by Means of Natural Selection,* or *The Preservation of Favoured Races in the Struggle for Life*, published on 24th November 1859,[54] at about the time that Clausius was formulating his ideas on the science of thermodynamics. Chapters 3 and 4 in this epoch-making book are called 'Struggle for Existence' and 'Natural Selection', which led the economist Herbert Spencer to coin the phrase 'survival of the fittest' in 1864.[55] This is not unreasonable, for the more adapted individuals and species are to the circumstances in their lives, the more likely they are to survive. That is why *Homo sapiens* is the most threatened species on this planet today. We are simply not adapting to the unprecedented rate of evolutionary change we are currently experiencing.

While we do not want to blame Darwin for this precarious situation, for he was a product of his times, the first two chapters of his book did not help. They were called 'Variation under Domestication' and 'Variation under Nature'. So how has all the beautiful diversity we see in the world around us arisen? Well, Darwin began his investigation by studying the way that gardeners propagate new varieties by grafting, etc. In this way, "variability may be largely attributed to the ovules or pollen, or to both, having been affected by the parent prior to conception".[56] So natural selection not only determines which varieties can best survive, but it also influences the generation of the varieties themselves. Life or God the Creator is not involved in any way at all, a denial that that has affected all mainstream theories of evolution ever since.

This is very strange for no doubt scientists use the words *enthusiasm*, from Greek *enthousiasmos*, from *enthous*, 'possessed by a god', which is based on *theos* 'god', and *inspire*, from Latin *inspirare*, 'breathe into', from *spiritus*, 'breath or spirit'. So why do they still think that the atheistic laws of physics and biology can explain their enthusiasm, why they are inspired? Traditionally scientists have not accepted the notion of human energy arising directly from our Divine Source, or if they have accepted it, they say that such energies lie outside the domain of science. As Carl Jung once said, analytical psychology does not fit into the prevailing scientific paradigm, but it works, so let us continue with it.

Thankfully, the Unified Relationships Theory shows that there are no closed systems in the Universe. All systems are abstractions from Consciousness, which, through Life or the Logos arising from our Divine Source, creates all the organized forms and structures we see within and around us. But the fact that Consciousness is all there is is not well known in scientific circles because we are taught in our culture that we are separate from God, Nature, and each other. So maybe it will help to end this isolationist philosophy to look a little more closely at how evolution has moved us increasingly closer to Wholeness during the last two-thirds of the twentieth century, developing what is today called 'holistic science'.

One of the pioneers in this movement was Ludwig von Bertalanffy, who in the 1920s became deeply concerned that the then prevalent mechanistic approach "appeared to neglect or actively deny just what is essential in the phenomenon of life. He advocated an organismic conception in biology, which emphasizes consideration of the organism as a whole or system, and sees the main objective of biological sciences in the discovery of the principles of organization at its various levels."[57] In the next decade, he went on to develop what is today called General System Theory (GST), general because it can be applied to systems and organizations in many disciplines, including economics, psychology, and sociology, as well as biology. If we are to fully understand these disciplines, GST thus takes a holistic, organismic approach rather than the reductionist, mechanistic approach that prevails in science even today.

In his standard textbook on the subject in 1969, von Bertalanffy included Norbert Wiener's *Cybernetics: Or Control and Communication in the Animal and the Machine,* published in 1948, within the embrace of GST.[58] The word *cybernetics* derives from Greek *kubernetes*, 'steersman, governor', from *kubernan* 'to steer', which is also the root of the English verb *govern* and hence *government*. In choosing this name, Wiener acknowledged that the first significant paper on self-regulating, feedback mechanisms was a paper on governors published by Clerk Maxwell as early as 1868.[59]

But on the same page, Weiner introduced a conceptual confusion that pervades in the literature even today. He said, "Just as the amount of information in a system is a measure of its degree of organization, so the entropy of a system is a measure of its degree of disorganization; and the one is simply the negative of the other." Thus the terms *negative entropy* and *negentropy* emerged, which are appropriately deprecated in IBM's *Dictionary of Computing*.

This relationship between information and entropy arose through Claude Shannon's 'A Mathematical Theory of Communication' published in 1948.[60] But there were some differences between Shannon and Weiner's respective formulæ for entropy. While "Both regard information as 'that which removes uncertainty', and both measure it by the amount of uncertainty it removes,"[61] as W. Ross Ashby has pointed out, Shannon's formula for entropy was positive, while Weiner's was negative.[62]

Shannon, himself, was uncertain what to call the 'measure of uncertainty' or attenuation in phone-line signals that he had developed:

> My greatest concern was what to call it. I thought of calling it 'information', but the word was overly used, so I decided to call it 'uncertainty'. When I discussed it with John von Neumann, he had a better idea. Von Neumann told me, "You should call it entropy, for two reasons. In the first place your uncertainty function has been used in statistical mechanics under that name, so it already has a name. In the second place, and more important, nobody knows what entropy really is, so in a debate you will always have the advantage."[63]

One of the reasons why there has been so much confusion around the concept of entropy is that is a mathematical concept, not intuitively obvious. Actually, what is significant here is the *change* in entropy, rather than entropy itself. Whatever entropy might be, we can say that when a system loses structure or organization, there is an increase in entropy and loss of available energy. Conversely, the growth of form and structure leads to a decrease in entropy, and hence an increase in energy. However, Weiner was adamant that this was not the case, when he said: "Information is information, not matter or energy. No materialism which does not admit this can survive at the present day."[64]

Ilya Prigogine, who studied open systems, in contrast to closed ones tending towards equilibrium, took another major step in the development of holistic science in the 1970s. On open system is one that exchanges matter and energy with its environment. As Prigogine and his co-writer Isabelle Stengers said,

> In far-from-equilibrium conditions we may have transformation from disorder, from thermal chaos, into order. New dynamic states of matter may originate, states that reflect the interaction of a give system with its surroundings. We have called these new structures *dissipative structures* to emphasize the constructive role of dissipative processes in their formation.[65]

I must admit, I don't really understand why these open systems are called dissipative structures, for such an understanding is not directly relevant to the theme of this book. What we are interested in here is what surrounds the Totality of Existence viewed as a system of systems all interacting with each other. As this book explains, the universal environment or context is Consciousness. But Consciousness does not appear in the theory of dissipative structures and so this cannot help us to heal our fragmented minds in Wholeness.

In 1973, Humbert R. Maturana and Francisco J. Varela took another major step in the development of General System Theory with their book *Autopoiesis: The Organization of the Living*.[66] *Autopoiesis* means 'self-producing, self-creating', deriving from the Greek *auto* 'self' and *poiesis* 'creating, producing' from *poien* 'to make, create', which is also the root of *poem* 'something created'. Maturana and Varela were thus attempting "to define living systems *not* as they are objects of observation and description, not even as interacting systems, but as self-contained unities whose only reference is to themselves."[67] Nevertheless, they still regarded living systems as machines not organisms, as this definition indicates:

> An autopoietic machine is a machine organized (defined as a unity) as a network of processes of production (transformation and destruction) of components that produce the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in space in which they (the components) exist by specifying the topological domain of its realization as such a network.[68]

There is no mention of the role of the Logos in this organizing process. For as Richard Tarnas tells us, Heraclitus, the mystical philosopher of change, used the word *Logos* to mean an "immanent conception of divine intelligence" signifying "the rational [organizing] principle governing the cosmos".[69] So as Fritjof Capra emphasizes, Maturana and Varela were intent to keep Life or vitalism out of their theory: "Our approach will be mechanistic: no forces or principles will be adduced which are not to be found in the physical universe."[70] Nevertheless, the very next sentence established them as bona fide systems thinkers not as Cartesian mechanists: "Yet, our problem is the living organization and therefore will not be in properties of components, but in processes and relations between processes realized through components."[71]

Other systems theories that emerged in the 1970s and 80s were chaos theory[72] and complexity theory.[73] But these remained at the superficial level of things, drawing heavily on nonlinear mathematics and computerized technology. In my experience, they are very little help in our search for Wholeness, in the complete unification of Western reason and Eastern mysticism.

Of course, during the twentieth century, there were a number of vigorous attempts to bring Life back to science, particularly to evolutionary theory. In 1907, Henri Bergson published a book called *L'Evolution créatrice*, translated into English four years later as *Creative Evolution*. Bergson suggested that by looking at humanity's natural creative impulse there must be an *élan vital*, or vital impetus in the English translation, at work in the Universe. Indeed, he went as far to say that there is an *original impetus* of life, which "is the fundamental cause of variations"[74] in Nature.

In *The Human Phenomenon*, written at the end of the 1930s, Pierre Teilhard de Chardin extended this theme when he wrote in a chapter called 'The Inside of Things':

> We shall assume that all energy is essentially psychic. But we shall add that in each individual element this fundamental energy is divided into two distinct components: a *tangential energy* making the element interdependent with all elements of the same order in the universe as itself (that is, of the same complexity and 'centricity'); and a *radial energy* attracting the element in the direction of an ever more complex and centered state, toward what is ahead.[75]

These notions of tangential and radial energy correspond directly to the horizontal and vertical dimensions of time illustrated in Figure 4.11 on page 272 in Chapter 4, 'Transcending the Categories'. As with all opposites, we need to include both if we are to find Wholeness.

Then in 1940, Reginald Kapp, a professor of electrical engineering at London University, was brave enough to publish a highly challenging book called *Science versus Materialism*. As an engineer, he said, "We know that it is not in the nature of Matter unaided to fall into the form of machines."[76] Other enlightening quotations from this splendid book are, "In this book, we are pointing to overwhelming evidence for the existence of non-material influences;"[77] "The field of study of biologists is not Life but living organisms. They investigate the structure and behaviour of these, not the causes of such structure and behaviour;"[78] and "Any evidence which proves the organic world to be subject to laws from which the inorganic world is free is evidence for vitalism."[79]

I did not come across this book until 2005, when I was introduced to it by his children John and Elinor Kapp,[80] at a Mystics and Scientists conference called 'Healing the Split: An Alchemy of Transformation', organized by the Scientific and Medical Network in the UK, an organization seeking to go beyond the materialism of modern science.[81]

Unifying Darwinism and Creationism

Tragically, such organizations are still a minority in society. Ever since Francis Crick and James Watson discovered the structure of the deoxyribonucleic acid (DNA) molecule in

1953,[82] drawing on earlier work by Maurice Wilkins and Rosalind Franklin, there has been a widespread believe that DNA contains the secret of life, that this nucleic acid "contains the genetic instructions used in the development and functioning of all known living organisms".[83] Crick and Watson, well aware of the significance of their discovery, humbly began their nine-hundred-word article, published in *Nature* on 25th April 1953,[84] with these words: "We wish to suggest a structure for the salt of deoxyribose nucleic acid (DNA). This structure has novel features which are of considerable biological interest."[85]

More than this. The DNA molecule is a double helix of a linear sequence of bases, bonded across the two strands of the helix in pairs: adenine-thymine and guanine-cytosine.[86] Thus the DNA language has just four letters—A, T, G, and C—with which to generate all the complexity of living organisms. As Watson said, "Anything that simple, that elegant just had to be right."[87] In 1961, Sydney Brenner and Francis Crick "did the definitive experiment that demonstrated that the code was triplet-based",[88] that all the words in the DNA language are just three letters long. This means that there are 64 (4^3) possible words with which to generate the twenty standard amino acids that are used by cells in protein biosynthesis.

Actually, the DNA molecule does not generate these amino acids directly. It does so via a messenger RNA molecule, which also contains four bases, but with thymine replaced by uracil. All that remained therefore was to discover which triplets generated which amino acids. The key breakthrough was made in 1961 by Marshall Nirenberg and Heinrich Matthaei, who showed, using a technique developed by Marianne Grunberg-Manago six years earlier, that UUU generates polyphenylalanine.[89] Gorbind Khorana then picked up the challenge of decoding the other 63 triplets or codons, which led to the unravelling of the complete genetic code by 1966, listed in Table 5.1.[90]

So the genetic code is a type of information, informing cells about which amino acids to make. And as the Unified Relationships Theory shows, all forms and structures that are causal in this way are types of energy. But here we are only looking at tangential energies. To develop a full understanding of the secret of life, by the Principle of Unity, we also need to include the role of radial energies arising directly from our Divine Source as Life. I know this from my own life experience. There is no evidence whatsoever that the DNA that I inherited from my parents and grandparents played any role in the emergence of the URT. On the other hand, there is a wealth of evidence to indicate that the traumatic events that took place in my environment in my early life provided the key motive power, as I describe in detail elsewhere.

Undoubtedly, Life—God the Creator—also played a key creative role in the discovery of the structure of the DNA molecule. But Life is almost totally ignored by biologists today. As Watson believes, life originated when RNA-based life forms emerged some four billion years ago. He does not acknowledge the role of Life in the big bang ten or eleven billion years earlier.[91]

Amino acid	**RNA codon**
Alanine	GCA GCC GCG GCU
Arginine	AGA AGG CGA CGC CGG CGU
Asparagine	AAC AAU
Aspartic acid	GAC GAU
Cysteine	UGC UGU
Glutamic acid	GAA GAG
Glutamine	CAA CAG
Glycine	GGA GGC GGG GGU
Histidine	CAC CAU
Isoleucine	AUA AUC AUU
Leucine	UUA UUG CUA CUC CUG CUU
Lysine	AAA AAG
Methionine	AUG
Phenylalanine	UUC UUU
Proline	CCA CCC CCG CCU
Serine	AGC AGU UCA UCC UCG UCU
Threonine	ACA ACC ACG ACU
Tryptophan	UGG
Tyrosine	UAC UAU
Valine	GUA GUC GUG GUU
Stop codons	UAA UAG UGA

Table 5.1: *The genetic code*

The belief that the DNA molecule is the basic building block of life, an atomistic notion that has a parallel in physicists' search for a fundamental particle as the basic building block of all matter in the Universe, has led James Watson to pick up on the eugenics movement, popular at the end of the nineteenth century and beginning of the twentieth.[92] The word *eugenics* was coined by Francis Galton, a half-cousin to Charles Darwin, in 1883,[93] from the Greek *eu* 'good, well' and the Proto-Indo-European base **gen-* 'to produce' (the Greeks had a word *eugenes* 'well-born'). So eugenics originally meant "an opportunity for humans to control their own evolutionary destiny".[94]

Now if the DNA molecule controls the development and functioning of all known living organisms, then if we are ever to live in love and peace with each other, free of the conflict and suffering that has afflicted human affairs for millennia, then we must engage in genetic engineering to ensure our health and well-being. James Watson's belief in a renewed eugenics[95] got him into very hot water on a visit to the UK in October 2007, when he suggested that black people are less intelligent than white.[96]

Another scientist determined to take Life out of biology, literally 'the study of life', from Greek *bios* 'life', is Richard Dawkins, who calls himself a neo-Darwinist. As a promoter of evolution only by natural selection, he has said that it is not only individuals and species that fight for survival. As "A gene is defined as any portion of chromosomal material that potentially lasts for enough generations to serve as a unit of natural selection," genes themselves must be selfish.[97]

One of the key features of genes is that they replicate themselves.[98] It seems that it is this property that leads biologists to believe that these forms of life are life itself. Dawkins extends this notion of self-replication into the noosphere with his concept of *meme*, a contraction of *mimeme*, from the Greek *mimeisthai* 'to imitate' from *mimos* 'imitator', the root of *mime* and *mimic*. A meme is "a unit of cultural transmission, or a unit of *imitation*".[99] "Examples of memes are tunes, ideas, catch-phrases, clothes, fashions, ways of making pots or of building arches."[100] So memes are examples of what we called passive and active cognitive structures—we know that and we know how—described in Section 'Analogous human cognitive characteristics' in Chapter 8, 'Limits of Technology' on page 639.

A similar replicating idea is described in Rupert Sheldrake's *The Presence of the Past*. He suggests that through the action of morphic fields, once a particular structure is formed in evolution, it tends to repeat itself through habit. *Morphic* derives from the Greek *morphe* 'form'. Yet in *A New Science of Life*, Sheldrake denies that formative causation is energetic: "although morphogenetic fields can only bring about their effects in conjunction with energetic processes, they are not in themselves energetic."[101] He seems to have made this statement because he did not wish to break the laws of physics as they are widely understood.[102]

Dawkins holds a similar reverence for the conventional laws of physics: "The physicist's problem is the problem of ultimate origins and ultimate natural laws. The biologist's problem is the problem of complexity." And "The kind of explanation we come up with [for how complex things come into existence] must not contradict the laws of physics."[103] It is this sort of belief that leads evolution to be blind, that prevents us from managing our business affairs with full consciousness of the evolutionary energies that cause us to behave in the way we do. If the human race is to survive for very much longer, it is imperative that we break the habitual systems of thought that we have inherited from our less than fully conscious ancestors. In this way, we could end the war between Darwinism and Creationism, and peace could break out.

Information and entropy

To this end, let us see if we can bring some conceptual clarity to the concept of information in Claude Shannon's 'A Mathematical Theory of Communication'. For he used the word *information* in quite a different way from that used by information systems designers, who regard information as data with meaning, as we see on page 159 in Chapter 1, 'Starting Afresh at the Very Beginning'. As Claude Shannon admitted in an article he wrote for a now obsolete edition of the *Encyclopædia Britannica*, communications theory is not concerned with the meaning of the information in messages, but solely with signs, codes, and the quantitative measurement of these entities in a mechanistic, stochastic sense.[104]

So it is misleading to use the word *information* in this connection, as Theodore Roszak has pointed out.[105] For the essence of information is to inform and to provide meaning. So the concept of information is essentially semantic, not mathematical. But when we view information mathematically, it becomes "disjointed matters of fact that [come] in discrete little bundles".[106] Nevertheless, such a mechanistic approach can shed some light on a more holistic perspective, showing how entropy relates to meaningful information and hence energy, for in the URT meaning is energy.

Although Shannon did not use the word in his papers, central to an understanding of information entropy in his theory is the concept of *variety*, which W. Ross Ashby seeks to quantify.[107] It is, of course, this variety that so pleases us in the diversity of all the forms of life we see around us, which Darwin addressed in the first two chapters of his epoch-making book.

If we begin with a set of distinguishable elements, Ross Ashby defines variety as "either (i) the number of distinct elements, or (ii) the logarithm to base 2 of the number". The chief advantage of using logarithms here is that operations can be additive rather than multiplicative. So the variety of a coin is 1 bit and of a pack of cards it is $\log_2 52 = 5.7$ bits. Tom Schneider, in his 'Information Theory Primer', calls variety uncertainty.[108] "In reading an mRNA, if the ribosome encounters any one of 4 equally likely bases, then the uncertainty is 2 bits."[109]

However, in general the various elements are not all equally likely. If the probability that the ith element in a set of n elements occurs is p_i, then

$$\sum_{i=1}^{n} p_i = 1$$

We now come to perhaps the central dilemma of the theory, surrounding the concept of $-\log_2(p_i)$ (the minus sign is added to make the quantity positive). What should we call this? Well, D. S. Jones calls it 'self-information'[110] and Myron Tribus called it 'surprisal' in the first textbook that based the laws of thermodynamics on information theory.[111] For in a device that is transmitting symbols, the smaller p_i is, the more surprised the receiver will be to see the ith symbol. Conversely, when $p_i = 1$, then there is no surprise, for $\log_2(p_i)=0$. In human terms, we are told something we already know and no information is conveyed.

Now if we take a weighted sum of these surprisal terms, we obtain the following formula for entropy with the symbol H rather than Clausius' S because this is the symbol that Ludwig

Boltzmann used in his similar formula in statistical thermodynamics.[112]

$$H = -\sum_{i=1}^{n} p_i \log(p_i)$$

Ross Ashby calls this measure the 'degree of variety',[113] which we could perhaps call 'diversity'. It is at a maximum when all elements are equally likely.[114] For instance, if four elements are equally possible, the entropy is 2 bits. On the other hand, if the probabilities are ½, ¼, 1/8, and 1/8, then the entropy of this set is 1.75 bits (0.5*1 + 0.25*2 + 0.125*3 + 0.125*3).

In systems terms, the growth of structure leads to greater diversity and hence a decrease in entropy and increase in available energy. However, this quantitative measure omits the immense energy contained in the relationships in the structure. There is also a tentative link between surprisal and meaning. The more unlikely a message transmitted by a system, the more symbols are required to convey it and the more information that these symbols might convey. But these symbols must be meaningful to the receiver, otherwise they contain very little information and hence energy. This applies particularly to the symbols in this book, which actually have immense power if interpreted in the context of Wholeness rather than filtered through a set of fragmented, inherited belief systems.

And it is here that the whole theory of communication breaks down. For such a theory supposes the existence of a separate transmitter and receiver. But in Wholeness, these are not separate. Wholeness is so improbable in the context of the prevailing culture that either an infinite number of symbols is required or none at all. It is through silence that Wholeness can best be conveyed.

One more point we can draw from cybernetics. As Ross Ashby points out, elements in a system or set of possibilities often don't have the same properties as the population as a whole. For instance, a gram of hot iodide gas at any one moment might be 37% iodized. But this does not apply to individual molecules, which are either wholly iodized or not at all.[115] In human terms, we cannot fully know ourselves if we take an egocentric, ethnocentric, anthropocentric, geocentric, or even a kosmocentric perspective. We can only fully heal our fragmented minds when we view our lives within the overall context of Wholeness.

Chapter 6

A Holistic Theory of Evolution

In modern scientific man, evolution is at last becoming conscious of itself.

Julian Huxley

When the word *evolution* is used in society today, people think particularly of the biological evolution of the species, described by Charles Darwin in *On The Origin of Species by Means of Natural Selection* with its alternative title *The Preservation of Favoured Races in the Struggle for Life*. This first edition was published in 1859 with five further editions, the last coming out in 1872, when the short title was changed to *The Origin of Species*.[1]

However, Darwin's theory of evolution is not the only way of viewing evolutionary processes. For instance, the editors of the *What is Enlightenment?* magazine, led by Andrew Cohen, devoted their January-March 2007 issue to the theme 'The Mystery of Evolution: A spiritual & scientific exploration of where we came from and where we're headed'. In an article titled 'The Real Evolution Debate', they presented a spectrum of scientific and spiritual views of evolution, displayed in Figure 6.1.[2]

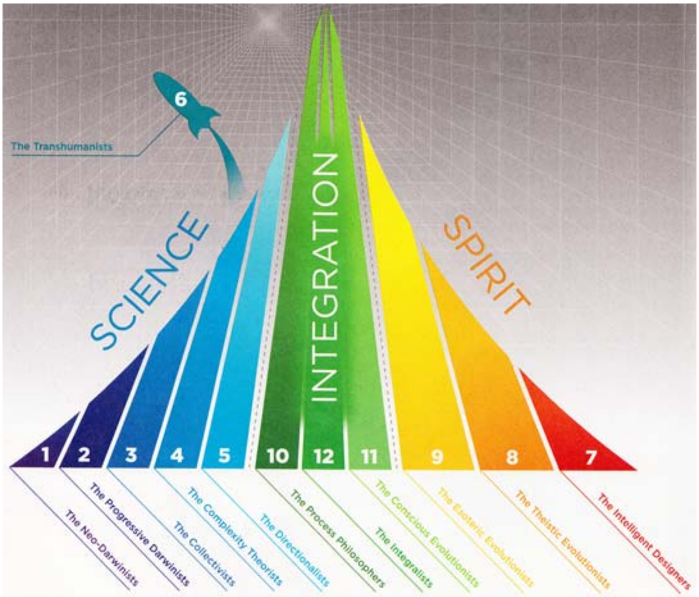


Figure 6.1: *Scientific and spiritual views of evolution*

This article points out that many scientists, philosophers, and spiritual leaders have attempted to explain evolutionary processes over the years. The core idea of the integralists, for instance, endeavouring to unify science and spirituality, is: "Evolution is a holistic process that includes both objective and subjective dimensions of reality as it moves toward greater exterior complexity of form and greater interior depth of consciousness."[3]

Yet, nowhere in the magazine is Jan Christiaan Smuts mentioned, the man who coined the word *holistic* from Greek *ὁlos* 'whole', from PIE base **sol* 'whole', also the root of *safe, catholic*, *salubrious*, *saviour*, and *solid,* among other words. In contrast, *whole* derives from an Old High German word *heil*, cognate with *heilida* 'health' and *heilag* 'holy', from PIE base *kailo-* 'whole, uninjured, of good omen'. It seems that it is just a happy coincidence that the PIE bases for *healthy* and *holistic* are different.

Smuts coined *holistic* in *Holism and Evolution*, written in 1926, shortly after J. B. M. Hertzog, leader of the National Party, defeated him at a general election. Before writing this seminal book, Smuts (1870-1950) was the second prime minister of the Union of South Africa, as the leader of the South Africa Party. Smuts, a man of many contradictions, had been a brilliant scholar in his early life in the natural sciences, the arts, and the law, and took the opportunity of comparative leisure to describe the scientific philosophy that guided his life.[4] "After Einstein studied *Holism and Evolution* soon upon its publication, he wrote that two mental constructs will direct human thinking in the next millennium, his own mental construct of relativity and Smuts' of holism."[5]

In the Preface to *Holism*, Smuts highlighted a factor in the physical and biological sciences that he felt had been neglected. As he said:

> This factor, called Holism in the sequel, underlies the synthetic tendency in the universe, and is the principle which makes for the origin and progress of wholes in the universe. An attempt is made to show that this whole-making or holistic tendency is fundamental in nature, that it has a well-marked ascertainable character, and that Evolution is nothing but the gradual development and stratification of progressive series of wholes, stretching from the inorganic beginnings to the highest levels of spiritual creation."[6]

In summary, "The whole-making, holistic tendency, or Holism, operating in and through particular wholes, is seen in all stages of existence, and is by no means confined to the biological domain to which science has hitherto restricted it. … Wholeness is the most characteristic expression of the nature of the universe in its forward movement in time. It marks the line of evolutionary progress. And Holism is the inner driving force behind that progress."[7]

Indeed, except that Holism acts more in the vertical than the horizontal dimension of time through the integrating power of the Logos. Although Smuts fought against the British in the Boer war, famously jailed Mohandas Gandhi in 1908, organized the Royal Air Force in the First World War, and was a British Field Marshall in the Second, he constantly sought unity and wholeness, being the only person to sign the charters of both the League of Nations and the United Nations, having previously signed the peace treaties that brought the two World Wars to an end, the only person to be a signatory of both. He was also a firm advocate of the British Commonwealth of independent nations, including South Africa.[8]

Of course, the Internet and global economy are also manifestations of this natural, convergent, holistic tendency, counteracting the predominant divergent mode of evolution, which has led to specialism and fragmented, split minds, unable to see the Big Picture. So drawing inspiration from the Internet, as we are now looking at the Universe as an information system—in terms of structure, form, relationships and meaning—we can see how to create a holistic theory of evolution.

But evolution did not begin with the first forms of life about four billion years ago and did not end with the birth of *Homo sapiens sapiens* some 200,000 years ago. The formation of both small and large physical structures, which produced the elements, our solar system, and all the other stars and galaxies, studied by particle physicists and astronomers, is also an evolutionary process. As is human learning, and when we are conscious of how we learn, we can develop a comprehensive theory of evolution, which can explain our origin as a species and tell us where we are all rushing at ever-increasing rates of change.

We can thus answer Paul Gauguin's questions, "*D'où venons-nous? Que sommes-nous? Où allons-nous?*", 'Where Do We Come From? What Are We? Where Are We Going?', illustrated by his famous painting of that name, depicted in Figure 6.2.

Figure 6.2: *Where Do We Come From? What Are We? Where Are We Going?*

The man who showed us most clearly where we are all going was Pierre Teilhard de Chardin, who saw that all the diverse streams of evolution are converging on what he called the Omega Point. In his book *The Human Phenomenon*, he distinguished four major stages of evolution from beginning to end called 'Prelife', 'Life', 'Thought', and 'Superlife', each stage and transition phase between the stages being much shorter than the previous ones because of the accelerating pace of evolution, illustrated in Table 6.1, where 'm' is millions of years The first three stages of the overall process of cosmogenesis or hologenesis[9] of the past fourteen billion years were the evolution of matter and the physical universe, of forms of life, and of concepts in the mind, which we can call hologenesis, biomorphogenesis, and noogenesis, respectively. Narrowing the focus of our attention, the transition between the second and third stage took place during the comparatively peaceful age of the Great Mother,[10] briefly described in Chapter 10, 'Entering Paradise' on page 761, coming to an end about 5,000 years ago[11] with the birth of history, marked in the West by the mythical Garden of Eden.

Evolutionary stages, years ago						Transition phases, years ago		
Teilhard	**Type**	**Context**	**Start**	**End**	**Duration**	**Start**	**End**	**Duration**
Prelife	Physical	Hylosphere	14,000 m	4,500 m	9,500 m	4,500 m	3,500 m	1,000 m
Life	Biological	Biosphere	3,500 m	25,000	3,500 m	25,000	5,000	20,000
Thought	Noological	Noosphere	5,000	50	5,000	50	-50	100
Superlife	Spiritual	Numinosphere	-50	-300	250			

Table 6.1: *Teilhard's four-stage model of evolution from Alpha to Omega and back again*

During the patriarchal, mental-egoic age (me-epoch) that followed, described in some detail in Chapter 11, 'The Evolution of the Mind' on page 783, some twenty major civilizations have been born,[12] most naturally dying in the course of time, as we see in Figure 6.16, 'Timeline of major civilizations' on page 568. This includes Western civilization, which today dominates the world through the global economy. In turn, this great civilization is now dying because it is based on the false assumption that we human beings are separate from God, Nature, and each other, when the truth is that we are in gnostic union with the Divine at every instant of our lives.

It is now crystal clear that we are entering the fourth and final stage of evolution in general and the third and final stage of human evolution, as illustrated in Figure III.1, 'The three stages of human phylogeny' on page 756. As evolution changes from a predominantly divergent mode to a convergent one, the war-ridden, self-centred epoch is being transformed into a holistic, wisdom society, which is emerging very fast because evolution is an accumulative process that has been accelerating exponentially for fourteen billion years and has now reached mind-shattering speeds—literally, as we explore further in Chapter 12, 'The Crisis of the Mind' on page 989 and Chapter 13, 'The Prospects for Humanity' on page 1027.

However, there are actually many factors that prevent us from reaching evolution's glorious culmination. One of these is our lack of understanding of the orders of magnitude of the exponential series. In Teilhard's evolutionary model, the first three major stages of evolution began some 14 billion, 3.5 billion, and 5,000 years ago. They are of rapidly decreasing duration because of the accumulative nature of evolutionary processes. But they lack detail and cannot directly be expressed as an exponential series in mathematics, the language of science. So we shall first look at some of the surprising characteristics of the exponential series.

Another inhibiting factor is our limited sense of time, which is reflected in the calendars of the world, with the notable exception of the Hindu and Mayan calendars. So we shall look at some of these, which will lead us into an exponential timeline that we can map on to some of the major turning points in evolution, showing that we are currently passing through the most momentous turning point in fourteen billion years of evolution.

Taxonomic considerations

Even though the evolution of the species has been progressing for some 3.5 billion years and noogenesis has been under way for some 25,000 years, it was not until 1735 that evolution began to help us human beings bring a sense of order to all the beautiful diversity that we see in the world around us. It was in this year that Carl Linnæus[13] from Sweden published his seminal *Systema Naturae*[14] during a stay in the Netherlands. In it, he outlined his ideas for the hierarchical classification of the natural world, dividing it into the animal kingdom (*Regnum animale*), the plant kingdom (*Regnum vegetabile*), and the mineral kingdom (*Regnum lapideum*).

In dividing Nature into three kingdoms, Linnaeus was implicitly using Integral Relational Logic at a very high level of abstraction, intuitively using defining attributes to distinguish the differences. Linnaeus also defined some narrower terms for classifying the natural world: class, order, genus, and species, to which were later added phylum or division, between kingdom and class, and family, between order and genus.[15]

The defining attributes that Linnaeus used in his system were morphological, based on the similarities and differences in the forms that he observed. However, distinguishing different flowers from the colour of their petals, for instance, is not very useful. Rather he used a sexual system in classifying the plants. He put plants with nine stamens and one pistil into a single class, using an analogy with the bedroom: “Nine men in the same bride’s chamber, with one woman”.[16] During the thirty-five years after the first edition, which had just eleven pages, thirteen editions were published, the last posthumously, consisting of some 3,000 pages.

The tenth edition published in 1758 marked an important milestone. First, whales, which had previously been classified as fish, were classified as mammals. But more importantly, this was the first edition when the binomial system of naming the species was introduced based on genus and species, like *Canis lupus* for the common wolf. A trinomial system is used for subspecies, such as *Canis lupus occidentalis* for the northern timber wolf, illustrated in Table 2.17, “Biological classification,” on page 205.

Linnaeus thus introduced taxonomy as the science of classification, well demonstrating the immense power of IRL in organizing our ideas. *Taxonomy* was actually coined in French in 1813 by A. P. de Candolle[17] from Greek *taxis* 'arrangement, order' and *nomia* 'distribution, method', from *nomos* 'custom, law', from *nemein* 'manage, control, arrange, assign'. So *astronomy* is an arrangement of the stars and *economy* is the management of the household. Similarly, *taxonomy* is an arrangement of an arrangement, today either meaning classification, in general, or specifically, the systematic classification of living organisms. As we saw in Part I, IRL, as an egalitarian generalization of all classification methods, is a commonsensical way of bringing universal order to all our ideas and experiences.

In taxonomy as applied to living organisms, a taxon is a category or group, such as a phylum, order, family, genus, or species, a hierarchical generalization structure of broader/narrower terms in IRL. Taxonomists have found that seven basic taxa were not sufficient for their purpose. They have introduced legion and cohort between class and order and tribe and alliance between family and genus. But even this was not enough to classify all the levels of similarities and differences that they could observe. Taxonomists needed broader and narrower terms of the basic taxa, such as superclass and superfamily and subfamily and subspecies. So today, there are around thirty-five ranks of taxa in biology, although both the framework and its application are still evolving as new similarities and distinctions are made using various defining attributes in IRL.

For instance, the 50,000 species of fungi were originally classified as plants, but "because they lack chlorophyll and the organized plant structure of stems, roots, and leaves, they are now considered to constitute a separate kingdom."[18] But adding fungi as a kingdom and dropping minerals from Linnaeus' three kingdoms, because minerals are the subject of mineralogy not biology, is not enough to classify all living organisms. There are a multitude of bacteria and other microorganisms that do not fit into this general scheme. So taxonomists today generally use a five- or six-kingdom structure, depending on the defining attributes in IRL that are used to differentiate these groups: Animalia, Plantae, Fungi, Protista, and Prokaryota or Monera, introduced in 1968 and used in the UK and Australia, or Animalia, Plantae, Fungi, Protista, Archaea, and Eubacteria, introduced in 1980 and used in American textbooks.[19]

In 1990, Carl Woese then introduced the concept of domain as a group of kingdoms, lumping together all organisms that contain cells with a nucleus within a membrane, called eukaryotes, such as Animalia, Plantae, and Fungi, to distinguish them from prokaryotes, cells that lack a membrane.[20] He then divided the prokaryotes into two domains, Bacteria and Archaea to give a three-domain system. So there are many ways of applying IRL in taxonomy, with no right or wrong way. How this is done at any one point in the evolution of human learning depends on which defining attributes are used and the context or scientific theory in which similarities and differences are being interpreted.

But even then there are fuzzy edges on the borders of classification, in biology as in general. For instance, what does one do with the viruses? These organisms contain nucleic acid, either DNA or RNA, as genetic information, but are not self-reproducing and do not have cells. However, they evolve by natural selection. So are they living organisms or not? The biologists do not know how to answer this question because they do not recognize the existence of Life arising directly from our Divine Source.[21]

Inspired by Carl Linnaeus' *Systema Naturae*, taxonomists classify the millions of extant species in a hierarchical fashion in a snapshot in time.[22] But, as Arthur Koestler pointed out, hierarchical structures also exist through time in an evolutionary fashion,[23] for it doesn't matter in which way we slice the cake, the same underlying patterns are there wherever we look. This evolutionary perspective has a somewhat complicated taxonomy, which we need to clarify if we are to understand the evolutionary influences on our lives and so wake up to what is happening to our species at the present time.

We can begin with ontogeny or ontogenesis, 'the origin and development of the individual living being from embryo to adult' from Greek *einai* 'to be', and phylogeny or phylogenesis, 'the genesis and evolution of the phylum, tribe, or species' from Greek *phulun* 'race, phylum'. There is a strong connection between ontogeny and phylogeny, for as noted in the *Microscopic Journal* in 1872, "'The ontogeny of every organism repeats in brief … its phylogeny', i.e. the individual development of every organism … repeats approximately the development of its race."[24] In other words, in normal circumstances, ontogeny recapitulates phylogeny, a phrase introduced by Ernst Haeckel in 1866.[25] But when new species emerge, individuals develop characteristics that are different from their parents. When a critical mass of such individuals emerges, this is the birth of a new species and phylogeny recapitulates ontogeny.

Normal science is an example of ontogeny recapitulating phylogeny, within the species we can call *Homo divisionis*. We must bear this in mind when interpreting conventional theories of evolution. For *Homo divinus*, recognizing the existence of Life within the overall context of Consciousness, looks at evolution in a radically new way, which is the essence of the scientific revolution taking place today.

We can see from these definitions of *ontogeny* and *phylogeny* that there is an overlap between them, which is not always made clear. First, ontogeny and phylogeny are concerned with the development of a particular individual or species, respectively. In the case of ontogeny, this is described in the individual's biography from conception and birth to death. Similarly, phylogeny can be seen as the biography of a species from birth to death, describing the succession of individuals' lives as they themselves pass from birth to death. In human terms, such studies are the subject of family history, as individuals seek information on their parents, grandparents, great grandparents, and so on.

So the phylogeny of a species is actually a succession of ontogenies. Similarly, the phylogeny of a genus can be seen as the succession of specific phylogenies. But *phylogeny* applies to any level of taxa. So the phylogeny of a family, in taxonomic terms, can be seen as the succession of generic phylogenies and so on. In general, the phylogeny of all forms of life is the succession of the phylogenies of all taxonomic ranks. So what patterns can we see at all these different levels of development?

Well, if we begin with the evolution of the human race, each of us has two parents and each of them had two parents, and so on and so forth. If we go back 30 generations, about 900 years, it would appear that we would have had 1,073,741,824 (2^{30}) ancestors around 1100. But in year 1000, there were just 300 million people on Earth,[26] which we need to compare with 8 billion, the number of ancestors that we supposedly had at that time. The difference, of course, is that cousins, fifth cousins, seventeenth cousins three times removed, and so on, marry and/or copulate and have children. So while it would appear that family-tree structures are hierarchical, both backwards and forwards in time, as *tree* indicates, mathematically they are actually directed acyclical graphs (DAG), like Figure 6.3.[27] In other words, there is a flow between the nodes in one direction, which does not flow back on itself to form cycles. Such DAGs are useful in other fields, such as dataflow programming languages used in investment banking.[28] DAGs are thus special cases of the underlying structure of the Universe, which is cyclical and not directed.

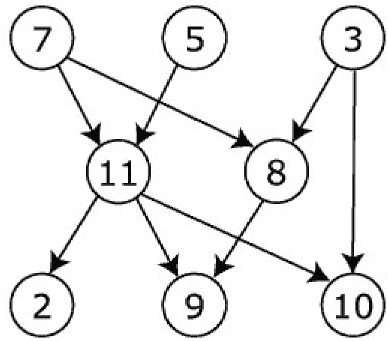


Figure 6.3: *A directed acyclical graph*

Because we are all cousins of each other in some way, the question then arises do we have a single ancestor in common? In evolution theory, such an ancestor is called a last common ancestor (LCA) or most recent common ancestor (MRCA). Both these terms can be used in both ontogeny and phylogeny, as well as in other fields, such as linguistics. It helps to differentiate them by using MRCA in ontogeny and LCA in phylogeny, the latter also being called concestor by Richard Dawkins at the suggestion of Nicky Warren.[29]

So do we human beings have an MRCA? Well, let us look at a simple example, the seven reigning monarchs in Western Europe: Harald, King of Norway; Carl XVI Gustav, King of Sweden; Mergrethe II, Queen of Denmark; Elizabeth II, Queen of England (and other countries); Beatrix, Queen of Netherlands; Baudouin I, King of the Belgians; and Juan Carlos, King of Spain. Harald, Carl Gustav, Mergrethe, Elizabeth, and Juan Carlos are all descendents of Queen Victoria of England (1891-1901) and Albert (1819-1861), while Harold, Mergrethe, Elizabeth, and Baudouin are all descendents of King Christian IX of Denmark (1818-1906) and Louise (1817-1898). But we need to go back to George II of England (1683-1760) and Caroline (1683-1737) to find the MRCA for all these monarchs.

A similar situation probably applies to *Homo sapiens* as a whole. While it might be possible for an MRCA to exist for a finite section of the population, it is most probable that we are collectively descendents of a group of a few pioneering individuals as *Homo sapiens* emerged as a viable species. This is rather like the way that these seven reigning monarchs were descended from Victoria and Christian, who lived almost identical timespans. Furthermore, these pioneering ancestors of *Homo sapiens* were probably not the total population. It is quite possible that some of them did not have a line of descendents to the present day, for lines die out.

To complete this section on taxonomic considerations, we must now turn our attention to phylogeny. When Linnaeus began his mammoth project to classify all forms of life, he did so using morphological characteristics at the macro level as defining attributes in IRL. Morphology is primarily concerned with anatomical features that are visible to the naked eye or with a conventional light microscope, with the way an organism develops, and with it's behaviour. The assumption is that the larger the number of shared structures, the more closely related are the organisms.[30] Morphology gives rise to phenotypes, from the Greek *pheno* 'shining', from *phenein* 'to show, bring to light, appear'. A phenotype is "A type of organism distinguishable from others by observable features."[31]

Examples of phenotypes are animals that have a backbone, have four limbs, have embryos that are protected by membranes, suckle their young, are warm-blooded, and have wings. The first two characteristics divide the phylum Chordata into the subphylum Vertebrata and other subphyla, and divide the subphylum Vertebrata into the superclass Tetrapoda and other superclasses, which include fish. The third characteristic is classified as Amniota, but which is unranked in taxonomy. If it were, it would be between superclass and class. The fourth characteristic leads to class Mammalia, animals "characterized by the presence of sweat glands, including sweat glands modified for milk production, hair, three middle ear bones used in hearing, and a neocortex region in the brain".[32]

All these characteristics can be organized into hierarchical structures that lead to an LCA. But things get more complicated with the last two examples. The warm-blooded animals (endotherms) are mammals and birds, which have Amniota as a common ancestor, but which was cold-blooded (an ectotherm), as are the reptiles. So endothermic characteristics evolved independently in mammals and birds. Similarly, insects, birds, pterosaurs, and bats all have or had wings, and so could fly although they evolved in quite different ways.[33]

As always, the Principle of Unity, the fundamental design principle of the Universe, helps us to understand what is going on here. Those phenotypes with a clearly defined LCA or concestor are called homologous, while characteristics that evolved independently are analogous or homoplastic. This situation leads us to the opposite of the phenotype, which is concerned with the macro characteristics of organisms, to the genotype, focused on micro characteristics.

We now come to genetics, the scientific study of heredity. Gregor Mendel, an Austrian Augustinian monk in what is now Brno in the Czech Republic, is today credited as the founder of genetics. In 1856, three years before the publication of Darwin's *On the Origin of Species*, Mendel began an extensive study of the peas in the garden of his monastery. He began his studies by wondering why peas were coloured either yellow or green with nothing in between. How were these traits inherited from their parents?

After several years of painstaking experimentation, Mendel realized that there is a gene for pea colour that has two alleles, from Greek *allel* 'one another', one each for yellow and green peas, using modern terminology. An offspring inherits one allele in the gamete of each parent. In the case of pea colour, Mendel also discovered that the yellow allele is dominant, green being recessive; a pea will only inherit a green colour if both alleles are green. So if both parents have both a yellow and green allele, there is a 75% chance that their offspring will be yellow. This result is also dependent on another result that Mendel discovered: which allele is inherited from each parent is completely random; there is no preference in the selection process.

These experiments gave rise to two fundamental principles or laws: (1) Law of Segregation, "Each parent has a pair of genes (alleles) for traits such as pea colour and flower colour, but each gamete (egg or sperm) has only one of two versions" and (2) Law of Independent Assortment, "During the formation of gametes, chromosomes and the genes they carry are distributed randomly."[34] The major consequences of this second law is that when all genes on all chromosomes are taken into consideration, the chances that two offspring will have the same set of genes is highly improbable. Whatever characteristics we might share with each other, we are all unique beings.

Mendel published his two genetic laws and the results of the experiments on which these laws were based in 1866. But his ideas were almost completely ignored during his lifetime, perhaps because he was made abbot of his monastery two years later more focused on his religious duties than his scientific interests. It was not until 1900 that three other European botanists, Carl Erich Correns, Erich Tschermak von Seysenegg, and Hugo de Vries, independently obtained results similar to Mendel's and in searching the literature found that both the experimental data and the general theory had been published thirty-four years previously.[35]

The discovery of the basic structure of the DNA molecule in 1953 by Crick and Watson led to a detailed explanation of how genetic information is passed from one generation to another. This has led to the widespread belief that the genotype influences the phenotype,[36] which naturally affects the way that the species are classified. The focus of attention today is more on the similarities and differences in the genes of the various species than on their morphology and behaviour.

This has given rise to the notion that each level in the taxonomy of the species has a temporal aspect, representing the time when the evolution of the species split into different lines, each with a common ancestor. Taxonomy has thus become the science of cladistics, from the Greek *klados* 'branch'. A clade is then "a taxonomic group comprising a single common ancestor and all the descendants of that ancestor".[37] Not all dictionaries agree on the second defining attribute for a clade. For instance, the OED defines *clade* in this simple way: "A group of organisms that have evolved from a common ancestor."[38]

The introduction of clades has rather complicated the taxonomy of the species, not the least because the assumptions that underlie cladistics can affect the way that biologists and anthropologists interpret the evidence that is rapidly increasing as new discoveries are made. Most importantly, cladistics, based solely on phylogenetic considerations, leads to a divergent view of evolution, ignoring its convergent tendencies. This is symptomatic of postmodernism, which denies the possibility of a grand narrative that heals the fragmented, split mind in Wholeness, or the existence of the Absolute, which underlies and encompasses everything there is.

In many cases clades, based on genotypical considerations, correspond to taxa or grades, based on phenotypes, but not in all. A major casualty is the class Pisces, for all fish species do not fit neatly into a clade that includes them all and excludes all species that are not fish.[39] Class Reptilia is not a clade because it does not include class Aves, the birds, which have a common ancestor with lizards and crocodiles. One way round this problem is to use the term *Sauropsida* as the clade that includes both the reptiles and birds. Sauropsida was the second of the three primary groups of Vertebrata in T. H. Huxley's *Classification of the Animals* published in 1870, the other categories being Ichthyopsida, fishes and amphibians, and Mammalia.[40]

In summary, when the taxonomy of both phenotypes and genotypes match, the clade is called monophyletic, such as classes Mammalia and Aves. If a clade includes some, but not all its descendents, like class Reptilia, it is paraphyletic. Reptilia are the clade Sauropsida *minus* the clade Aves. A defining attribute, such as warm-blooded, can lead to a polyphyletic group, having evolved independently of genetic considerations. Endotherms thus consist of class Mammalia *plus* class Aves.[41] It seems that taxonomists today favour monophyletic structures, disparaging paraphyletic and polyphyletic ones, for these do not fit in well with their one-sided view of evolutionary processes.

What this suggests is that a molecular view of evolution cannot provide the foundation for a general theory of evolution. The DNA molecule consists of a double helix of strings of nucleic acids, purines (adenine, A, and guanines, G) and pyrimidines (cytosine, C, and thymine, T), A matching with T and G with C in the helix. These nucleotide bases are grouped in threes to form 64 (4^3) codons, which match the 20 amino acids contained in proteins (the genetic code), depicted in Table 5.1 on page 516 in Chapter 5, 'An Integral Science of Causality'.

Actually, these codons are grouped together to form genes in several chromosomes in any one species. For instance, we human beings have about one billion codons in 46 chromosomes consisting of about 27,000 genes. As an example taken from the human genome project, EYCL1 is the gene (allele?) for green/blue eye colour, coded in positions 870 to 2,569 on the 19th chromosome.[42] But can the actions of 20 amino acids explain the whole of human behaviour? Of course not, any more than the particle physicists engaged in the 4.4 billion-dollar experiment at CERN, begun on 10th September 2008, can explain how the Universe originated or is designed.

As an example, when two gametes, each with a single haploid, one of a pair of a set of chromosomes, unite in fertilization, the result is a single-cell zygote containing genetic information from both parents. The zygote then begins to split into two, four, and eight similar cells to form a morula, from the Latin *morum* 'mulberry' rather like a blackberry. Then something magical happens in the human embryo around five days after conception. Although every cell contains the same genetic information, some cells form different characteristics from others to form a blastocyst, as Figure 6.4 illustrates.

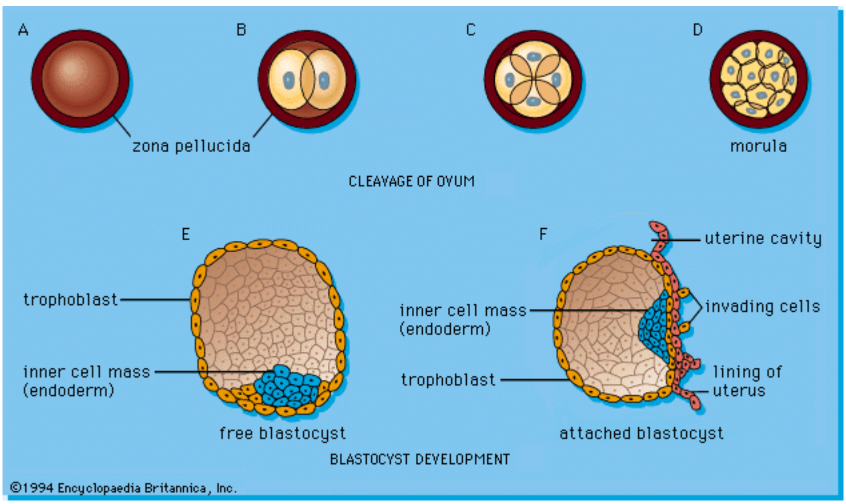


Figure 6.4: *Blastocyst development*

How is this possible? In general, all cells, whether they be bone cells, brain cells, heart cells, skin cells, or whatever, contain the same genetic information. As Richard Dawkins says, "Skin cells have the same genes as bone cells, but different genes are switched on in the two tissues.

… Genes … behave as if they 'know' where they are'. … There are formidable difficulties in working out how they 'know'."[43]

We can begin to resolve these difficulties by noting that human learning is evolutionary. So if we are to develop a comprehensive theory of evolution that embraces all developmental processes, the fundamental principles that apply in the noosphere must also apply in the biosphere. So to understand how human beings entered Paradise thousands of years ago and how we can today return Home to Paradise, we can only do so by understanding the evolutionary processes that cause us to behave as we do through self-inquiry. Any theory developed by scientists who do not fully know themselves must be open to doubt, for the mystics are the true scientists.

In studying where we human beings have come from, we should not therefore forget that Consciousness is all there is and that everything in the relativistic world of form is simply an appearance in or abstraction from Consciousness. By the Principle of Unity, as well as mechanistic processes in the horizontal dimension of time, studied by the atheistic scientists, we need to include the creative power of Life, acting in the vertical dimension of time in the Eternal Now, in our evolutionary theories. For as John said in the opening words of his gospel, "In the beginning was the Logos [as the organizing principle of Life], and the Logos was with God, and the Logos was God."

Exponential growth

But what does it mean to reach the Omega point of evolution? Well, perhaps a little mathematics could shed some light on this visionary experience. The mathematical function that describes accumulative processes, such as evolution, is the exponential one, expressed as e^x, where e is the exponential constant, 2.71828. Now this function has some interesting properties. The rate at which it changes accelerates exponentially and the rate at which acceleration accelerates also accelerates exponentially, and so on. The exponential function thus describes the amazing rate at which evolutionary change can occur through the power of synergy, when new relationships are created out of 'nothing'.

Now, because the accumulative processes of evolution accelerate exponentially, the time periods between successive significant turning points diminish exponentially; greater and greater changes happen in less and less time, as we have been witnessing in the hyperexponential expansion of the Internet during the past couple of decades. This phenomenon is most simply depicted in a geometric series of distinct terms, diminishing from a by a constant factor, let us say r, where $r>1$. Now, an infinite series of such terms does not diverge to infinity—

as would be the case if r is equal to or less than one—but converges to a finite limit, which we can call a mathematical singularity, expressible in this formula:

$$\sum_{k=0}^{\infty} \frac{a}{r^k} = \frac{ar}{r-1}$$

For instance, when $a = 1$ and $r = 2$, we have:

$$1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \ldots = 2$$

It was David Attenborough's enthralling television series *Life on Earth*, broadcast in 1979, which graphically brought the exponential rate of evolutionary change to my attention. It is now some 3.6 billion years since the first self-reproducing forms of life appeared on this planet. So if we consider 10 million years to be a day, we can map the whole of evolution on this planet to the days of the year.[58] Table 6.2 illustrates what this means for various periods of time.

	Day	Hour	Second	10th second	100th second
Years	416,667	6,944	116	12	1

Table 6.2: *Mapping evolutionary years on Earth to one calendar year*

This model was made very real to me when I took my children to the Natural History Museum in London in the early 1980s, when they were about eleven and eight years of age. The first two exhibits we saw there were a fossilized tree trunk, some 300 million years old, in the grounds, and a dinosaur skeleton, in the entrance hall.

Using Attenborough's model, if we are now at midnight on 31st December, these two exhibits were alive at the beginning of December and during the week before Christmas. Table 6.3 shows a number of other significant evolutionary events, indicating how rapidly evolution is now speeding up.

Date and time	Event
1 January	First single-cell organisms
Middle August	First multicellular organisms
End September	Sexual reproduction
End November	Fish, land plants, and reptiles emerged
10 December	Dinosaurs and mammals appeared
25 December	Dinosaurs disappeared in a cataclysmic catastrophe
26 December	First primates
30 December, 12:00	Great apes appeared
31 December, 09:00	First hominids
31 December, 19:00	First humans appeared
31 December, 23:30	*Homo sapiens*
31 December, 23:56	Great Mother Goddess epoch began
31 December, 23:59:15	Birth of history and the Fall

Table 6.3: *The accelerating pace of evolution*

The industrial revolution began two seconds before midnight, the computer was invented half a second ago, and the World Wide Web was set up just eighteen hundredths of a second before the start of the New Year, changing all our lives in what Marshall McLuhan (1911–1980) presciently called the 'Global Village' in the early 1960s.

Peter Russell provides a similar metaphor in *The White Hole in Time*[59] and its sequel *Waking up in Time*. He uses the 108 floors of the 400-metre-high former World Trade Center in New York as a measuring stick for evolution since the formation of the Earth some 4.6 billion years ago.[60]

Using this metaphor, the first living cells appeared on the twenty-fifth floor, "photosynthesis evolved around the fiftieth floor, and bacteria that breathed oxygen came another ten floors later—more than halfway up."[61] Dinosaurs reached floors 104 to 107 and mammals arrived on the top floor. And the time since the first scientific revolution is less than the thickness of the layer of paint on the ceiling of the top floor. In *The Awakening Earth*[62] and its sequel *The Global Brain Awakens*, Peter extends his view of evolution still further back.[63] To get a complete picture, we need to look at evolution as starting from the most recent big bang, some fourteen billion years ago.

To understand this rapidly changing situation, we need to see evolution as an accumulative process of divergence and convergence that proceeds in an accelerating, exponential fashion by synergistically creating wholes that are greater than the sum of the preceding wholes through the new relationships that are formed, apparently out of nothing. And the mathematical structure that most simply illustrates accumulative processes is the exponential series.

The way that compound interest accumulates is the most familiar example of an exponential series. If we invest $100 dollars at 5% or 10% interest, after one year it becomes $105 or $110, after 10 years we have $163 or $259, and after 100 years, the $100 has accumulated to $13,150 or $1,378,061! These are examples of a divergent series; the numbers get bigger and bigger by a factor of 1.05 or 1.1, in these cases.

This rapid rate of exponential growth leads to a major difficulty that we have in understanding the root causes of our rapidly changing world. As the physicist Albert A. Bartlett has said, "The greatest shortcoming of the human race is our inability to understand the exponential function."[64] We have some sense of what 100 years is like or even 1000, measured from our own life-span of three-score years and ten, as the Psalmist put it.[65] But what is a billion years in our experience or a quintillion years? Our lack of understanding of large numbers is well illustrated by a story that is said to have originated from the invention of chess.

> According to an old tale, the Grand Vizier Sissa Ben Dahir was granted a boon for having invented chess for the Indian King, Shirham. Since this game is played on a board with 64 squares, Sissa addressed the king: 'Majesty, give me a grain of wheat to place on the first square, and two grains of wheat to place on the second square, and four grains of wheat to place on the third square, and eight grains of wheat to place on the fourth square, and so, Oh King, let me cover each of the 64 squares on the board.' 'And is that all you wish, Sissa, you fool?' exclaimed the astonished King. 'Oh, Sire,' Sissa replied, 'I have asked for more wheat than you have in your entire kingdom, nay, for more wheat than there is in the whole world, verily, for enough to cover the whole surface of the earth to a depth of the twentieth part of a cubit.'[66]

The reason for this is that the number of grains of wheat on the *n*th square is 2^{n-1}. And $1 + 2 + 4 + ... + 2^{63}$ is $2^{64} - 1$, equal to 18,446,744,073,709,551,615, about 18 quintillion. This is one less than the theoretical storage capacity of a 64-bit processor, such as the Intel Core i3 processor, used in Apple's iMac, and the x86-64 processors introduced by Intel and AMD in 2003. These theoretically support 16 exabytes, or 4 billion gigabytes, of main memory, far, far greater than can be physically implemented today. (The Intel iMac I am using to write this book has just 16 gigabytes, and the maximum that Apple currently offers on its Mac Pro, used mainly by graphics artists, is 64 gigabytes, 2^{36}, only sixteen times more than the maximum of a 32-bit processor.) The number 2^{64} also appears in another story from antiquity:

> In the great temple at Benares, beneath the dome which marks the centre of the world, rests a brass plate in which are fixed three diamond needles, each a cubit high and as thick as the body of a bee. On one of these needles, at the creation, God placed sixty-four discs of pure gold, the largest disc resting on the brass plate and the others getting smaller and smaller up to the top one. This is the tower of Brahma. Day and night unceasingly, the priests transfer the discs from one diamond needle to another, according to fixed and immutable laws of Brahma, which require that the priest on duty must not move more than one disc at a time and that he must place this disc on a needle so that there is no smaller disc below it. When the sixty-four discs shall have been thus transferred from the needle on which, at the creation, God placed them, to one of the other needles, tower, temple, and Brahmans alike will

crumble into dust, and with a thunderclap, the world will vanish.[67]

Now it turns out that the number of transfers that the priests would need to make is again $2^{64} - 1$. If the priests were to make one transfer every second, and work 24 hours a day for every day of the year, it would take them 584,542,046,091 years to perform this feat, 11 orders of magnitude or about 40 times longer than the time since the most recent big bang. And if we measure time in yoctoseconds or septillionths of a second, (10^{-24}), the shortest unit of temporal measure that I am aware of, the most recent big bang happened about $4*10^{41}$ yoctoseconds ago, just yesterday in the cosmic scale of things.

Yet 41 orders of magnitude are really quite minuscule. As far as I am aware, the largest number that has been given a name is the googolplex, which is 10^{googol}. A googol, in turn, is 10^{100}. Edward Kasner tells us in *Mathematics and the Imagination* that these names were created by his nine-year-old nephew, who was asked to think up a name for a very big number.[68] As some know, Google, the popular Web search engine, is named after this latter number, and its headquarters is called, naturally enough, Googolplex.

But we can create some even bigger finite numbers quite easily. For instance, we can raise a googolplex to the power of a googolplex three times, like this, a number that is quite beyond our imagination:

$$googolplex^{googolplex^{googolplex^{googolplex}}}$$

Yet even raising a googolplex to the power of a googolplex googolplex times is tiny compared with infinity, which has some very strange characteristics. As we saw on page 235 in Chapter 3, 'Unifying Opposites', Georg Cantor proved that there is not just one infinite cardinal, but an infinite number of them. And as we saw on page 272 in Chapter 4, 'Transcending the Categories', the notion of eternity or infinite time actually exists in the Eternal Now, in the vertical dimension of time.

Be that as it may, as for practical purposes we live in the horizontal dimension of time, we need to look at how evolution has unfolded during the past few billion years. If we look at evolutionary history, backwards in time, we can see a similar divergent series to the ones we have been looking at. The time periods between the major turning points get longer and longer as we look backwards. But if we look forwards in time, towards the present moment, the time periods between the major turning points get shorter and shorter; the exponential series becomes convergent; the numbers in the series get smaller and smaller. This is a simple example:

In this case, the numbers in the series get smaller by a factor of 0.5 or ½. Now in the case of convergent series, the total sum of the series is not infinity; it is a finite number, in this case 2. In general, the sum of a series where we divide each term by n is:

$$\frac{n}{n-1}$$

So if n is 3, the sum of the series is 1.5, if n is 11, the sum is 1.1, and if n is 1.111111 (1.1 recurring), the sum is 10. In this last case, we multiply each term by 1/1.111111, which is 0.9.

The banks use this last number to create money as debt. In the old days, governments created nearly all the money in circulation in the form of coins and paper out of nothing. The profit on this process is called seigniorage,[69] from Latin *senior*, 'older, elder'. But then the banks discovered that they could also create money out of nothing by lending money that they do not have, as we look at in Chapter 11, 'The Evolution of the Mind'. They cannot do this without limit. The amount they can lend is limited by the required reserve ratio. Let us say that this is 9:1. Then a deposit of $1,111.11 can generate a loan of $10,000. If this loan is used to buy something, a used car, let us say, then the seller of the car can then deposit this $10,000 in her bank. Of this, the bank can use $1,000 as a deposit on which it can lend a further $9,000. This process can continue indefinitely. In theory, the initial deposit of $1,111.11 can generate loans up to $100,000 based on accumulated deposits of just $11,111.11.[70] It is therefore not surprising that the whole world is in debt to the banks. Some 97% of the money in circulation is money as debt, an inherently unstable situation, as we look at in Chapter 12, 'The Crisis of the Mind'

The growth curve

To see where evolution could carry humanity in the years to come, we need to look more closely at the rate of growth of evolutionary processes. These do not progress at a steady rate, as the simple exponential function might imply. Evolution progresses in fits and starts, in a process called 'punctuated equilibria' by Niles Eldredge and Stephen Jay Gould.[45] There are long periods of virtual standstill (equilibrium), punctuated by episodes of very fast development of new forms.

However, they were not the first biologists to notice this fundamental characteristic of the growth of form. In his monumental work, *On Growth and Form*, first published in 1917 and expanded in 1948, D'Arcy Wentworth Thompson devoted the longest chapter in the book (208 pages) to the mathematical study of 'The Rate of Growth', particularly of organisms and populations, processes that can reasonably easily be quantitatively measured.[46]

The phenomenon of punctuated equilibria is not just a biological phenomenon. We can also see it in the noosphere, in the history of human learning. Nearly everything we have learned about ourselves and the world we live in has taken place during two short axial periods, between 600 and 300 BCE and from the sixteenth century to the present day,[47] which we explore in Section 'First axial period' in Chapter 11, 'The Evolution of the Mind' on page 818 and Section 'Second Axial Period' on page 883.

In mathematics, the sigmoidal (S) shape of the growth curve is called the logistic or logistics curve (from the Greek *logistikos* 'skilled in calculating'), with this formula:

$$y = \frac{a}{1 + be^{-cx}}$$

This equation, graphically illustrated in Figure 6.5, has apparently been used in population studies of humans and other animals and in economics to study the growth of product sales.[48] So this curve does not just apply to biological evolution; it is equally applicable in other fields, most particularly noological evolution, which we call human learning. However, I have not seen any examples of values for the parameters *a*, *b*, and *c* in practice.

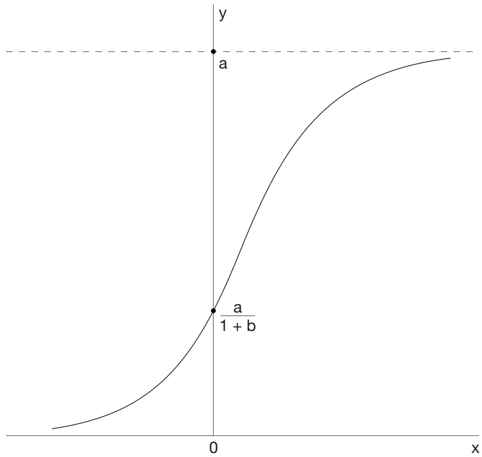


Figure 6.5: *Logistics curve*

But we do not need any mathematics to understand the key characteristics of this curve. We can regard the S-shape of the growth curve more as a 'tool of thought' than a precise mathematical tool, as the biologist, C. H. Waddington, did to some extent.[49] As we are particularly interested in where human learning is taking us all as a species, let us use this example of a growth process.

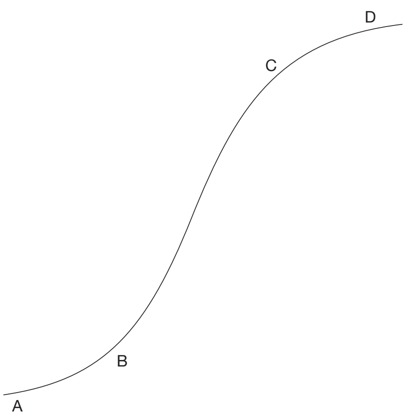


Figure 6.6: *Learning curve*

As we can see from the learning curve, illustrated in Figure 6.6, learning falls into three distinct phases. In the first phase, growth is very slow and apparently non-existent until at point B there is a sharp turn that can be most unexpected. This can be simply illustrated with a child learning to ride a bicycle. Characteristically, the child will take some time when little progress seems to be made and she could fall off the bicycle. Then eventually she will manage to coordinate the skills of balancing, steering, and pedalling, and suddenly she is away. Learning can then develop very rapidly as the child develops her skills so that she can go farther and faster. It is not long before she cries, "Look Dad, no hands!"

We can call point B the co-ordination point of the learning curve, when all the various elements of a structure have grown sufficiently to become integrated as a coherent whole. However, there is a limit to growth, either because of the technology of the cycle or because the child grows tired and learning tails off.

A similar situation exists in the world of athletics. When women were first allowed to compete in events that had previously been barred to them, their performances fell far short of the men's. But in the last couple of decades of the twentieth century, we saw the gap close considerably, even when the athletes did not take performance-enhancing drugs. Nevertheless, there is a limit to how long world records can continue to be broken. Olympic athletes are competing at the very top of the growth curve, when improvements are of the order of hundredths of a second or a centimetre or two. We cannot envisage a sprinter running the hundred metres in five seconds or a high jumper clearing four metres.

Product sales have similar growth characteristics. Once a new product catches on it becomes in fashion and more and more people go out and buy one. But this cannot go on forever. Eventually, the market becomes saturated, and product sales settle down or even fall. Another example is population growth. When a particular habitat can no longer support the growth of the population of a group of animals, the animal population reaches a maximum, which is what is happening to the human population right now, as we see in Figure 13.13 on page 1054 in Chapter 13, 'The Prospects for Humanity'.

We can call point C, when the rate of growth reaches a limit, the saturation point. We can also see the way that growth processes have a limit in the magnetic hysterisis loop, illustrated in Figure 6.7. In this example, a bar of iron, for instance, is placed in a coil of wire carrying an alternating electric current. Under the influence of the magnetic field so induced, the atomic magnets in the material first align in one direction then another. The saturation point is reached when they are all aligned in one direction; no further change is possible.

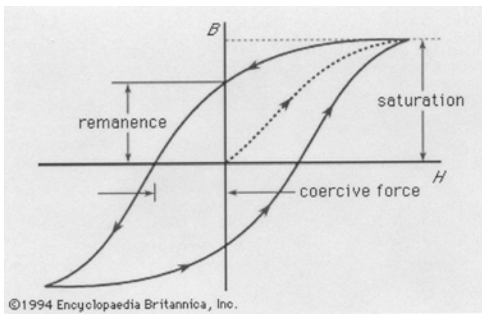


Figure 6.7: *Magnetic hysteresis loop*

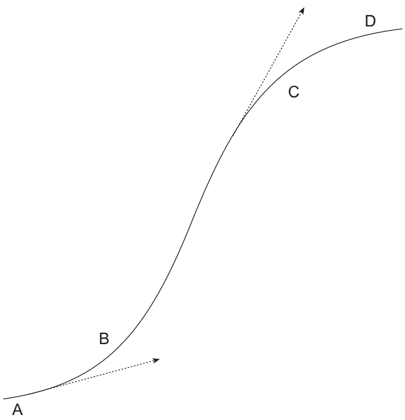


Figure 6.8: *False extrapolations of learning curve*

A major problem with the learning curve is that few recognize its vital turning points. There is a tendency to extrapolate the curve so that when on AB, the assumption is that growth will develop slowly. "I'll never manage this" is a familiar cry. And when growth is very fast, people often think that it will continue indefinitely. These fallacious extrapolations are shown in Figure 6.8.

Even when people know the delusions that can arise from a limited understanding of one particular growth curve, for a particular technology or product, for instance, there is such a belief that technological growth can drive economic growth indefinitely that people have faith that another technology will come along to replace one that is reaching its limit.

This situation has often happened in the past. For instance, our mode of transport has been getting faster and faster since the beginning of the industrial revolution, when we no longer relied on just animal power to move around the Earth, whether our own power or that of horses and other animals.

This situation is well illustrated in Figure 6.9, which shows how a growth curve can be depicted as an envelope of a set of growth curves (the Eisenbahn is a railway line in Germany as far as I have been able to ascertain).[50] However, this process does not continue indefinitely. On 24th October 2003, Concorde made its last commercial flight accompanied by eloquent outpourings from the journalists. This is a clear indication of the slowing down of technological growth.

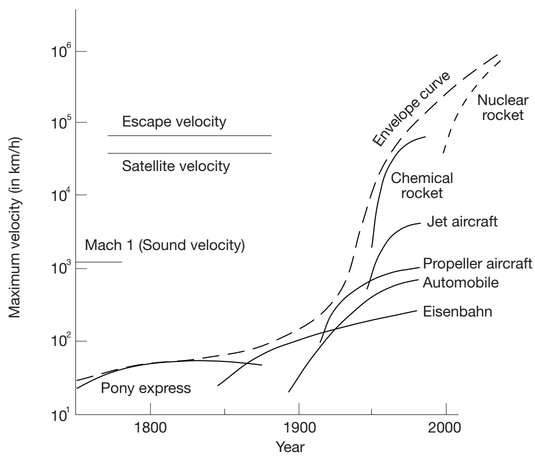


Figure 6.9: *Envelope of growth curves*

The singularity in time

However, everyone does not understand that technological development cannot drive economic growth indefinitely. In particular, some computer scientists still believe that humans are mere machines and that therefore it is inevitable that computers will develop artificial intelligence, far exceeding human intelligence.

And when this happens, we shall have a singularity in evolutionary history, a term coined by Victor Vinge in a NASA paper in 1993 called 'The Technological Singularity'. As he said in his Abstract, "Within thirty years, we will have the technological means to create superhuman intelligence [in machines]. Shortly after, the human era will be ended." Continuing, Vinge said,

> From the human point of view this change will be a throwing away of all the previous rules, perhaps in the blink of an eye, an exponential runaway beyond any hope of control. Developments that before were thought might only happen in 'a million years' (if ever) will likely happen in the next century. … I think it's fair to call this event a singularity ('the Singularity' for the purposes of this paper). It is a point where our old models must be discarded and a new reality rules. As we move closer to this point, it will loom vaster and vaster over human affairs till the notion becomes a commonplace. Yet when it finally happens it may still be a great surprise and a greater unknown.[51]

Ray Kurzweil, author of *The Singularity is Near*, is another who believes in this technological singularity in time, saying, "By 2019, a $1,000 computer will match the processing power of the human brain."[52] He seems to believe that artificial intelligence is a function of the calculating capacity of computers—an inevitable consequence of the exponential nature of growth processes. In terms of computer hardware, this is known as 'Moore's Law' after Gordon E. Moore, the co-founder of Intel, the chip manufacturer, published a paper in 1965 indicating that computers would double in power every two years.[53] However, Moore is well aware of the limits of evolutionary growth. As he told a meeting of the world's top chip designers and engineers on 10th February 2003, "No exponential is forever." Irrationally, he then went on to say, "Your job is to delay forever."[54]

Another who sees computers taking over world is Hans Moravec, who foresees an Age of Robots, which he calls our 'mind children'. For instance, in *Mind Children*, Moravec thinks that computers are the members of a new species, described by such words as *posthuman*, *postbiological*, or even *supernatural.* As he says, "It is a world in which the human race has been swept away by the tide of cultural change, usurped by its own artificial progeny."[55] And in *Robot* he says, "The fourth robot generation, and its successors, will have human perceptual and motor abilities and superior reasoning powers. They could replace us in every essential task and, in principle, operate our society increasingly well without us. … Intelligent machines, which will grow from us, learn our skills, and initially share our goals and values, will be the children of our minds."[56]

Yes, a new species is emerging today, but it will be a mystical one, not a technological one, free of our mechanistic conditioning,

One possible danger that Rees foresees is not going to happen. He says, "A superintelligent machine could be the last invention that humans need ever make."[57]

Calendars of the world

We need to look at how we have developed a sense of time over the years. As mystics, we know that time is an illusion, that only the Eternal Now is real. But as human beings, living our daily lives, time feels very real to us. Our prehistoric ancestors began to form a sense of time from three cyclic phenomena in their experience: the daily cycle of night and day, the phases of the moon, and annual cycle of the four seasons, in temperate zones of the Earth, at least. These experiences have given us our basic units of time measurement: day, month, and year, which all have Proto-Indo-European (PIE) etymological origins.

Day, with its Germanic relatives, comes from a prehistoric Germanic **dagaz*, which probably comes from the PIE base **dhegh-*, meaning 'time when the sun is hot'. *Dawn* is also derived from *day*. *Month* has evolved from the PIE base **menes-*, which meant both 'moon' and 'month'. It seems that in some cultures women's menstrual (from the same root) periods were synchronized with the cycles of the moon, a phenomenon that continues to this day, as a search of the Internet reveals.[71] Going deeper into the archæology of language, these words probably derive from the PIE base **me-*, which is the source of English *measure* and *metre*. *Year* similarly has a PIE base: **jer-*, with the sense of 'go', giving the sense of time proceeding.

With the dawn of history, the various cultures created calendars of years, months, and days of the week, this last time measure recognizing that human beings cannot work continuously; we need to take a break from our labours on a regular basis. These are rather complicated measurement systems, which do not fit neatly into a metric system or any other regular pattern, like miles, furlongs, chains, yards, feet, and inches.

Today, the most widely used calendar in the world is the Gregorian calendar, which arose from a decree by Pope Gregory XIII on 24th February 1582.[72] The Gregorian calendar was introduced to resolve an anomaly of the Julian calendar, on which it was based. The Julian calendar, introduced by Julius Caesar in 46 BCE, has a year of 365.25 days slightly longer than the actual length of the year.[73] In turn, the Julian calendar was based on an ancient Roman calendar, which may have been based on one of the Greek lunar calendars.[74]

Years in the Gregorian calendar are numbered from the traditional birth year of Jesus of Nazareth, called *Anno Domini* (AD), 'in the year of our Lord'. Years before year 1 in this calendar (curiously there is no year 0), are labelled *Before Christ* (BC). In recent years, there has been a trend to free the calendar from it religious associations, calling AD and BC Common Era (CE) and Before Common Era (BCE), respectively. However, this is not without controversy because the term *common era* can be used in other cultures.[75]

The Gregorian/Christian calendar is one of a number whose origin coincides with the time of the founder of one of the great religions in the world. For instance, the origin of the Buddhist calendar is 543-545 BCE in Gregorian terms.[76] The Islamic calendar dates from 622 CE, not from Mohammad's birth in 570 CE, but from the Hijra, meaning 'withdrawal', when Mohammad and his follows emigrated from Mecca, where they were being persecuted, to Medina.[77]

The dawn of recorded history, about four or five thousand years ago, corresponds to the beginning of some calendars and marks a significant date in some others. For instance, the Chinese calendar began in 2637 BCE or 2697 BCE, marking the time of Huang Di or Yellow Emperor, the legendary father of the Chinese people.[78] The start of the Jewish calendar is 3761 BCE,[79] which corresponds to the supposed creation of the universe, as described in the book of Genesis.

In the seventeenth century, James Ussher, Anglican Archbishop of Armagh in Ireland, and John Lightfoot, vice-chancellor of the University of Cambridge, made independent calculations of the date of the Creation based on a study of the Old Testament. There is some confusion about the course of events because Andrew Dickson White misquoted John Lightfoot in his 700-page treatise *History of the Warfare of Science with Theology in Christendom*, published in 1896. White wrote:

> The general conclusion arrived at by an overwhelming majority of the most competent students of the biblical accounts was that the date of the creation was, in round numbers, four thousand years before our era; and in the seventeenth century, in his great work, Dr. John Lightfoot, Vice-Chancellor of the University of Cambridge, and one of the most eminent Hebrew scholars of his time, declared, as the result of his most profound and exhaustive study of the Scriptures, that "heaven and earth, centre and circumference, were created all together, in the same instant, and clouds full of water," and that "this work took place and man was created by the Trinity on October 23, 4004 B.C., at nine o'clock in the clock in the morning."[80]

Actually, Lightfoot did not mention a date in the work that White is quoting; he added this himself. According to Wikipedia, it was Ussher who about 1650 "deduced that the first day of Creation began at nightfall preceding Sunday October 23, 4004 BC in the proleptic Julian calendar, near the autumnal equinox". Between 1642 and 1644, "Lightfoot similarly deduced that Creation began at nightfall near the autumnal equinox, but in the year 3929 BC." And nine o'clock in the morning refers to the creation of man, not the Earth, which, for Lightfoot was nightfall.[81]

The Hindu calendar

In a similar fashion, the Hindu calendar has a significant date around the dawn of history. The Kali-Yuga, the period that we are in now, which is 432,000 years long, began in 3102 BCE.[82] However, this is just a short period of time in the calendar as a whole. The *Mahabharata*, one of the two major epics of ancient India, which includes the *Bhagavad Gita*, describes a far more expansive view of time than the limited view that scholars in the West had in the middle of the scientific revolution of the sixteenth and seventeenth centuries.

The periods in the ancient Hindu calendar represent the cyclic changes that society as a whole goes through over time, within the time-cycle of the creation and destruction of the Universe, denoted by the life span of Brahma, the god of creation. The basic unit of these cycles is the *mahayuga*, consisting of four *yugas* of diminishing time periods, measured in divine years, each of which is 360 human years, although some writers refer to the four cycles collectively as a yuga.[83] Table 6.4 shows these time periods, which diminish in arithmetic progression.

Name	Characteristic	Years	Divine years
Krita- or Satya-Yuga	Golden age	1,728,000	4,800
Treta-Yuga	Sacrifices begin	1,296,000	3,600
Dvarpara-Yuga	Spiritual decline	864,000	2,400
Kali-Yuga	War, fear, and despair	432,000	1,200
Mahayuga		**4,320,000**	**12,000**

Table 6.4: *The four Mahayuga Yugas*

Shambhala's *Encyclopedia of Eastern Philosophy and Religion* gives this description of these yugas:

> Krita is the ideal or golden age, in which neither hate nor envy, care, nor fear exist. There is only *one* God, *one* Veda, *one* law, and *one* ritual. The castes have varying tasks, and each fulfills its duty selflessly. The performance of sacrifices begins in the Treta-Yuga, when righteousness declines by one quarter. The sacrifices necessitate rites and ceremonies. The actions of human beings are marked by intentionality; people expect rewards in exchange for their rituals and offerings, and the sense of duty declines. In the Dvarpara-Yuga, righteousness is reduced by half. There are now four Vedas, which are studied by only the few. Ritual is predominant; only few abide by the truth. Desire and diseases surface, and injustice grows. In the Kali-Yuga, righteousness has declined to one quarter of its original substance. Spiritual efforts slacken off, knowledge is forgotten, evil dominates. Disease, fatigue, anger, hunger, fear, and despair gain ground; humanity has no goal.

When the degeneracy of a Kali-Yuga comes to an end, a new mahayuga begins with a golden age. In all, there are a thousand mahayugas in the day of the life of Brahma, where day is not 'twenty-four' hours, but is daylight, in contrast to night. So a day and a night in the life of Brahma is 8,640,000,000 years, about twice the age of the Earth and half the time since the last big bang, much shorter than it would take the monks in the temple at Benares to move the 64 discs in the tower of Brahma from one needle to another, moving them one second at a time.

The cycle of 1000 yugas or mahayugas is called a *kalpa*, a Sanskrit word meaning 'world cycle' or 'world age', lasting 4,320,000,000 years. In Buddhism, *kalpa* is a "term for an endlessly long period of time, which is the basis of Buddhist time reckoning. The length of a *kalpa* is illustrated by the following simile: suppose every hundred years a piece of silk is rubbed once on a solid rock one cubic mile in size; when the rock is worn away by this, one *kalpa* will still not have passed away."[84]

In the Hindu attempts to capture the vastness of time before the discoveries of modern mathematics, Brahma is deemed to live 100 Brahma-years, to denote the creation and death of the universe, each Brahma-year consisting of 360 Brahma-days and nights or 720 *kalpas*. So in the Hindu calendar, the life and death cycle of the Universe is 311 trillion years, or 14 orders of magnitude, still quote small.

It is important not to take the Hindu (and Buddhist) sense of time too literally. Nevertheless, it does show that even about 2,600 to 2,800 years ago, when the *Mahabharata* was reputedly written,[85] its writers had a sense that human society was degenerating, as the egoic mind began to take people further and further away from the Divine. Furthermore, these sages seemed to have had a far clearer vision of the vastness of time than their Western counterparts. It is only in the last century that we in the West have begun to develop a similar sense of time as the result of much scientific research.

But Hindu cosmology goes even further. It consists of a world-view of time and the timeless that is very similar to the Unified Relationships Theory, as this passage from the *Bhagavad Gita* tells us:

> Those that know the cosmic laws know that the Day of Brahma ends after a thousand yugas and the Night of Brahma ends after a thousand yugas. When the day of Brahma dawns, forms are brought forth from the Unmanifest; when the night of Brahma comes, these forms merge into the formless again. This multitude of beings is created and destroyed again and again in the succeeding days of Brahma. But beyond this formless state there is another unmanifested reality, which is eternal and is not destroyed when the cosmos is destroyed. Those who realize life's supreme goal know that I am unmanifested and unchanging. Having come home to me, they never return to separate existence.[86]

The Mayan calendar

One other calendar that has both cyclic features and a vast view of time is the Mayan calendar. However, it differs from all calendars that I am aware of in that its key feature is exponential, enabling us to use the calendar to map major turning points in evolutionary history. We can then move from there into systems theory, providing an exponential timeline for the whole of evolution, as we view it here from Earth.

Actually, there were three Mayan calendars: the Long Count (the cosmic calendar), the Tzolkin (the sacred calendar), and the Haab (the civil calendar).[87] It is the first of these that is most useful in our evolutionary studies. The reason why this calendar is so useful is that it is vigesimal; it is based on 20, in contrast to our decimal counting system, based on 10, and the binary system in computers. Interestingly, the Mayans created a number of time periods that increased going backwards in time by a factor of 20, with one exception. A uinal (also spelled vinal and winal) is 20 kins or days and a tun is 18 uinals or 360 kins. This one exception to the vigesimal system is probably because the tun then becomes quite close to the length of a solar year. A katun is 20 tuns, 19.7 years because a tun is slightly shorter than a year. Table 6.5, taken from Carl Johan Calleman's *The Theory of Everything*, shows the names that the Mayans gave to ever-increasing periods of time.[88]

Period	Factor	Units	Years	Cycles
uinal	20	kins		
tun	18	uinals		13
katun	20	tuns	20	256
baktun	**20**	**katans**	**394**	**5,125**
piktun	20	baktuns	7,885	102,507
kalabtun	20	piktuns	157,704	2,050,146
kinchiltun	20	kalabtuns	3,154,071	41,002,929
alautun	20	kinchiltuns	63,081,429	820,058,580
hablatun	20	alautuns	1,261,628,585	16,401,171,606

Table 6.5: *Cycles in Mayan calendar*

However, they did not measure time in exactly these units. They saw each period of time repeating itself in thirteen cycles, perhaps because there were thirteen gods in the Mayan pantheon. The last column in Table 6.5 shows the number of years since the beginning of each major cycle. The thirteen baktun cycles of 5,125 years, shown in bold, is called the Great Cycle, or Long Count, which we shall come back to in a moment.

But first we need to be aware that the cycle of thirteen hablatuns, the longest cycle that they gave a name to, is not the Mayans' view of the time since Creation. A stele, shown in the diagram on the previous page, has been found in Coba in Northern Yucatan Peninsula that places the creation date at $13*20^{21}$ tuns ago, 14 orders of magnitude greater than the length of the hablatun series of cycles.[89]

This is 27,262,976,000,000,000,000,000,000,000 tuns, about 27 octillion years (27 followed by 27 zeroes). This is a pretty big number, double the order of magnitude of the Hindu's view of the time since the Creation, but still tiny compared to the infinity of infinite cardinals that Georg Cantor discovered, described on page 235 in Chapter 3, 'Unifying Opposites'.

Now, as the time periods looking backwards in time get longer and longer, looking forwards, they get shorter and shorter. They form an exponential series where each term diminishes by 20. Using the formula on page 534, the limit of this series is 1.052631579:

$$1 + \frac{1}{20} + \frac{1}{400} + \frac{1}{8000} + \frac{1}{160000} + \dots$$

Let us suppose then that the 16,401,171,606 years of the hablatun cycle is the sum of this series multiplied by some factor. The first term in the series would then be 15,581,113,026, the length of the period from the beginning of the hablatun cycle to the beginning of the alautun cycle. So we can reverse Table 6.5 to show these periods decreasing in length. But as 16,401,171,606 years is actually 5,990,400,000,000 days, we can more accurately perform the calculations in days, with 5,690,880,000,000 as the starting point, as in Table 6.6:

Cycle	# in series	Days between periods	Accumulative days	Accumulative years
hablatun	1	5,690,880,000,000		
alautun	2	284,544,000,000	5,975,424,000,000	16,360,168,677
kinchiltun	3	14,227,200,000	5,989,651,200,000	16,399,121,460
kalabtun	4	711,360,000	5,990,362,560,000	16,401,069,099
piktun	5	35,568,000	5,990,398,128,000	16,401,166,481
baktun	6	1,778,400	5,990,399,906,400	16,401,171,350
katun	7	88,920	5,990,399,995,320	16,401,171,593
tun	8	4,446	5,990,399,999,766	16,401,171,605
(uinal)	9	222.3	5,990,399,999,988	16,401,171,606
(kin)	10	11.115	5,990,399,999,999	16,401,171,606
	11	0.55575	5,990,400,000,000	16,401,171,606
	12	0.0277875	5,990,400,000,000	16,401,171,606
	13	0.001389375	5,990,400,000,000	16,401,171,606

Table 6.6: *Finite limit of sum of exponential series of lengths of Mayan cycles*

Table 6.6 shows that by the 11th term, the time between periods is less than one day; in just 13 terms, the series has decreased from 5 trillion days to 2 minutes. There is no need to add any more terms, because the accumulative total in days has been reached. Furthermore, the series is not very sensitive to the starting number. It could be 10 or 20 billion years, and the series would still converge after eleven terms. Neither is the series affected by the fact that the tun in 18 uinals, not 20. These are insignificant details.

Now, the estimate of time since the physical universe was created has varied between 12 and 16 billion years during the past few decades, with 14 billion being most often quoted. This is reasonably close to the length of the cycle of thirteen hablatuns: about 16 billion years. As the beginning of the hablatun cycle roughly corresponds to the most recent big bang, can we find any other correlations between the beginning of the other cycles and significant points in evolutionary history? Well, this is exactly what Carl Johan Calleman of Dalarna University in Sweden has done. Table 6.7 is taken from his book *The Theory of Everything*, slightly modified:[90]

The central question now is when will the Mayan calendar come to an end in terms of the Gregorian calendar? Well, the difficulty of solving this correlation problem is that the high

Cycle	Formula	Years from 'today'	Initiating phenomenon	Modern dating in years
hablatun	$13 * 20^7$ *tun*	16,401,171,606	First matter, "Big Bang"	14–16 billion
alautun	$13 * 20^6$ *tun*	820,058,580	First animals	850 million
kinchiltun	$13 * 20^5$ *tun*	41,002,929	First monkeys	40 million
kalabtun	$13 * 20^4$ *tun*	2,050,146	First tool-makers (*Homo*)	2 million
piktun	$13 * 20^3$ *tun*	102,507	First object-makers (*Homo*)	100,000
baktun	$13 * 20^2$ *tun*	5,125	First construction-makers (*Homo*)	5,100
katun	$13 * 20^1$ *tun*	256	First machine-makers (*Homo*)	242
tun	$13 * 20^0$ *tun*	13	?	?
(uinal)	13 * 18 *kin*	1	?	?

Table 6.7: *Mapping of cycles in Mayan calendar to major evolutionary turning points*

point of the Mayan civilization was between 200 and 900 CE, long before the Spaniards landed in Mesoamerica. And by that time, the Long Count had ceased to be used. Nevertheless, Mayan scholars have made some reasonable estimates of the first and last days of the Long Count, denoted as 0.0.0.0.0 and 12.19.19.17.19, 12 baktuns, 19 katuns, 19 tuns, 17 uinals, and 19 kins. The day after this will not be the beginning of a fourteenth baktun cycle, as some believe, but the first day after the end of the Mayan calendar, which actually has a finite limit.

Rather than matching the Mayan calendar directly to the Gregorian calendar, Mayan scholars use Julian day numbers, which astronomers use to make predictions such as solar and lunar eclipses. Astronomers regard the zero point of their numbering system to be 12:00 UT on Monday 1st January 4713 BCE in the proleptic Julian calendar (*proleptic* means that it is applied to cases from before it was invented), or 24th November 4714 BCE in the proleptic Gregorian calendar. This is taken as the beginning of recorded history. Using this way of measuring time, Saturday, 1st January 2000 had a Julian day number of 2,451,545, which we can call the correlation coefficient when matching the Mayan calendar to the Gregorian calendar.

So which correlation coefficient marks the beginning of the Long Count of 5,125 years or 1,872,000 days? Well, after many years of considering information from varied fields such as astronomy, ethnography, archæology, and iconography, J. Eric S. Thompson found a correlation coefficient of 584,283, which is now known as the Goodman-Martinez-Thompson (GMT) correlation.[91] This gives the first and last days of the Long Count as Monday 11th August 3114 BCE and Thursday 20th December 2012, respectively. The next day, the winter solstice, is the first day after the end of the calendar, when a New Age is supposed to begin. However, Floyd Lounsbury, supported by Linda Schele, David Freidel, and a number of others, is promoting 584,285 as the correlation coefficient, giving 23rd December 2012 as the first day after the end of the calendar.[92] I don't know the reasons for this.

Carl Johan Calleman has argued for another correlation coefficient. He has several reasons, the most important is that the tzolkin cycle of 260 days in the Tzolkin calendar is not synchronized with the Long Count. As there are exactly 7,200 tzolkins in the Long Count, it should be possible to synchronize the Long Count with the Tzolkin calendar. However, the first day of the Long Count is generally regarded to be 4 Ahau, the 160th day in the Tzolkin, and the last day is 3 Cauac. Whereas, the first and last days in the Tzolkin calendar are 1 Imix and 13 Ahau.

As the Long Count cycle begins at 0 and the tzolkin at 1, we either need to go forwards 101 days or backwards 159 days, plus a multiple of 260 to synchronize the two calendars. In fact, Carl Johan has chosen to go back 419 days (159 + 260), regarding 11th August 3114 BCE as the first day of the Long Count, which is 1 Imix in the Tzolkin calendar. The last day in the Long Count is then 28th October 2011.[93] But why not choose 14th July 2012 or 31st March 2013 as the last day of the Long Count? Both these dates are closer to 20th December 2012 than Carl Johan's proposed date.[94, 95]

What this means is that in Carl Johan's model, he is using the GMT correlation coefficient of 584,283 to map the Gregorian calendar to the Tzolkin calendar still used in the highlands of Guatemala.[119] But he is effectively using a correlation coefficient of 583,864 to map the Gregorian calendar to the Long Count, which then becomes synchronized with the Tzolkin calendar. He has done this despite the fact that the Tzolkin date on the Creation stele on page 547 is given as 4 Ahau. So it seems that the Mayans themselves did not synchronize the Long Count and Tzolkin calendars. Curious.

Timewave zero

Let us now look at another way of showing how all evolutionary processes in the Universe are leading to a singularity of time, a model that I discovered in an essay that Peter Russell wrote in 2007.[96] In 1971, 24-year-old Terence McKenna and his 20-year-old brother Dennis travelled to Amazonian Columbia to study ethnobotany, the way that various plants are used by shamans to induce psychedelic transformations in consciousness, *psychedelic* deriving from Greek *psychē* 'soul, mind' and *dēlos* 'clear, visible', from PIE base **dyeu-* 'to shine', also root of *divine*, *deity*, and *jovial*.

The McKennas were drawn to the Amazon because they had read a report that said, "shamans, under the influence of potent monoamine oxidase-inhibiting, harmine- and tryptamine-containing *Banisteriopsis* infusions, are said to produce a fluorescent violet substance by means of which they accomplish their magic." Dennis, in particular, who was later to receive a doctorate in psychopharmacology, speculated that such substances could transform genetic archetypes through changes in the waveform hologrammatic configuration of ESR (electron spin resonance). Such a macro-molecule "would be a superconductive holographic information storage system, containing all genetically and experientially coded information within its waveform pattern. It would respond to thought, which would be an interference pattern set up by resonating tryptamine-RNA complexes."

To test his hypothesis, on 4th March 1971, at a tiny mission settlement at La Chorrera, Dennis and Terence embarked on an experiment, which turned out to be life-changing. They ingested some mushrooms (*Stropharia cubensis*), whose major psychoactive constituent is psilocybin, and drank a beverage of *ayahuasca*, from the leafy, woody plant *Banisteriopsis caapi* containing harmine and tryptamine.[97] The effect was mind-shattering, which you can read about in Terence's book *True Hallucinations*, from 1993, and the brothers' book *The Invisible Landscape*, first published in 1975, but republished in 1994 with more mathematical information about the singularity in time that was revealed to Terence, in particular.

In essence, it seems that Terence, who Jay Stevens describes as a 'quicksilver poet-philosopher', almost immediately opened up to the entire Cosmos, seeing time as a series of hierarchical timewaves, resonating with each other within greater and lesser timespans, somewhat like fractals, with their property of self-similarity. Within a month of this life-changing experience, as he returned to Berkeley, Terence came "to realize that the internal logic of the timewaves strongly implied a termination of normal time and an end to ordinary history".[98] In other words, he could see a rapidly approaching singularity in time, just like

But how could Terence make sense of this vision? He and Dennis had been educated in the USA, within the delusional worldview of Western civilization. However, they were also well aware of the great movement towards a fundamental paradigm shift in science, one that embraces Eastern mysticism and ancient wisdom, going far further than the scientific revolution of the sixteenth and seventeenth centuries. Following this emerging zeitgeist, Terence turned to *I Ching* '*Book of Changes*' in which to describe his vision, outlined in Subsection 'Chinese axial figures' in Chapter 11, 'The Evolution of the Mind' on page 821.

It was the sense of wholeness in the Chinese system of divination that drew Terence McKenna to *I Ching* in which to express his psychedelic vision. As he said, "The *I Ching* is a mathematical divinatory tool of great age whose probable origin is the mountainous heart of Asia—the home of classical shamanism and Taoist magic". So as "divination is the especial prerogative of the shaman, whatever the cultural context … the unconscious contents which our experiment made accessible were constellated around the *I Ching* because it is particularly concerned with the dynamic relationships and transformations that archetypes undergo."[99]

But what sequence of hexagrams should McKenna use for his fractal view of time, terminating at a singularity? As there are 64 different hexagrams, there are 64! different ways of arranging them in a sequence, which is 1.27×10^{89}:

126,886,932,185,884,164,103,433,389,335,161,480,802,865,516,174,545,192,198,801,894,375,214,704,230,400,000,000,000,000

Perhaps the most obvious way of ordering the hexagrams in this digital age is from 0 to 63 (000000 to 111111 in binary notation), 0 being yang, the unbroken line. This is the sequence that Shao Yung studied in the eleventh century, during the Sung (Song) dynasty. Shao Yung is regarded as the founder of the idealistic school,[100] focused much more on iconographic and cosmological concepts than on traditional literalistic and moralistic concepts, followed by his contemporaries,[101] depicted as a square and circle in Figure 11.12 on page 823 in Chapter 11, 'The Evolution of the Mind'. It was this sequence, laid out in an 8 x 8 table, that Leibniz studied, establishing amazing parallelisms between Eastern and Western thought.[102]

However, this arrangement overlooks the reciprocal nature of the hexagrams, which can be arranged in pairs in two ways: (1) in complementary pairs, like ䷺ and ䷶ and (2) in inverted pairs, like ䷺ and ䷻. In the first of these, all six lines change in every pair, whereas in this example of inverted pairs, only two lines change. There is thus greater variety in the second arrangement and therefore more information. However, this arrangement does not work in eight cases, when the hexagram is palindromic, the same when inverted, like ䷝, when its complement is used: ䷜. Nevertheless, there are still $2^{32} \times 32!$ possible arrangements of these inverted pairs, or 1.13×10^{45}, about one quadrillion cubed, a quattuordecillion:

1,130,138,339,199,322,632,554,990,773,529,330,319,360,000,000

So around 1000 BCE, when the *I Ching* came into wide use, the Chinese had many arrangements of the pairs to choose from. The oldest of these is known as the King Wen sequence, listed in Table 6.8, also the series of transitions that Richard Wilhelm presented in his translation of *I Ching*. But why this sequence? What is special about it? How could this particular sequence of universal categories or archetypes shed light on one's fate? Well, McKenna discovered three interesting properties:

1. There are no transitions with a value 5.
2. A transition value of 1 is only used when the alternative would violate rule 1.
3. There is a ratio of three to one in the even and odd transitions.[103]

6	2	4	4	4	3	2	4
2	4	6	2	2	4	2	2
6	3	4	3	2	2	2	3
4	2	6	2	6	3	2	3
4	4	4	2	4	6	4	3
2	4	2	3	4	3	2	3
4	4	4	1	6	2	2	3
4	3	2	1	6	3	6	3

Table 6.9: *First-order differences*

Nevertheless, McKenna discovered that these properties are very far from random. He generated 1.2 million random inverted pairs on a computer and found that only 805 had these three properties, 0.07%, or 1 in 1,769 Wen-like sequences. So he was quite content to use the King Wen sequence of transitions for his studies into novelty theory in fractal time, listed in Table 6.9 of first-order differences.[104]

McKenna also noticed that not only are there 64 hexagrams in the I Ching, there are also 384 (6 × 64) lines. Now, according to

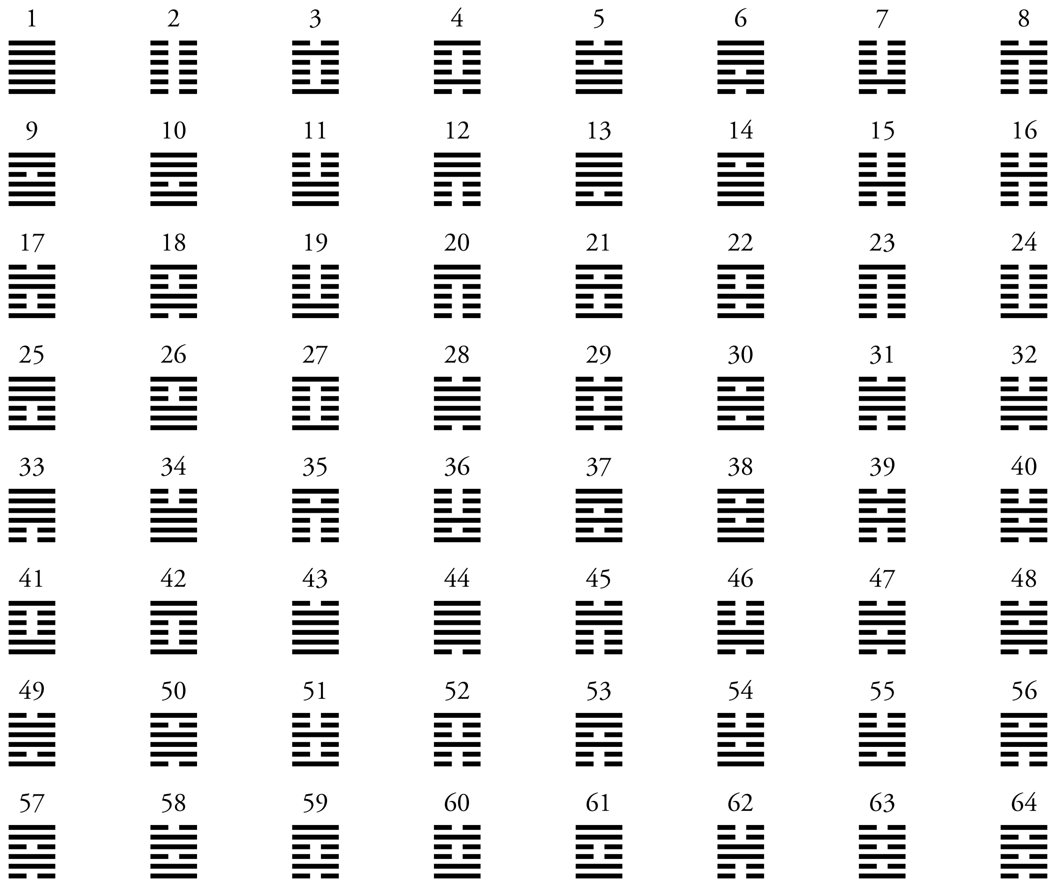
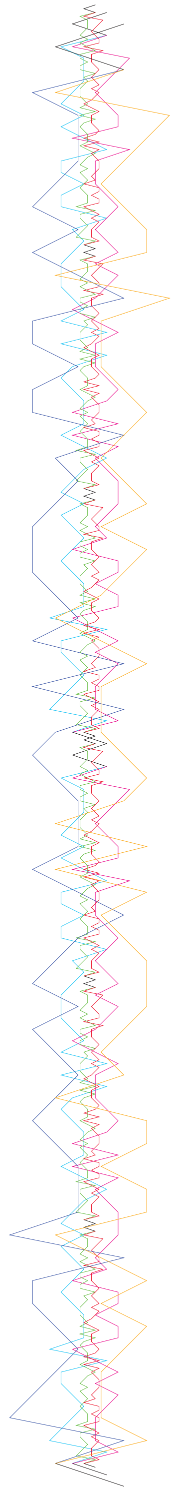


Table 6.8: *The King Wen arrangement of the sixty-four* I Ching *hexagrams*

Joseph Needham, from an examination of oracle bones dating to the thirteenth century BCE, the Chinese knew that the length of a lunation is 29.53 days, compared to 29.530588, as is known today. So the ancients knew that thirteen of these lunations are 383.89 days (13 × 29.53), a pretty accurate correspondence on which to base a calendar.[105]

Knowing the Chinese love of cycles, hierarchies, and resonances, McKenna then surmised that what can be done with the *yao* (lines) could also be done with the entire set of *yao*. So he hypothesized a set of resonances based on 384 × 64 days, 384 × 64 × 64 days, and so on. Not only this, he saw time in shorter and shorter durations as well as longer and longer ones. So using 6 days as the base, he found 26 levels and durations of temporal hierarchy of the form 6×64^k days, where *k* ranges from 7 to -18 or of the order of 1018 to 10–27 when measured in seconds. In physical temporal terms, these range from five times longer than the time since the most recent big bang to the range of Planck's constant.[106]

With these premises, McKenna now needed to express his resonating novelty theory in mathematical terms. In essence, he saw time "as the ebb and flow of two opposed qualities; novelty and habit, or density of connectedness versus disorder". So even though he believed in the absolute truth of the second law of thermodynamics, he saw that in localized areas entropy could decrease through *concrescence* 'growing together', a recent instance being the appearance of language.[107]



However, it was not until 1986 that McKenna began working with Peter Meyer to develop software that could translate the former's mathematical intuitions into C and thus define the core algorithm in Timewave theory. So, even though McKenna had other programming assistants, listed in full in Meyer's documentation, it was not until then that McKenna's rather obscure vision of resonant timewaves could be expressed in a fractal function.[108]

Nevertheless, the first step is quite simple. McKenna drew a graph of the 64 hexagrammatic transitions or first-order differences in Table 6.9, shown in-Figure 6.10 in red. He then rotated this graph 180° and cycled it by one position, so that three lines matched at the ends, shown in green. He called these three levels of closure, marked in black, the key to calculating his way of viewing a singularity in time.

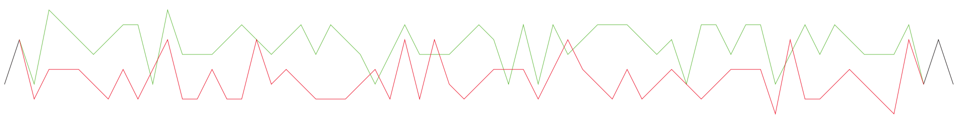


Figure 6.10: I Ching *first-order and inverted differences*

As McKenna considered that trigrams and hexagrams should be treated in exactly the same way as lines, he next expanded this pair of waves, shown on the left. He called this the 'eschaton', from Greek *eskhatos* 'last', also the root of *eschatology*. However, he defined *eschaton* as 'a universal and fractal morphogenetic field', a quantized wave-particle of time.[109] The eschaton is formed by linearly arranging six versions of the basic wave, two versions of the wave expanded three times, representing trigrams, and one version expanded six times, representing the hexagram as whole.

He next found the differences between the distances and slopes of each of the three pairs of waves, the slopes being the second order of differences between the transitions, which could be either positive or negative depending on the direction of the skew. The documentation on Peter Meyer's C program that performs these calculations doesn't make the underlying semantics crystal clear. So I've written a Python program to illustrate what is a rather inelegant algorithm, available on request.

Sometime before Meyer's program became available, Matthew Watkins discovered McKenna's transformation of the hexagrammatic transitions and developed a single formula for what he called a 'piecewise linear function', which he described as worryingly arbitrary and mathematically clumsy, lacking a sound foundation. He was particularly critical of the sign reversal in the first

32 slope differences, known as the 'mysterious half twist', which he said invalidated the entire enterprise.[110]

However, we need to remember that McKenna was not trying to prove anything mathematically, following Euclid's linear method of proof, based on assumed axioms. Rather, he was expressing in mathematical terms the harmony of the Universe that had been revealed to him during his psychedelic trip, rather like the way that Mozart composed symphonies. Timewave Zero is a divine revelation, just as this essay is.

All the differences in the distances and slopes between the wave function and its inverse are then totalled to produce 384 data points for the timewave fractal transform, listed in Table 6.10:

0	0	0	2	7	4	3	2	6	8	13	5	26	25	24	15	13	16	14	19	17	24	20	25
63	60	56	55	47	53	36	38	39	43	39	35	22	24	22	21	29	30	27	26	26	21	23	19
57	62	61	55	57	57	35	50	40	29	28	26	50	51	52	61	60	60	42	42	43	43	42	41
45	41	46	23	35	34	21	21	19	51	40	49	29	29	31	40	36	33	29	26	30	16	18	14
66	64	64	56	53	57	49	51	47	44	46	47	56	51	53	25	37	30	31	28	30	36	35	32
28	32	27	32	34	35	52	49	48	51	51	53	40	43	42	26	30	28	55	41	53	52	51	47
61	64	65	39	41	41	22	21	23	43	41	38	24	22	24	14	17	19	52	50	47	42	40	42
26	27	27	34	38	33	44	44	42	41	40	37	33	31	26	44	34	38	46	44	44	36	37	34
36	36	36	38	43	38	27	26	30	32	37	29	50	49	48	29	37	36	10	19	17	24	20	25
53	52	50	53	57	55	34	44	45	13	9	5	34	26	32	31	41	42	31	32	30	21	19	23
43	36	31	47	45	43	47	62	52	41	36	38	46	47	40	43	42	42	36	38	43	53	52	53
47	49	48	47	41	44	15	11	19	51	40	49	23	23	25	34	30	27	7	4	4	32	22	32
68	70	66	68	79	71	43	45	41	38	40	41	24	25	23	35	33	38	43	50	48	18	17	26
34	38	33	38	40	41	34	31	30	33	33	35	28	23	22	26	30	26	75	77	71	62	63	63
37	40	41	49	47	51	32	37	33	49	47	44	32	38	28	38	39	37	22	20	17	44	50	40
32	33	33	40	44	39	32	32	40	39	34	41	33	33	32	32	38	36	22	20	20	12	13	10

Table 6.10: *384 data points for timewave fractal algorithm*

Now this list of 384 data points is both finite and discrete. So to turn it into an infinite continuous function, Meyer created a linear interpolation of these 384 values, repeated to infinity. The algorithm is given here as a Python expression, because it is clearer that way, `ds` being short for `dataSet`.

$v(x)$ = `ds[int(x)%384] + (x - int(x)) * (ds[int(x+1)%384] - ds[int(x)%384])`

Now came the master-stroke. Meyer was able to express McKenna's vision of resonant, harmonic time terminating at the end of time in a fractal transform of the function $v(x)$.[111] He first generated a general function, showing that it exists provided that two conditions are met:

1. $v(x)$ is finite for all x.
2. $v(x)$ is zero for all x less than a finite number.

The interpolated data points generated from the *I Ching* hexagrammatic King Wen transitions fit these conditions. So Meyer was able to define a specific fractal transform for Timewave Zero:

$$f(x) = \sum_{i=-\infty}^{\infty} \frac{v(x \cdot 64^i)}{64^i}$$

Meyer proved that this infinite series sums to a finite limit. The first condition is needed for zero and positive values of *i*. This series terminates like the formula on page 534, where $a = 79$, the maximum of the generated data set, and $r = 64$. For negative values of *i*, the second condition ensures that there are just a finite number of finite terms to be summed, for when *i* is absolutely greater than some finite number, the term is zero. Also $f(x) = 0$ when $x = 0$, denoting maximum novelty at zero time. $f(x)$ also has the desired resonant properties because Meyer also proved this simple relationship:

$$f(x \cdot 64^j) = 64^j \cdot f(x)$$

This was key. For instance, Figure 6.11 shows a plot of $f(x)$ for the six days before the zero date, amazingly generated using a 1990s DOS program under Mac OS X,[112] the days corresponding to lines in the *I Ching* hexagrams:

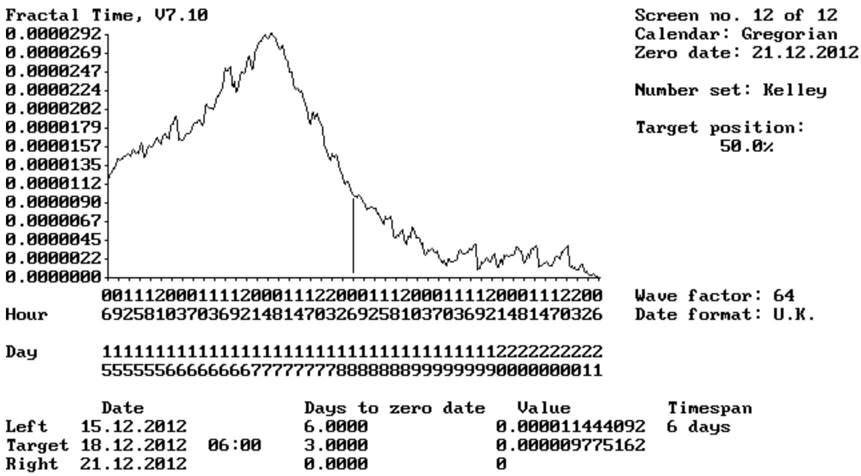


Figure 6.11: *Fractal time, six days before timewave zero*

This wave is exactly the same as for 384 days (6 × 64), for 67 years (6 × 64 × 64), for 4306 years (6 × 64 × 64 × 64), and so on. The timewave does not need to end at the zero date. To illustrate the fractal nature of the fractal transform, we can zoom into just a part of the wave, like in a Mandelbrot set. For instance, the timewave in Figure 6.12 covers forty-eight hours from 18:00 on 18th December 2012 to 18:00 on 20th December 2012. It similarly covers

128 days from 14th July to 19th November 2012, days starting at 6:00 in the morning, and 8,192 days from 8th December 1984 to 14th May 2007.

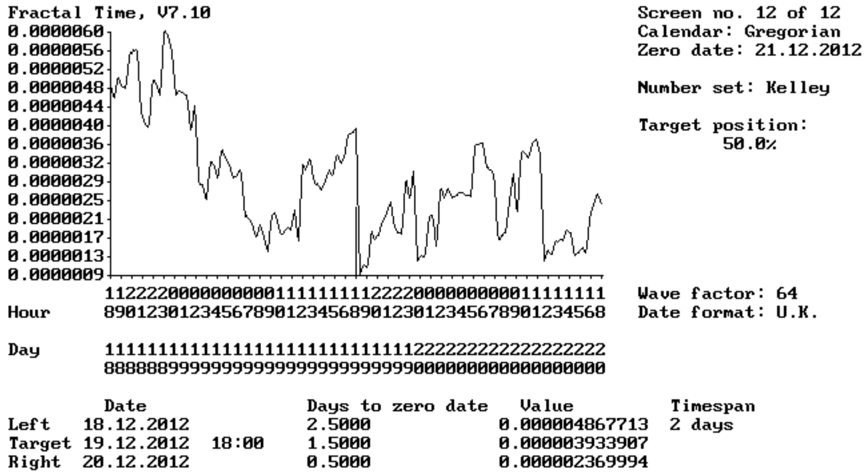


Figure 6.12: *Fractal time for two days*

With Meyer's *Fractal Time* software, McKenna was able to study many periods of time, noting resonances in historical events between periods differing in length by a factor of 64. Such mappings are similar to Carl Johan Calleman's mappings to the Mayan calendar on page 547, using a factor of 20. It was these mappings that led McKenna to 2012 as the singularity in time that his vision foretold. At first, he thought that November 2012 provided the best mapping to historical events.[113] But then he discovered the projected end of the Mayan Great Count and so was happy to jump onto this bandwagon.

However, from what I have seen of the correlations between the timewave function and historical events, these are subject to much interpretation and debate. There is even much debate about McKenna's original vision for generating the data points, from which Royce Kelley and Leon Taylor developed the original algorithm in the early 1970s. For apparently, this algorithm did not exactly match McKenna's psychedelic vision. Then there is the Watkins algorithm, without the 'half-twist'. The mathematician John Sheliak has developed yet a third algorithm, quite different from the other two.[114] Furthermore, the equally ancient Huang Ti sequence of the hexagrams has a closure of 9, compared with 3 in the King Wen sequence, generating quite different timewaves.[115]

So, rather than exploring the historical resonances that McKenna studied further, it is far more relevant to note that at his singularity in time, novelty and concrescence are zero. This might seem strange, but it is easier to plot increasing novelty diminishing on a graph. There is a facility in the *Fractal Time* software to show novelty tending towards infinity, more meaningful, but not so easy to display on a finite computer display.

So what does it mean to say that novelty is now reaching its evolutionary maximum? Well, this essentially means that there are no longer any inhibitors to creativity, no paradigms or dogmatic religious, scientific, or economic worldviews preventing evolution flowing with its full power. In the next section, we look at what this means in systems theory terms. For this is like turning a tap full on so that it flows profusely at evolution's accumulation point, the most momentous event in fourteen billion years of evolution. Furthermore, as concrescence also reaches a maximum at this point, all the divergent streams of evolution, which have led to our fragmented minds and schizoid society, converge in Wholeness at the beginning and end of time in the Eternal Now.

A systems perspective

However, as you may have noticed, there is one highly significant evolutionary turning point missing from this model: the emergence of self-reproducing forms of life about 3.6 billion years ago. This is what Nick Hoggard, a student at Holma College of Holistic Studies in southern Sweden noticed when Carl Johan gave a talk there in the late 1990s. To fit the 'origin of life' on this planet into the model, Nick spotted that $\sqrt{20}$ is 4.472. So if this could be used as the factor of the exponential series, rather than 20, then not only could the beginnings of life, as science understands it today, be accommodated in the model, but many other intermediate points could also be inserted.

In 2000, Nick drafted a book on his radically new evolutionary theory called *SuperEvolution*, which fitted very closely to the comprehensive theory of evolution I had been working on for the previous twenty years.[120] Table 6.11 contains some information from his book.

The terms marked in bold correspond to entries in Table 6.7 that Carl Johan Calleman drew up based on the Mayan calendar. Nick pointed out that each of the transitions in his table created a new, faster way of generating evolutionary solutions, building on what had gone before, not replacing the old ways. It is interesting to note that the midpoint in his table marks the emergence of the first humans on this planet. Also, many of the turning points in Nick's table mark a technological leap of some sort; they are more concerned with external evolution than inner development of the individual and the species.

The exceptions are 7, 8, and 9, the first two completing the biological period of evolution that began at the first turning point in the series. Nick wonders about point 9. Well, for me, this is the most important turning point in the whole of evolution. For this was about when we human beings acquired self-reflective Intelligence, the ability to look inwards to our divine Source, as well as outwards. It was this development that gave rise in many cultures to the myths of gods and goddesses with divine powers, as Barry Long explains.[121] But these ancestors were really like babies in adult bodies, as yet having no conceptual understanding of what

#	Event	Description	Best known date
0	**Big Bang**	The universe is created and matter starts to evolve into ever more complex forms. This eventually results in the organic molecules, which are needed for life to appear.	13-16 billion years ago
1	Emergence of life	Organic molecules join together in self-contained entities, which are able to replicate and mutate.	3.5-3.8 billion years ago
2	**Sexual reproduction**	Two organisms are able to combine their genes to produce new, novel organisms. This substantially increases the rate of biological evolution.	1,000 million years ago
3	Passing on learned behaviour (mammals)	Animals start to care for their young. This gives them an opportunity for them to pass on useful experience to the next generation. This turns out to be a faster way of evolving behaviour than waiting for behaviour to evolve purely genetically.	200 million years ago
4	**Use of tools (primates & monkeys)**	Using tools allows animals to spontaneously extend their bodies. They no longer have to wait for body extensions to evolve biologically.	38-65 million years ago
5	Making tools (great apes)	Animals cease to be limited to the tools they can find lying around. They can actually design them.	10 million years ago
6	**Making tools with tools (Homo habilis)**	In a simple but crucial change, animals begin to use their tools to make other tools. The first man, Homo habilis, appears.	2-2.5 million years ago
7	Homo sapiens	The appearance of the first of our species gives evidence that yet another major evolutionary change has occurred.	400,000-450,000 years ago
8	**Homo sapiens sapiens**	Modern man arrives on the scene, coinciding with the appearance of art—a sign that imagination has evolved to a new level.	100,000 years ago
9	Unknown event	The theory predicts a transition which has not been identified, but which perhaps explains the appearance of agriculture.	25,000 years ago
10	**First civilization**	Diversification of skills means that man moves on to new heights of creativity, technology, and culture.	6,000 years ago
11	First technological revolution	A wave of mechanization gathers pace across Europe and eventually the world.	500-800 AD
12	**Industrial revolution**	A combination of factors triggers the industrialization of society, revolutionizing daily life.	1733
13	Invention of computer	The universal machine is invented, and technological development moves from hardware to software.	1946-1948
14	**Cyberspace (World Wide Web)**	The invention of cyberspace connects people in an interactive environment free from the limitations of physical distance.	1991

Table 6.11: *Interpolated mapping of diminishing exponential series to major evolutionary turning points*

was happening to them. It has taken some 25,000 years of turbulent development for us to understand what is happening to us all.

Nick estimated that this series would converge around 2002. Being curious, I have done my own calculation, given in Table 6.12.

#	Event	Date Years ago	Factor
0	Most recent big bang	14,000,000,000	
1	Self-reproducing forms of life	3,600,000,000	
2	Sexual reproduction	1,000,000,000	4.00
3	Nurture (mammals)	200,000,000	3.25
4	Use of tools (primates)	40,000,000	5.00
5	Making tools (great apes)	10,000,000	5.33
6	Making tools with tools	2,200,000	3.85
7	Homo sapiens	500,000	4.59
8	Homo sapiens sapiens	100,000	4.25
9	Reflective intelligence	25,000	5.33
10	The Fall	6,000	3.95
11	First technological revolution	1,300	4.04
12	Industrial revolution	1733	4.57
13	Invention of computer	21st June 1948	4.76
14	Introduction of WWW	6th August 1991	5.01
15		8th May 2003	*4.67*
16		21st November 2003	*4.67*
17		2nd January 2004	*4.67*
18		11th January 2004	*4.67*
19		13th January 2004	*4.67*
20		13th January 2004	*4.67*

Table 6.12: *A calculation of evolution's finite accumulation point*

It might seem surprising to put the introduction of the World Wide Web on the same chart as the emergence of self-reproducing forms of life on Earth. But as the periods of time between each major turning point decrease, the events they mark decrease in significance in the cosmic scale of things. Nevertheless, these events mark significant turning points for those living at these momentous times. Figure 6.13 shows a graph of Table 6.12 at a logarithmic scale:

The first 11 points are based on a best estimate of when the various major turning points took place. The factors between them are calculated in this way:

$$\frac{f(n-2)-f(n-1)}{f(n-1)-f(n)}$$

You can see that the factor between the periods varies quite a lot, but the points nevertheless are quite close to a straight line in the logarithmic graph above. Furthermore, the average

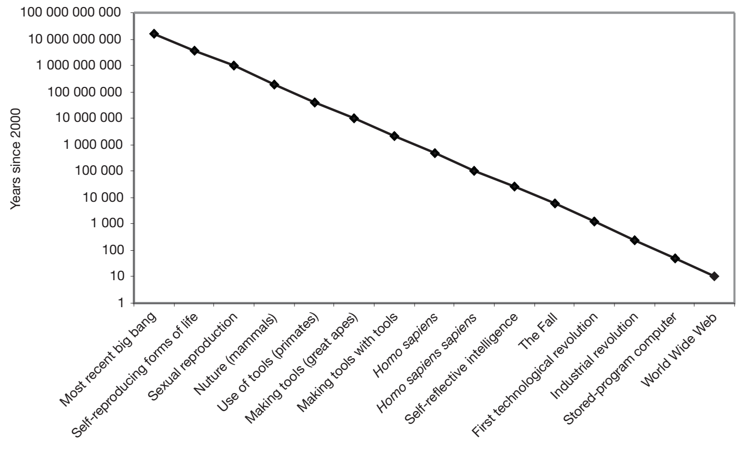


Figure 6.13: *Major evolutionary turning points*

is 4.37, not far from 4.472. However, we know the dates of the last three points with reasonable accuracy. Well, the date of the beginning of the industrial revolution varies quite a lot. Carl Johan used 1769, when James Watts invented the steam engine. For myself, I have used Nick's date of 1733, although if I remember rightly, Arnold Toynbee,[122] the uncle of the author of *A Study of History*, with the same name, used 1760.

I have taken 21st June 1948 as the invention of the computer, for this is when engineers at Manchester University switched on the first stored-program computer called 'Small-Scale Experimental Machine',[123] although the EDSAC was the first practical stored-program computer, which ran its first program on 6th May 1949 at Cambridge University.[124]

These were the most significant events in the whole history of technology, for programs were stored in the computer's memory for the first time, rather than externally. We had thus built a machine that enhances our mental abilities; in contrast to the many tools we have created over the years to extend our rather limited physical abilities, such as the wheel, the steam engine, the telephone, and the aeroplane. And we know that Tim Berners-Lee launched his first web site at CERN on 6th August 1991.[125]

Using a factor of 4.669, for reasons that I will shortly explain, I then calculated when this series would converge. Of course, 13th January 2004, a revision of the date I gave in my book *The Paragonian Manifesto*, is one of spurious accuracy. But this series is not very sensitive to either the starting point or the exponential factor. I have done some sensitivity tests with 13, 14, and 15 billion years as the starting point, and with evolutionary factors ranging from 4.4 to 4.7. In all cases, the 21st term was less than a day.

This convergent point of around 2004 does not quite match the end of the Long Count in the Mayan calendar. However, in the cosmic view of evolution, which I am endeavouring to describe here, these differences are not significant. What is significant, however, is that we are clearly living at the most momentous time in evolutionary history, as this book is endeavouring to explain.

When Nick Hoggard began his evolutionary studies, he looked for a scientific explanation for the patterns he was observing. To do this, he first noticed that 4.472 is reasonably close to 4.669, the Feigenbaum constant in complexity theory.[126] And 4.669^2 is 21.8, quite close to the factor of 20 in the Mayan calendar. So he set out to study the history of evolution in terms of systems theory, described in his unpublished book *SuperEvolution*.

He is not alone in this endeavour. For instance, in *The Phenomenon of Science*, the Russian Valentin Turchin explored the history of evolution in terms of cybernetics.[127] And the biologist Elisabet Sahtouris is well known for presenting evolutionary processes in terms of conventional systems theory.[128] However, Nick has made a major contribution to our growing understanding of evolutionary processes. Here is a brief summary of his findings.

Like many others, Nick turned to systems theory because evolutionary processes can be seen as examples of autopoiesis or self-organization, which sadly does not recognize the existence of Life arising directly from our divine Source. A self-organizing system is one in which order arises out of chaos, giving rise to systems of ever-increasing complexity, which Pierre Teilhard de Chardin called the law of complexity-consciousness, the greater the complexity, the greater the consciousness.[129]

But paradoxically, underlying all this complexity are patterns of great simplicity. One of these patterns is that systems do not develop steadily; they pass through sudden leaps in levels of complexity. Leaps in complexity in self-organizing systems are known as bifurcations, divisions into two forks or branches. Such bifurcations have been studied by a physicist called Mitchell Feigenbaum at the Los Alamos Laboratory in 1975. He noticed that these bifurcations occur faster and faster diminishing by a factor of 4.6692016090, now known as the Feigenbaum number, which can be calculated to any level of precision, like π and e. The Feigenbaum number is thus a fundamental constant of nature.

A simple example of bifurcation is a dripping tap. When it is first turned on, the drips are equally spaced: drip-drip-drip. But as more water flows, the drips form pairs, with a larger distance between the pairs than within the pairs: drip-drip--drip-drip--drip-drip. This is the first bifurcation. Then, as the tap is opened up, the number of different distances between the drops doubles: drip-drip--drip-drip---drip-drip--drip-drip----drip-drip--drip-drip. At each bifurcation, the number of different distances doubles each time, as illustrated in Figure 6.14 from Nick's book:

As Figure 6.14 indicates, the bifurcations get closer and closer together at each point, the bifurcations decreasing by a factor that gets closer and closer to the Feigenbaum number. (Actually, Nick drew this diagram with a factor that is close to 2 because if he had used 4.6992, the bifurcations would have got too close together too fast.) Now this series has the same form

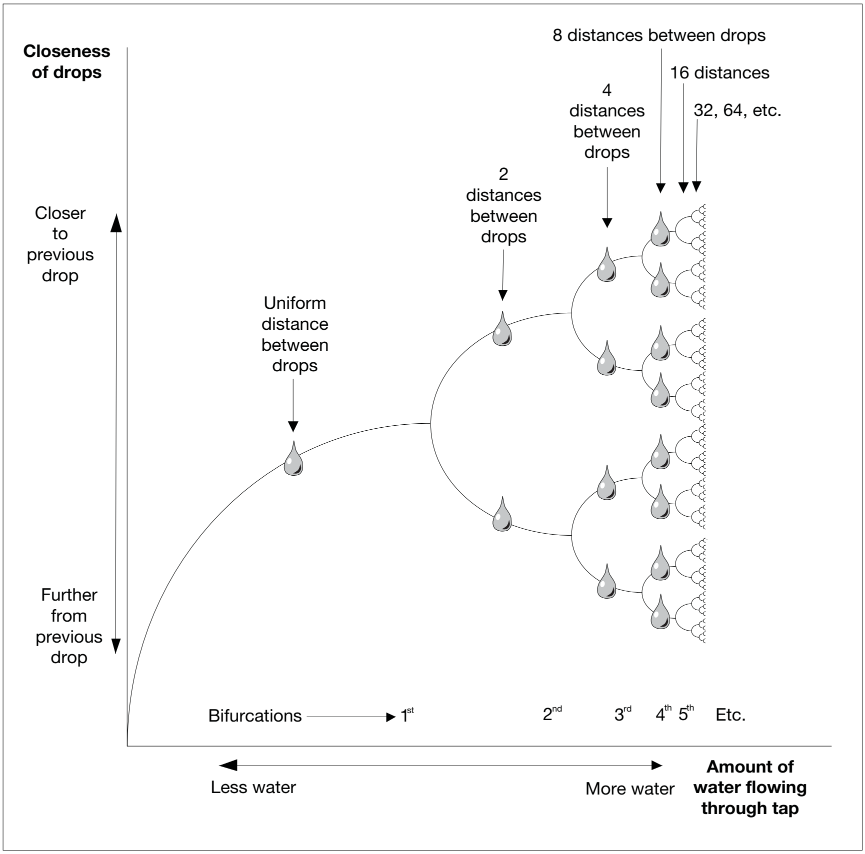


Figure 6.14: *Bifurcations of dripping tap*

as the other exponential series we have looked at, with each term diminishing by 4.6692 at each point:

$$1 + \frac{1}{4.6692} + \frac{1}{21.801} + \frac{1}{101.79} + \frac{1}{475.30} + \ldots$$

And like the other series, it has a finite limit, even though there are an infinite number of terms. The limit is 1.272538854. What does this mean in terms of the dripping tap? Well, when the finite limit is reached, the tap stops dripping; the water flows continuously. In complexity theory, this limit is known as the accumulation point.

Now what Nick noticed in his evolutionary calculations, which are slightly different from mine, is that the time periods between the evolutionary turning points get closer and closer to the Feigenbaum number. And, as I have indicated, this series reached a finite limit around 2004. We can therefore say that all the accumulating evolutionary processes of the past fourteen billion years or so have reached the evolutionary accumulation point. There are no longer any major turning points that can be discerned. Evolution is now flowing continuously, like a tap that is turned full on, the most fundamental change in the whole history of evolution. Evolution is becoming fully conscious of itself as it changes from a predominantly divergent mode to a convergence of everything.

Seven simultaneous turning points

As evolution passes through the most momentous turning point in its history, this is giving rise to seven major turning points, all of which are taking place simultaneously in human history. So what Peter Russell calls our 'next evolutionary leap' is likely to be a very big jump indeed.[130] To provide some structure for these changes, here is a brief summary of these different levels.

At the broadest level, we can distinguish, with Pierre Teilhard de Chardin, just four major stages in evolution during the fourteen billion years since the most recent big bang: physical, biological, mental or noetic, and spiritual. As I described on page 523, the first three of these stages happened some 14 billion, 3.5 billion, and 5,000 years ago. Despite the secularization of Western civilization, there is now considerable evidence that we are now entering the eschatological spiritual stage of evolution, when all the organized religions that have dominated human societies during the mental epoch will disappear.

Teilhard himself saw evolution as a rise of consciousness, which is brought about through the effect of union. He therefore prophesied that all the diverse streams of some fourteen billion years of evolution will one day converge or coalesce in a megasynthesis, "a gigantic psychobiological operation".[131] This synthesis of everything will usher in an eschatological epoch of superconsciousness and superintelligence according to his law of complexity-consciousness: the greater the complexity, the greater the consciousness. However, Teilhard did not see that this megasynthesis would first happen in us as individuals. Rather, he prophesied that this ultimate convergence would happen to us all in the collective. As he said:

> The way out for the world, the gates of the future, the entry into the superhuman, will not open ahead to some privileged few, or to a single people, elect among all peoples. They will yield only to the thrust of *all together* in the direction where all can rejoin and complete one another in a spiritual renewal of the Earth.[132]

He then went on to say, "The human being can have no hope of an evolutionary future except in association with all the rest."[133] This convergent evolutionary process will then take us beyond the collective, into the impersonal, leading to the Omega Point of evolution at the end of time. All the religions in the world would then have disappeared except Christianity, which "*alone*, absolutely alone, on the modern Earth shows itself capable of synthesizing the whole and the person in a single vital act".[134] As Sarah Appleton-Weber tells us, for Teilhard Alpha and Omega "refer to both the beginning and end of space-time and to the universal Christ".[135] However, Teilhard, writing at the end of the 1930s, did not see these momentous evolutionary events happening in the immediate future. As he said, "despite an almost explosive acceleration of noogenesis at our level, we cannot hope to see the Earth transformed before our eyes in the space of a generation."[136]

Secondly, an increasing number of people today are noticing that a New Humanity is emerging,[137] with characteristics that are so different from early forms of human that we can say that a new species is emerging. The *Homo* genus, from the Latin *homo*, 'human being, man', is about 2.5 million years old, with *Homo habilis*, 'handy man' or 'skilful person' living in East Africa from approximately 2.5 million to 1.8 million years ago at the beginning of the geological Pleistocene epoch, meaning 'most new', from the Greek, *pleistos* 'most', and *kainos* 'new'.[138]

Since then, fossils of several species of *Homo* have been found, such as *Homo erectus*, 'Upright Human, living about 2 to 1 million years ago in Africa, Europe, and Asia,[139] and *Homo neanderthalensis*, 'Neanderthal Human', living in Europe and parts of western Asia from 350,000 to 24,000 years ago.[140] *Neanderthal* means 'Neander Valley', named after German theologian Joachim Neander. There is some doubt whether either of these species was our direct ancestor.

Homo sapiens, 'Wise Human', emerged in Africa about 200 to 250 thousand years ago.[141] I am not sure why there is a subspecies of *Homo sapiens sapiens* unless it is to distinguish it from *Homo sapiens idaltu* 'elderly wise man', discovered in 1997 in Ethiopia.[142] The difficulty with these classifications is that they have been made by biologists, and so do not recognize the two major turning points in human evolution so far. The first was the emergence of self-reflective Intelligence about 25,000 years ago, as evidenced by cave drawings of that time, such as this drawing from Lascaux in south-west France, dating from about 15,000 to 17,000 years ago.[143]

Then between 4,000 and 5,000 years ago, the egoic mind reached its full power, giving rise to written language, recorded history, and the patriarchal age, during which women in nearly all cultures have been treated as second-class citizens. We really need to give names to these quite distinctive changes in human behaviour. Perhaps they could be considered as subspecies of *Homo sapiens*, which we can now see is a misnomer. For the most part, we are very far from being wise humans.

Be that as it may, Barbara Marx Hubbard, founder of the Foundation for Conscious Evolution[144] and the Evolutionary Edge,[145] has suggested these names for our emerging species in a letter recently published in the *What is Enlightenment?* magazine: *Homo universalis*, *Homo noeticus*, *Homo spiritus*, and *Homo sapiens sapiens sapiens*.[146] Another possible name for our emerging species is *Homo divinus*, in recognition of the fact that it was not only Jesus of Nazareth who was both human and divine; all of us are divine human beings. So another term

Figure 6.15: *Cave drawing from Lascaux*

we could use is *Homo divinus universalis*, a name that encapsulates the complete unification of mysticism and reason, key characteristics of the emerging species.

Thirdly, we can look at the phylogeny of human consciousness from about 25,000 years ago in three stages, which we can call innocent, mental, and spiritual, explored in much more detail in Part III, 'Our Evolutionary Story'. During the first phase, our ancestors were like innocent, young children, from the Latin *nocentem*, present participle of *nocere*, 'to hurt, injure'. So someone who is innocent is literally 'harmless'. It seems that this innocent matrifocal or matriarchal age was comparatively peaceful, in contrast to the conflict-ridden mental epoch.

Ken Wilber has further characterized the three stages of human development as subconscious or prepersonal, self-conscious or personal, and superconscious or transpersonal,[147] which we can also call matrifocal, patriarchal, and androgynous. However, he is at pains to point out that just because the prepersonal and transpersonal have some characteristics in common, we should not conflate them in what he calls the 'pre-trans fallacy'.[148] We are not going *back* into a golden age, but *forward* into an androgynous Age of Light. To emphasize this point, I generally say that today we are in the transition between the selfish, patriarchal, mental-egoic epoch (me-epoch) and a healthy, cooperative epoch of universal spirituality (us-epoch).

Fourly, in *A Study of History*, Arnold Toynbee distinguished some twenty civilizations that have emerged, flourished, and died during the patriarchal epoch. Using the fundamental principle of pattern recognition that forms the basis for IRL, he saw that civilizations go through various stages, the most important of which are creative growth, a time of troubles, and a universal state, when the creative energies that brought the civilization into being become ossified. Figure 6.16 shows a timeline of these civilizations:[149]

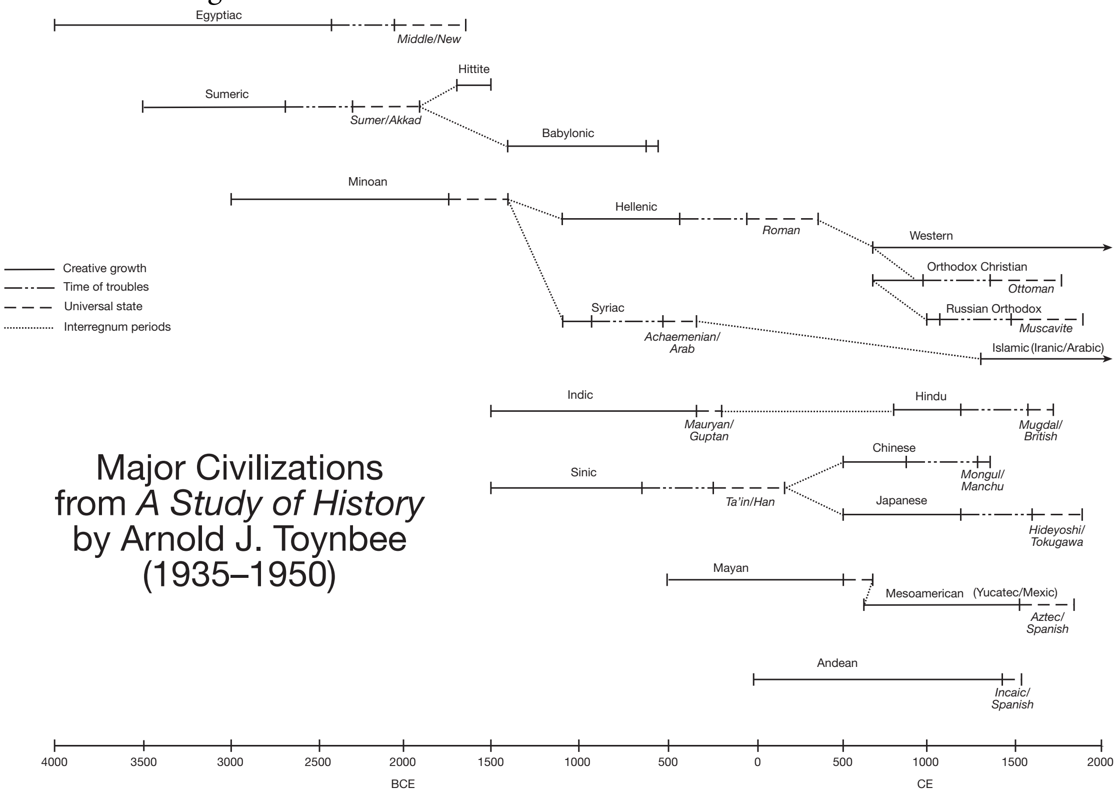


Figure 6.16: *Timeline of major civilizations*

Toynbee summarized the reason for the death of civilizations in this way, which quite clearly applies to Western civilization today:

> The nature of the breakdowns of civilizations can be summed up in three points: a failure of creative power in the minority [the leaders who brought the civilization into being], an answering withdrawal of mimesis [imitation] on the part of the majority, and a consequent loss of social unity in the society as a whole.[150]

In *The Turning Point*, Fritjof Capra depicted the rise and fall of some of these civilizations around the Mediterranean, reproduced as Figure 6.17[151] The important point to note is that all, with the exception of Western civilization, have a bell shape, although it is clearly premature to indicate that the Islamic civilization is dying. This is because, by the Principle of Unity, evolution must be balanced by a period of decay.

Today, the two dominant civilizations in the world, Christocentric Western civilization and the Islamic, have both lost the creative power that brought them into existence. So they must both die so that the Age of Light, a society soundly based on Love and Peace, Life and Freedom, Wholeness and the Truth, and Consciousness and Intelligence, can emerge. Figure 6.18, an extension of one in Fritjof Capra's *The Turning Point*, illustrates this death and rebirth of civilization as we know it today.[152]

Fifthly, as our self-reflective Intelligence emerges with its full power once again, as the fragmented mind becomes translucent in Wholeness, we are moving from an either-or way of thinking and living to a both-and approach, able to see both sides of every situation. As Part I of this book on Integral Relational Logic described, a nondualistic, both-and system of thought is emerging that is radically different from the either-or principles of logic laid down by Aristotle some 2,350 years ago.

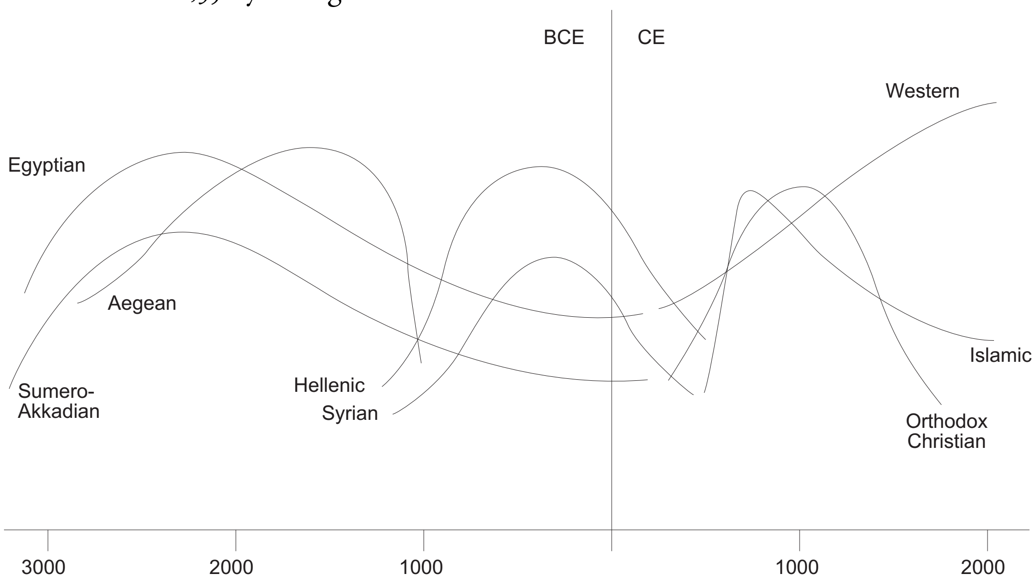


Figure 6.17: *Birth and death of major civilizations around the Mediterranean*

Sixthly, there is a revolution in science taking place today that is even more far-reaching than the Copernican revolution completed by Isaac Newton in 1687 with his *Mathematical Principles of Natural Philosophy*. In 1986, Willis Harman, then president of the Institute of Noetic Sciences, described this vision in these words, "Most educated people in this country [the USA] would think it pretty preposterous to suggest that the change that is taking place is at as deep a level as the change that took place during the Scientific Revolution, because that would imply, of course, that the near future—the early part of the next century—would be as different from present times as present times are from the Middle Ages."[153]

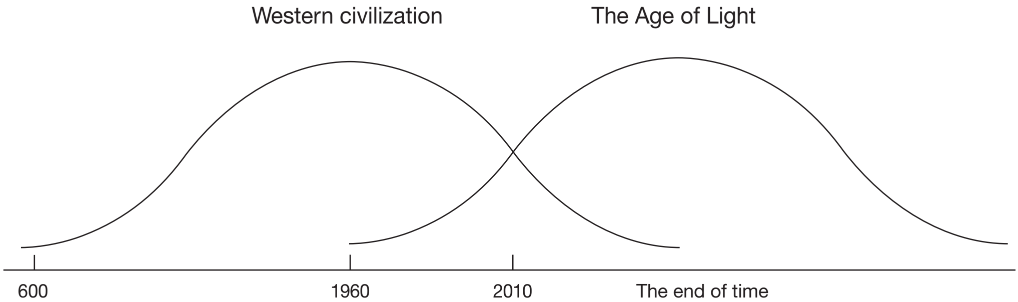


Figure 6.18: *Crossover of civilizations*

The current President of IONS, Marilyn Schlitz, is following in his footsteps, saying, in a One-Minute-Shift video on the Web:

> When Copernicus proved that the Earth revolves around the Sun, he literally changed the world as we knew it. Darwin and Einstein did the same in their day. What if we are now going through the next scientific revolution, one every bit as profound? For centuries, science and religion have been at odds. Science has focused on the physical, denying the reality of what most religions believe. However, today's science is showing that some spiritual insights are actually scientific truths; that psychic abilities may be real; that we are all fundamentally interconnected; and that we all have innate abilities to heal and transform ourselves. Science and technology without wisdom can endanger life as we know it. But when we marry the best of science with the best of our wisdom traditions, humanity will have the capacity to create a more just, compassionate, and sustainable future.[154]

But it is important to note here that the scientific revolution being introduced by the Unified Relationships Theory is not a paradigm in any of the senses that Thomas Kuhn used. Scientific materialism and mechanism of the last three or four hundred years are dying, being replaced by a gnostic, vital science that recognizes that ineffable, nondual Consciousness, not the physical universe, is the primary reality. We are thus returning Home to Wholeness, recognizing that the entire world of form, including this book, is just an illusion, called *maya* in the East.

Seventhly, the materialistic economies of capitalism and communism, which threatened to blow us all up during the second half of the twentieth century, are inherently unstable and are causing severe psychological and ecological damage. If today's children are to have any chance of growing old enough to have children of their own, the global economy needs to die, giving way to a life-enhancing, ecologically sustainable Sharing Economy, sometimes called a gift economy,[155] in which we shall all be empowered to reach our highest potential as human beings.

We look at all these transformations in more detail in Chapter 13, 'The Prospects for Humanity' on page 1027.

Chapter 7

The Growth of Structure

Evolution is an ascent towards consciousness.
Therefore it must culminate ahead in some kind of supreme consciousness.
Pierre Teilhard de Chardin

The main purpose of this chapter is to illustrate the exponential chararacteristics of the growth curve, which occurs throughout Nature, with the growth of structure in the computer industry in particular. We can thereby see how evolution could overcome the limits of technology, outlined in Chapter 8, 'Limits of Technology' on page 619, taking humanity out of the evolutionary cul-de-sac we find ourselves in today, outlined in Chapter 9, 'An Evolutionary Cul-de-Sac' on page 643. Chapter 6, 'A Holistic Theory of Evolution' on page 521 showed how the accelerating pace of evolutionary change can be modelled by an exponential series of diminishing terms, which has a finite limit at the present time, the most momentous turning point in some fourteen billion years of evolutionary history.

But because of science's ignorance of the Principle of Unity—the fundamental design principle of the Universe—science has no satisfactory explanation for this exponential rate of evolutionary change. As a consequence, we are managing our business affairs with little understanding of the evolutionary energies that cause us to behave as we do. Even when the Principle of Unity is presented to scientists, they tend to deny that it is a universal truth, because it threatens their deeply held scientific convictions, the implications of which we shall look at in the Epilogue.

In the meantime, we can use the Principle of Unity to examine this critical situation. In essence, evolution is a process of divergence and convergence, of analysis and synthesis in the noosphere. But when we analyse without subsequently integrating the divergent parts that are produced, the result is a fragmented mind. Because of academic specialization, we can see sections of the jigsaw puzzle, but not how they coherently fit together in the Big Picture. Our mechanistic conditioning thus prevents us from realizing our fullest potential as divine, cosmic beings, living in Wholeness.

The Unified Relationships Theory provides this synthesis of everything. The URT views the Universe in the abstract terms of structure, form, relationships, and meaning, rather than the primary concepts of science today: space, time, matter, and energy. This means that meaningful structure-forming relationships are universally causal, being created by Life or the Logos, arising directly from our Divine Source. With these abstract concepts, we can see that evolution is not just a biological process. The development of the stars and atoms—the large and the small—in the physiosphere and our learning or mental development in the noosphere are as much evolutionary processes as the evolution of the species in the biosphere.

In other words, we can view all fourteen billions years of evolution since the most recent big bang as a seamless continuum of development in the Eternal Now. And as all evolutionary processes follow the same underlying pattern, it is sufficient to study our own learning processes to understand evolution as a whole through self-inquiry. In terms of business information systems modelling, it is thus necessary to use our self-reflective Intelligence to include this modelling process in the territory being modelled, as explained in Part I. It is in this way that evolution can become fully conscious of itself, leading to superconsciousness, in conformity with Teilhard's law of complexity-consciousness: the greater the complexity, the greater the consciousness.[1] But if we are not to be overwhelmed by this complexity, we need to acknowledge the simple role of the Principle of Unity in this developmental growth of structure.

Growth of computer technology

So what about the information technology industry, which dominates all our lives today? Where are we on the growth curve of this industry and where is it likely to lead in the coming years? Well, we cannot possibly answer these questions unless we are willing to adapt to the accelerating pace of evolutionary change and thus be liberated from the seven pillars of unwisdom that influence so much thinking on this subject today.

The key point to recognize here is that the programmable computer, which forms the hub of the IT industry, is a tool that enhances our mental faculties in some sense, not our physical abilities. We can say this because the computer provides a means of storing data, not unlike our memory, and a means of processing this data, somewhat analogous to our thinking, reasoning, and calculating skills.

On this point, it is interesting to note that the Greek word *logos*, which is the root of both *logic* and *logistic*, could mean both 'reasoning' and 'reckoning'. However, in a culture that is obsessed with quantitative measure, the emphasis is more on the latter skill than the former, as the word *computer* indicates. The Swedes call the computer *dator*, meaning 'a machine for processing data', a more accurate term.

The computer is not the first tool that we have invented to extend our mental abilities. The first such tool is generally regarded as the abacus, which is probably of Babylonian origin. "The word *abacus* is probably derived, through its Greek form *abakos*, from a Semitic word such as the Hebrew *ibeq* ('to wipe the dust', noun *abaq* 'dust')".[2] The tool was so named because originally people used a board or slab covered in sand in which they made marks to help them with their calculations. It was only later that the tool evolved into one where counters were strung on wires. In Roman times, these counters were stones moving in grooves on the board, hence the English words *calculate* and *calculus*, from the Latin *calculus*, meaning 'a stone'.

Then in the seventeenth to nineteenth centuries, there was a flurry of activity as a series of inventors built various kinds of calculating machines. The first of these appears to be a German astronomer and mathematician, Wilhelm Schikard, who built what he called a 'calculating clock' in 1623. This invention was followed by a calculator, called the 'Pascaline' or 'Arithmetic Machine', designed and built in 1642 by Blaise Pascal, the French mathematician-philosopher, for his father, who was a tax collector. Over fifty of these machines were built over the next ten years.[3]

Then in 1671, the German mathematician-philosopher, Gottfreid Wilhelm von Leibniz, designed a calculating machine called the Set Reckoner, this machine being built two years later[4]. But Leibniz's thoughts went further than this. He dreamed of a machine for mechanizing reason by manipulating symbols that represent concepts, a goal that computer scientists are still trying to realize.[5]

Not much more seems to have happened in the development of calculating machines until 1820, when Charles Xavier Thomas de Colmar of France invented the first mass-produced calculating device to come on the market, called the Arithmometer (progress in the eighteenth century was still on the AB section of the growth curve). The Arithmometer was based on Leibniz's technology and was so successful that it was still in production in 1926.[6]

However, theoretically, at least, the greatest breakthroughs came through Charles Babbage, an English mathematician, who held the Lucasian chair of mathematics at the University of Cambridge, as Isaac Newton had done before him, for some eleven years in mid-life.[7] About 1821, Babbage first conceived of a mechanical device that could automate long, tedious astronomical calculations. Babbage was concerned that the logarithm tables used for navigation at sea contained many errors. This was because they were produced by 'computers', the name given to the people who operated calculating machines.

Babbage gave two different descriptions of the circumstances that gave rise to the idea of calculating mathematical tables automatically by machine, the one he gave in 1834 probably being more accurate than his recollections in his autobiography published thirty years later. Babbage was with John Herschel at the Astronomical Society in London when the former exclaimed, "I wish to God these calculations had been executed by steam." To which Herschel replied, "It is quite possible."[8] It was from this chance remark that Babbage devoted the rest of his life to the design of machines that could automate calculations.

Babbage called his first calculating machine the Difference Engine because it was based on the mathematical method of differences.[9] By the summer of 1822, he had constructed a prototype of this machine and began to show it to his friends and colleagues with the purpose of obtaining funding to build a fully operational machine.

It was this machine, or a development of it, that Ada Byron, the poet Byron's only legitimate child, saw on 5th June 1833 on a visit to Babbage's home when she was just seventeen. Her mother, Byron's widow, commented at the time in a letter, "We both went to see the *thinking machine* (for such it seems) last Monday." Lady Byron then went on to say, even though she was quite an accomplished mathematician, "I had but faint glimpses of the principles by which it worked." Ada Byron, it seems, had no such difficulty. Her friend, Sophia Frend, records in her memoirs, "Miss Byron, young as she was, understood its working, and saw the great beauty of the invention."[10]

However, despite receiving Government grants to build this machine, for a variety of reasons this project was never completed in Babbage's lifetime[11]. A partial reason for this is that in 1833 Babbage had what must be regarded as one of the greatest leaps in imagination in the whole history of human learning. He conceived of a machine with the power "to combine together general symbols in successions of unlimited variety and extent", which would embody "the science of general reasoning".[12] Babbage was thus attempting to realize Leibniz's dream with what he called the Analytical Engine because it covered the whole field of analysis in mathematics, an extension of what we called calculus at school.

The key difference between the Analytical Engine and the Difference Engine was that the former was general-purpose, while the latter was special-purpose. The Difference Engine could only work with a particular set of problems, albeit quite common ones. For many expressions, such as logarithmic, exponential, and trigonometric, can be expressed in terms of a polynomial series, whose successive terms tend to zero. So it is possible to use the mathematical method of differences as an aid in calculating these expressions, calculating them to as many decimal places as are needed.

However, the design of the Analytical Engine *does* take us a step nearer to Wholeness and the Truth, to a universal science of reason. Rather than incorporating a particular algorithm into the structure of the machine, Babbage envisaged a universal machine that could handle a wide variety of different algorithms, not unlike the modern computer.

The Analytic Engine consisted of two principal parts. The first was a mill that could execute all four basic arithmetical operations directly. It was called a mill on analogy with the cotton mill. The mill was not unlike the central processing unit (CPU) in computers today.

Secondly, there was a store to hold the data being processed, consisting of columns of up to forty discs, each column being equivalent to one storage unit in a modern computer. Unlike the Difference Engine, the discs were able to rotate independently of each other, the angular position of each disc indicating a value of 0 to 9 for the decimal position in the column.

The input, both instructions and data, was provided on punched cards, called Operations and Variable cards, using the card-reading technology of the Jacquard loom. As Ada Lovelace, as Ada Byron was to become,[13] wrote later, "We may say most aptly, that the Analytical Engine weaves algebraic patterns just as the Jacquard-loom weaves flowers and leaves."[14]

Ada Lovelace had one great difficulty in her relationships with her contemporaries: she was highly intelligent. She was able to see in the essence of forms and structures what few of her contemporaries could see, even when what she could see was pointed out to them. One of her biographers, Doris Langley Moore, says that she lived "a hundred years too soon".[15] But this is an underestimate. It is only in recent years, with the identification of Indigo children, that superintelligence has been recognized in a positive light, rather than as a mental disorder.[16] I feel sure that if Ada had been living today, she would have been one of the few people who understood The Principle of Unity, that Wholeness is the union of all opposites.

Ada Lovelace is credited with being the first computer programmer. But she wasn't really. In describing the Analytical Engine, Babbage, himself, had to sketch out elementary programs illustrating how the machine could be used. So I see Ada more as a technical writer, clearly describing a system that the originator does not necessarily have the skills to do, rather like the relationship between technical writers and some program designers today.

Being ignored by his contemporaries in England, Babbage accepted an invitation from a number of mathematicians and engineers in Italy to present his work in 1840 in Turin.[17] One of the mathematicians there, Luigi Federico Menabrea, subsequently wrote a sketch of the Analytical Engine published in French in Switzerland two years later. This sketch contained the outline of a program to solve a pair of simultaneous equations in two variables, which, I guess, could be called the first published program.[18]

Unbeknownst to Babbage, Ada translated this sketch into English. When Babbage heard about it, he wondered why she had not written an original piece about a machine with which she was 'so intimately acquainted' and suggested that she do so. She jumped at this task, writing notes to the translated sketch that were three times longer than the original. The translation and appended notes were published in *Taylor's Scientific Memoirs* in September 1843, when Ada was just 27.[19]

One of the major aims of her notes was to clear up the many misconceptions that her contemporaries held about the Difference Engine and the Analytical Engine: "No very clear or correct ideas prevail as to the characteristics of each engine, or their respective advantages or disadvantages."[20] Nothing much has changed even today. There is still no clear understanding of the essential differences and similarities between human beings and computers, a critical situation that led me to begin this research project in 1980. For instance, Ray Kurzweil has said that by the end of the century there will no longer be any clear distinction between humans and computers,[21] which is utter nonsense, of course.

Regarding Ada's concerns, she was at pains to point out in Note A, which goes deepest into the essential nature of these two machines, they are two quite different species of animal. As she said, "the Analytical Engine does not occupy common ground with mere 'calculating machines'. It holds a position wholly its own."[22]

Ada could even see that the Analytical Engine was so abstract in the way it handled symbols that it could be used not only in mathematics, but also in musical notation. This led her to say, "The engine might compose elaborate and scientific pieces of music of any degree of complexity or extent". Here, Ada seems a little confused. When Menabrea said, "although it [the Analytical Engine] is not itself the being that reflects, it may yet be considered as the being which executes the conceptions of intelligence,"[23] Ada responded with a cautionary note. She said:

> It is desirable to guard against the possibility of exaggerated ideas that might arise as to the powers of the Analytical Engine. In considering any new subject, there is frequently a tendency, first, to *overrate* what we find to be already interesting or remarkable; and, secondly, as a natural reaction, to *undervalue* the true state of the case, when we do discover that our notions have surpassed those that were really tenable.[24]

The claim that Ada was the first programmer is based on a significant program included in her paper to calculate Bernoulli numbers. She did not create this program from scratch herself; Babbage gave her an outline to work with. However, she did find an error in Babbage's notes that he had not found himself. There was also one mathematical error in Ada's memoir that neither she nor Babbage spotted. This was caused by a misprint in Menabrea's original French article.[25] So while she was both highly intelligent and paid meticulous attention to both detail and conceptual clarity, she was, nevertheless, subject to error like the rest of us.

In the event, the Analytical Engine was never built,[26] and neither did it have much influence on the development of the stored-program computer one hundred years later.[27] Its interest today is to show that we are still sleepwalkers, having very little understanding of the machine that was invented over half a century ago.

It was to be one hundred years before the first programmable computer actually came to built, not in the USA or in the UK, as many believe, but in Germany. In Berlin, Konrad Zuse applied to patent an electromechanical automatic calculator in 1936.[28] However, it was not until 1941 that he was able to build the third version of his machine, known as the Z3, today regarded as the world's first general purpose program-controlled computer, the machine being controlled by a paper tape.[29]

Obviously, because of the war, Zuse knew nothing of the work of the Americans at the time, and vice versa. Anyway, the next most notable advance was the Harvard Mark I, again an electromechanical device, designed by Howard Aitken and built by IBM. This machine, which became operational in May 1944, was also controlled by an external program on paper tape or punched cards, I am not sure which.[30]

Then came a number of electronic machines, which greatly increased the speed of calculation. The most notable of these was the ENIAC (Electronic Numerical Integrator and Computer), designed by the Moore School of Electrical Engineering at the University of Pennsylvania.[31] The ENIAC, which contained 19,000 valves, became operational in the autumn of 1945.[32]

However, the ENIAC was not controlled by a paper tape or cards. It was necessary to set up plugboards and banks of switches, even sometimes to reroute cables.[33] So setting up these machines was a time-consuming process.

What was needed was a *stored-program* computer, in which the instructions could be stored in the memory of the machine, along with the data being processed. The implications of this epoch-making change is that a program could not only operate on numerical data, but also read and modify itself during the course of execution, a subject that we looked at in the previous chapter. For this issue is key to understanding the essential differences between human beings and computers.

It is not clear exactly when the idea of a stored-program computer first appeared in human consciousness. Ada Lovelace refers in her memoir to the Analytical Engine being able to operate on symbolic data as well as numerical data.[34] But it is not clear whether she envisaged that this symbolic data is the program itself, the symbols of mathematics, such as *Mathematica* is able to handle today, or something else entirely. Neither is it possible to determine whether Babbage conceived of the idea of a stored program.[35]

Both Konrad Zuse and Alan Turing seem to have seen the possibility of a stored program in the papers they wrote in 1936. However, the idea seems to have fully emerged within the ENIAC group at the Moore School in 1944 or 1945.[36] They envisaged a computer called the EDVAC (Electronic Discrete Variable Arithmetic Computer), which was described in a draft paper, apparently never finished, by the eminent mathematician, John von Neumann, published on 30th June 1945.[37] In 1946, Alan Turing, who had met von Neumann during the war, also proposed that the National Physical Laboratory in England build a stored-program computer called an Automatic Computing Engine (ACE).

However, neither the EDVAC nor the ACE were the first stored-program computers to be built. This honour went to the MADM (Manchester Automatic Digital Machine), constructed at the University of Manchester in England in 1948 by a team led by M. H. A. Newman.[38] However, this was more a prototype than a practical machine. The first practical stored-program computer was the EDSAC (Electronic Delay Storage Automatic Calculator), built by a team led by Maurice Wilkes at the University of Cambridge, also in England.[39] This machine ran its first program on 6th May 1949. In 2 minutes 35 seconds, it computed a table of squares from 0 to 99 and printed out the results.[40] The Computer Age was truly born.

The first commercial stored-program computer to be built was the UNIVAC (Universal Automatic Computer), which was bought by the US Census Bureau in 1951 to process the mass of data that they were being deluged by. The UNIVAC was designed by J. Presper Eckert and John W. Mauchly, who had worked at the Moore School, but who left to form a fledgling company bought by Remington Rand, the electric razor company.[41]

But it was not until the presidential election between Dwight D. Eisenhower and Adlai E. Stephenson the following year that the capabilities of the computer caught the public imagination. As the results of the election were being processed at election headquarters, someone in the media asked the UNIVAC for a prediction of the result. The machine predicted a landslide victory for Eisenhower, something that no one believed so the prediction was not broadcast immediately.[42] It was only after the result was published that the media rather sheepishly admitted that the machine seemed to know more about the future than they human beings did, thus leading to much hype around the computer, which even today has not died down.

With the birth of the stored-program computer, we can say that we have now reached the point B in the growth curve for computer technology. The complexity of computer hardware then began to accelerate due to significant advances in electronics. This was aided and abetted by the growth of structure in databases, programming, and modelling, which we look at in later sections in this chapter.

The key component in the first computers was the thermionic valve, a device that was invented in 1904 by J. A. Fleming and improved on two years later by Lee de Forest.[43] The early computers were thus very large machines, filling whole rooms.

Then in 1947, a team of engineers at Bell Laboratories invented the transistor, a device that was smaller, more reliable, and used less power than the valve[44]. It was this invention, above all, that was to make the computer a practical business machine. This was well demonstrated by the second generation of computers that appeared in the late 1950s and early 60s, of which the most successful was IBM's 1401.

The next major change occurred in the 1960s when engineers discovered that computer components could be assembled together on or within a continuous substrate. The integrated circuit (IC), commonly known as the silicon chip, came into being. Since then, these integrated circuits have been further compacted in an accelerating manner giving rise to even more advanced technologies called large-scale integration (LSI), very large-scale integration (VLSI), and very high-speed integrated circuit (VHSIC). As each change in technology has been introduced by the data-processing industry, a new generation of computers has emerged.

The most noticeable effect of these electronic developments has been that each generation of computers has been smaller than the previous one. This phenomenon has come to be known as Moore's law. In 1965, Gordon E. Moore, cofounder of Intel the chip manufacturer, wrote an article called 'Cramming more components onto integrated circuits' for the journal *Electronics*, in which he stated that the number of transistors on a silicon chip doubles every year.[45] This came about because the surface area of a transistor was halving every twelve months. In 1975, Moore revised this trend to two years, or, as some say, eighteen months, it doesn't matter which. Table 7.1 provides a set of figures that shows Moore's law at work with the chips manufactured by Intel.[46]

Year	Transistors on Intel chip
1972	3,500
1974	6,000
1978	29,000
1982	134,000
1985	275,000
1989	1,200,000
1993	3,100,000
1995	5,500,000
1997	7,500,000

Table 7.1: *Illustration of Moore's law*

Now the overall effect of this phenomenon is twofold. Not only has the number of chips doubled every year or two, the speed of the circuit has also doubled, for the simple reason that the signals between the components have a shorter distance to travel. In business terms, this has meant that the price-performance of computers—the amount of performance available per dollar—has effectively quadrupled every year or two, which has, of course, greatly expanded the marketplace.

These characteristics of computers have led to the economics of the data processing industry being quite different from any other. To give an analogy, if the car industry had developed in a similar manner, cars would now cost just a few dollars and be able to travel at several times the speed of sound. (How the passengers would fit in is quite another matter!)

But as nearly everyone now recognizes, silicon-based technology is limited. This fact was brought vividly home to me in the mid-seventies when I attended an IBM hundred-per-cent club conference, for those salespersons and managers who had reached their sales quota for the year. One of the speakers at the conference held his hands in front of him about 30 centimetres or one foot apart and said, “this is one light nanosecond”. It takes 10^{-9} of a second for light to travel this distance. So miniaturization cannot continue forever along this line.

Gordon Moore is well aware of this fact for he told a meeting of the world’s top chip designers and engineers on 10th February 2003, “No exponential is forever.” But he then went on to say, “Your job is to delay forever.”[47]

Well is this possible? Will quantum computers, molecular electronics, nanotechnology, or other exotic technologies one day replace conventional silicon chips, leading to the beginning of another growth curve, not unlike the envelope of growth curves in Figure 6.9 on page 541 in Chapter 6, ‘A Holistic Theory of Evolution’.

Maybe. But this is not the point. The capabilities of the computer are not a function just of raw processing power. Neither is the cognitive power of the computer viz-à-viz human beings dependent on the development of ever more complex algorithms, leading to what James Martin has called ‘alien intelligence’, something that human beings cannot understand.[48]

The principal reason for this is that computers are essentially symbol processing machines. They can only handle what is explicit—the appearance of things—not the implicit essence of forms and structures, which, in human terms, we often call intuition, in contrast to reason. So the growth curve of computer technology is inherently limited by the capabilities of symbol processing.

To continue this theme, who needs even the processing power that is projected to become available in the next few years. I was using a four-year old computer to write this chapter in 2007. At the time I bought it, it was the top of its range. Today, the top of the range is a computer running many times faster. But do I really need this additional processing power? The computer I have satisfies my needs quite well, although I really need some more memory.

Some CIOs have also recognized this situation. Do people whose primary use of the computer is word processing really need a 10 GHz machine, or even a 2 GHz one? Of course, professional graphics designers, creating and editing still or moving pictures in two and three dimensions, make much use of the enhanced computing power, as do computer programmers and scientists. But these people are a minority today.

Growth of program structure

When human beings began programming computers in the 1950s, they had to do so directly in the machine’s instruction set. For instance, a move instruction could be `1011`, `B` in hexadecimal. Even though this was comparatively high in the hierarchical structure of computers—as we see in Section ‘Computer structure’ in Chapter 8, ‘Limits of Technology’ on page 624—this was extremely cumbersome, requiring the programmer to perform many tasks that the machine could do far better, such as calculating addresses.

So assembly programming languages emerged that provided a symbolic representation of the instructions as mnemonics (such as `mov`), which were then translated into the machine's opcodes for execution. Each type of computer had a different set of instructions. So each required its own assembler.

But assemblers did not allow programmers to think in the conceptual terms of the problems that they were endeavouring to solve. So high-level languages began to emerge. Among the first of these languages was FORTRAN (FORmula TRANslation), for scientific applications, developed by John Backus, becoming available from IBM in 1957,[49] and COBOL (Common Business Oriented Language), developed by CODASYL (COmmittee/COnference on DAta SYstems Languages) led by Grace Hopper, for business applications.[50] Because FORTRAN had been developed at IBM, then rapidly becoming the dominant force in the data-processing industry,[51] a group of computer scientists in Europe, seeking a 'universal' computer language, introduced ALGOL (ALGOrithmic Language) in 1958, which was the progenitor of PASCAL, named after Blaise Pascal (1623–62), among other languages.[52]

Two other significant developments arose at this time. First, in the example of FORTRAN, functions were provided to perform standard algorithms, such as returning the maximum of a list of numbers and calculating the sine of an angle. This was an extremely important development, the beginning of creating 'building blocks' for program developers. Comparing the task of program development with designing and building a house, pioneering programmers did not have a set of bricks, tiles, doors, windows, light switches, and so on, with which to construct their programs. They needed to create each of these themselves, often 'reinventing the wheel'.

Secondly, operating systems, which provided overall control of the resources of the computer system, became available. The first one I worked with in 1964 was IBSYS, the OS for IBM's 7094, its most powerful computer at the time, which had initially been developed by an IBM customer: General Motors' research division,[53] which was not an uncommon happening. Sometimes customers of computer manufacturers were ahead both of their suppliers and the theoreticians in academia.

Then in 1966, IBM introduced OS/360, designed to run on its System/360 range of computers, so-named to indicate a sense of wholeness, for there are 360 degrees in a circle. By some magic, this later evolved into System/370 and System/390. In terms of reducing the semantic gap between the machine and the human programmer, one of the most important features of OS/360 was the 'device independence' of input/output (I/O). To some extent, programs could be written without specifying the hardware device that they were reading from or writing to. This could be specified in data definition (DD) statements in the Job Control Language (JCL), interpreted at run time. So sequential data, for instance, could be read from cards, tape, or disk without changing the program.

This was all very fine. But there was still one outstanding problem that inhibited the growth of structure of computer programs. Programs are generally seen as a sequence of instructions to the computer. However, sometimes this sequence needs to change depending on some condition or other. To allow for such situations, computers include jump or branch instructions in their instruction set. In high-level languages, these switching instructions were generally implemented by a `goto` instruction.

However, the use of this instruction could lead programs to look like plates of spaghetti, which were notoriously difficult to debug and maintain. The breakthrough came in 1966 in one of the most important papers in the history of the data-processing industry. In that year, Corrado Böhm and Giuseppe Jacopini from Italy wrote a paper, today known as the 'Structured Program Theorem', in which they proved mathematically that all programs could be written with just three control structures.[54]

The first is simply a sequence of instruction executing one after another. In terms of structure, these sequences could be grouped together in functions or subprograms, executed sequentially. The key concept here is a process box, with only one input and output, as shown in Figure 7.1:[55]

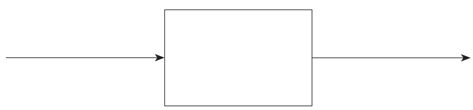


Figure 7.1: *Programming process box*

Secondly, which was the next instruction block to be executed could be selected by testing a Boolean variable, as in Figure 7.2.[56] Note that this is also a process box with one input and output. Thus the process blocks in this diagram could also be selection blocks in a nested, hierarchical fashion, most simply implemented as if-then-else instructions in high-level languages, or just `if-else` in C. When a choice has to be made between several options, to avoid too many levels of nesting, C provides a `switch-case` statement. There are similar facilities in other high-level languages.

The third control structure is the loop or iteration block, as shown in Figure 7.3.[57] In C, this construct is implemented with `for`, `while`, and `do` blocks. However, on their own, these statements are not sufficient to avoid the use of the `goto`, which actually exists in C. Sometimes, it is necessary to interrupt the normal flow of control. In C this is done with a `break` statement, which causes an exit from the innermost loop or `switch` statement, and `continue` statement, which jumps directly to the next iteration of the loop.

However, like so many ground-breaking ventures in all fields, this paper was initially ignored by the mainstream of the data-processing industry. It was left to a few pioneering individuals to promote the benefits of structured or modular programming. Foremost among these was Edsger W. Dijkstra from the Netherlands who wrote a famous letter in 1968 called

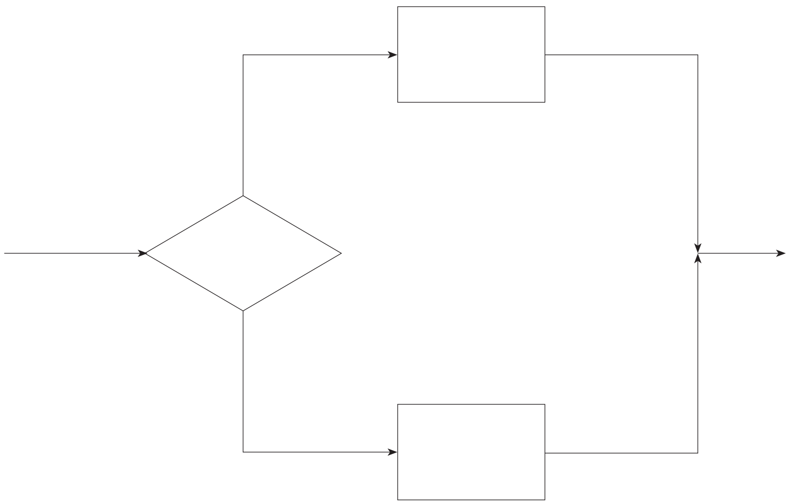


Figure 7.2: *Programming selection block*

'Go To Statement Considered Harmful', in which he described the 'disastrous effects' of the go to statement, and that it should be abolished from all-high level languages.[58]

One who took up the challenge of creating structured programming languages was Niklaus Wirth from Switzerland, the chief designer of Pascal, and several other programming languages. To show how these languages could be used, in 1971, Wirth published a classic paper called 'Program Development by Stepwise Refinement'.[59] Using the example of the 8-Queens problem on a chessboard, he showed how programs could begin with a very high-level description, the program then being developed in a sequence of refinement steps. "In each step, one or more instructions of the given program are decomposed into more detailed instructions. This successive decomposition or refinement of specifications terminates when all instructions are expressed in terms of an underlying computer or programming language."

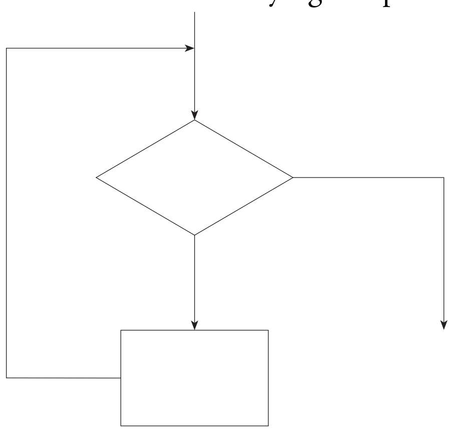


Figure 7.3: *Programming iteration block*

This is a splendid example of human learning as a structured evolutionary process. The whole is visualized from the start in simple terms, which then evolve through a process of divergence and convergence until the structure is complete. A familiar example from the biosphere is the development of an organism from a single fertilized cell, as we see in Figure 6.4 on page 532 in Chapter 6, 'A Holistic Theory of Evolution'. The Unified Relationships Theory and implicate relational logic have become manifest by just such a holistic evolutionary process.

Another major contributor to the development of structured programming was C. A. R. Hoare, from the UK, who was the co-author with Dijkstra and Ole-Johan Dahl, from Norway, of an influential book *Structured Programming*, published in 1972. Dahl, along with Kristen Nygaard from the Norwegian Computing Center, was the originator of the next great step in the growth of program structures. But before we move on to this, it is interesting to note that all these pioneers came from various countries in Europe.

From these theoretical and programming foundations, several people, from both sides of the Atlantic, began to develop tools and techniques that could bring structured programming into human consciousness. These included Larry Constantine and Edward Yourdon from the USA, co-authors of *Structured Design*, Michael A. Jackson from the UK, author of *Principles of Program Design* and initiator of Jackson Structured Programming (JSP), and Glenford J. Myers from IBM, author of *Reliable Software Through Composite Design*, all first published in 1975. In the late 1970s, IBM also introduced a tool called Structured Programming Facility (SPF) running under the Timesharing Option (TSO) of MVS, the then latest version of its mainframe operating system.

But back to the Norwegian Computing Center. As early as the mid 1960s, Kristen Nygaard and Ole-Johan Dahl, together with Bjørn Myhrhaug, designed a computer language called SIMULA (SIMUlation LAnguage)[60] intended to describe complex dynamic systems.[61] The key concepts in SIMULA are class and object, where objects are instances of classes, just as entities are instances of classes in IRL. It is these concepts that gave rise to object-oriented programming and modelling techniques in computer science, bringing these processes close to the way humans think and hence to how the Universe is designed. However, computer scientists are not generally aware that they are implicitly using Integral Relational Logic in this process.

At its simplest, the concept of class can be considered as an extension of the basic [passive] data types in programming languages that match to data types in the hardware. In C, examples are `char`, 'K'; `int`, 7564; and `float`, 3.142857. These can be extended into arrays, called strings when the data type is `char`. Data types can be further expanded in C by the use of `typedef`, which extends the identifiers that can be used to denote data types, making them more meaningful in specific situations, and `struct`, which allows for complex data structures to be defined. Explicitly stating the data types of variables in programs is an important factor in making them more robust. (Active data types in C are operators, such as +, and functions, the 'heart and soul' of the language, which can sometimes be treated in a similar manner to passive data types. For instance, they can be passed as arguments to other functions.)

In an object-oriented programming language, a class includes not only a set of data attributes, but also a set of allowable operations on that data, called member functions in C++, for instance.[62] "A class is a set of objects that share a common conceptual basis."[63] Examples are **book** in a library lending system and **flight** in an airline booking system. To take a simpler example, **rectangle** could be a class with data attributes breadth and height. Member functions could calculate the area and circumference of a particular instance of rectangle. If other attributes are added, such as position, other functions could move, rotate, or draw a rectangle in a drawing program. Data attributes thus determine the shared semantics of a set of objects and functions define their behaviour. So classes contain both passive and active data types, described in more detail on page 625 in Chapter 8, 'Limits of Technology'.

One great benefit of classes is that they provide the basic building blocks for the development of information systems. Once one programmer creates a class, other programmers can use or reuse it, greatly increasing productivity. So unlike the early days of programming, developers no longer need to create their own bricks and tiles in building their 'houses'; they have masses of class libraries available to them. It is therefore not surprising that developers today are inspired by the architect Christopher Alexander's pattern language[64] in developing holistic and 'ecological' systems.[65]

Classes can be reused in this way because programmers do not need to be concerned with how classes are actually implemented. In principle, at least, they are provided with an external interface that is separated from implementation details, called encapsulation or information hiding. Another major benefit of object-oriented programming is that classes form hierarchical structures. Data attributes and functions in a high-level class can be inherited by subclasses lower down the hierarchy. For instance, class **polygon** could have an attribute area, which could be calculated in different ways depending on the type of polygon. Programmers can thus work at whatever level of abstraction suits them, leaving the system to determine what algorithms should be used in which particular instance.

The object-oriented paradigm has also had a profound effect on the way that human beings communicate with computers. The Macintosh desktop metaphor was partially inspired by the Smalltalk programming environment, which built on ideas in SIMULA, developed by a group of researchers led by Alan Kay at Xerox Palo Alto Research Center (PARC) in the 1970s. For instance, icons on the desktop are objects with various attributes, such a creator and type, and functions, such as open. In Word, a character can have various attributes, such as **bold** or <u>underline</u>.

But the Apple Macintosh introduced an even-bigger change in the human interface. In the 1970s, computer programs tended to be menu-driven; users were given a list of options from which to choose. The computer was in charge. This changed with the Mac, which introduced an event-driven approach, giving the user control over the program, in theory, at least. Application programs were written to respond to different events, such as characters entered from a keyboard or mouse clicks on a button or menu.

The practice, however, falls some way short of this ideal. Most particularly, I struggle today with Microsoft products. Not only have they become so complex that I no longer fully understand their underlying conceptual model, Microsoft programmers try to second-guess what I want to do, automating some actions, which I then need to spend time undoing. In the years since I bought my first Mac in 1986, I have used three programs for writing and publishing: Microsoft Word and Adobe FrameMaker and InDesign. But none of these programs on their own provide me with all the tools I need to write this book with full ease-of-use and functionality. Because of the intense competitiveness of the marketplace, evolutionary convergence is still struggling with divergence, leaving users with a set of fragmented tools that do not fully meet their integrative requirements.

Growth of systems modelling structures

Writing computer programs is but one part of designing and developing the information systems that modern enterprises need to manage the complexity of their business organizations. What is needed here is a fully integrated model of all the processes taking place within an organization and of the entities on which these processes operate, independent of whether these processes are performed by machine or human being.

Not surprisingly, the modelling methods and tools that have evolved over the years show the same growth of structure as any other evolutionary process. These have led to the Unified Relationships Theory, which provides a comprehensive model of the psychodynamics of the whole of society, including the modeller's own creative thought processes, and hence of the whole of evolution from Alpha to Omega. Some of these modelling techniques became extinct species, unable to evolve any further, while others have been the basis for further development or have survived more or less intact as primitive species.

One of the extinct species is Business Systems Planning (BSP), which was one of the triggers that led to Integral Relational Logic, as I describe on page 19 in Part I, 'Integral Relational Logic'. As I explain, the difficulty of representing an APL program dynamically creating and destroying other programs in a BSP process-entity matrix was a major factor that led to me to discover the essential difference between human beings and computers, for this led me to see that computers cannot program themselves without human intervention, as I describe in the Section 'Computer-driven program development' in Chapter 8, 'Limits of

Technology' on page 633.

On the other hand, one basic species that is still in use today is the flowchart, introduced by Frank Bunker Gilbreth, an early advocate of scientific management, to members of the American Society of Mechanical Engineers (ASME) in 1921. A flowchart is a

> graphical representation of a process, such as a manufacturing operation or computer operation, indicating the various steps that are taken as the product moves along the production line or the problem moves through the computer. Individual operations can be represented by closed boxes on the flowchart, with arrows between boxes indicating the order in which the steps are taken.[66]

Actually, flowcharts were used both for modelling systems and programs, and suffered from the same problems as the programs themselves using the `goto` statement. The rhombus symbol was used to represent choices in flowcharts, leading them to great complexity, often stretching over many sheets of paper, with links between the sheets. As computers still had very limited graphical facilities in the 1960s, these flowcharts were very difficult to maintain and could easily get out-of-date.

When flowcharts got really complicated with multiple choices to be made, these could be elegantly represented in a concise tabular form called a decision table, which corresponded to `if-then-else` and `switch-case` statements in a structured programming language. Here is a simple example for a printer troubleshooter.[67]

		Rules							
Conditions	Printer does not print	Y	Y	Y	Y	N	N	N	N
	A red light is flashing	Y	Y	N	N	Y	Y	N	N
	Printer is unrecognized	Y	N	Y	N	Y	N	Y	N
Actions	Check the power cable			X					
	Check the printer-computer cable	X		X					
	Ensure printer software is installed	X		X		X		X	
	Check/replace ink	X	X			X	X		
	Check for paper jam		X		X				

Table 7.2: *A decision table*

Structured programming also led naturally to a set of structured system analysis and design methodologies. Many innovators contributed to these techniques, including those already mentioned: Larry Constantine, who invented data flow diagrams, Ed Yourdon, Glenford Myers, and Michael A. Jackson. Others who also made major contributions were Wayne Stevens,[68] Peter Checkland,[69] and Chris Gane and Trish Sarson.[70]

One of the methods that arose from these theoretical foundations was Structured System Analysis and Design Method (SSADM) developed by Learmouth and Burchett Management Systems (LBMS) in conjunction with the UK government's Central Computer and Telecommunications Agency (CCTA) in the early 1980s. Such a structured approach was absolutely essential because the UK government was the largest user of information systems in the UK and had suffered some very expensive failures with taxpayers' money in the 1970s, although I do not remember the details.

SSADM is based on a staged approach to systems analysis and design, beginning with a feasibility study, continuing with requirements analysis and specification, which leads to a logical systems specification, which can then be physically implemented in a particular computer system.[71] There are three basic techniques in SSADM: logical data modelling, creating a data model of entities and the relationships between them; data flow modelling, describing the way data moves through a system; and entity behaviour modelling, documenting the events that affect each entity and the sequence in which these events occur.[72]

Another interesting structured design technique was developed by the U.S. Air Force Program for Integrated Computer Aided Manufacturing (ICAM), which sought to increase manufacturing productivity through systematic application of computer technology. This technique is called IDEF, initially standing for ICAM DEFinition language, later becoming Integration DEFinition, when the technique became standardized. IDEF was based on Structured Analysis and Design Technique (SADT), originally developed by Douglas T. Ross of SofTech in 1972.[73]

There were initially three basic modelling techniques in IDEF:[74]

IDEF0, used to produce a 'function model'. A function model is a structured representation of the functions, activities or processes within the modelled system or subject area.

IDEF1, used to produce an 'information model'. An information model represents the structure and semantics of information within the modelled system or subject area.

IDEF2, used to produce a 'dynamics model'. A dynamics model represents the time-varying behavioural characteristics of the modelled system or subject area.

IDEF0 is perhaps the most interesting. It is a strictly hierarchical modelling method, based on a decomposition technique. At the highest level is a diagram called A0, which encapsulates the function of the entire system in a single box, such as Figure 7.4:

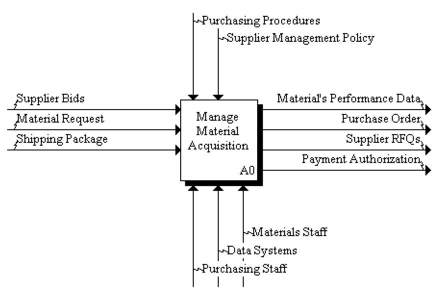


Figure 7.4: *IDEF0 A0 top-level chart*

The horizontal lines mark inputs and outputs. Arrows connected to the top side of the box are controls, specifying the conditions required for the function to produce correct outputs.

Arrows at the bottom represent mechanisms, identifying some of the means that support the execution of the function.[75] An A0 box would then be decomposed into A1, A2, A3, etc, and then into A11, A12, A13, etc.Today, IDEF has been extended up to IDEF14,[76] although I do not know to what extent the additional modelling techniques are being used.

With the development of these structured analysis and structured design methods, there was a great need to use the computer itself to help with the documentation of systems. In the early days, systems analysts suffered from the problem that you never see a tailor in a new suit of clothes. This problem began to be solved in the early 1980s with the introduction of computer-aided software engineering (CASE) tools, a term coined by Nastec Corporation in 1982. Today, there are a multitude of different CASE tools covering a wide range of modelling techniques. However, there is not yet an educational tool for IRL, which enables the modeller to model her or his own thought processes.

The introduction of object-oriented programming languages naturally led into object-oriented systems analysis and design techniques, taking these methods as close as possible to the underlying structure of the mind and hence of the Universe. One of the pioneers in this field was Peter Coad, founder of Object International in 1986,[77] and co-creator with Edward Yourdon, a structured design pioneer, of the Coad/Yourdon of object-oriented analysis[78] and design.[79]

Other pioneers were Grady Booch, who developed the Booch method[80] at Rational Software around 1990, and James Rumbaugh, who developed the Object Modeling Technique (OMT)[81] at General Electric Research and Development Center.[82] Rumbaugh joined Booch at Rational Software in 1994 to develop the Unified Modeling Language (UML).[83] They were joined there by Ivar Jabobson, who invented use cases as a way to specify functional software requirements when working for Ericsson in Sweden in the 1980s.[84] In 1987, he had left Ericsson to set up Objective Systems, a company where he created Objectory also known as Object-Oriented Software Engineering (OOSE).[85] Ericsson purchased a substantial stake in this company in 1991, renaming it Objectory AB, and then sold it to Rational Software in 1995.[86]

It was a natural evolutionary process for all these different object-oriented modelling tools to be integrated into a single system, for they were all addressing essentially the same problem. After twenty-five years struggling to develop practical modelling tools, IBM bought Rational Software in 2003 for 2.3 billion dollars,[87] which shows how central to the management of the complexity of modern corporations these modelling tools have become. Not unnaturally, the UML has become the de facto information systems modelling tool in business today.

Although the designers are not aware of this fact, the UML is implicitly based on IRL, which models both the structure of the Rational Unified Process (RUP), an iterative software development process covering the software development life cycle,[88] and beings in the UML itself, which are called things, relationships, and diagrams. Things and relationships correspond to nodes and arcs in a graph in mathematics, displayed in diagrams. So the UML operates at a very high level of abstraction.

Things are classified as structural, behavioural, grouping, and annotational things, the first two being the nouns and verbs of the language. The other two are organizational and explanatory elements. Relationships are the basic relational building blocks in the UML. There are four of them: dependency, association, generalization, and realization. The overall architecture of the UML can be looked at through five interlocking views, documented in nine or more different types of diagram, of which the class model is the most important, as described in Chapter 1, 'Starting Afresh at the Very Beginning'.

There is no need to go any further into these levels of complexity, for the purpose of this chapter is illustrate the growth of structure, with the UML representing a very high point in the growth of the complexity of business information systems. This evolutionary process is not only modelled in Integral Relational Logic, but this growth of complexity-consciousness has also led to IRL's development as a universal modelling method of the utmost abstraction and generality.

Growth of data storage structures

Not that the UML was the immediate precursor to IRL, which began to emerge in consciousness in 1980, some fifteen years before UML. It is only in retrospect that some of the structures of UML have been used to describe IRL. Actually, it was Ted Codd's relational model of data that was IRL's immediate predecessor, as explained in Part I, 'Integral Relational Logic'. So in the next section, we look briefly how this modelling technique fits into the growth of data structures, perhaps the most fundamental of all growth processes in human society, for this relates to how we have long organized our records, giving birth to the sense of linear time.

However, before we look at how we organize our records today, it is useful to put modern storage technology into its historical perspective. As human memory is both fragile and personal, we have used a variety of materials over the years to store our records, in the widest sense of this word. The earliest records we have discovered from about 5,000 years ago in Mesopotamia were inscribed on clay tablets before they were fully dry. This material was to be in use for about two thousand years alongside papyrus, before the latter eventually won the day.[89]

Papyrus, which was in plentiful supply along the Nile, was, of course, the primary writing material of the ancient Egyptians and later of the Greeks and Romans[90]. However, it had one major disadvantage: it could not be folded without cracking.

So records on papyrus were written on rolls, which could get quite long. This meant that the user had to rewind the roll after reading it.[91] It was also not easy to find a specific reference on the roll. The papyrus roll, which was in regular use until the ninth century AD and sporadically until the twelfth century,[92] was thus rather like a magnetic tape in the early days of the data-processing industry or a cassette tape in the music industry.

The major alternative to papyrus during ancient times was parchment, invented about 190 BC, although raw leather had been used as a writing material long before this date. It seems that Ptolemy V of Egypt was afraid that the library of Eumenes II of Pergamum in Greece (now in Turkey) would outstrip his own book collections at Alexandria.[93] So Eumenes invented parchment (derived from *Pergamum*), a greatly refined form of leather made from sheep, goat, or calf skins, the last being called vellum.[94]

Parchment had several advantages over papyrus. "A sheet of parchment could be cut in a size larger than a sheet of papyrus; it was flexible and durable, and it could better receive writing on both sides."[95] Furthermore, it could be folded and stitched together to form a codex, not unlike our modern books. The codex was the world's first random access device, because it was possible to go directly to a page of information, not possible with a roll of papyrus, which could only be read sequentially.

Eventually paper was to replace both papyrus and parchment, although it took a long time in coming. Paper was invented in China about 105 AD. However, it did not reach the Middle East until the eighth century and it was not in common use in Europe until the fifteen century, when the invention of the printing press greatly increased its demand.[96]

For most of this time, paper was made from rags. It was not until the beginning of the nineteenth century that wood pulp became the most common source of fibre for paper-making. At about this time, the first paper-making machine was invented that could use this wood pulp to make a continuous sheet of paper wound round cylinders. Before this time, each sheet of paper was individually made by hand.[97]

During all these millennia, it was human beings who both wrote and read records on these various materials. Then, in the 1880s, this situation changed radically. During this decade, Herman Hollerith invented a machine to punch and count cards, which he used in the 1890 census in the USA.[98]

This was not entirely a new invention. At the beginning of the nineteenth century, Joseph-Marie Jacquard had enhanced the punched card, invented fifty year earlier, to automatically control the patterns of weaving of cloth in a loom.[99] And Charles Babbage adopted this invention as an input/output device for his analytical machine, which never actually got built in his lifetime.

Hollerith's machine was so successful that in 1896 he organized the Tabulating Machine Company, incorporated in New York, to manufacture these machines; through subsequent mergers this company grew into the International Business Machines Corporation (IBM).[100]

Punched cards were to play a key role in business data processing until well into the 1970s. They were eventually replaced as a storage medium by magnetic devices, such as tapes and disks, and as an input medium by MICR and OCR machines, human beings at visual display units (VDUs), and by computers being directly connected to each other in networks.

But this was not the only thing that changed at this time. During the 1950s, the stored-program computer began to be used as a business machine. This invention introduced the most fundamental change in the storage of our records in five thousand years. For the computer is an extension of our minds. And by storing our records in computers, we were, in effect, extending our collective memory.

This was a gigantic step. For while some people can remember a large number of telephone numbers, for instance, for myself, I can barely remember more than about five at a time. And how many of us can remember a whole directory of telephone numbers, never mind the vast quantities of other records we keep in our computers?

Of course, if we were to make use of this extended memory, we needed to find ways to organize and access it. At first, this facility was fairly limited because records were stored on magnetic tape, a sequential medium. So tapes had the same limitations that papyrus rolls had had two or three thousand years earlier.

This situation led to computers getting quite a bad name. For when customers rang companies enquiring about their orders or bills, they were often told something like, "Sorry, I don't have that information, it's on the computer."

What changed this was the invention of random access devices, like disks and drums, which IBM generically called direct access storage devices (DASD). With these devices, it was possible to go directly to a particular record of interest, thus enabling customer service personnel and other staff immediate access to the stored data.

The first computer disk storage system, the RAMAC (random access), was invented by IBM in 1956. It was displayed at the 1958 World's Fair in Brussels, where it was used to answer questions on world history in ten languages.[101] But it was not until the mid sixties that it became a practical proposition in business. Even then, it was severely limited. The first (removable) disk drive I worked with around this time was the IBM 2311, with the capacity of 7 MB, about four floppy disks familiar in the 1980s and 90s. Since then the capacity of random access storage devices has grown exponentially, so that today the capacity of these disks is measured in gigabytes and even terabytes.

Growth of data structures

When programmers began to use random access devices to store data, they inevitably needed to work closely with the machine. At the basic physical level, random access devices are divided into sections with various names such as blocks, clusters, sectors, and pages. These sections typically range in size between 512 and 4096 bytes, corresponding to pages in a book.

It is the job of the disk management software to organize these pages, most commonly through a hierarchical directory structure familiar to us on the desktops of our personal computers. It is this directory structure that is being created when we format our hard disks, with HFS or HFS+ on Mac OS, FAT16, FAT32, or NTFS on Windows, HPFS on OS/2, and UFS on UNIX, including Mac OS X.[102] At this level, the disk stores folders and files, analogous to the filing systems we use to organize our papers. Hence the desktop metaphor introduced in the Macintosh in 1983 or thereabouts.

However, what we are really interested in is the structure of the data in these files. In the 1960s, a number of access methods were developed to facilitate this process. The ones I was familiar with came with OS/360. There were three main types.

The simplest, SAM (sequential access method), merely mimicked on disk the sequential processing of a tape drive or card deck. At the opposite end of the spectrum, there was DAM (direct access method), which provided random access to records typically using some form of hashing algorithm, determined by the programmer. ISAM (index sequential access method) came between these two extremes. It sought to get the best of both worlds: to enable programs to process files sequentially when this was necessary, while at the same time providing direct access to individual records through a set of hierarchical indexes. However, these access methods were still more oriented to the machine than the programmer. What was needed was for the human view of the data to be completely independent of the data structures in the machine.

Thus the concept of data independence arose, which can be seen as an extension of an earlier concept: device independence, as mentioned on page 581. Data independence goes one step further than this. The aim is to develop a system whereby programs are independent of the way that the data is stored and accessed. In this way, databases can be designed so that they provide a flexible and accurate representation of the changing nature of the business. If it is decided to change these data structures and access methods, there is less need to change programs or recompile them.[103]

The means by which data independence is provided is through database management systems (DBMS). The purpose of the DBMS is to provide a single repository of all the data in an organization so that it can be managed as a coherent whole. This is not to say that the database is physically in one place. Databases can be distributed across an organization. But the aim is to make all these physical databases look like a single unit.

The overall effect of a DBMS is that files of data do not belong to individual departments or the applications that automate the processes in these departments. A central role of a

DBMS is therefore to provide access to this integrated repository to all authorized users in the organization, or, in these days of the Internet, to users throughout the world.

To perform this integrating activity, two key roles emerged in many organizations: database administrator and data administrator. The former is responsible for technical management of the DBMS, itself, while the latter takes a more business-oriented view of the overall information structure of an organization.

The network approach

The pioneering figure in database management systems was Charles Bachman, who worked for General Electric in the 1960s and later Honeywell. He developed a DBMS called Integrated Data Store (IDS).

The word *integrated* is interesting here. It indicates that right from the outset of random access devices, the emphasis was on integrating data that had previously been held in separate files. It is a clear example of the convergent tendencies in evolution.

The basic data structure in IDS, as Bachman explained in a seminal article published in 1965,[104] was the chain, which permitted groups of related records to be linked together, as Figure 7.5 shows. Each record in the chain contained a pointer to the next record, a facility that was quite impossible until the introduction of random access devices.

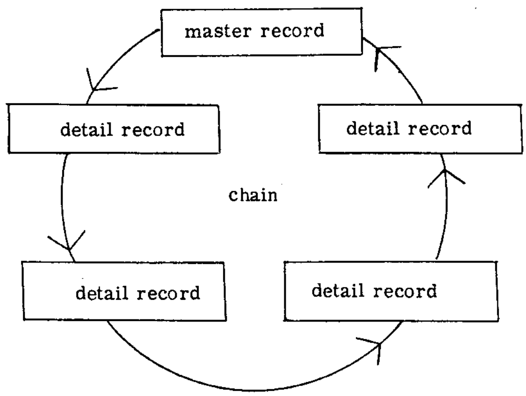


Figure 7.5: *IDS chain of records*

One of the first uses of IDS was in the management of engineering parts lists, commonly called 'bill of materials', the foundation of a manufacturing business. Typically, the products that businesses sell consist of a multitude of parts and subassemblies, which can be incorporated into many different products. Organizing and managing all these records was quite a challenge, especially as the number of products and their subassemblies could be in the tens of thousands.

This network approach to data management was then picked up by the Data Base Task Group (DBTG) of CODASYL (Conference On DAta SYstems Languages), the organization that had introduced the programming language COBOL in 1959.

The DBTG did not set out to develop a DBMS per se. Rather they sought to define a Data Description Language (DDL), which could describe the structure of a database independent of any programming language, and a Data Manipulation Language (DML), which could be embedded in a host language such as COBOL or PL/1, for accessing the records in the database. The aim was to set an industry standard that could provide the foundation for the development of DBMSs.

Charles Bachman was naturally an influential member of this committee, which included representatives from many of the leading computer companies at the time, including IBM, Honeywell, Burroughs, and Univac, and some leading business corporations, such as General Motors and Bell Telephones.

The DBTG produced two reports, in 1969 and 1971, defining what they hoped would become the industry standard.[105] During the 1970s, several DBMSs were developed based on the DBTG proposal, of which the leading exemplar was Integrated Database Management System (IDMS) from Cullinet Software.[106]

In essence, data structures in DBTG are very simple. They contain just two constructs, records and a set of links connecting them, called either a DBTG or CODASYL set, to distinguish these sets from sets in mathematics. To use an example given by Chris Date, a leading authority on DBMSs, suppose we wish to record information about concerts, which works are performed at each concert, and who the composer of each work is.

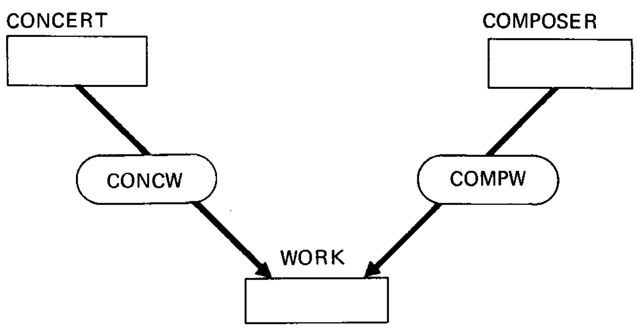
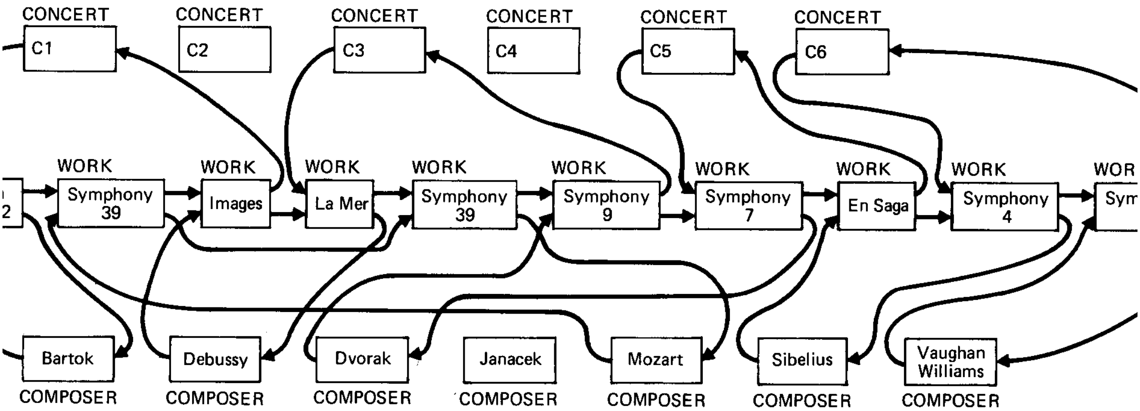


Figure 7.6: *CODASYL's DBTG conceptual model example*

Figure 7.6 illustrates the relationships between the DBTG constructs in this case.[107] The rectangular symbols represent records and the other symbols the DBTG sets of links between them. Notice that these links are unidirectional. A set of links is always between an owner or parent and members or children.

Now this diagram just shows the relationships between the various elements in the database at the abstract, conceptual level. It does not show how individual concerts, works, and composers are linked together. An example of these connections is shown in Figure 7.7. Notice the chains of links between works and concerts and between works and composers.



: *CODASYL's DBTG instance model example*

The basic weakness of this approach is that while the DBTG model has the property of device independence, as the 1971 report indicates, it does not fully support data independence. This was spelt out quite clearly by Robert W. Engles, one of the IBM representatives on the 1971 committee.[108] His paper on this subject became known as the 'IBM position paper'.[109]

The hierarchical approach

In the meantime, what was IBM, itself, doing? Well, in the early 1960s, it had developed a DBMS called BOMP, designed to support bills of materials in manufacturing industry, just like IDS.[110] However, when IBM came to standardize on a single DBMS in 1969, when they 'unbundled', began to charge separately for software and services, they chose to do so with a product called Information Management System (IMS),[111] a system developed by or with North American Rockwell.[112]

Now the basic data structure in IMS is exactly the opposite of the DBTG model. It is hierarchical rather than nonhierarchical in the network approach. Of course, the DBTG supports hierarchical structures, just as IMS supports nonhierarchical ones. For any DBMS must support both these opposites as they are both inherent in Nature by the Principle of Unity.

However, for myself, I find hierarchical structures easier to understand. For hierarchies are the fundamental organizing principle of the Universe. For example, this book is hierarchically structured. It consists of parts, chapters, sections, subsections, paragraphs, sentences, words, and characters, all organized hierarchically. Arthur Koestler[113] and more recently Ken

Wilber[114] have placed their primary emphasis on hierarchical structures in their unifying theories.

Nevertheless, hierarchical structures have had something of a bad press in recent years because they are associated with patriarchal, authoritarian structures, as in the military, churches, schools, universities, governments, and companies. We can see why this is so from the root of the word *hierarchy*, which means 'chief priest'.

So today there is a powerful movement emphasizing the 'Web of Life', led by such people as Fritjof Capra.[115] For such people, the tree of knowledge is deprecated, a clear sign of dualism at work. For Wholeness is the union of all opposites.

Because not all structures in the Universe are hierarchical in nature, IMS provides two hierarchical views of data. The first describes the physical structure of the database, and the second logical structures, defined through various constructs that correspond to the DBTG DDL. The DML in IMS is called Data Language/1 (DL/1) presumably modelled on IBM's PL/1 (Programming Language/1).

The disadvantage of these two hierarchical views of data in IMS is that the symmetry of the network approach is lost. It is not possible to treat all data elements in the same, consistent manner. So while the latter is symmetrical and rather complex, the former is simpler, but unsymmetrical.

To illustrate the hierarchical structures of IMS, Figure 7.8 shows an example, again borrowed from one of Chris Date's many books.[116] It shows a record type in an education database consisting of courses, their prerequisites, dates on which they are held, the teachers of each offering, and the students enrolled on each course. The parts of the record in the hierarchy are called segments in IMS.

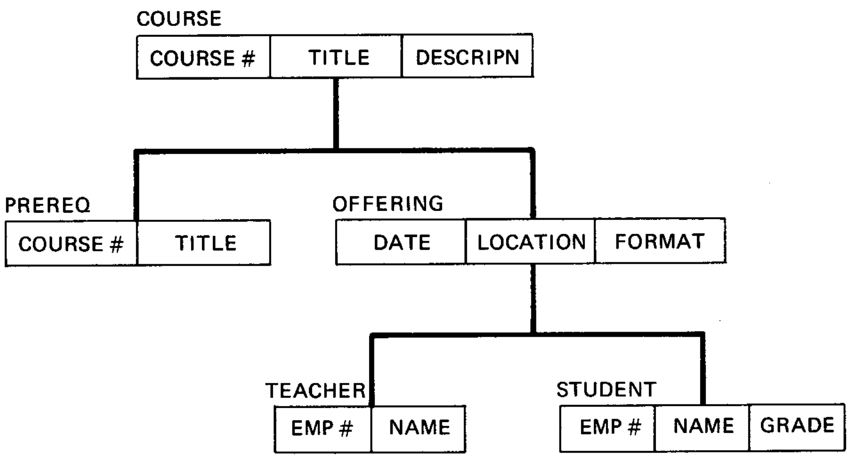


Figure 7.8: *IBM's IMS conceptual model example*

Like the concerts example in the network approach, this diagram shows just the abstract, conceptual relationships between the various segments in the record. It does not show relationships between actual occurrences of segments in the database. Such an example is given in Figure 7.9.[117]

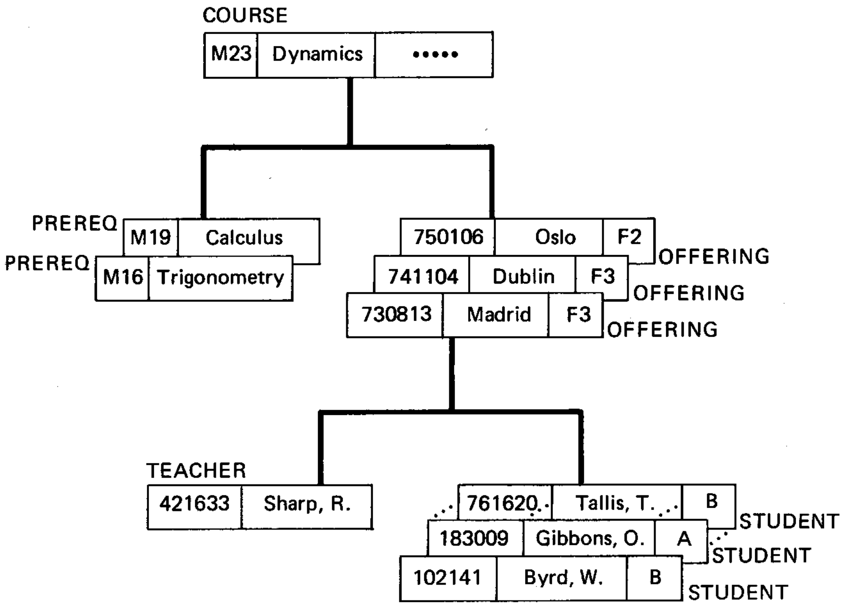


Figure 7.9: *IBM's IMS instance model example*

This diagram shows that, like the DBTG model, IMS does not fully support data independence. For instance, if it were decided to store offerings before prerequisites for some reason, then the programs that access the database would need to be changed. They are not independent of the way that the data is stored.

The relational model of data

The man who solved the problem of data independence was Ted Codd, an English mathematician who joined IBM in the USA after the Second World War, when he had served as a pilot in the Royal Air Force. In the late 1960s, Codd was working as a fellow in IBM's research laboratory in San Jose in California.

While there he realized that all data structures in a database could be seen in terms of mathematical relations, which are simply a type of set. Furthermore, he saw that the members of these sets could be expressed in the language of predicate calculus. He called this approach to database design a relational view or model of data.

Codd published his ideas in two seminal papers in 1969 and 1970 called 'Derivability, Redundancy and Consistency of Relations Stored in Large Data Banks'[118] and 'A Relational

Model of Data for Large Shared Data Banks',[119] respectively. This is the key sentence in both these papers: "It [the relational view (or model) of data] provides a means of describing data with its natural structure only—that is, without superimposing any additional structure for machine representation purposes."

The first paper was published as an IBM research report. It therefore had a limited availability and is not well-known, even by database experts. For instance, it is not available from the British Library Document Supply Centre (BLDSC), the largest repository and supplier of research papers in the world.

In this initial paper, which I did not read until 2001, Codd thought that he would need to use second-order predicate logic as the basis of a language to retrieve records from a relational database. However, by the next year, he had simplified the model by eliminating repeating groups in records, like those shown in the IMS education database above.[120] He thereby realized that first-order predicate logic was a sufficient basis for any language designed to query the database.

This second paper was published in the *Communications of the ACM*, ACM being the leading organization of computer scientists in the USA. In it, Codd acknowledged that he was not the first to think of applying relations to data systems. Someone called D. L. Childs had published this idea in 1968. However, as this paper was not mentioned in Ted Codd's first paper, it is likely that Codd had had the idea relatively independently, a clear sign of morphic resonance at work.

It is impossible to overstate the significance of the 1970 paper. Quite simply, it described the key features of a mathematical theory for the basic resource of the data processing industry: data itself. It is the foundation on which the whole of computer science and the information technology industry can be built.

Well, nearly. As Kurt Gödel showed in 1931, mathematics has no foundation within the dualistic framework of Western civilization. In order to give mathematics and indeed all knowledge a solid foundation, we need a Nondual Context that unifies and transcends all opposites, as this book shows.

The reason why this is possible is that data structures in databases are nondeductive in character, as Codd pointed out in a little-noticed second paragraph in his 1970 paper. So Integral Relational Logic, which has evolved naturally from the relational theory of data, is essentially noninferential, and therefore not constrained by the Aristotelian assumptions of mathematics and conventional logic.

Despite the impeccable pedigree of the relational model of data, it fell on very stony ground when it was first published. The blindness and short-sightedness that Arthur Koestler described in *The Sleepwalkers* still pervades many today. It is amazing how long it sometimes takes us to see something that is standing right in front of us.

In the case of the relational model of data, it is not difficult to find the reasons for this blindness and short-sightedness. First of all, as Chris Date, another English mathematician who worked for IBM in the 1960s and 70s, acknowledged, even those who advocated the relational approach did not fully understand it at the time.[121] It has naturally taken many years to gain a clear understanding of its full implications; this is in the nature of evolution.

Secondly, the relational model of data entered the world when two branches of the Establishment, CODASYL and IBM, favoured the network and hierarchical approaches, respectively. They saw the relational model as a threat, as just another way of structuring data; they did not see that the relational model could unify and heal the conflict between the two opposing approaches at the time.

In terms of the DBTG model of CODASYL, this led to a 'Great Debate' in 1974 between Charles Bachman, for the network approach, and Ted Codd, for the relational approach, complete with 'seconds', like an old-fashioned duel.[122]

This is how Robert Ashenhurst reported the session:

> ... the whole session must certainly be put down as a milestone event of the kind too seldom witnessed in our field—Charlie Bachman, representing the Establishment and the folks who gave us the Data Base Task Group Report and many more-or-less functioning data management systems, *versus* Ted Codd, representing the Alternative Way, not extensively embodied in large systems as yet.[123]

As for IBM, they issued a statement of direction in 1971 stating that IMS and DL/1 were to be their strategic database products for the foreseeable future.[124] In the light of the Great Debate they reaffirmed this strategy in 1976. Evidently, IBM wanted nothing to do with either the DBTG or the relational model of data, developed by one of its own employees.[125]

In the event, commonsense prevailed. During the 1970s, a number of organizations, including IBM, explored how the relational theory of data could be used to build relational DBMSs, call RDBMSs. Ted Codd's eleven-page, arcane paper has led to the development of a multibillion-dollar industry, including such major companies as Oracle and Sybase, whose product lines are based solidly on Codd's seminal ideas. Forbes magazine once judged Larry Ellison, the founder of Oracle, the richest man in the world,[126] such is the significance of the relational model of data.

Oracle Corporation, founded in 1977 as Software Development Laboratories (SDL),[127] is the market leader in database systems, and a Fortune 500 company.[128] IBM, itself, did not introduce DB2, its primary RDBMS until 1983.[129] In 1984, Mark Hoffman and Bob Epstein founded Sybase, which went into partnership with Microsoft in 1988.[130] Even though they subsequently diverged, there are many similarities between Microsoft SQL Server running under Windows, and what is now called Sybase Adaptive Server Enterprise (ASE), running mainly under UNIX.

However, these developments led to further debates between the mathematicians and the practitioners. The former, led by Ted Codd and Chris Date, pointed out that in many respects, RDBMSs implemented only some of the principles of the relational model, and even, in some cases, violated some of its rules.[131] We do not need to go further into these rather technical issues here.

Nevertheless, it is useful to look in a little more detail at the relational model, for it helps to give Integral Relational Logic a greater air of authenticity for those who feel threatened by its central proposition: the Principle of Unity.

It is important to note here that the underpinning of the relational model of data is more mathematical than semantic in origin, even though the central concept of relation is based on that of set, which is as much key to semantics as mathematics. For while mathematics is generally considered to be the science of number, quantity, and space, more generally it is the science of patterns and relationships, which underlie the new maths.

What then, is a relation in the relational theory of data? Well, it is something that is familiar to us all. It is a table consisting of rows and columns, as we see on page 193 in Chapter 2, 'Building Relationships'. The table is a most convenient way of organizing sets of related information. Indeed, the clay tablets that were found in Mesopotamia some 5,000 years ago contained tables of information with three columns containing drawings of objects, numerals, and personal names, no doubt the numerals indicating the number of each pot, knife or whatever, and the names stating who owned them.

The formal definition of a relation illustrates a number of other key features of this fundamental data structure. This is the mathematical definition of a relation that Ted Codd gave in his original papers:

> Given sets S_1, S_2, …, S_n (not necessarily distinct), *R* is a relation on those *n* sets if it is a set of *n*-tuples each of which has its first element from S_1, its second element from S_2, and so on. We shall refer to S_j as the *j*th *domain* of *R*. As defined above, *R* is said to have *degree n*. Relations of degree 1 are often called *unary*, degree 2 *binary*, degree 3 *ternary*, and degree *n n-ary*.[132]

In early editions of *An Introduction to Database Systems*, Chris Date provided a similar definition of a relation. But in the seventh edition, he provides a revised definition, which makes a clear and important distinction between the heading and the body of a relation:

> Given a collection of *n* types or domains *Ti* (*i* = 1, 2, …, *n*), not necessarily all distinct, *r* is a **relation** on those types if it consists of two parts, a *heading* and a *body*, where:
>
> a.The **heading** is set of **attributes** of the form *Ai:Ti*, where the *Ai* (which must all be distinct) are the *attribute names* of *r* and the *Ti* are the corresponding *type names* (*i* = 1, 2, …, *n*).
>
> b.The **body** is a set of *m* **tuples** *t*, where *t* in turn is a set of components of the form *Ai:vi* in which *vi* is a value of type *Ti*—the *attribute value* for the attribute *Ai* of tuple *t*, (*i* = 1, 2, …, *n*).
>
> The values of *m* and *n* are called the **cardinality** and the **degree**, respectively, of relation *r*.[133]

Two key points are contained within these definitions. First a relation consists of two parts, a heading and a body. These correspond to what are called intension and extension, respectively, in traditional logic. However, the heading is more often called a schema or scheme, which defines the structure of the relation, which corresponds to the epistemological level of IRL.

Secondly, each attribute in the relation draws its value from a domain of values. For instance, an attribute denoting someone's age would typically draw its values from a domain that ranged from 0 to 120 years, let us say. Not that domains of values consist of just numbers. The relational model of data supports both quantitative and qualitative values with equal facility.

For example, a domain of values could consist of the set {red, blue, green, cyan, magenta, yellow} and many other colours. The attribute value would then be a member of this set. But domains of values can contain much more complex members. For example, if we wanted to create a relation containing information about different species of birds, we might want to have attribute values that are still pictures of the birds, video pictures of the birds in flight, and sound clips of bird songs.[134]

Each row or tuple in a relation contains a record of information about a particular entity. The set of entities represented in a relation form a class. A relation can thus be thought of as a propositional function in first-order predicate logic. For instance, in the telephone directory example in Chapter 2, the telephone subscriber relation could be written as a propositional function, where the unknowns are predicates, like this:

The telephone subscriber with name *Name* lives at address *Address* and has telephone number *Telephone number*.

Replacing the unknowns with entries in a particular row in the relation could generate this sentence:

The telephone subscriber with name Jackie Butler lives at address 25 Orchard Way and has telephone number 955-4395.

This record is then a proposition in logic, with the value 'true'. If the telephone number read '429-8490', then this would be a false proposition. So providing all unknowns in propositional functions have a value, a database can be seen as a collection of true propositions.[135] In practice, this is not always the case. Some attribute values may be NULL, a subject that has caused no end of debate among the cognoscenti.

While values in relations are atomic, there is no theoretical reason why domains should not include data structures like arrays and sets, including relations. This would not violate the rule that data elements in relations should be atomic if these structured data types are encapsulated in object-oriented programming terms. In other words, from the point of view of the relational model, the internal structure of a structured domain of values is hidden from the user, in contrast to the structure of the relation, itself, which is completely open for access.[136]

This situation has led to some confusion in the relationship of the relational model of data to the object-oriented view. Each row or tuple in a relation contains a record of information about a particular entity. The set of entities represented in a relation form a class, which Ted Codd called an 'entity type' in his 1969 paper.[137]

It thus seems obvious that entity type in the relational model corresponds to class in the object-oriented model. However, Chris Date has emphatically called this mapping a 'Great Blunder'.[138] For him, a class in OO languages is just a data type and relations are not domains. This is because in the relational model a relation is a variable that can take different values dynamically, while a domain of values is a relatively static construct. The latter is neither a variable nor a value. To illustrate this, in C a data type can be given a name with the `typedef` statement called a 'tag'.

However, this is not an either-or situation. As far as I can tell as a nonprogrammer, a class in OO languages actually functions like both an entity type and a data type. These languages do not make a clear distinction between these two quite different ways of determining semantics. So Rational Rose Data Modeler, for instance, maps both a Table (entity type) and Domain (data type) in the relational model to a Class in the UML, which seems the correct approach.

This rather technical problem has given rise to a dispute between the OO and relational communities. The former seems to think that they could extend these programming techniques into the database arena, displacing the relational model of data, just as the relational model had displaced the earlier network and hierarchical approaches. However, as far as I am aware, most databases today are still based on the relational model, not the least because of its mathematical pedigree.

Nevertheless, the last time I investigated this issue, around 2002, this confusion had still not been satisfactorily resolved, as evidenced by two major books on this subject. They are *Foundation for Future Database Systems: The Third Manifesto, Second Edition*, written by Chris Date and Hugh Darwen and *The Object Database Standard, Third Edition*, edited by R. G. C. Cattle and Douglas Barry, both published in 2000.

Be that as it may, the relational and object-oriented modelling techniques have merged in Integral Relational Logic, which is not directly concerned with the expression of these structures in computer technology. IRL is more concerned with healing the mind in Wholeness, which we look at in Chapter 13, 'The Prospects for Humanity' on page 1027.

Growth of conceptual modelling structures

The growth of data structures has led naturally to the growth of data modelling structures, which would be better called information, conceptual, or semantic modelling. For as we saw on page 159 in Chapter 1, 'Starting Afresh at the Very Beginning', in the data-processing industry, information is data with meaning. And all we can really say about the structure of data prior to interpretation by a knowing being is 'Wholeness is the union of all opposites'—the Principle of Unity—and 'The underlying structure of the Universe is an infinitely dimensional network of hierarchical relationships,' as we see on page 250 in Chapter 4, 'Transcending the Categories' and page 217 in Chapter 2, 'Building Relationships', respectively.

These models can be expressed in terms of a data definition language (DDL), such as that in Structured Query Language (SQL),[139] the primary language for defining and accessing relational databases, initially developed at IBM by Donald D. Chamberlin and Raymond F. Boyce in the early 1970s.[140] But it is more informative to show the relationships between relations in graphical form.

This is not a new idea. John Sowa tells us that in the third century BC the Greek philosopher Porphyry began the practice of conceptual modelling by illustrating the hierarchical structure of Aristotle's categories.[141] Then in the latter part of the nineteenth century, the philosopher, Charles S. Pierce, did much work in developing relational graphs depicting formulæ in first-order predicate logic,[142] independently of Gottlob Frege, who represented such propositions as trees in his seminal work *begriffsschrift* 'concept writing'.[143] (The German words *Begriff* 'concept' and *begreifen* 'to comprehend' are cognate with Swedish *begrepp* and *begripa*, with the same meanings, from the PIE base **ghreib* 'to grip', also the root of *grip* 'grasp, clutch', with a figurative meaning 'Intellectual or mental hold; power to apprehend or master a subject'. So a concept is something that can be held in the mind.)

Today, conceptual models, whether in the field of database design or artificial intelligence, can be seen as applications or extensions of the mathematical concept of graph. This consists of a collection of nodes with lines drawn between them, generally called arcs or edges, not to be confused with the graphs that we drew in school, which provide a visual representation of algebraic equations, or simply collections of data values.

There are many conceptual modelling techniques in use today. One is entity-relationship (ER) modelling, which is sometimes extended into entity-attribute-relationship (EAR) modelling, although *entity* here really means 'entity-type' or 'class'. ER and EAR modelling arose directly from the relational model of data.

Another technique is object-oriented (OO) modelling, already mentioned, which arose from object-oriented programming. Again, this would perhaps be more meaningfully called class-oriented modelling, for it is mainly classes rather than objects that are being modelling. Objects only come into existence when the database is created or programs are executed; they are particular instances of general classes, universals in Plato's terms. Such objects generally do not exist during the modelling process itself, although it is sometimes useful to create an object diagram as well as a class diagram in UML. An example of an object diagram is Figure 2.10, 'An instance diagram for a family tree' on page 210. Figures 7.7 and 7.9 on pages 596 and 598, respectively, are examples of instance diagrams in the network and hierarchical data modelling methods.

A third method, which has evolved from some conceptual modelling techniques developed in Europe, is called Object Role Modelling. The key distinction between this method and the others is that attributes are treated in exactly the same way as entity types or classes, leading to a more explicit and detailed model. It thus has some similarities with EAR modelling.

Now it is one thing to learn these modelling techniques. It is quite another to learn how to use them in practice. For there are, in general, many ways in which a universe of discourse can be modelled in terms of classes, entities, attributes, and the relationships between them. The best book I have come across on this topic is Bill Kent's *Data and Reality*.

Entity-relational modelling

Credit for the creation of entity-relationship modelling is normally given to Peter Chen, who published a seminal paper on this subject in 1975.[144] However, as Chen himself acknowledged in this paper, Charles Bachman had previously developed a visual modelling technique, which he had published in 1969.

Figure 7.10 shows an example taken from Chen's original paper. Notice that in this notation, there are two forms of node, one depicting concepts and the other relationships between them. This is similar to John Sowa's notation of conceptual graphs in the field of artificial intelligence.[145]

It is interesting to note that Chen subtitled his seminal paper 'Toward a Unified View of Data'. He did not see himself building on the foundations of the relational model of data. Rather, he presented his work as a synthesis of the network model, the relational model, and something called the entity set model, developed by four researchers at IBM.

Over the years, many researchers and practitioners further extended the business information captured by such entity-relationship diagrams. These included Information Engineering, developed by Clive Finkelstein and James Martin,[146] both formerly of IBM; IDEF1 and IDEF1X, developed for the US Air Force;[147] and a number of techniques developed for the vendors of RDBMSs, such as Oracle's CASE*Method developed by Richard Barker,[148] subsequently incorporated into Oracle's Designer product, and Sybase's PowerBuilder, the only modelling tool with which I have had limited experience with in practice. For while these tools were emerging in the marketplace, I was not in paid employment, as my primary focus of attention was in the development of IRL in order to heal my fragmented mind in Wholeness.

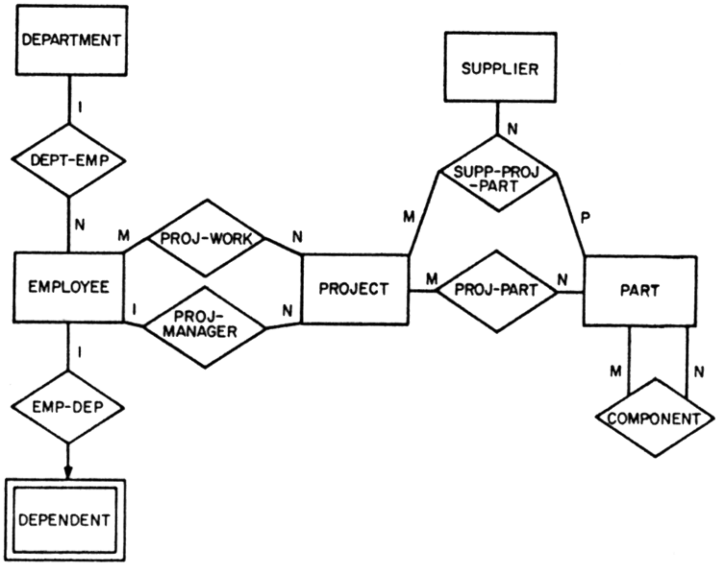


Figure 7.10: *Chen's entity-relational modelling notation*

Figure 7.11 shows some of the key features of an entity-relational model in the CASE*Method notation.[149] The rectangles denote entity types, together with a few of their attributes. There are two major ways of representing relationships: in meaningful sentences and as annotated lines between the entity types. Both methods are provided to ensure that all parties understand the database design as well as possible. This is vital because so many information systems have failed to meet the needs of the users because the universe of discourse was not sufficiently well understood at the analysis stage of development.

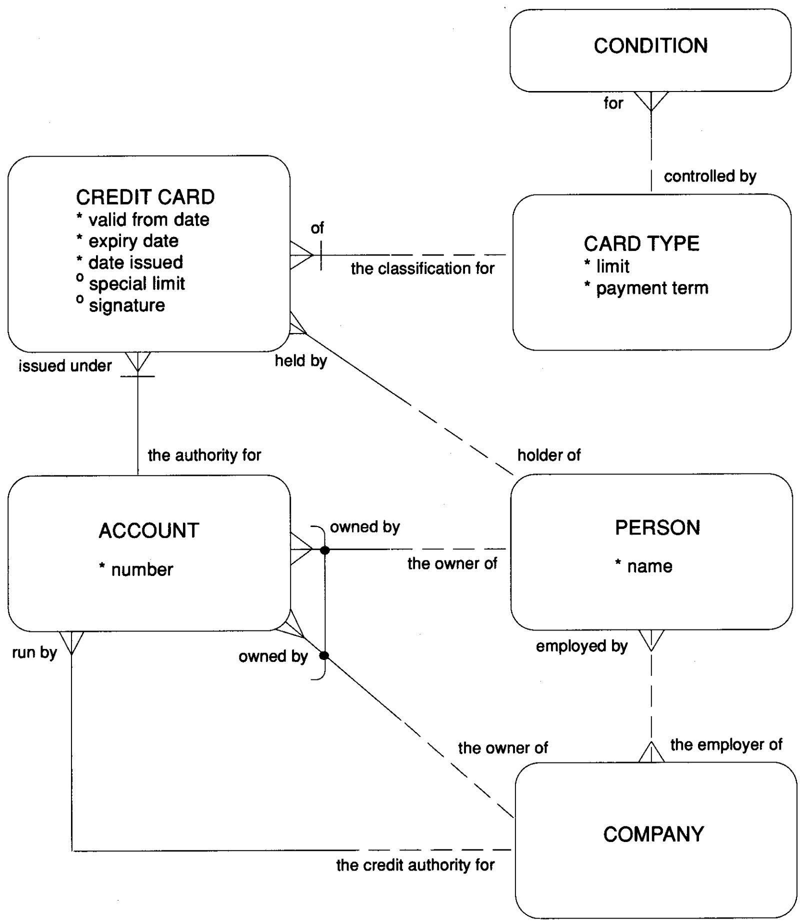


Figure 7.11: *CASE*Method entity-relational modelling notation*

In CASE*Method, relationships are first defined as sentences in this form:

Each *entity-type one* must be/may be *relationship* one and only one/one or more *entity-type two*.[150]

As David Hay points out, the relationship is either a prepositional phrase or gerund phrase from the names of a relationship and its following entity. Verbs, as such, are not used as definitions of relationships because verbs denote actions, such as functions, not relationships. "This makes it possible to translate a relationship into sentences that not only sound natural but which precisely describe its nature, its cardinality, and its optionality."[151]

For example, in the situation depicted in the diagram above, the two sentences that represent the relationships between Credit Card and Person are:

Each Person may be holder of one or more Credit Cards.

Each Credit Card must be held by one Person.

Whether or not the relationship is mandatory or not (must be or may be) is depicted by a solid or dashed half line. The cardinality of the relationship (one and only one or one or more) is determined by a symbol at the end of the line. A 'toasting fork' symbol, called a crow's foot, denotes a one or more relationship. A lack of this symbol denotes a one and only one relationship. As you can see from the diagram, the relationships are appended to each end of the relationship line in this notation, although some techniques merge the two reciprocal relationships into one.

Another key concept captured by these relationships is the role that each entity type plays in the relationship. For instance, there could be two relationships between Cars and Persons, one denoting ownership and the other the driver of the car. In the example we are looking at, there are two relationships between Company and the Account that the Credit Card authorizes. One denotes a company that is the owner of a credit card, while the other denotes the fact that a company is the issuer of a credit card, thereby acting as the credit authority for the card.

This example illustrates another complication in conceptual modelling. There are two types of entity that can own a credit card, Persons and Companies. This fact is denoted in the diagram by an arc joining the two ownership relationships, indicating that they are mutually exclusive.

Object-oriented class modelling

To illustrate a class model in UML, Figure 7.12 shows an example taken from the standard textbook on the subject.[152]

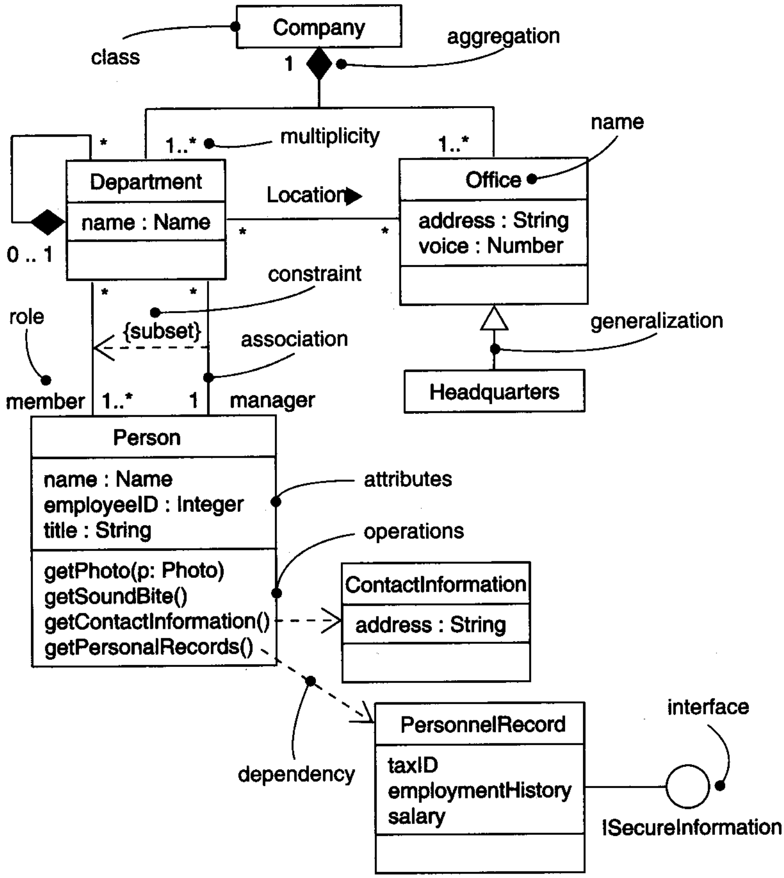


Figure 7.12: *UML class model notation*

Here the boxes represent object classes, most often called just classes, which from a business modelling perspective correspond to entity types in ER modelling. In general, the class box consists of three parts: a name, a list of attributes, and a list of operations that process objects in the class. The last of these define the interface to methods in an object-oriented language, such as C++, and as such are presumably of greater interest to programmers than business modellers.

It is possible to define many different types of relationship in UML, the most important from a business modelling perspective being association and generalization. A subtype of association relationships is the aggregation relationship, which typically has a direct physical mapping, for example in an engineering parts database. Another common example is an organization consisting of divisions, departments, sections, and teams, which can be depicted as reciprocal relationships, as in the example.

Yet another example of an aggregation relationship is the human body consisting of organs, cells, molecules, atoms, and subatomic particles, which are aggregated in reverse order of the list here. It was from this type of relationship that Arthur Koestler coined the term 'holon', meaning an entity that is both a part and a whole.

However, not all hierarchical relationships consist of holons. Generalization relationships are the most obvious counterexample. For instance, human beings are a type of primate, which is a type of mammal, and so on. Generalization relationships play a central role in OO programming because properties and methods can be inherited by subtypes from a supertype.

Object-role modelling

Another conceptual modelling method that I did not come across until doing some research for this chapter in the autumn of 2001 is object-role modelling (ORM). I was doing a search on the Web for references to conceptual modelling and found a site that published the *Conceptual Modeling Journal*.

The term *Object-Role Model* was coined by Eckhard Falkenberg in a paper presented to an IFIP conference in 1976. In the 1980s, ORM evolved into NIAM, originally aN Information Analysis Method, but now known as Natural-language Information Analysis Method. Research into this method then moved to Australia, where Terry Halpin renamed it ORM and developed a CASE tool to support it. A early version of this tool was called InfoModeler, which was then bought by a company called Visio, becoming VisioModeler. Visio was, in turn, bought by Microsoft, which now markets the product. So even though ORM is not well known, it has now become mainstream.[153]

As far as I have been able to ascertain, ORM would seem to the most comprehensive and thoroughly researched conceptual modelling method available today. All other methods, such as UML and ER, "can be easily abstracted from ORM models", as Halpin states in his scholarly book.[154]

Figure 7.13 shows an example of an ORM model for employees.[155] Note here that entity types and attributes are treated in exactly the same way in the method. Also, like Peter Chen's original ER method, relationships are shown explicitly in the diagram, in this case as two or more rectangles depending on whether the relationship is binary, ternary, and so on.

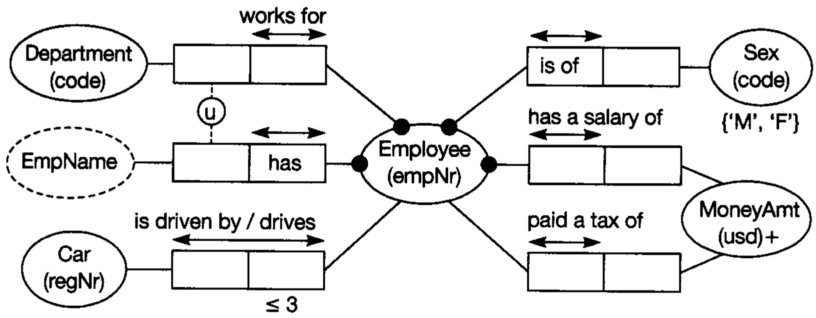


Figure 7.13: *ORM conceptual model notation*

Also, like Richard Barker's ER method, a key feature of ORM is that both facts and constraints are defined in formal sentences in natural language, which helps to ensure that the model matches as well as possible the rules of the business. For instance, we can say that 'Employee with *EmpNr* is of *Sex*', which is essentially a propositional function in predicate logic.

Other conceptual-modelling tools

These are just three examples of conceptual modelling tools. Others I am aware of, but have not studied, are ConceptDraw, Inspiration, and OmniGraffle, available on the Mac. In the 1990s, IBM had an OS/2 product called Thesaurus Administrator/2, which could be used for creating, managing, and using thesauri. No doubt there are other similar semantic modelling tools on the market today.

Thesaurus Administrator/2 was developed at the IBM software laboratory in Germany that produced Storage and Information Retrieval System (STAIRS) in the early 1970s, which I marketed as a systems engineer in IBM's Government sales office at the time. STAIRS was a precursor to the search engines like Google that we see on the Web today, for it could search through unformatted sections of text, such as book abstracts in libraries, looking for a match on one or more words.

It was about this time that I first learned about Ted Codd's relational model of data and wondered whether it would be possible one day to create a generalized modelling method that modelled both formatted and unformatted data. This would be most useful in the UK Government's employment system that I was working on at the time, which required both structured information, such as name, date of birth, and so on, as well as textual description, such as job description.

There is another fascinating stream in the growth of structure here. In the late 1960s and early 70s, we did not have the graphical displays we have today. Text that STAIRS worked with was mainly entered on punched cards or golf-ball typewriter terminals managed by a software package that evolved into Script, an IBM text formatting language. Script provided the micro-level for a set of macros in the IBM Generalized Markup Language (GML),[156] developed as far back as 1969[157] by Charles Goldfarb, Edward Mosher and Raymond Lorie, whose surnames conveniently had the initials GML.[158] GML was a part of the IBM Document Composition Facility (DCF), DCF/GML being known as BookMaster, a product I used extensively in the 1990s.

Charles Goldfarb then developed GML into the Standard Generalized Markup Language (SGML), a metalanguage in which one can define markup languages for documents, but which is monstrously difficult to understand and use.[159] Nevertheless, Tim Berners-Lee, a physicist working at CERN, developed HyperText Markup Language (HTML) as an application of SGML and the World Wide Web was born in 1989.[160] Another application of SGML is Extensible Markup Language (XML),[161] a general-purpose markup language that enables users to define their own elements much more simply than in SGML. Indeed, XML is so powerful that it is used today as a common language for a wide variety of structured systems.

Metamodels

This is possible because the Universe has a deep underlying structure that is expressed in the most generalized modelling method of all: Integral Relational Logic, which can even model itself, as can a number of the modelling tools that we have looked at in this section. For modelling methods themselves use a set of concepts, which can be modelled using exactly the same set of conceptual modelling techniques as are used to model normal business domains. Thus a metamodel of the method can be produced. Using our self-reflective Intelligence, it is in this way that we can model all business processes, including our own modelling processes, and so create a comprehensive model of the psychodynamics of the whole of society, and hence of evolution from Alpha to Omega.

For instance, there are four basic concepts in entity-relationship modelling, entity type, attribute, domain, and relationship. Richard Barker shows how these can be modelled, reproduced in Figure 7.14, although he uses the term *entity* rather than *entity type*.[162]

For instance, we can say that 'each entity type must be described by one or more attributes' and conversely, 'each attribute may be of one and only one entity'. As all relationships between entity types are binary in CASE*Method, there are two relationships between Relationship and Entity Type. Another interesting point about this model is that both domains, or data types, and entity types are related to each other in a hierarchical set of supertypes, types, and subtypes, as illustrated by the recursive relationships attached to these two entity types, sometimes called a 'pig's ear'!

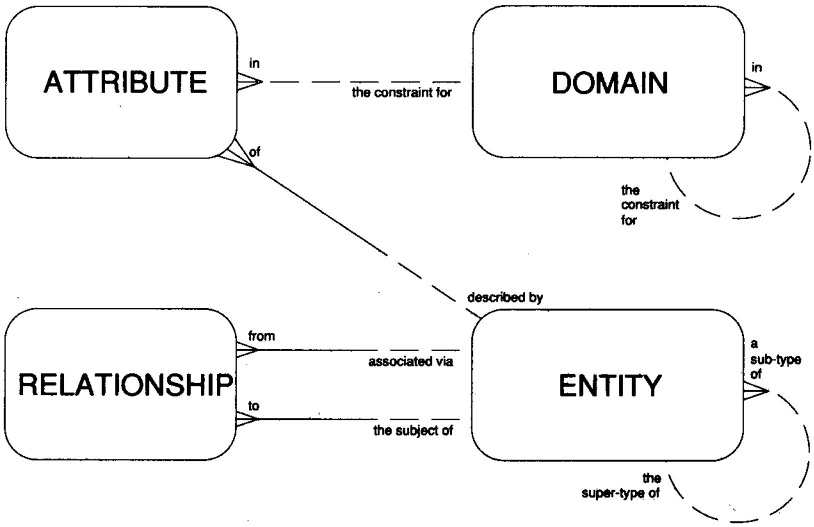


Figure 7.14: *CASE*Method metamodel*

David Hay provides another metamodel in the CASE*Method notation in his book *Data Model Patterns: Conventions of Thought.* In his book, Hay defines several general models of commonly found universes of discourse, including the enterprise itself, things of the enterprise, accounting, and process manufacturing. At the end of the book, he then proposes a generalized model that could model all the patterns illustrated in his book, reproduced in

Figure 7.15, which he calls a 'Universal Data Model'.[163]

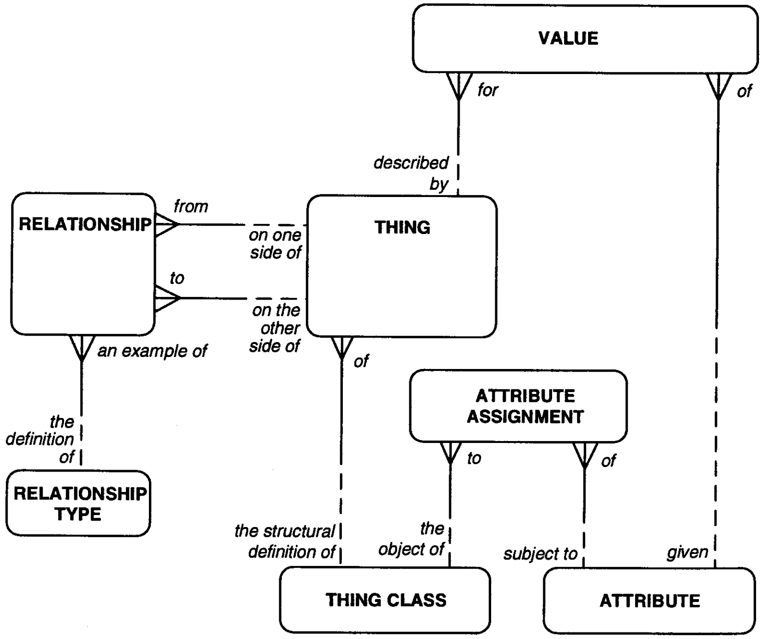


Figure 7.15: *A Universal Data Model*

Hay is clearly moving in the direction of Integral Relational Logic because he suggests that the Universal Data Model "covers all things in the Universe", adding in a footnote, "Well, all right, perhaps not *all* things … ."

These metamodels show that underlying the complexity of the world we live in there is the most exquisite simplicity. Academic subjects that attempt to describe the complexity of systems may be difficult to understand because we do not understand their underlying simplicity. When I was at school, the next year's textbooks could look really complex. But when I understood them, they became quite simple, for I could grasp their subject matter as a coherent whole. The underlying simplicity of the complexity of the Universe is encapsulated in the Principle of Unity and in Figure 1.47, 'Overall design of the Universe' on page 167, which shows that all beings in the Universe are related to all other beings in zero to many ways.

This diagram is both a metamodel and a model, for there is no separation between them. The observer and observed are one. Indeed, we can extend this to a metametamodel and metametametamodel indefinitely. The elegance with this abstract way of thinking is that we are not trapped in an infinite series of regress, which so troubled Bertrand Russell, who developed his theory of types and *Principia Mathematica* to try to avoid the paradoxes that arise from this situation. In mathematics, this series of metamodels is not unlike the infinite series of derivatives of e^x, which are all e^x. Nothing changes in this series.

It we then integrate all the conceptual models that any knowing being has developed or ever will develop, whether formally or informally, explicitly or implicitly, into a coherent whole, we see a picture of the utmost complexity, which nevertheless contains the elegant simplicity of the Principle of Unity at its centre. By the Principle of Unity, we can then allow all these forms, structures, and relationships to dissolve into Ineffable, Nondual, Wholeness, a seamless continuum, with no divisions or borders anywhere, and we are in the bliss of nirvana, which means 'extinction' (of the sense of a separate self). This then is central to the complete union of Western reason and Eastern mysticism.

The end of the growth of structure

What all this means is that we are nearing the end of the growth of structure on this planet at evolution's glorious culmination. The business modelling methods that have evolved into Integral Relational Logic, the foundations and framework for the Unified Relationships Theory, the solution to the ultimate problem in science have reached the saturation point at the top of the growth curve. This book shows not only how to unify the two major business modelling methods, it also shows how we can unify *all* opposites, thus bringing some fourteen billion years to an end at the Omega point of evolution. So IRL provides the framework or infrastructure not only for the data-processing industry, but also for all human activity.

Within this overall framework, we can also see that the underlying architecture of operating systems, which provide the context for all application programming, are now reasonably stable and mature. While changes are still being made to the nucleus and to the application programming interface (API) of the major operating systems, it is difficult to envisage a major new operating system being developed from scratch to replace the UNIX and Windows families. There simply is too much investment in these operating systems for such radical changes to be made.

A similar point can be made about programming languages, the theory and practice of which is now well understood. These too are very close to the top of their growth curve. It is difficult to foresee C, its object-oriented versions, like C++ and Objective C, and other object-oriented languages, like Java, being superseded as the major programming language used by software developers. For these object-oriented languages reflect very closely the underlying structure of the Universe. There is nowhere further for them to grow.

And what about the basic applications used in offices, like Word, Excel, and Photoshop? Are we going to see Word version 67 or even 23? When these applications were first developed, the facilities added to each version were quite significant. For instance, table handling did not appear in Word on the Mac until version 3 if I remember rightly, and was significantly improved in the following version. But how much extra function can software houses add to these applications anyway? And who needs all these functions? Judging from the Word documents I receive from time to time, many people have still not learnt how to use the tab command.

To encourage us all to use the increased processing power available today, companies are promoting the notion of a digital lifestyle, with a multitude of audio/video products available on the market today. But how much further can the compression algorithms go? These certainly appear to be approaching the top of their growth curve. And how much further can improvements be made in the quality of pictures and sound that we human beings can discern? The quality of my home cinema system is almost as much as I could possibly wish for. Digital television, which has now arrived in Sweden, would no doubt be an improvement. But this is something that I could live without if I had a choice.

If we take just these factors into consideration, ignoring the deeper spiritual, psychological, and ecological changes that are happening in the world today, it is quite clear that the overall growth curve for the IT industry looks something like that shown in Figure 7.16.

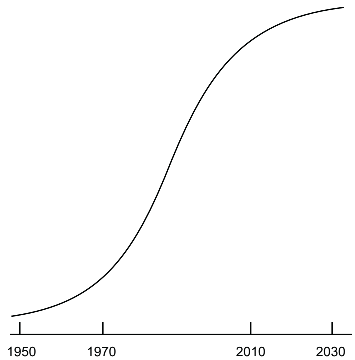


Figure 7.16: *IT growth curve*

It is difficult to be precise about the exact date of point C on this growth curve, because growth processes are generally continuous in nature. However, it is clear that the curve will be travelling in a quite new direction by the beginning of the second decade of this century, which curiously corresponds very closely to the end of the 25-year period of Harmonic Convergence, introduced by José Argüelles, which is also associated with the end of the Mayan Great Cycle, described in Subsection 'The Mayan calendar' in Chapter 6, 'A Holistic Theory of Evolution' on page 546. As many are aware, this harmonic convergence is coming about through the action of morphogenetic fields, a concept introduced by Rupert Sheldrake in *A New Science of Life* in 1982.

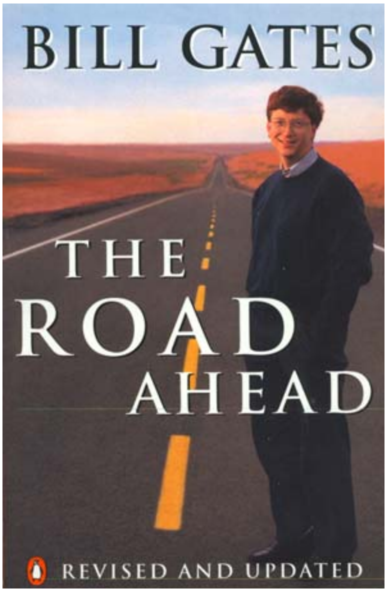


Figure 7.17: *A deluded vision*

It is thus false to assume that technological growth can continue to drive economic growth for very much longer. We are rapidly approaching the limits of technology's ability to enhance our mental and physical capabilities. The overall effect of this evolutionary inevitability will be the total collapse of the global economy, the end of civilization as we have known it for the past several centuries and millennia.

Yet no government in the world is preparing for such a major change in the way that we organize society and conduct our business affairs. The road ahead is utterly different from that envisaged by Bill Gates, illustrated on the front cover of this book.

If the death of Western civilization and the global economy is not to lead to the immediate extinction of the human race, it is thus imperative that we rebuild the infrastructure of society on the seven pillars of wisdom, becoming free of all the delusions that inflict our learning today, as we explore further in Chapter 12, 'The Crisis of the Mind' on page 989. Maybe this book can make a small contribution to helping us through this discontinuity in evolutionary history. For the only choice we have as a species is to turn the attention inwards so that we might realize our fullest potential, both collectively and individually. It makes no sense to put the primary focus of our attention on building machines that extend the capabilities of the human mind, when such a policy is driving humanity insane; it is just technological madness.

Chapter 8
Limits of Technology

The Analytical Engine has no pretensions to originate anything.
It can do whatever we know how to order it to perform.

Ada Lovelace

That materialistic and mechanistic science is driving humanity into an evolutionary cul-de-sac is nowhere clearer than in the business world. There is a widespread belief in society today that technological development can drive economic growth indefinitely, that technology is the solution to all human woes. But is it? Since soon after the invention of the stored-program computer in the middle of the last century, computer scientists have claimed that they could create artificial intelligence, artificial consciousness, and even artificial life in their machines. We can see from Chapter 4, 'Transcending the Categories' that we human beings are not machines and nothing but machines, for we are Divine Cosmic beings.

It is thus abundantly clear that the invention of the stored-program computer requires us to make fundamental changes to the work ethic and the way we run our businesses. For those still not convinced of the fact that both capitalism and communism are incompatible with the invention of the stored-program computer, this chapter shows beyond any doubt that technology is limited, that human beings are the leading edge of evolution, not computers. We do so by asking the question, "Could computers program themselves without human, that is, divine intervention?"

Part I, 'Integral Relational Logic' showed how we can model the task of an information systems architect in developing a comprehensive model of the processes and entities of a business enterprise and hence of the Universe. In this chapter, we use IRL to model the job of a computer programmer. This subject is rather technical; it requires a good knowledge of computers and computer programming languages to fully understand. But this is not knowledge that computer scientists normally highlight. For if they did, it would be only too obvious that it is not possible to program a computer to perform all the cognitive activities performed by human beings in the workplace.

Can machines think?

The key to this issue is the possibility that machines might be able to think, which is a fairly recent subject in Western philosophy. As Vernon Pratt has pointed out, it arose from the introduction of the Cartesian-Newtonian mechanistic paradigm in the seventeenth century.[1] Since the invention of the programmable computer in the middle of the last century, this question has come under the auspices of cognitive science, defined by Howard Gardner as psychology, philosophy, artificial intelligence, linguistics, anthropology, and neuroscience.[2]

Alan Turing, often considered the father of modern computer science, made a major contribution to this debate in his much-quoted article published in the philosophical journal *Mind* in 1950,[3] which began with the words, "I propose to consider the question 'Can machines think?'"[4] Turing himself was of the opinion that the answer to his question is yes, for he went on to conclude in his article that "I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted".[5]

Since then, despite all the efforts of computer scientists to create artificial intelligence,[6] consciousness,[7] and even life,[8] Turing's prediction does not seem to have come to pass. I know of no machine in the world that has passed the Turing test, that claims that it is at least as intelligent as human beings. Why is this? Well, we can get an inkling for this 'failure' from the insightful memoir on Charles Babbage's Analytical Engine,[9] written in 1843 by Ada Lovelace,[10] the poet Byron's daughter, which Turing quoted in his article.[11] Ada wrote:

> The Analytical Engine has no pretensions to originate anything. It can do whatever we know how to order it to perform. It can follow analysis; but it has no power of anticipating any analytical relations or truths. Its province is to assist us in making available what we are already acquainted with.[12]

So what is the truth? Even today opinions vary.

The many computer scientists working in the field of artificial intelligence obviously favour Turing's opinion. This can be seen most clearly from the Dartmouth Conference in 1956, when the foundations of AI were laid down by a number of leading computer scientists, among them Marvin Minsky and John McCarthy. For the latter stated the fundamental hypothesis of AI as follows: "Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it".[13]

On the other hand, the management scientists in the American business schools who classified all activities in business into structured, semi-structured, and unstructured tasks,[14] seem to favour Ada Lovelace's view. For if it were possible to discover the deep structures that underlie semi-structured and unstructured tasks in a formal manner, as the AI scientists claim, all tasks would be structured and automatable, and there would be no need to make a distinction between the different types of task.

So if the aims of the AI scientists are achievable, the fundamental principle of all monetary economies would break down. While human beings might wish to consume the products of a materialist society, it would be machines that would be the principal creators of goods and services. Thus the loop between human beings as workers and consumers in the economy would be broken. As virtually no economist or politician is looking at the possibility of such a situation, we must assume that they do not believe that it will happen.

The reason why scientists and philosophers cannot agree on this vitally important issue is that science, as it is practised today, is not capable of resolving the issue. The arguments tend to oscillate between the Turing test, described in his 1950 *Mind* article, and the consequences of Gödel's Incompleteness Theorems,[15] identified by J. R. Lucas in his article 'Minds, Machines and Gödel' first published in the journal *Philosophy* in 1961.[16]

He argued that Gödel's metamathematical reasoning could not possibly be done by a machine, because human consciousness is necessary to see the truth of Gödel's statement, "This theorem is unprovable". Another philosopher, John R. Searle,[17] has used his famous Chinese room thought experiment to refute the possibility of what he calls 'Strong AI'. He argues that it is quite possible for an English-speaking human being, who has no knowledge of Chinese, to mechanistically process a string of Chinese characters fed to him, without any understanding of what he is doing. Nevertheless, the answer produced at the end of the process is the correct one from the perspective of a Chinese who understands the symbols. Both Lucas and Searle have been much attacked for their endeavours by Hofstadter and Dennett.[18]

Roger Penrose, Rouse Ball Professor of Mathematics at Oxford University, has taken up J. R. Lucas's arguments in his best-selling book, *The Emperors New Mind: Concerning Computers, Minds, and the Laws of Physics*. A key point he makes is that mechanical processing is essentially algorithmic. So, are all human cognitive activities algorithmic—insight, for example? The answer he comes to is a tentative no; tentative because Penrose is aware that his understanding of the relationship of the mind and consciousness is still limited. As he says in the final paragraph of his first book, "For the answers to such questions [about the nature of human existence] to be resolvable in principle, a theory of consciousness would be needed. But how could one even begin to explain the substance of such problems to an entity that was not itself conscious … ?"[19]

In a review of his book in *Time* magazine in June 1990, Penrose encapsulated his view with the statement: "Computers will never think because the laws of nature do not allow it." Marvin Minsky is quoted as saying in response, "As far as I can tell, he is just plain wrong."

In fact, this is an argument that nobody can win. It is not so much a win-lose game as a lose-lose one. For if the AI scientists are right our economic system will collapse and all will be losers. And if they are wrong, why spend so much effort in doing something that is impossible? Isn't genuine human intelligence much more energizing and life-enhancing than its false pretender?

So perhaps I can explain a little more how we can answer the question "Can machines think?" Like Alan Turing's Turing Test and John Searle's Chinese room, my approach is based on the experiment in learning that I described in Part I. At the core of this experiment is one simple rule of concept formation: to notice carefully the similarities and differences of the data patterns of our experiences. In this chapter, we apply this rule to examine carefully the job of a computer programmer and then look to see what the analogous activities are in the human psyche.

Some computer background

In the early days of the data processing industry, computer systems were predominantly designed from the system out to the user; they were technology-driven. In the 1970s this situation began to change as an increasing number of general users, being unable to obtain a satisfactory service from the traditional methods of their data-processing departments, began to seek ways of doing their own personal computing.

Originally, the principal tools that these intrepid pioneers had available to them were mainframe timesharing systems, designed, not for non-technical users, but for systems and applications programmers. With the introduction of the personal computer in the 1980s, this situation changed radically. It is now generally recognized that if the full productivity potential of computer systems is to be realized, then they need to be designed from the human user inwards. This is as true for computer professionals as it is for users whose primary function is in finance, personnel, and other divisions not directly involved with information systems development.

The two most important factors that have led to computer systems being designed from the human perspective are the windows interface introduced by Apple in the 1980s, and object-oriented modelling, which develops systems closely related to the structure of the human mind, reflected in the Macintosh's innovative desktop metaphor.

However, these interfaces don't just happen by magic. Programmers have had to learn to develop programs in quite new ways from those used during the early years of the data-processing industry. As these methods use structures that closely model the deep underlying structure of the Universe, programming becomes much more natural, as professional programmers using these methods know only too well.

Programmers have also had to learn to look much more closely at the way human beings actually work at a computer interface. In the 1980s and 90s, a number of interface design methods evolved to help them, which provide guidelines for a human-oriented approach to computer systems design. These include Apple's *Human Interface Guidelines*[20] and IBM's *Object-Oriented Interface Design: Common User Access [CUA] Guidelines*,[21] quoted in Chapter 1, 'Starting Afresh at the Very Beginning' on page 50. There are similar design guides for UNIX systems[22] and many for Microsoft Windows systems.[23]

While these guidelines differ somewhat in detail, they all agree that the starting point for sound interface design is the development of a conceptual model or metaphor of the interface that is expressible in terms that are familiar to users' experiences and matches, as closely as possible, their thought processes as they communicate with the machine. So we have seen the metaphor of the desktop come into being, together with folders, documents, and other familiar objects represented as icons.

These developments have led to the term *user-friendly* entering the English language, used, not only for computer systems, but also for any device that is comparatively easy to use. The reason why non-computer specialists can now use computer systems is that there has been a fundamental semantic change in the interface between human users and the computer. Using a technical term from the IT industry, the semantic gap between the technology and the user has narrowed in the trend from technology-driven to human-oriented design. At least, that's the theory. With developers putting more and more complexity into their products, arrogantly trying to second-guess what users want to do, practice actually falls far short of this ideal.

I began to look at the problem of modelling the human-computer interface in earnest during the winter of 1979-80, shortly after I realized that our capitalist economic system held the seeds of its own destruction within it, but long before the modern computer interfaces we see today. At that time, I was wondering how to model the computer programmer's job in the process-entity matrix of an enterprise business model, such as that used in IBM's Business Systems Planning modelling technique, described on page 21 in Part I, 'Integral Relational Logic'.

As such models are developed independently of whether human beings or computers are doing the work of the business, I needed to look at what is common to human thinking and computer programming. This was essential if I were to discover whether a computer could perform a programmer's job without any intervention from a human being.

The central problem that I faced in developing this model is that there is no clear-cut distinction in computer systems between what is a process and what is an entity being processed. As a human being interacts with a computer, what is an entity being processed by the computer sometimes becomes a process acting on some other entity. In the case of personal computer users, this change takes place within a few milliseconds, a change that I found extremely difficult to represent in a process-entity matrix, which is more concerned with operational procedures that take minutes, hours, or even days. Now, many years later, I have found a solution to this problem, which I describe in this chapter.

We can look at the human-machine relationship from three perspectives:

1. A human programming a machine.
2. A computer programming itself.
3. A human 'programming' herself or himself.

We can take it that a machine programming a human being is a 'man-bites-dog' type of problem, and does not need to be considered explicitly. We are not just concerned with how professional computer programmers in software development labs and IS departments interface with the computer; we also need to consider the work of information assistants in user departments using query languages, users themselves doing their own personal computing, and any other use of a computer that can, in any way, be construed as programming.

From here, we shall then look at how a machine rather than a human being might perform the programming task; that is how a computer might program itself. This will lead us to consider how human beings could 'program' themselves, an activity that can be regarded as humans teaching themselves to think.

Computer structure

Before we begin to look at the way human beings program computers, we need to look at the overall data processing function in a computer in the most general manner. We can best begin by looking at the computer as a black box, without considering its internal design. This shows us the basic mechanism of data processing: data is fed in, it is processed by the machine in some way, and data comes out. Figure 2.1, 'Basic data processing function' on page 177, illustrates this process quite simply.

The key point about the basic data-processing function is that it operates through linear time. The input always exists before the output can be produced. It is vitally important to remember this point for it leads to the explanation why it is possible for human beings to program a computer, while a computer cannot do this for itself.

Of course, if we now look inside the computer, we can see that what is actually happening is that there is a program being executed in the computer. So we can revise Figure 2.1 with Figure 8.1.

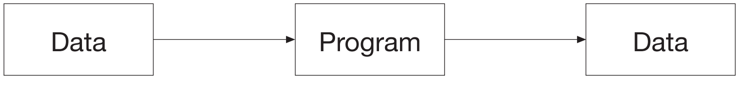


Figure 8.1: *Program execution*

Now in the computer's memory there is no essential difference between programs and the data that they process; they are both data. The central processing unit (CPU) can interpret a bit pattern as either a computer instruction or data to be manipulated. Which it is, is dependent on the context. If the bit pattern is presented as an instruction, the CPU attempts to execute it. If the bit pattern is fetched as data to be processed, the CPU acts on it according to its current instruction.

These two types of data we can call active and passive data respectively, as illustrated in Figure 8.2. These correspond to what Charles Babbage called the mill and store in his Analytical Engine designed over 150 years ago, although not built in his lifetime.[24]

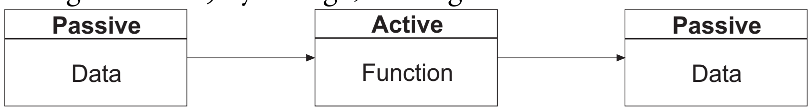


Figure 8.2: *Distinguishing active and passive data*

This pattern is the essential mechanism of mechanical data processing: passive data is transformed into another form of passive data by an active process in some way or other.

However, the modern computer is not like the flat tape of Turing's Universal machine, being directed to move backwards and forwards by the instructions on the tape.[25] A computing system contains many levels of structure arranged hierarchically from high-level languages to machine level. And at each level the data processing mechanism occurs. So it does not matter at which level we view the system; we still see a process taking an input and producing an output. This table shows some examples of what these processes look like on each level.

Level	**Example**
High level language	a = b + c;
Assembler language	ar r_0, r_1
Micro-order	mbr = a + c;
Elementary logic	$(C\wedge(A\vee B))\wedge(A\vee B)$
Sheffer stroke	$\vert$ab

Table 8.1: *Hierarchical levels of computer languages*

Starting with a program written in a high level programming language, such as C or C++, this consists of instructions that are translated into machine-level or assembly-level instructions. Each of these instructions is then broken down further until finally the chip is operating on individual bits of data using the basic logic elements, AND, OR, and NOT gates.

An example of how arithmetical operations can be represented by logic circuits is given in Figure 8.3.[26] Here two bits, A and B, are added to a carry over, C, from a previous operation. The result is S, with a new carry over, D. Using the notation of Boolean logic, described in Subsection 'The laws of thought' in Chapter 9, 'An Evolutionary Cul-de-Sac' on page 650:

$$S = (C\vee(A\vee B))\wedge((\sim((C\wedge(A\vee B))\vee(A\wedge B)))\vee((A\wedge B)\wedge C))$$

$$\text{and } D = (C\wedge(A\vee B))\vee(A\wedge B).$$

However, conceptually there is no need to stop at this point. It is quite possible to represent all logical operators in terms of just one, known as the Sheffer stroke, after Henry Maurice Sheffer, who in 1913 discovered this operator, which he called 'rejection', corresponding

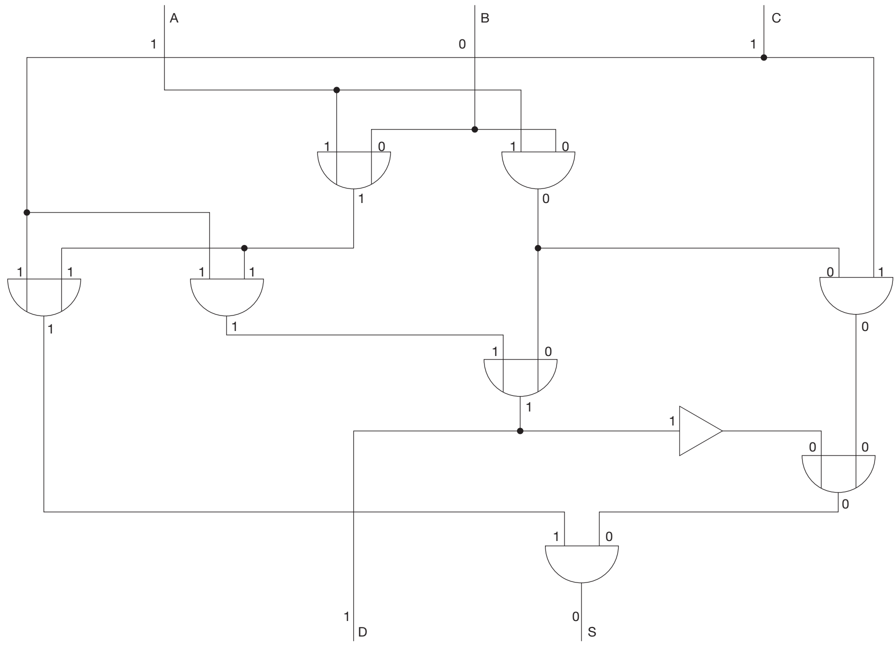


Figure 8.3: *One-bit adder using basic logic constructs*

to the NOR (not-OR) operator, the opposite of disjunction. Sheffer found this function when attempting to reduce the primitive ideas and propositions of Whitehead and Russell's *Principia Mathematica*[27] to the minimum possible, rather like the way the superclass **Being** is the most fundamental concept in IRL, described on page 167 in Chapter 1, 'Starting Afresh at the Very Beginning'. For as Sheffer said, "not all propositions can be proved and not all non-propositional entities can be defined, some logical constants must be primitive, that is, either unproved or undefined."[28]

In a similar paper four years later, Jean Nicod used the stroke as a sign for non-conjunction (NAND),[29] which has since become current practice.[30] In computer science, this is known as a NAND gate, giving:

$$a|b = \sim(a \wedge b)$$

To avoid the use of parentheses, the Sheffer stroke is today written as |ab, using a prefix rather than an infix operator.[31] The basic three operators in propositional (Boolean) logic can then be written like this:

$$\sim a = |aa$$
$$a \vee b = ||aa|bb$$
$$a \wedge b = ||ab|ab$$

So all computer programs could, in principle, be reduced to a long string of Sheffer operators processing individual bits of data, although such a program would, of course, be quite indigestible. The vitally important semantics that human beings need to understand the function being performed is missing at this level, and, indeed, all levels lower than the semantic model of the program itself.

Douglas R. Hofstadter has called this way of looking at systems at different conceptual levels 'chunking'.[32] For example, chess masters don't look at a chess board in terms of the individual pieces, but as groups of pieces, which have significance from the master's perspective. In a computer, groups of bits or groups of machine instructions can be chunked so that they are meaningful to engineers and programmers working at these levels.

We can thus see that there is no essential difference between hardware and software, they can be considered as a continuum, as Andrew Tanenbaum has pointed out.[33] This is most obviously seen with the operating system (OS), which acts as the control program for the computer, for parts of the OS might be 'hard-wired' into the computer, while other parts are loaded in from external sources.

Indeed, some programming languages can also be implemented in the microcode of the hardware, more usually called firmware. For example, the BASIC interpreter on the early IBM PCs and many home computers and the APL interpreter on the IBM 370/145 mainframe,[34] although these were implemented in different ways.

In more recent times, the programming language Java, which has taken Internet developers by storm, also demonstrates that there is no essential difference between hardware and software. When running on the Internet, a Java applet runs in a virtual machine (VM), with an instruction set that is different from all the physical machines it is running on. But SUN Microsystems have implemented this VM as a hardware chip that can embedded in such things as toasters and television sets.[35]

I cannot overemphasize the importance of this principle. As Tanenbaum has said, "*hardware and software are logically equivalent* ."[36] Whether a particular function is implemented in hardware or software is concerned with practical issues like cost, speed, memory, and flexibility.

So there is no need to get excited about the prospects of a DNA computer, as I have seen reported on the Internet. Such a computer would not add any functional potential to those computers that already exist vis-à-vis human potential. Neither would a computer built with the level of complexity of the human brain, although such a computer might work quite quickly. So why oh why do the computer scientists deceive the public (and themselves) into believing that the functional capabilities of a computer are a property of the hardware? As every computer scientist must surely know, what a programmable computer can do is determined by its software. Analogously, human behaviour is mostly determined by our learning, not from the proteins generated by the DNA molecule or a few chemical scurrying about in the brain.

Human program development

In the early days of data processing, programs that were being developed were punched on to cards or paper tape, which was then fed into the machine for processing. Nowadays, programs are stored within the computer itself as files of data. These programs are created by a human programmer using some form of text editor, which may or may not be part of the language translator, or, since the 1990s, through the use of a visual interface, generally called an integrated development environment (IDE), such as IBM Rational Software Architect, which is driven by the Unified Modeling Language (UML), Microsoft Visual C++ (MSVC), and Apple's Xcode for Mac OS X.

So the computer is now involved, not only in executing programs, but also in assisting in their development. How this is done in practice varies from language to language and from implementation to implementation. The first distinction we can make is between compilers and interpreters.

Whether or not a language is compiled or interpreted is not a function of the language per se, although languages generally lend themselves more to one form than the other. For example, PASCAL programs are normally compiled, although I had a PASCAL interpreter on my Macintosh Plus in the mid 1980s. Conversely, BASIC and LISP programs are usually interpreted, although there are a number of compilers for these languages available.

Compiled programs

We can begin by looking at the job of a professional programmer developing operational applications within a business enterprise or software development house. These programs are normally compiled into a concise executable form. A compiler is a program that translates procedure descriptions from a high-level language into a machine level, most usually.

A notable exception to this is Java. This language is compiled into architecture-independent bytecodes, which can run on machines with any instruction set. To speed up the execution of these programs, a Java applet running under a World Wide Web browser can be compiled when it is loaded, using what is called a Just-in-Time compiler (JIT). In these cases, Java programs go through a two-stage compilation process.

There are two distinct steps: program development and program execution. In the program development phase, the programmer will normally enter her program through a visual interface or an editor, which may check for simple syntax errors if it is part of the language. The machine-readable source program is then input to the compiler, linked with other programs and library routines to become an executable application. Figure 8.4 illustrates program development using a compiler.

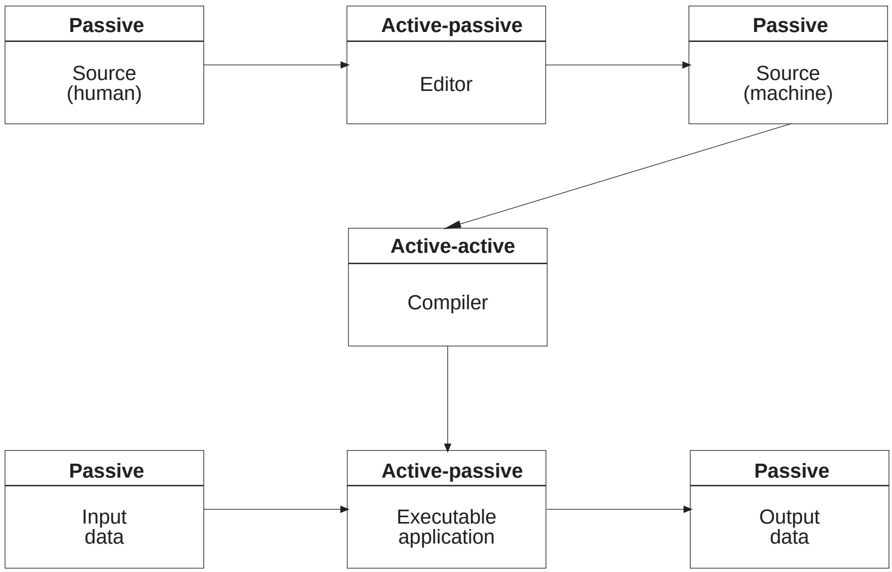


Figure 8.4: *Program development using a compiler*

It is most important to note from this diagram that there are essentially two types of program in computers, those that are used to perform some particular function for a business, like payroll and word processing, called generated programs, and others that generate these programs, like compilers in this example. Both these types of programs are active data. In order to distinguish them, we can call them active-passive and active-active respectively, a refinement of data types, as they are conventionally viewed, as described on page 584 in Chapter 7, 'The Growth of Structure'. Figure 8.5 illustrates the relationships between these more unconventional data types in a computer.

The difference between active-active and active-passive programs can be illustrated by the development and use of a consumer durable, like a washing machine. Before a washing machine becomes available on the market, designers create blueprints that describe its features and components. These are then passed on to a manufacturing plant, which actually makes the product. This is then packaged ready for distribution to the consumer, who can then use the product.

The design and manufacturing phases of developing a consumer durable are analogous to program development. When I began modelling this program development process in 1980, there was very little specific computer support for the design phase. Design documents were produced by typists, before even word processors became generally available.

Today, in the object-oriented world we now live in, this situation has changed radically. There is increasing emphasis on model-driven architecture (MDA), tools that are becoming increasingly integrated within software development tools such as IDEs. As I have been re-

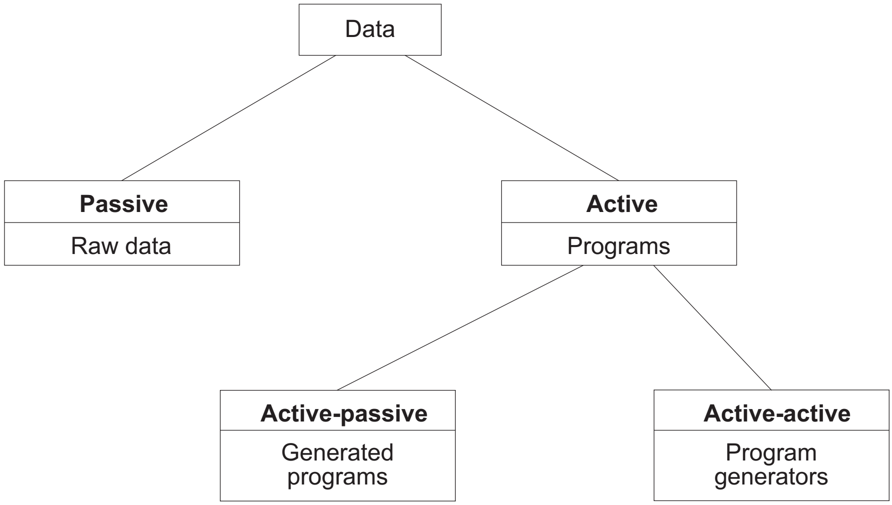


Figure 8.5: *Principal data types in a computer*

tired from the IT industry for several years, I am not up-to-date with this rapidly changing environment. Just a few products that have caught my eye are IBM Rational Software Architect, System Architect from Telelogic in Sweden, now a subsidiary of IBM, and Casewise Corporate Modeler. It was some extinct predecessors to these modelling tools that led to the development of Integral Relational Logic and the Unified Relationships Theory. However, these modelling tools have somewhat complicated the points that I want to make about modelling computer programming rather than modelling the modelling process itself. To keep the exposition as simple as possible, we can consider both modelling tools that are a source of executable code and compilers as active-active data.

Once a software house has developed a product, it is then packaged in the shrink-wrapped package we can buy at our local computer store. At first sight, this process might look like software manufacturing. But it isn't really. This can be best seen by noticing that we can now download software products that have gone through the first two phases of development directly from Internet. In this case, the packaging step is eliminated.

The product is now ready for use, just as we can use a washing machine once we have purchased it. This software product is a generated program, which I call active-passive data. It is this type of program that actually determines the functional capability of the computer.

Notice that a chess-playing program is a generated, active-passive program. Thus studying the capabilities of such programs can tell us little about the nature of the creative software development process. To determine whether a machine can think creatively or not, we need to examine closely the nature of program generators. However, because of the cumbersome way that program compilers operate, they do not really match the dynamics of the human creative process. We therefore need to turn to the other type of program generator: the interpreter.

Interpreted programs

A formal definition of an interpreter that I have picked up somewhere on my travels is "a program that follows an explicit procedure description incrementally, doing what the procedure description specifies". In other words, an interpreter executes each instruction of a high-level language as it is presented to it, without converting a sequence of instructions, or program, to machine-level first.

In the interesting case of a Java applet running under a World Wide Web browser, the compiled program is interpreted in a virtual machine. But as the instructions that the interpreter is processing have been produced by a machine rather than a human being, we don't need to be concerned with this here.

The subject of interpreters is rather complicated because there are so many different ways of interfacing with them. But as my whole approach to learning is to abstract simple patterns that underlie the complexity of the world we live in, let me do this here.

Interpreters usually work in two ways: either immediate or deferred execution, the one being non-procedural in nature and the other, procedural. In the immediate mode of execution, the computer immediately executes an instruction that we give it. The input to be executed needs to be a syntactic whole. This is normally a command or instruction, which looks like a one-statement program to the language interpreter.

One way of doing this is through a prompt in a command window, such as the Terminal application in Mac OS X or the command interface in Windows, inherited from DOS. For example, when I once entered `dir d:\docs` in the Windows command interface, the computer immediately responded by giving me a listing of the `docs` directory on my D drive. Here the command `dir` is active data operating on the passive data `d:\docs`. Similarly, in the Terminal application, which provides a UNIX interface to Mac OS/X, we can get a list of the files and folders in the Documents folder with this statement: `ls -al Documents`.

In immediate execution, the three steps of program development using a compiler illustrated above are combined into one as illustrated in Figure 8.6. In this case, there is no distinction between the instruction to be executed and any data that is to be processed. Both are contained in the one source statement.

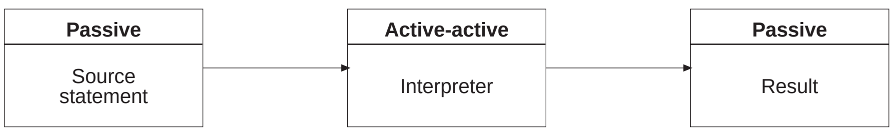


Figure 8.6: *Immediate execution of an intepreter*

In deferred execution, statements of an interpreted language are stored in the computer as a sequence of instructions, or programs, for later execution. These programs are usually given names and so become new entities that can be interpreted by the interpreter. The main difference between such programs and ones generated by a compiler is that a compiled program runs directly under the operating systems independently of the compiler, while an interpreted program executes within the environment provided by the interpreter. This is illustrated in Figure 8.7.

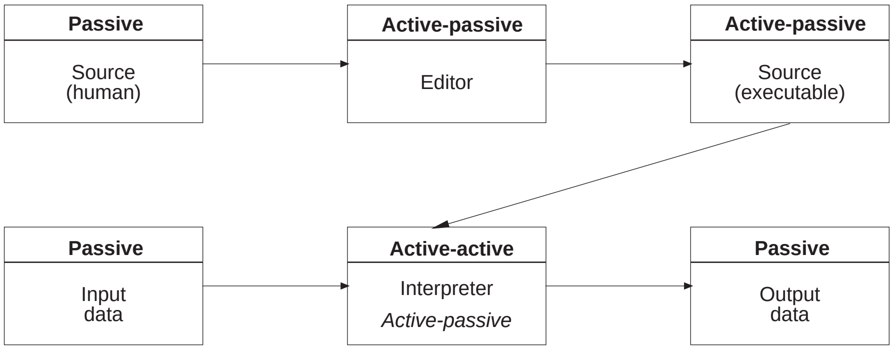


Figure 8.7: *Deferred execution of an interpreter*

How then does the interpreter distinguish between these two modes of operation? This varies widely from language to language. I collected several examples during the 1980s and 90s to illustrate this distinction, as listed in Table 8.2. No doubt others could be added with more up-to-date examples.

	Execution mode from terminal	
	Immediate	**Deferred**
APL	Everything else	∇ (begins function def) or program window
Basic	No statement no.	Statement no.
HyperTalk	Message box	Script editor
LISP	Well-formed list	DEFUN (begins function def)
MS/DOS	Command	Text editor to create file
MVS/TSO	Command	ISPF/PDF editor
PostScript (Host)	Executive command	Program stream from host
PostScript (Printer)	Object with executable attribute	Executable array encountered directly
Python	Statement	Text editor to create module as file
PROLOG	? (instruction for goal)	consult(user).
REXX	User-written program	Normal method
SQL	Interactive mode	Embedded in host language (Dynamic SQL in interpretative language)
VM/CMS	Command	XEDIT or other text editor

Table 8.2: *Modes of execution in interpretative languages*

Computer-driven program development

So far we have been looking at the programming process as it is performed by a human programmer. However, a number of languages provide facilities for programs themselves to generate and execute programs dynamically. The language that drew my attention to this possibility is A Programming Language (APL), a language that was used extensively in IBM in the 1970s as a personal computing language for management information.

APL was initially developed by Kenneth Iverson when he worked at Harvard University in the late 1950s as a mathematical notation to assist students in analysing various topics in data processing.[37] It became a programming language in 1966 after Iverson joined IBM. I myself learned something of the language in 1978 when I was responsible for selling IBM personal computing products in IBM's North London sales office.

APL is perhaps the most concise of languages, using just one or a few symbols for functions that would require several statements in other languages, such as matrix inversion and division (⌹) and matrix multiplication (+.×), where . denotes a general-purpose inner-product operator whose operands are other operators. APL was also designed from the outset as an interactive language, enabling human beings to communicate directly with the computer.

However, it is not these features of the language that I am concerned about here. APL also has some little known features that enable an APL program to create, modify, and erase other programs without the intervention of the human programmer. APL is not the only language that has these capabilities; there are a few others that I shall mention. It is not good programming practice to write programs that dynamically modify themselves, because they are notoriously difficult to debug. But there are occasions when such a facility is useful. Otherwise, they would not have been built into the language.

In the words of Gilman Rose, "This leads to application systems that can appear intelligent (in the sense of programs that write or edit other programs)".[38] As it is these facilities that are mimicking the creative programming process of a human being sitting at a computer terminal, we now need to study these languages in more depth.

The subset of programming languages that provide commands to enable a program to be created or modified from within the program and then to be executed dynamically without the agency of a human programmer we can call dynamically active. In contrast those languages that are statically active, such as BASIC, C, COBOL, FORTRAN, PASCAL, and PL/I, do not have such a facility. It is not possible, for example, to modify a program written in C within a program written in C and then to execute that program from within the program. While it is theoretically possible for a C program to modify, or even create C source statements from some other form of data, it is not then possible to execute this program from within the C program.

As dynamically active languages are more procedural than non-procedural in nature, we can call them, in full, Dynamically Active Procedural Programming LanguagEs, or DAPPLES for short. Examples of dapples are APL, Python, HyperText, the language of Apple's HyperCard (now withdrawn), LISP, a list processing language developed by John McCarthy of MIT, and PostScript, a page description language for high quality printers created by John Warnock of Adobe Systems.[39] We can use these examples to see the nature and diversity of these types of languages. All these languages have two particular features, both of which are probably necessary for a language to be dynamically active.

The first of these is that they are all extensible. That is, they have an open grammar as opposed to the closed grammar of most conventional programming languages used in business. This means that programs written in extensible languages become new functions of the language, which syntactically are treated in exactly the same way as the primitive functions of the language. There is thus no distinction between commands and functions as there is in non-extensible languages.[40]

Secondly, dapples treat active and passive data in a similar way, to a greater or lesser extent. This can most simply be seen when using these languages interactively. If the name of a variable is presented to the translator, its value is immediately returned. Similarly, if the name of a function is entered then this is executed, and the result is again displayed on the screen. To give a simple example of this phenomenon, as addition is generally a primitive function of dapples it is possible to enter 2+2 in a syntax recognized by the language and to receive the answer 4. Dapples can thus be used as rather expensive calculators!

It was this situation that led me to the difficulty of representing active and passive data in a process-entity model. Most particularly, conventional modelling techniques are not able to satisfactorily represent the read-eval-print loop in LISP, which well illustrates the fundamental mechanism in data processing. In LISP, evaluating passive data simply means to return its value, given its name, while evaluating a function is just another name for executing it.

The key point to note is that when used in this way, dapples perform the translation and execution processes immediately and consecutively. In other words, a statement presented to it is passive data to the translator and active data to the evaluator. To separate out these two functions, it is necessary to tell the translator to defer execution in the manner outlined above.

Now, as I have said, the key characteristic of some dynamically active languages is that they are able to modify and create programs written in the language and then immediately execute them in exactly the same way as they would translate and execute a program presented by a human programmer. Rather than using the text editor built into the language, dapples do this by regarding programs as strings of characters, which can then be manipulated by the string or symbol handling facilities of the language like any other symbols.

There are three steps in the human programming process that we need to look at:

1. Telling the computer that a program is to be entered and not executed.
2. The entering of the program at the terminal or modifying an existing program.
3. Presenting that program to be executed.

The second of these is the essence of human computer programming, the creative part. The other two functions are mechanical in nature, and act in support of the programming function. To examine how a computer might simulate the human programming function, we need to look at how these three functions can be programmed into a program.

In a dapple, a program can mechanically perform all the tasks mentioned above, but typically in a somewhat different way from the human programmer. Let us suppose, then, that a human programmer has written a program that can write new programs, and execute them dynamically.

Dynamically deferring execution

First of all, the program must tell the interpreter not to execute the instructions presented to it by the program, but to go into deferred execution mode. Whether it uses the same facility as the human programmer depends on the language and the environment. What is needed is the facility to convert programs, stored in their active, executable state, to a passive form that can be manipulated by the program. The modified program then generally needs to be converted back into its active form by some means. Alternatively, if the computer program is creating a completely new program from scratch, only the second of these facilities is required. Table 8.3 shows how active data can be converted to passive and vice-versa in the five languages we are looking at as examples.

	Deferred execution from program	
	Active→Passive	**Passive→Active**
APL	⎕*CF*	⎕*FX*
HyperTalk	*Get the script*	*Set the script*
LISP	Not known	*DEFUN*
PostScript	*cvlit*	*cvx*
Python	Not known	*def*

Table 8.3: *Converting active and passive forms of program dynamically*

For example, in APL, ⎕*CF* creates a matrix from the function, whose dimensions are the number of lines and the maximum number of characters in a line. In APL*PLUS, there is also a function, ⎕*VR*, which converts the function to a vector representation. ⎕*DEF*, a more powerful version of ⎕*FX*, converts both matrix and vector representations to active functions.

In LISP, both functions and function definitions are lists, for *LISP* stands for *LISt Processing*. For instance, a human programmer could enter this statement to define a function to square a number, which could then be evaluated:

```
CL-USER 1 > (defun square (x) (* x x))
SQUARE

CL-USER 2> (square 8)
64
```

As function definitions are lists, a human programmer could write a function definition that sets a variable to a list that defines a function as passive data. This could then be converted into active data with `eval`. Then this function could be executed. Here is an example in interactive mode:

```
CL-USER 1 > (setq funcdef '(defun square (x) (* x x)))
(DEFUN SQUARE (X) (* X X))

CL-USER 2 > (eval funcdef)
SQUARE

CL-USER 3 > (square 7)
49
```

Dynamically editing programs

When the computer creates or modifies a program, it generally needs another method of doing so from that used by the human programmer; it cannot use the text editor directly because this is intended for people. So generally there is no way of invoking the text editor from within the language.[41]

Instead, program interpreters that create or modify programs do so by using the string or symbol handling facilities of the language. The purpose often is to assist in the programming function; to use a program to manipulate other programs rather than doing this process manually, which can be tedious work. The text, of course, needs to conform to the syntax of the language in order for it to be recognized by the interpreter when it is converted into executable form. In mathematical terms, the string of symbols needs to 'well-formed'; otherwise there will be a syntax error when the interpreter tries to execute the statement.

In an extensible language, programs that are created in this way, or by a human programmer, become new instructions in the language. The power of the programming language is thus increased whenever a new function is created.

Now, two types of program can be created in this way: either the program is a simple application, which processes passive data, and so can be called active-passive, or it may contain instructions to enable it to generate new functions to be added to the language. In this latter case, the program is active-active. When this program is then executed by the interpreter, there is thus an active-active program running another active-active program beneath it.

Two key issues relating to whether computer programs can be creative or not arise from this mechanism. The first is that, in theory, a program could be written that would indefinitely go on creating new active-active programs to be added to the language. This process is somewhat like a program that calls itself recursively in that the process needs to be terminated in some way if it is not to lead to an infinite regress, a repetitive process illustrated in Figure 7.3, 'Programming iteration block' on page 583. However, it is not exactly the same.

A recursive program is active-passive and is following some well-defined algorithm in a predetermined manner. After a specified number of iterations, this process terminates, and the program returns a result. The PostScript program that produced a fractal fern in Figure 1.38 on page 134 in Chapter 1, 'Starting Afresh at the Very Beginning' was written recursively. The diagram you see is the result. The purpose of an active-active program, on the other hand, is to create new functions dynamically. This is not a mechanistic iterative process, so there is no purpose in writing a program that continues to create active-active programs indefinitely.

The second key issue is where do the symbols come from that are to form the new or modified program? Within the computer these cannot be created out of nothing. Every symbol, which is to form part of the new program, must exist before the program can start. The computer cannot create new symbols that are meaningful in any real sense. The meaning of symbols is something that is only understood by human beings.

Dynamically executing programs

Having created or modified a program, there now needs to be a means of dynamically executing it. In extensible languages, programs are executed simply by entering the name of the program. However, sometimes it is necessary to explicitly execute a program. This is necessary when the program does not have a name; for instance, it consists of just one, or a few, statements. Table 8.4 lists some of the commands that do this.

In APL, for example, `⍎` also acts like `⎕FX` or `⎕DEF` in that passive data can be executed directly by this execute function. This does not need to be in the form of a function. For example, `⍎'A+B'` is exactly the same as `A+B`. There are times when it is more convenient to express this operation using execute, rather than with the active data directly. Variables can be assigned these active pieces of code, as passive data, and then executed. The `INTERPRET` instruction and the `VALUE()` built-in function provide similar facilities in REXX.

	Immediate execution from program	
	Implicit	**Explicit**
APL	*Function name*	⍎ or ⎕*FX*
HyperTalk	Script name	Script name
LISP	Function name	*EVAL*
PostScript	Executable array encountered indirectly	*exec*
Python	Not known	*def*

Table 8.4: *Dynamically executing programs*

The whole process of computer-driven program development and execution is depicted in Figure 8.8. The first line shows a human programmer creating a program that can execute under the control of an interpreter to create another program, shown in the second line. But is it possible to dispense with the second line in the diagram so that this diagram reduces to Figure 8.7 on page 632, but with a machine providing the initial input not a human being? In other words, could a computer initiate the process of programming itself, or can a machine only do what we tell it to do, as Ada Lovelace surmised 150 years ago?

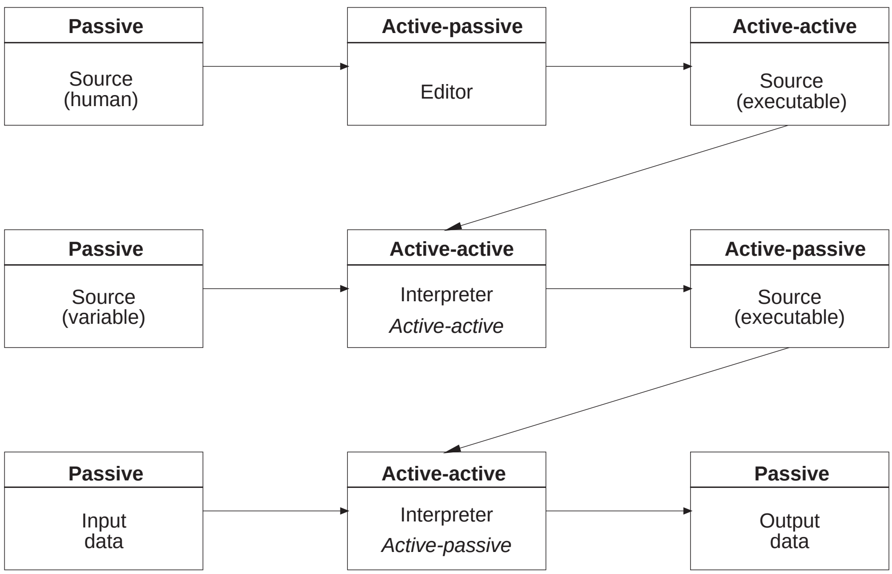


Figure 8.8: *Program development with dynamically active languages*

The key to the answer to this question lies in the fact that the basic data processing function in computers always operates through linear time. Every program that has ever been written has been helped on its way by a program generator along the lines that I have described in this chapter. There is thus a long mechanical cause and effect chain going back to when the very first computer was built. So who built the first computer? Where did this come from? How is it that we human beings can create computer programs without apparently having some already pre-existing program to get us started? To see the answer to these questions, we must now look at the characteristics of human beings that correspond to the features of computing systems that I have been describing.

Analogous human cognitive characteristics

Not unlike computer systems, we human beings, also process data. However, rather than taking in data that is input to us, the Totality of Existence provides us with the data that we process. As our inner cognitive faculties are part of the Universe, they also provide us with data. We process all this data by using our intelligence and intellect to interpret the data patterns of our experiences, which gives us the knowledge and information that we need to live in the world of practical affairs.

So our cognitive faculties can be divided into two groups, just as in a computer. Our knowledge and information correspond to passive data and intelligence and intellect to active data. Our passive cognitive faculties—our knowledge—can be further subdivided into two categories. As Gilbert Ryle has observed, human knowledge can be considered both as the facts we know and the skills we know how to perform.[42] These we can call passive-passive, which reduces to passive without any loss of meaning, and active-passive respectively. Human knowledge is thus analogous to 'raw' data and generated programs respectively.

Our intelligence and intellect also naturally fall into two parts. First of all, it is our intelligence that drives our thinking and learning, which are also skills that are quite different from our other skills. Thinking is the skill that helps us to learn skills, including thinking and learning themselves. We can see thinking as a visualization process, that sometimes, but not always, helps us with the development of our skills. Thinking is most useful in developing mental skills, such as playing chess and computer programming. But it is less useful in learning to play the piano or to speak a foreign language, for instance, where feeling is vitally important.

In general, the more that we think about the development of our skills the more proficient at them we become. Most particularly, in my case, because I have developed a model of my learning skills since 1980, I can now learn at a very rapid rate. If this were not so, it would have been quite impossible to develop a framework for a synthesis of everything. I would have been quite overwhelmed by the task.

While our intelligence lies behind our thinking skills, it is intellect that drives our reasoning skills. Sometimes, when intelligence sees a new pattern, a new concept or thought arises, which we can store as a mental image to which we can attach words and other symbols. Once we have formed these concepts, we can then arrange them in a multitude of ways according to the rules of Integral Relational Logic, which embraces traditional Aristotelian logic within it. We can call this process reasoning.

Reasoning doesn't really assist in the development of our skills. It is a mental process that enables us to derive new facts from already existing concepts, while thinking is the process of creating those concepts in the first place, as illustrated in *Integral Relational Logic (to be moved)*. Reasoning is thus more like a developed skill, which, of course, we can improve through practice. As is well known, no new knowledge is ever created through the deductive logic of mathematics.

We can therefore consider intelligence, which lies behind our thinking and learning skills, to be analogous to program generators in computers, while intellect, which drives reasoning, corresponds to developed programs. Figure 8.9 shows these relationships, which are analogous to the data types in Figure 8.5 on page 630.

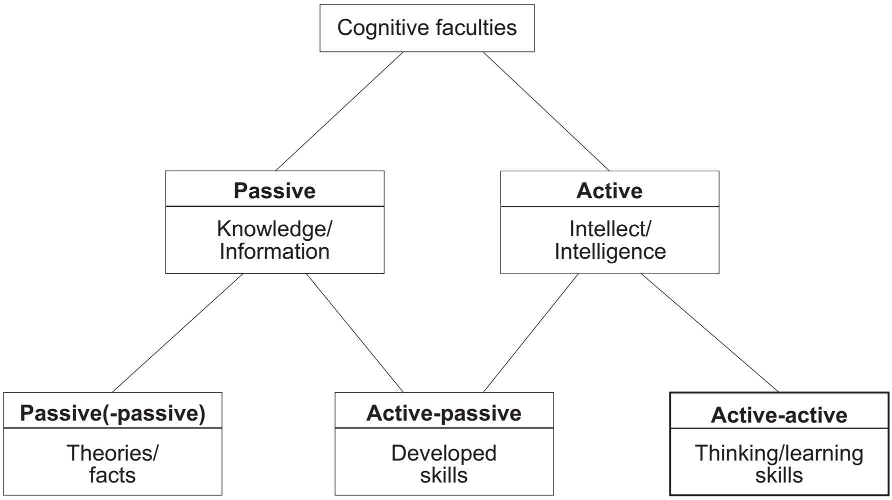


Figure 8.9: *Analgous human cognitive faculties*

So can machines think? Well, the analysis in this chapter shows quite clearly that the feature of a computer system that is closest to our thinking and learning skills is a program written in a dynamically active programming language programming itself. But we have seen that for a dapple to write programs, the symbols that it uses must already exist. All mechanical processes are trapped in the linear, horizontal dimension of time.

We can compare this perspective to the reasoning that led Aristotle to the existence of an unmoved mover, which led Thomas Aquinas to the first of his five 'proofs' for the existence of God. As Aristotle said, "That which is moved must be moved by something, and the prime mover must be essentially immovable, and eternal motion must be excited by something eternal."[43] In Thomas' words, "Now anything changing is being caused by something else. … Now we must stop somewhere, otherwise there will be no first cause of the change, and, as a result, no subsequent causes. … We arrive then at some first cause of change not itself being changed by anything, and this is what everybody understands by *God*." [44]

In terms of computer programming, every program that has ever existed has come into being through another program. So where did the first program come from? There is only one possible answer to this question. As the first program cannot have originated along the horizontal dimension of time, through an endless string of cause and effect processes, by the Principle of Unity, it must have arisen from the vertical dimension, from the timeless, formless, Absolute Whole, from God the creator. This means that Richard Dawkins' program *The Blind Watchmaker*, which is designed to show that evolution progresses without divine intervention, could not have become manifest without the creative power Life arising from our Divine Source. All scientific theories that deny the existence of Wholeness are actually being created by those very same energies whose existence the theories deny!

In general, it is only possible for us to use our intelligence to develop new concepts and to learn new skills because of the divine energies within us. This means that our creative learning is the leading edge of all evolutionary processes on this planet, not the development of computer programs. It is thus a great delusion to believe that technological development can drive economic growth indefinitely. The only way forward for humanity is therefore to focus our attention on our spiritual awakening and liberation, being guided to Oneness and Wholeness by the Principle of Unity: Wholeness is the union of all opposites.

Chapter 9
An Evolutionary Cul-de-Sac

Gerontomorphosis cannot lead to radical changes and new departures;
it can only carry an already specialized evolutionary line one more step further
in the same direction—as a rule into a dead end of the maze.

Arthur Koestler

As evolution during the past 5,000 years has been more mental than biological, our behaviour as human beings has been primarily determined by our learning. For the most part, we are not conscious of how we learn. We go about our daily lives focusing attention on building a home, growing food, painting pictures, earning a living, and so on and so forth. However, over the years, scientists, mathematicians, logicians, and philosophers have attempted to formalize our learning processes in order to ensure that our reasoning is valid, that it produces an accurate picture of the world we live in. For if our reasoning is invalid, then we must inevitably be deluded.

These principles of scientific inquiry and logical reasoning have not been static over the years. Like all our learning, they have undergone an evolutionary development, sometimes leading to a crisis when the assumptions on which these rational processes take place have proved to be unreliable. That is the situation in the world today. By denying the role that Life plays in our creative evolutionary processes, traditional Western reasoning has reached an evolutionary cul-de-sac; there is nowhere else for it to grow and develop.

In the preface to Part I, 'Integral Relational Logic', I pointed out that, in general, when evolution reaches a dead end, it needs to backtrack to an earlier stage in its development and continue growth from there. For such a pædomorphic process is rejuvenating, enabling evolution to continue on its relentless path towards Wholeness. IRL is just such a holistic science of reason that enables us to fly like the birds in the sky, without any restrictions on what we learn or how we learn it. This is because it is based on profound, abstract structures that are equally applicable in all domains of learning.

So let us use IRL to look at the evolution of scientific method and mathematical logic to see how we have reached the impasse that we are in today and what we might be able to do to unblock and heal our split minds. We can liken this situation to a dam wall holding back immense potential energy behind it. If this energy is to be released for the benefit of us all, we need to demolish the wall, either bit by bit or in one great explosion, rather like a tsunami sweeping away all before it. This chapter takes the former approach, examining some of the concrete slabs in the wall that prevent us from making peace possible by healing the split between Western reason and Eastern mysticism and between logic and psychology.

The central point here is that we can only act consciously in the world with full awareness of what we are doing through self-inquiry. Historically, the mystics have led the way in this endeavour through their meditative and contemplative techniques. The mystics have thus shown us the way to the Truth, being far more scientific than those we call scientists claim to be. For scientists avoid looking at their inner worlds in the belief that an external, objective reality exists independent of a knowing being. We urgently need to correct this misconception.

We first look at the way that mathematics, the language of science, and logic, the science of mind and reason, has also reached an evolutionary cul-de-sac. For centuries, mathematics was seen as the one discipline in which certainty and irrefutable truth could be found. But when mathematicians sought certainty in mathematics in the first half of the twentieth century, it eluded them, basically because they were using linear thought processes in the horizontal dimension of time, not nonlinear, initiated by Life in the vertical dimension.

We next take a brief overview of the way scientific method has evolved over the years, showing that it has reached a dead end because it cannot explain why the pace of technological development is accelerating exponentially, why evolution is currently passing through its accumulation point in systems theory terms. As a result, we are managing our business affairs having very little understanding of what we are doing.

As neither mathematical logic nor scientific method can lead us to Wholeness and the Truth, it is not surprising that physicists' theories of what they consider to be the universe have reached an evolutionary blind alley. We look at some of the consequences of this and how we can resolve the incompatibilities found by the physicists in the last century within the context of the Universe viewed as Consciousness. In so doing we can also bring Life back to science, which the biologists are doing their best to deny.

The loss of certainty

Although it is not necessary to know anything about the history of mathematics and logic to be an awakened individual in an awakened society, the hidden assumptions of these subjects lie deep in the collective unconscious of Western civilization. So if we are to be free of this conditioning, to end our sleepwalking habits, it is vitally important that we bring our suppositions into awareness so that they can be examined in the full light of Consciousness.

Now because the ancient Greeks were living some two thousand years after the dawn of history, the idea that time is linear, with a past and future, was well established in their culture. So it was natural for them to assume that both the chain of cause and effect and human reasoning are also linear. In the case of the former, Aristotle reasoned that there must be an unmoved mover that brings all motion into effect.[1] This meant that Aristotle was not aware that the unmoved mover is the Absolute and that all change arises through the effect of Life or the Logos arising directly from our Divine Source in the vertical dimension of time.

The one outstanding exception to this state of ignorance in ancient Greece was Heraclitus, the mystical philosopher of change, who lived between 540 BCE and 475 BCE, about 150 years before Aristotle. Very little of Heraclitus' writings survive, only fragments, some of which are quotations by others, not direct quotes. But the fact that these fragments exist at all shows that his was a voice that could not be ignored.[2]

Heraclitus was essentially a both-and thinker, grounded in Wholeness, as this fragment shows quite clearly: "God is day and night, winter and summer, war and peace, satiety and want."[3] As a mystic, he was also acutely aware of the primal energy that makes manifest the entire world of form. He called this the *Logos*, which Lao Tzu called *Tao*, the *Upanishads* and *Vedas rit*, and Shankara *brahma*, as Osho points out.[4]

He was very well aware that few of his contemporaries understood what he meant by *Logos*, as these fragments indicate: "Although the Logos is eternally valid, yet men are unable to understand it—not only before hearing it, but even after they have heard it," "Yet, although the Logos is common to all, most men live as if each of them had a private intelligence of his own," and "Although intimately connected with the Logos, men keep setting themselves against it."

This lack of understanding of the mystical meaning of *Logos* led Heraclitus to say, "Eyes and ears are poor witnesses for men if their souls do not understand the language."[5] So his contemporaries called him 'the Obscure' and Aristotle accused him of not reasoning.[6] Aristotle did not understand that Wholeness is the union of all opposites, and as such, is the basis of all reason. Rather Aristotle said, "it is impossible for anyone to suppose the same thing is and is not, as some imagine that Heraclitus says."[7] Rather more precisely, Aristotle asserted, not in *Organon*, but in *Metaphysics*, "It is impossible for the same attribute at once to belong and not to belong to the same thing and in the same relation,"[8] which is the seventh pillar of unwisdom underlying Western civilization.

From the point of view of Wholeness, it does not matter whether this Law of Contradiction, the fundamental law of Western thought, is true or not. Indeed, as mathematicians and logicians discovered in the twentieth century, this divisive law is not universally true. So it is time to put the Logos back into logic, which neither Aristotle nor any of his successors have been able to do, and thereby to put logic back into psychology, where it properly belongs. Indeed, it was not until the invention of the stored-program computer in the middle of the last century that we were able to discover the error of our ways. As Heraclitus said, "We should let ourselves be guided by what is common to all," that is by the Logos.[9]

Beginnings of Western reason

However, Aristotle did not do this. For Aristotle, time was linear, which is well demonstrated in the *Organon*, the five books that constitute the foundations of Western reason called *Categories*, *On Interpretation*, *Prior Analytics*, *Posterior Analytics*, and *Topica*. In the third of these books, he developed the syllogism by examining structures consisting of three propositions (also called statements or sentences), called the major premise, minor premise, and conclusion, respectively. Each proposition has two terms called the subject and predicate.

Aristotle developed some rules for determining which of these structures leads to a valid conclusion and which do not. In doing this, he naturally used Integral Relational Logic in studying the various attributes of the propositions. For instance, the terms in a proposition are related to each other in four different ways, as the relation in Table 9.1shows. The diagrams come from Leonhard Euler (1707–1783), which were extended in 1880 by John Venn (1834–1923), known today as Euler and Venn diagrams.

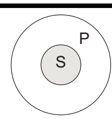
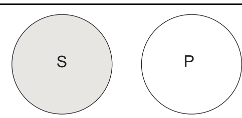
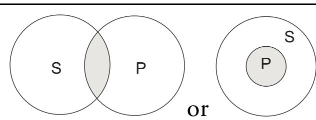
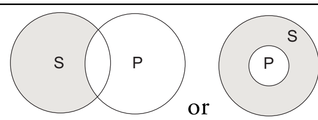
Class name	*Syllogistic propositions*		
Attribute name	*Name*	*Form*	*Diagram*
Attribute values	A	All S are P	
	E	All S are not P	
	I	Some S are P	
	O	Some S are not P	

Table 9.1: *Forms of syllogistic propositions*

These propositions have three pairs of attributes that characterize the propositions, as the following relation shows. Any two of these attributes uniquely defines the proposition. So we could call them defining attributes, with the third being derivable from the other two, as in Table 9.2.

Class name	*Syllogistic propositions*			
Attribute name	*Name*	*Universality*	*Positivity*	*Symmetry*
Attribute values	A	universal	positive	asymmetrical
	E	universal	negative	symmetrical
	I	particular	positive	symmetrical
	O	particular	negative	asymmetrical

Table 9.2: *Characteristics of syllogistic propositions*

Aristotle called the symmetrical propositions convertible because they are equivalent when the terms are interchanged. A and E are also convertible into weaker forms, I and O, respectively. Furthermore, if we assume Aristotle's Law of Contradiction to be true, A and O and E and I are contradictory; they exclude each other.

One other property of these propositions relates to the terms in the proposition, rather than the propositions themselves. A term is distributed if, in some sense, it refers to all entities with the particular property (called a class), otherwise it is undistributed. The subject of universal propositions and the predicate of negative propositions are distributed, as shown in the relation in Table 9.3.

Class name	*Syllogistic propositions*		
Attribute name	*Name*	*Subject*	*Predicate*
Attribute values	A	distributed	undistributed
	E	distributed	distributed
	I	undistributed	undistributed
	O	undistributed	distributed

Table 9.3: *Distributed properties of syllogistic propositions*

The terms of the three propositions of the syllogism are related to each other in two ways:

a) One term is common to the major and minor premises; it is called the middle term (M).
b) The predicate (P) of the conclusion is the major term of the syllogism and the subject (S) is the minor term, because they are the non-middle terms in the major and minor premises, respectively.

As propositions are one of four types and as there are three propositions in each syllogism, there are 4^3=64 different syllogistic forms, called moods. These are naturally called AAA, AAE, AAI, etc.

In addition, the syllogism can have one of four figures, depending on whether the middle term is the subject or predicate in the major and minor premises, shown in Table 9.4. (Curiously, for some reason, Aristotle only recognized three of these figures; the fourth was not discovered until the Middle Ages.) There are thus 64*4=256 possible syllogisms in total.

Class name	*Syllogistic figures*	
Attribute name	*Name*	*Figure*
Attribute values	I	M P S M ――― S P
	II	P M S M ――― S P
	III	M P M S ――― S P
	IV	P M S M ――― S P

Table 9.4: *Syllogistic figures*

Aristotle examined each mood and figure in turn to determine whether it was valid or not. He then derived a number of common properties of these syllogisms, which can be called rules of deduction. I reverse this process here. These are the rules that Aristotle discovered:

1. Relating to premises irrespective of conclusion or figure
   a) No inference can be made from two particular premises.
   b) No inference can be made from two negative premises.
2. Relating to propositions irrespective of figure
   a) If one premise is particular, the conclusion must be particular.
   b) If one premise is negative, the conclusion must be negative.
3. Relating to the distribution of terms
   a) The middle term must be distributed at least once.
   b) A predicate distributed in the conclusion must be distributed in the major premise.
   c) A subject distributed in the conclusion must be distributed in the minor premise.

This leaves us with 19 valid syllogisms, found by Aristotle and his successors:

First figure: AAA, EAE, AII, EIO
Second figure: EAE, AEE, EIO, AOO
Third figure: AAI, EAO, IAI, AII, OAO, EIO
Fourth figure: AAI, AEE, IAI, EAO, EIO

Students in the Middle Ages were expected to know all these by heart. For instance, the statutes of the University of Oxford in the fourteenth century included this rule: "Bachelors and Masters of Arts who do not follow Aristotle's philosophy are subject to a fine of 5s for each point of divergence, as well as for infractions of the rules of the *Organum*."[10] Not surprising therefore that they needed a mnemonic to remember this rather arbitrary set of letters:

Barbara, Celarent, Darii, Ferioque
Cesare, Camestres, Festino, Baroco
Darapti, Felpaton, Disamis, Datisi, Bocardo, Ferison
Bramantip, Camenes, Dimaris, Fesapo, Fresison.[11]

These syllogisms can be further reduced because propositions E and I are symmetrical; the terms in these propositions can be interchanged. Also, some syllogisms are weak forms of stronger ones. This means that there are just eight core syllogisms out of the 256 candidates that we started with: AAA (I), AII (I), EAE (I), EIO (I), AOO (II), AAI (III), EAO (III), and OAO (III).

Just as Aristotle did not begin at our Divine Source in developing his logic, neither did Euclid, who lived about 200 BCE, about a century after Aristotle, in laying down the fundamental principles of mathematical proof in *The Elements*. Although many of the theorems in *The Elements* were not new, what is now a three-volume work, studied by all educated people until the twentieth century, was the first attempt to create a systematic approach to mathematical theorems.

Euclid began his first book of mathematical reasoning with twenty-three definitions, five postulates, and five common notions, which today we would call axioms.[12] To Euclid, these were self-evident truths, although he doesn't explicitly say this. Today, axioms are more likely to be regarded as assumed truths, none of which is, of course, the Truth, which cannot be expressed in symbols of any sort.

Nevertheless for more than two millennia, mathematics was regarded as a way of leading to certain knowledge about the world we live in. As Morris Kline tells us in *Mathematics: The Loss of Certainty*, "Mathematics was regarded as the acme of exact reasoning, a body of truths in itself, and the truth about the design of nature".[13] Maybe many still believe in this view of mathematics. Yet despite its great success in making predictions about the physical universe and the many theorems it has discovered, mathematics, as it has evolved today, falls far short of this ideal picture. Nevertheless, mathematics is regarded as the archetype of conceptual clarity, as this well-known joke illustrates:

> An astronomer, a physicist, and a mathematician (it is said) were holidaying in Scotland. Glancing from the train window, they observed a black sheep in the middle of the field. 'How interesting,' observed the astronomer, 'all Scottish sheep are black!' To which the physicist responded, 'No, no! Some Scottish sheep are black!'. The mathematician gazed heavenward in supplication, and then intoned, 'In Scotland there exists at least one field, containing at least one sheep, at least one side of which is black.'[14]

So what went wrong? Why is it that the pursuit of conceptual clarity has not led to conceptual integrity? Why is it that the great body of truths that mathematics has discovered do not add up to the Truth? Why doesn't mathematical logic tell us what it truly means to be a human being, in contrast to the other animals and machines, like computers? The answer is very simple. Mathematics, as it has been practiced over the years, is not based on the fundamental principle of mapmaking, "Accept everything; reject nothing".[15] Rather, mathematics is based on the first and seventh pillars of unwisdom, in particular. It is not surprising therefore that mathematics has no solid foundation and so cannot possibly lead us to Wholeness and the Truth.

The laws of thought

Logic, the science of reason, followed an independent path for over two thousand years, based primarily on Aristotle's syllogism. Mathematics and logic were seen as being quite distinct from each other.

However, in 1854, George Boole (1815–1864) wrote a seminal book called *An Investigation of the Laws of Thought on Which Are Founded the Mathematical Theories of Logic and Probabilities*, a development of an earlier pamphlet called *The Mathematical Analysis of Logic: Being an Essay towards a Calculus of Deductive Reasoning*, published in 1847. Here is the first sentence of this former work: "The design of the following treatise is to investigate the fundamental laws of those operations of the mind by which reasoning is performed," with the purpose of exploring "the nature and constitution of the human mind".[16]

Apparently, he had been moved to do so by a mystic experience he had had when seventeen in early 1833, when the thought flashed through him as he was walking across a field that logical relations could be expressed in symbolic or algebraic form. This was an idea that Gottfried Wilhelm Leibniz had explored during the last third of the seventeenth century,[17] although Boole was unaware of this at the time. By thus explaining the logic of human thought, he felt it possible to delve analytically into the spiritual aspects of man's nature. As Desmond MacHale, his biographer, tells us, "Boole referred to the incident many times in later life and seems to have regarded himself as cast in an almost messianic role."[18]

In preparation for these seminal books, in 1844, Boole wrote a paper called 'On a General Method in Analysis' published in the *Philosophical Transactions of the Royal Society of Lon-*

don.[19] At the time, there was a movement towards ever greater generalization in mathematics. For instance, the concept of number had evolved from all positive integers, to all integers, including zero, to rationals, reals, and complex numbers of the form $a + ib$, where $i = \sqrt{-1}$. However, while it was known in 1830 that while complex numbers could be used to represent vectors in two-dimensional Euclidean space, no way had been found to extend such numbers to three dimensions. In trying to solve this problem, in 1843, William R. Hamilton (1805–1865) discovered what he called quaternions of the form $a + ib + jc + kd$, where $i = j = k = \sqrt{-1}$.

However, when Hamilton attempted to apply the basic rules of arithmetic to quaternions, something quite revolutionary happened. While he could add and subtract quaternions by simply applying these arithmetic operations to the four terms individually, multiplication was much more tricky. He needed a way of multiplying quaternions so that the result is also a quaternion, satisfying the property of closure in group theory. What he found is that this would only be possible if these relationships held:

$$jk = i,\ kj = -i,\ ki = j,\ ik = -j,\ ij = k,\ ji = -k$$

However, these relationships mean that multiplication in quaternion algebra is not commutative. For instance, if p and q are quaternions, pq does not equal qp. This was a great shock to mathematicians. For as Kline tells us, “Here was a physically useful algebra which fails to possess a fundamental property of all real and complex numbers, namely that $ab = ba$.”[20] This result led mathematicians into quite new forms of algebra, where the objects being operated on are not necessarily numbers, even more revolutionary.

For instance, drawing on Duncan F. Gregory’s generalizing principles, Boole helped free mathematics from the tyranny of number systems, regarding the essence of mathematics as “the study of form and structure rather than content, and that ‘pure mathematics’ is concerned with the laws of combination of ‘operators’ in their widest sense.” As a result, in 1901, Bertrand Russell paid Boole the high compliment of having ‘discovered’ pure mathematics, although half a century later he said that he had said this to emphasize the central importance of Boolean abstractions.[21] For instance, Boole noted that the commutative and distributive laws of arithmetic could equally apply to differential operators and geometric transformations.[22]

However, the fellows of the Royal Society did not readily accept Boole’s major contribution to what is called ‘operator theory’, for he was precocious autodidact, working outside the constraining mainstream of mathematics at the University of Cambridge. As Gregory advised him, becoming an undergraduate at Cambridge, which Boole made some tentative inquiries to do, would have been unbearable to a man of his intellect and hunger for original research, even if Boole had had the funds to attend the university.[23] For Boole was the son of a shoemaker, who was much more interested in science, literature, and mathematics to attend fully to his business.[24]

So to support his parents and siblings, Boole had been a humble schoolteacher from the age of sixteen, setting up his own school in Lincoln at nineteen.[25] Thankfully, one of the referees—Phillip Kelland, Professor of Mathematics as the University of Edinburgh—saw the merits of Boole's paper and strongly recommended its publication. As a result, Boole was awarded the Royal Society's first gold medal for mathematics, known as the Royal Medal.[26]

By thus gaining a reputation as one of the leading mathematicians of his day, Boole applied for and was appointed the first professor of mathematics at Queen's College in Cork in 1849, even though he did not have a degree.[27] There he met Mary Everest, the niece of John Ryall, the Professor of Greek at the College, and Lieutenant-Colonel Sir George Everest, the Surveyor-General of India, who gave his name to the world's highest mountain.[28] Although Boole was seventeen years older than Mary, the daughter of a clergyman, they married in 1855, having some remarkable progeny.[29] One of the most noteworthy was Alicia Boole Stott, who had the rare ability to visualize four-dimensional space, mentioned on page 129 in Chapter 1, 'Starting Afresh at the Very Beginning'.

Regarding the books with which Boole laid down the initial principles of symbolic logic, he was following a long line of thinkers, from Aristotle to Leibniz, who had dreamt of making logic a precise science, whichpage 91 in Chapter 1, 'Starting Afresh at the Very Beginning' could be formalized and symbolized in such a manner that these principles could be applied "in a more or less mechanical or automatic way to the analysis of a wide range of human, linguistic, ethical, and scientific situations".[30] Of course, such an aim was bound to fail, for it was based on the fourth pillar of unwisdom, on the false belief that human beings are machines and nothing but machines.

Nevertheless, Boole's books were to have an immense influence, building on his earlier methods of abstraction and generality, which have reached their ultimate culmination with the Principle of Unity, the Ultimate Yoga, as we saw on page 91 in Chapter 1, 'Starting Afresh at the Very Beginning'. In *Laws of Thought*, Boole said in his first proposition that all the operations of language, as an instrument of reasoning, could be considered to be a set of literal symbols, such as x, y, and z, representing concepts, and signs of operation, such as +, -, and ×, with a sign of identity =, to compare expressions. For instance, x could denote 'all men', while y could serve as a representation of the class 'good things'. So xy would denote 'all good men', as would yx.[31] Alternatively, y could denote 'all women', exclusive to x. In this case, $x + y$ would denote 'all men and women'. And $z(x + y) = zx + zy$ could denote 'European men and women', these expressions obeying commutative and distributive laws.[32] It seems, however, that Boole did not consider the associative law, one of the oversights in his trail-blazing work.[33]

Now one key result of his algebraic logic is that if x and y have the same signification, their combination expresses no more than either of the symbols taken alone would do. In this case $xy = x$, as 'good, good things' is essentially the same as 'good things', just with added emphasis. But as $x = y$, we can say $xx = x^2 = x$.[34] By the Principle of Unity, there are two ways that we can view this relationship.

First, in algebra, this equation has the roots 0 and 1, constants that Boole took to denote the empty and universal set or class, respectively. So the expression $1 - x$ would denote 'all things that are not x' within some particular domain of discourse. Furthermore, as $x^2 = x$ could be rewritten $x(1 - x) = 0$, this equation represents Aristotle's Law of Contradiction, not as the most basic of axioms, but as a proposition. For as he said, if x represents 'men' and $1 - x$ 'not men', then the expression $x(1 - x)$ represents "*a class whose members are at the same time men and not men,*" which is the empty class, for such a set cannot exist if Aristotle's Law of Contradiction is universally true. Boole called this equation the 'law of duality',[35] later to be called by academics at Cambridge University 'Boole's equation', for in general, it applies no matter what class of beings that x might denote. As Mary his widow tells us, "George afterwards learned, to his great joy, that the same conception of the basis of Logic was held by Leibnitz, the contemporary of Newton."[36]

Alternatively, we could write the equation $x^2 = x$ as an expression or function, $f(x) = x^2 - x$ or $x(x - 1)$, which could take values other than 0. For instance, $x(x - 1) = 1$ could be interpreted as the union of all opposites is the Universe or Wholeness. In other words, the Principle of Unity. As such, Boole's function could represent both the Principle of Unity and the Law of Contradiction, depending on whether it is equal to 1 or 0, respectively.

Boole's function is an example of a general principle by which Boolean algebra could be used for the purely symbolic manipulation of classes. In an example given by Desmond MacHale, much clearer than in Boole's book, consider the classical syllogism 'all As are B, all Bs are C; therefore all As are C'. "In Boole's notation, the hypothesis could be written $a = ab$, $b = bc$. By substitution $a = ab = a(bc) = (ab)c = ac$."[37]

As the result of this seminal book, Boole's name has been immortalized in the operators of AND, OR, and NOT in Boolean algebra, well familiar to anyone engaged in making searches of databases on the Internet, and in the Boolean data type in many programming languages, having the values 'true' or 'false'. Basic arithmetical operations of binary digits can also be represented in Boolean algebra, as the one-bit adder in Figure 8.3 on page 626 shows.

So Boole could be considered one of the founding fathers of computer science, as much as Charles Babbage and Ada Lovelace, as parents who worked on Babbage's Analytical Engine. However, in 1901, Mary Everest Boole, added a postscript on the real meaning of Boole's contribution in a remarkable open letter written to a Dr Bose called 'Indian Thought and Western Science in the Nineteenth Century', published in *The Ceylon National Review* in

June 1909 and printed in booklet form in 1911 under the title of *The Psychologic Aspect of Imperialism*, stretching to twenty-one pages in her voluminous collected works.[38]

Figure 9.1: *Mary Everest Boole*

Mary was a widow for some 52 years, living to the age of 84, to her husband's 49, having had five daughters with him during nine years of marriage. She seems to have been one of the few people who understood the real intention behind his life's work, which is well explained by her letter. Although she was the daughter of a clergyman in the Church of England in Gloucestershire, her father was far from being conventional. Because of suspected consumption, he moved to Paris in 1837, when Mary was five, to be near Samuel Hahnemann, the founder of homoeopathic medicine.[39] On returning to England when Mary was eleven, her father was not a typical priest, regarding himself as a servant of the people, appointed to organize the culture of the parish *in accordance with the desires of the most serious and wise inhabitants*, much to the alarm and anger of the neighbouring clergy.[40]

An incident when preparing for confirmation sheds much light on her religious convictions. Mary asked her father what does it mean to say that Jesus is an Incarnation of God? He replied, "Why can't you understand? You are an Incarnation of God yourself." As she added, "This from a country clergyman in 1849!"[41] Also, she tells us that when her uncle George went out to India at sixteen, "He made the acquaintance of a learned Brahman, who taught him—not the details of his own ritual, as European missionaries do, but—the essential factor in all true religion, the secret of how man may hold communion with the Infinite Unknown."[42] She, herself, was horrified by the British governing classes and colonial attitudes, saying, "how can we expect to retain the loyalty of Hindus, if we trample out their normal development and their self-respect?"[43] And even though she knew that naming the highest mountain in the world after her uncle was to honour his services to engineering science, she still thought that altering the ancient name of the great mountain was a "queer kind of vandalism".[44]

This spiritual, almost mystical background, intuitively grounded in the ancient, perennial wisdom that underlies all the religions, shows us clearly how George and Mary Boole saw *The Laws of Thought*: it was as much a book about psychology as mathematics. For what else is logic, as the science of reason, but the foundation of psychology? To Boole, the human mind works both by receiving information from the external world and also by receiving knowledge directly from The Unseen every time it returns to the thought of Unity between any given elements (of fact or thought), after a period of tension on the contrast or antagonism between those same elements, an insight that arose from his mystical experience as a seventeen-year-old.[45]

However, this was not how the academic world saw this work, even though it was enchanted by it, Herbert Spencer saying that the book was "the greatest advance in Logic since Aristotle". Rather, "nearly all the logicians and mathematicians ignored the statement that the book was meant to throw light *on the nature of the human mind*; and treated [Boole's equation] entirely as a wonderful new method of reducing to logical order masses of evidence about external fact." To which Mary added, "Only think of it! The great English religious mind, which considers itself competent to preach *the Truth*, the only saving Truth, to all mankind; the great academic educational mind which is to improve Hindu culture off the face of the earth, fell into a trap which I believe would hardly have deceived a savage."[46]

As Mary tells us, her husband "went very little into university society, because he had good reason to know that the cordiality of his admirers would in most cases have been diminished if they had had any clear idea what his books really were about."[47] Mary herself had seen since the age of eighteen that 'Boole's equation' is "the mere algebraic expression of natural psychologic truth". However, every attempt on her part to explain Boole's equation or function as a law of the human mind known in Asia from the earliest recorded ages met with either violent opposition or blank non-intelligence by her contemporaries.[48] Apparently, few could see what she could see and feel, that the mystical strand underlying the religions

> consists of allusions to and hints of the great, world-wide, world-old secret, of the means by which man can maintain and increase his capacity for directly receiving into himself fresh force from cosmic sources, and fresh knowledge direct from that storehouse of the As-Yet-Unknown which remains always infinite, however much we may learn. I call this latter strand 'secret', not because those who most truly know it are unwilling to communicate it to anyone who wishes to know it, but because of the unwillingness of men agglomerated in groups either to know it or to let it be known. The majority both dislike for themselves the stern self-discipline which the knowledge of it imposes, and dread the mental power given to others by its possession.[49]

Given the resistance Mary felt to George and her attempts to base mathematical logic—the most fundamental of all the sciences, as the science of thought and consciousness—on mystical union with the Divine, which she had learnt from the East, it is perhaps not surprising that she mentions, "I am sometimes told that my experiences and my husband's are unique." To which she responded, "I do not think so. If they were, they would be in no way worth recording." For she suspected that the resolute determination of religious people to suppress evidence of the value of cultures other than their own had led to much work similar to her husband's being ruthlessly destroyed, giving two examples.[50] It seems that nothing has changed in one hundred years. Today, academics in all disciplines, as much as religionists, do their best to deny the universal truth that would enable us to live in love and peace with each other by ending the long-running war between science and religion.

Mathematical logic

Mathematics, having freed itself from attachment to number and space, then began to become ever-more abstract in the patterns and relationships that mathematicians discovered, whether or not these mapped to physical or metaphysical reality, including mental processes. These are often called 'occult', from Latin *occultus* 'secret', past participle of *occulere* 'to cover over'. In this sense, Isaac Newton—searching for *prisca sapientia* 'ancient wisdom'—was an occultist with his alchemical experiments and theological studies, as we see on page 973 in Chapter 11, 'The Evolution of the Mind'.

In the case of mathematical logic, its evolution is a long, confused story, which is mostly irrelevant to understanding "the fundamental laws of those operations of the mind by which reasoning is performed." Essentially, this is because mathematical logicians developed their subject solely in the horizontal dimension of time, without realizing that they were actually diving into the depths of the Cosmic Psyche, seeking a sound foundation for all knowledge and human learning.

It is not surprising that several of them suffered severe mental disturbances, some spending time in psychiatric institutions, as Gian-Carlo Rota tells us in *Indiscrete Thoughts*. These included Charles Sanders Peirce (1839–1914), Georg Cantor (1845–1918), Giuseppe Peano (1858–1932), Ernst Zermelo (1871–1953), Emil Leon Post (1897–1954), and Kurt Gödel (1906–1978). "Alonzo Church [(1903–1995)] was one of the saner among them, though in some ways his behaviour must be classified as strange, even by mathematicians' standards."[51]

In addition, Gottlob Frege (1848–1925), in later years, at least, was "a man of extreme right-wing political opinions, bitterly opposed to the parliamentary system, democrats, liberals, Catholics, the French and, above all, Jews, who he thought ought to be deprived of political rights and, preferably, expelled from Germany".[52] In contrast, Bertrand Russell (1872–1970) was a peacemaker, being imprisoned for four and a half months in 1918 for writing Pacifist propaganda.[53]

Yet even Russell feared he would go mad, like his uncle William—the son of a British prime minister—who spent the last fifty-eight years of his life in an asylum, a secure place of refuge for those in need.[54] At the time of his death aged ninety-seven in 1970, "Russell left two embittered ex-wives, an estranged schizophrenic son and three granddaughters who felt themselves haunted by the 'ghosts of maniacs', as Russell himself had described his family back in 1893." Five years later, one of these granddaughters committed suicide by setting fire to herself aged twenty-six.[55] And Alan Turing (1912–1954) committed suicide presumably for having been convicted of homosexual acts, which were illegal at the time, even though he was a wartime hero, having deciphered the German Enigma machine.[56]

But concerning the history of ideas, what is particularly interesting in the evolution of mathematical logic is the algebra of relations, which can be traced back to Augustus De Morgan (1806–1871) and Charles S. Peirce, for this evolved into Ted Codd's relational model of data and hence into Integral Relational Logic. Curiously, this pedigree is not mentioned by any of the contributors of essays at the Charles S. Peirce Sesquicentennial International Congress held at Harvard University in 1989,[57] even by Geraldine Brady, who has since done much to put Peirce's logic into its historical context,[58] or by John F. Sowa, who embodied Peirce's meaning triangle in the conceptual structures of artificial intelligence, as we see on page 126 in Chapter 1, 'Starting Afresh at the Very Beginning'.

However, the propositional calculus and first-order predicate logic also played a part in this evolutionary process, so we also need to look at these. However, it is not so easy to trace this process, for many different notations appeared along the way, which can hide the formation of logical concepts, also disguising to what extent pioneers were in touch with themselves and hence Reality. As Western civilization has been moving further and further away from Reality during the past couple of centuries, experts on mathematical logic are not generally very good at throwing light on this psychological process.

In contrast to Boole, De Morgan, nine years older, *did* study mathematics at Cambridge University, graduating as fourth wrangler, that is with first-class honours or *summa cum laude*. However, De Morgan, the son of an army captain of Huguenot descent in the East India Company and the grandson of James Dodson, a mathematician well-known in his day, was not awarded a fellowship because of his unorthodox religious views. Rather, in 1828, at the age of just twenty-two, he was appointed the first professor of mathematics at the new and nondenominational University of London (now University College), the youngest of thirty-two candidates.[59]

Although De Morgan was primarily a brilliant and popular teacher, his "mathematical and literary output was very extensive, probably the largest of any mathematician of his time," that is until Peirce. De Morgan published his first book on *Formal Logic* in 1847, the same year as Boole's *The Mathematical Analysis of Logic* was published. This shows that De Morgan, unlike Boole, was more a reformer of the old logic than a creator of a new one.[60] He began his investigations, primarily into syllogistic reasoning, by saying that Logic is "that part of reasoning which depends upon the manner in which inferences are formed, and the investigation of general maxims and rules for constructing arguments, so that the conclusion may contain no inaccuracy which was not previously asserted in the premises."[61]

So De Morgan studied within the linear framework of Western thought, which led to the invention of the stored-program computer a century later, but which can tell us little about the human mind, consciousness, and hence what the Universe is and how it is designed. Specifically, De Morgan saw logic "as a formal science, having nothing to do, directly, with questions of empirical psychology or abstract metaphysics. Its forms are forms of possible thinking, rather than of actual thought."[62] It was thus that mathematicians began to open up the split between logic and psychology—despite the Booles' worthy intentions—leading scientists today to assert that robots are about to take over the world, making humanity redundant.

De Morgan's *Formal Logic* also contains a chapter on what he called mathematical induction, a term introduced four years earlier in *The Penny Cyclopædia of the Society for the Diffusion of Useful Knowledge*.[63] In 1945, in *How to Solve It*, George Pólya (1887–1985) wrote that it was unfortunate the word *induction* is used in both science and mathematics, "because there is very little logical connection between the two processes."[64] However, De Morgan saw a connection because he first defined induction as "the inference of a universal proposition by the separate inference of all the particulars of which it is composed," which we explore in the next section. He then extended this into mathematics, where the particulars are beyond enumeration, but which nevertheless form a sequence, which can be mapped to the integers.[65] Euclid's proof that there are an infinite number of primes is one of the first uses of mathematical induction as a method of reasoning.[66]

Peirce's view of the relationship between logic, mathematics, psychology, and philosophy is much more complex, apparently varying over the years as his consciousness broadened and deepened, not the least as the result of a mystical experience in 1892.[67] To understand Peirce's ontogeny, we first need to know something of Peirce's family history. His five times great grandfather was John Pers (ca. 1588–1661), a Puritan weaver who moved from Norwich, England in 1637 to settle in Watertown, Massachusetts. So *Peirce* is actually pronounced *purse*. It was Peirce's great grandfather Jerathmiel (1747–1827) who changed the spelling of the family name, moving to Salem and prospering in the East India shipping trade. His son Benjamin (1778–1831) graduated from Harvard College, entered the shipping trade with his father, became a state senator, and, when Salem's shipping trade declined, became Librarian at Harvard, published a four-volume Catalogue of the library's holdings, and wrote a history of the university, which was published shortly after his death.[68]

His son Benjamin (1809–1880), Charles' father, became professor of mathematics and astronomy at Harvard, the leading American mathematician of his day. This Benjamin married Sarah Hunt Mills, the daughter of Elijah Hunt Mills, US senator for Massachusetts, the great great grandfather of Henry Cabot Lodge, Jr (1902–1985), the vice presidential candidate to Richard Nixon in the 1960 presidential election, won by John F. Kennedy. Three of the seven men who founded the National Academy of Sciences with Abraham Lincoln in 1863 were his father, Admiral Charles H. Davis, his mother's brother-in-law, the father-in-law of the elder Henry Cabot Lodge (1850–1924), a leading US senator, who married Peirce's first cousin, and Alexander Dallas Bache (1806–1867), his employer as the Supervisor of the U.S. Coast Survey.[69]

Peirce's first wife Harriet Melusina Fay, affectionately known as Zina, who he married when he was 23 and she 26, had a similar prestigious social background, being the granddaughter of John Henry Hopkins, the first bishop of the Episcopal Diocese of Vermont and the eighth Presiding Bishop of the Episcopal Church in the United States of America. Her father was also an Episcopalian clergyman, also called Charles, who conducted the service. Before the marriage, Peirce was confirmed by his grandfather-in-law-to-be, converting from unitarianism to trinitarianism.[70] We can compare this to Isaac Newton, Fellow of Trinity College, Cambridge, who was a closet unitarian and Arian, denying the divinity of even Jesus, as we see in Chapter 11, 'The Evolution of the Mind' on page 968.

So, on the face of it, Peirce came from an orthodox, upper-middle class family. However, this was far from being the case. On the day of Charles's birth, Benjamin wrote prophetically that he saw his son becoming a genius, celebrity, and great philosopher,[71] rather like the way astrologers have foreseen the destiny of the new-born through the ages. So Charles was the favoured son, even though the second born, destined to be his father's intellectual and spiritual heir.

Most importantly, the son inherited his father's evolutionary cosmology, elucidated in a series of lectures that Benjamin gave in 1879 at the Lowell Institute, published posthumously in 1881 as *Ideality in the Physical Sciences*. As his eldest son, James Mills Peirce, explains in the introduction to this book, Augustus Lowell invited Benjamin "to express his views on the true attitude of science to religion". For this eminent mathematician and astronomer did not see any division between the two. He was quite certain that the physical universe could not have come into being without God the Creator. As he said, "no finite agent can accomplish an infinite production." With the nebular theory of Emanuel Swedenborg (1688–1772), Immanuel Kant (1724–1804), and Pierre-Simon Laplace (1749–1827) as a background,[72] here is Benjamin Peirce's description of his cosmogonic worldview:

> The universe … commences with an all-pervading substance, in which there is no apparent structure nor division into parts, but the same monotonous uniformity throughout. Passing through innumerable transformations, it terminates in a system, whence disorganization has been wholly eliminated, and where vast multitudes of individuals, each a perfect organism in itself, are combined in indestructible harmony. In the beginning, it has the unity of monotony; in the end, it has the unity of complete organization.[73]

Now while this passage refers to the physical universe, it applies equally to the Universe, viewed as Consciousness, essentially a mystical cosmogony, very similar to that described in this book. Most particularly, underlying the Universe is a continuous substrate, out of which all forms evolve and become perfectly organized. However, Benjamin Peirce recognized that his ideality was still evolving as work in progress, for he began the second lecture on 'Cosmogony' with these words:

> How come we here, in the physical world, so curiously adapted to our material and spiritual nourishment? This is one of the first questions proposed by thinking man, as soon as he begins to reason. The inquiry into the origin of the world is, almost instinctively, the beginning of scientific speculation; whereas the complete solution of the question can be achieved only at the very close. So long as a scientific doubt remains, the story of cosmogony is partially untold.[74]

So what Benjamin was not ready to say, like modern evolutionaries, is that the complete organization of the Universe is only reached at the Omega Point of evolution, whence the Universe returns to Ineffable Wholeness through the opposite process of involution.

We can see clearly that Charles was a precocious genius from some biographical notes that he wrote when he was twenty, studying at Harvard. In 1850, when he was ten or eleven, he "Wrote a 'History of Chemistry' " which he began to study when seven years of age, as an antidote to being "seriously and hopelessly in love". He then "Worked at Mathematics for about six months in 1854, "Read Schiller's *Æsthetic Letters*, and began the study of Kant" in 1855, aged about fifteen.[75] He went to Harvard College that same year, graduating with an A.B. before he was twenty, but very low in the class, upgraded to A.M. in 1862. He then graduated *summa cum laude* with a bachelor of science in chemistry at the Lawrence Scientific School in 1863, having also been a regular aide to the U.S. Coast Survey for most of his two and half years' study. As if this was not enough, he and Zina married in the middle of this period, living with his parents at first.

In 1865 he gave a series of eight lectures at Harvard on 'The Logic of Science', given again the following year in a somewhat different form at the Lowell Institute as 'The Logic of Science, or Induction and Hypothesis', in which he planted the seeds for his life's work. Peirce began the first lecture, which effectively launched his career as a logician, although this was not published until 1982, by saying, "The one great source of error in all attempts to make a Logic of Science has been utter misconception of the nature and definition of logic." To try to resolve this confusion, which is still with us today, Peirce said that all the definitions of logic that had evolved during the previous two millennia could be divided into two classes: "those which do not and those which do give to logic a psychological or human character".[76]

In examining the relative merits of these two views of logic, Peirce said, "we ought to adopt a thoroughly unpsychological view of logic", for three reasons. First, "I say that the logical form is already realized in the symbol itself; the psychologists say that it is only realized when the symbol is understood." So "logic needs no distinction between the symbol and the thought; for every thought is a symbol and the laws of logic are true of all symbols." Secondly, Peirce said, "The second advantage of the unpsychological view is that it affords a most convenient means for exploding false notions of the subject," going on to say, "The third advantage of the unpsychological view is that it points to a direct and secure manner of investigating the subject."[77]

Oh dear! In saying this, Peirce was effectively taking meaning out of logic and hence science, a schismatic process that Frege and Russell were to complete at the beginning of the next century, as we see on page 674. By saying that we humans can only think in symbols, he was speaking as a modern computer, which indeed can only think in signs, if machines could think. Concepts, which Peirce later called interpretants, are mental images, which are first formed without words and symbols, which appear secondly, as Einstein wrote in 1945, as we see on pages 126 and 128 in Chapter 1, 'Starting Afresh at the Very Beginning'. This experience conforms entirely with the Peircean cosmogony. But it seems that Peirce junior could not see this at the time.

In saying that Peirce took meaning out of logic, he didn't really, for meaning has never been a part of science, not the least because for thousands of years Western reason has been disobeying the basic law of the Universe: *Wholeness is the union of all opposites*. For in order for our scientific knowledge to be meaningful, it must ultimately be formed and organized within the Cosmic Context of Consciousness or Ultimate Reality. And this is not possible until evolution carries us to its glorious culmination at the end of time.

Nevertheless, while mathematical logic has carried Western civilization into an evolutionary cul-de-sac, it does contain the seeds that we need to become free of this evolutionary dead end. So let us continue our investigations of how we have reached today's parlous situation, because perhaps this could help us extricate ourselves and thereby realize our fullest potential as superintelligent human beings, far surpassing any level of artificial intelligence in machines.

Charles S. Peirce was a major player in this respect, only belatedly being recognized, not the least because like so many creative geniuses, Charley, as he was affectionately known to family and friends, was a troubled soul at times, not easy to live and work with. During childhood, adolescence, and the first half of his career, he had the protection of friends and family, particularly his influential father, who as Supervisor of the Survey from 1867 to 1874 was Charley's boss, seemingly nepotistically promoting him as Assistant to the Supervisor after Bache died. However, things began to go awry in 1876, when Zina left him after fourteen years of marriage.

Amazingly, Zina explained why she had done this in a letter to Carlile P. Patterson, her husband's then boss. She wrote that since childhood, "everything had conspired to spoil him with indulgence," so he did not feel obliged to follow the generally recognized rules of society, including the organization that employed him. So while she recognized his 'brilliant but erratic genius', she nevertheless wrote, "if *only* he will act prudently, cautioning and carefully in everything—instead of rushing things through with recklessness and extravagance—would do him a great deal of good." She concluded the letter with these extraordinary words: "Be good to my Charley, dear Captain Patterson, and be above all judicious with him. Let us save him *together* … if we can."[78]

This letter is a reflection of how difficult it is for a culture that is designed to suppress people's innate intelligence to accommodate those who seek to break free of these shackles. However, this is not just a human problem. It is an example of how any structure—whether physical or psychological—seeks to protect itself in what systems theorists call homeostasis 'same state', a critical situation at these times of unprecedented evolutionary change, as we look at further in Chapter 13, 'The Prospects for Humanity' on page 1027.

But let us look briefly at Peirce's contribution to the foundations of mathematical logic. To keep this simple, I feel that it is easiest to look at a few key elements of mathematical logic as they are today and to trace their origins back to Peirce and others. For to interpret the thoughts behind the original writings, we need to penetrate deeply into the nineteenth and twentieth century mindset, as it existed prior to the invention of the stored-program computer, quite an onerous task.

Peirce's simplest paper on mathematical logic is one he wrote in 1880 titled 'A Boolian [sic] Algebra with One Constant', but not published until 1933 in Volume IV of his *Collected Papers*, titled *The Simplest Mathematics*. As the editors Charles Hartshorne and Paul Weiss pointed out, this unpublished manuscript anticipated Sheffer's landmark paper of 1913,[79] mentioned on page 625 in Chapter 8, 'Limits of Technology'. Then in 1892, Peirce further demonstrated the functional completeness of the NAND and NOR operators, the former known today as the Sheffer stroke, using the term *ampheck*, from Greek *amphēkēs* 'cutting both ways', for the NOR operator.[80] We thus see that Peirce was many years ahead of his time, but not generally recognized until a century later.

At the time, Peirce was working intensively on an uncompleted book titled *Minute Logic*, one of several unsuccessful attempts to write and publish his magnum opus. Chapter 3 of this book is titled 'The Simplest Mathematics',[81] well illustrating Peirce's thoroughness in seeking simple principles on which to build the entire world of learning. He began this chapter with this definition of mathematics taken from his father's 1870 paper on 'Linear Associative Algebra': mathematics is 'the science which draws necessary conclusions'. This definition well illustrates the linear—that is, mechanical—nature of mathematical proof.[82] However, it ignores the fact that the subject of mathematics—when viewed as a whole—is nonlinear, a perspective that Peirce also commented on, as I have read somewhere. It is absolutely essential to make this distinction if we are to discover what it truly means to be a human being, in contrast to machines, like computers.

The most significant point about this chapter is that Peirce carefully examined all possible ways in which a pair of mathematical values, which he called **v** and **f**, for *verity* and *falsity*, could be combined.[83] Curiously, the signs that Peirce used for the sixteen binary operators were omitted from the *Collected Papers* of 1933, as Glenn Clark pointed out in his contribution to the Sesquicentennial International Congress in 1989.[84] In the event, these were not published until 1976 in Volume 3 of *The New Elements of Mathematics*, edited by Carolyn Eisele.[85] There is no need to describe these strange signs here, for they do not really contribute to understanding the underlying concepts. It is simpler to list their modern equivalents in the propositional or sentential calculus in tabular form in Table 9.5.

Class name	*Binary logical operators*							
Attribute name		*Symbol*	*Operation*	*Operator*	*Values*			
Initial attribute values	p				T	T	F	F
	q				T	F	T	F
Derived attribute values	0	XAND	Contradiction	false	F	F	F	F
	1	NOR	Logical NOR	↓	F	F	F	T
	2		Converse nonimplication	⊄	F	F	T	F
	3	¬p	Negation		F	F	T	T
	4		Nonimplication	↛	F	T	F	F
	5	¬q	Negation		F	T	F	T
	6	XOR	Exclusive disjunction	⊕	F	T	T	F
	7	NAND	Logical NAND	↑	F	T	T	T
	8	AND	Conjunction	∧	T	F	F	F
	9	XNOR	Logical biconditional	↔	T	F	F	T
	10	q	Projection function		T	F	T	F
	11		Implication	→	T	F	T	T
	12	p	Projection function		T	T	F	F
	13		Converse implication	←	T	T	F	T
	14	OR	Disjunction	∨	T	T	T	F
	15	XNAND	Tautology	true	T	T	T	T

Table 9.5: *Truth table of binary logical operators as an IRL relation*

Once again, we see here the sleepwalking characteristics of the evolution of human learning. It was not until 1920 that Emil Leon Post (1897–1954) introduced the notion of truth table to display the truth values of binary operators. He did this in his doctoral dissertation at Columbia University, published the following year.[86] Also in 1921, Ludwig Wittgenstein (1889–1951) displayed such a truth table in the *Tractatus Logico-Philosophicus*,[87] apparently discovered independently. Where Peirce had used **v** and **f**, Post and Wittgenstein used + and – and T and F, respectively. Today, truth tables are a powerful way of proving the relationships between the various binary operators.

The propositional calculus is the simplest form of mathematical logic, for rather than looking at individual terms in propositions, as in the syllogism, entire propositions are denoted by a single sign, such as *P*, without any consideration for the structure of the proposition.

Now, having realized that human reason could be represented in mathematical language, to make logic a rigorous discipline, following Euclid, mathematicians also needed to define basic axioms, as assumed truths, and the rules for transforming these axioms into theorems.

Two rules of inference in propositional logic and boolean algebra have been called De Morgan's laws since 1918, after Augustus De Morgan, even though they were known to logicians in the Middle Ages and it is not clear when and where De Morgan defined these rules. These are a pair of transformation rules that allow the expression of conjunctions and disjunctions purely in terms of each other via negation.[88]

The rules can be expressed in English as:

- The negation of a conjunction is the disjunction of the negations.
- The negation of a disjunction is the conjunction of the negations.

The rules can be expressed in formal language with two propositions *P* and *Q* as:

$$\neg(P \wedge Q) \Leftrightarrow (\neg P) \vee (\neg Q)$$

$$\neg(P \vee Q) \Leftrightarrow (\neg P) \wedge (\neg Q)$$

where $\Leftrightarrow$ is a metalogical symbol meaning ‘can be replaced in a logical proof with’.

Another mechanism for the construction of deductive proofs, known since antiquity, is *modus ponens* or the rule of detachment, which states that if *P* is true and if *P* implies *Q*, then *Q* must be true. In formal sequent notion, *modus ponens* is defined thus:[89]

$$P \rightarrow Q, P \vdash Q$$

where $\vdash$ is a metalogical symbol meaning that *Q* is a syntactic consequence of $P \rightarrow Q$ and *P* in some logical system. It is also possible to express the rule of inference as a theorem in tautological form, showing that it is possible to represent *modus ponens* rather like passive and active data in computers, defined on page 625 in Chapter 8, ‘Limits of Technology’:

$$((P \rightarrow Q) \wedge P) \rightarrow Q$$

This brings us to the strange case of the axioms of propositional logic. They are all tautologies, true no matter what the values of individual propositions, such as *P* and *Q*, might be. As such, they do nothing to lead us to the Truth. I suspect that this is why I lost interest in mathematics as an undergraduate in the early 1960s, although I was too depressed to be able to articulate my thoughts and feelings in the way I can do fifty years later. As I can see now, I must have realized that the whole of Western thought, including my beloved mathematics, was completely meaningless. For further reference, Figure 9.2 shows a set of four axioms for propositional logic, essentially those of *Principia Mathematica*:[90]

Ernest Nagel and James R. Newman well illustrate the meaninglessness of tautologies with interpretations of these axioms. For there is no need in the propositional calculus for propositions to have any semantic relationship to each other. For instance, Table 9.5 is the example they use for the fourth axiom:[91]

$$(P \vee P) \rightarrow P$$

$$P \rightarrow (P \vee Q)$$

$$(P \vee Q) \rightarrow (Q \vee P)$$

$$(P \rightarrow Q) \rightarrow ((R \vee P) \rightarrow (R \vee Q))$$

Figure 9.2: *Axioms for propositional calculus*

P	Ducks waddle
Q	5 is a prime
R	Churchill drinks brandy

Table 9.6: *An instance of propositional variables*

This axiom reads: If (if ducks waddle then 5 is a prime) then (if (either Churchill drinks brandy or ducks waddle) then (either Churchill drinks brandy or 5 is a prime)). Now, who on earth would ever say such a sentence? There is an excellent example of the great gulf between mathematical logic and cognitive psychology. In this example, all the propositions are generally regarded to be true. But this is not necessary; any one of them could also be false, illustrated in Table 9.7, the truth table for the third axiom.

P	Q	$P \vee Q$	$Q \vee P$	$(P \vee Q) \rightarrow (Q \vee P)$
T	T	T	T	T
T	F	T	T	T
F	T	T	T	T
F	F	F	F	T

Table 9.7: *Truth table for a tautology*

Needless to say, the propositional calculus played very little part in the development of Integral Relational Logic. In the spring of 1980, I did spend a couple of weeks playing with truth tables, but this led nowhere. It was not until midsummer that year that the Principle of Duality emerged in consciousness, from the principle of duality in projective geometry—as described in Section 'The Principle of Duality' in Chapter 3, 'Unifying Opposites' on page 225—that my life took off. I haven't looked back since.

However, some other features of mathematical logic did play a role in the formulation of Ted Codd's relational model and hence in Integral Relational Logic. The most important of these is the logic of relations, for relation is a primal concept in IRL. As far as I can tell, Augustus De Morgan was the first to write about the logic of relations, in the fourth of five papers he wrote 'On the Syllogism' for the *Transactions of the Cambridge Philosophical Society*, between 1846 and 1862, However, he pointed out in the introduction to this fourth paper, dated 12th November 1859, but read on 23rd April 1860, that he had already mentioned relations in the second and third papers dated 1850 and 1858, for "the ordinary syllogism [is] one cane, and one case only, of the *composition of relations*."[92]

De Morgan first defined *relation* in his 1858 paper thus: "When two objects, qualities, classes, or attributes, viewed together by the mind, are seen under some connexion, that connexion is called a relation."[93] He thus generalized the notion of the copula, from Latin *cōpula* 'link', which connects the subject and predicate in syllogistic propositions. For as Morris Kline points out, the relation 'to be' is severely limited, leading to incorrect or possibly incorrect conclusions. He gives two examples:[94]

John is a brother;
Peter is a brother;
Hence John and Peter are brothers (of each other),

which can obviously be incorrect. Likewise:

An apple is sour;
Sour is a taste;
Hence an apple is a taste,

is also an incorrect conclusion. As De Morgan realized, the richness of the relationships between thoughts, although much studied by psychologists to his time, had been neglected by logicians. He mentions that Aristotle had paid scant regard to the abstract notion of relation, although in so doing, "Aristotle is rather too much the expositor of common language, too little the expositor of common thought."[95] In extending Boole's mathematical laws of thought, it seems that De Morgan was attempting to go beyond the structure of sentences and look at the underlying structure of thought, and hence of the Universe. However, he was still stuck with signs or symbols for thoughts, not able to see the data patterns that exist prior to interpretation as mental images, which, in themselves, have no sign, as we see in Section 'Concept of concept' in Chapter 1, 'Starting Afresh at the Very Beginning' on page 111.

Charles S. Peirce, a voracious reader of everything he could get his hands on (in 1896 he had twenty-nine volumes of the *Philosophical Transactions of the Royal Society* in his library),[96] read De Morgan's 'Logic of Relations' and used it as the basis of a paper he presented on 26th January 1870 to the American Academy of Arts and Sciences, titled 'Description of a Notation for the Logic of Relatives, Resulting from an Amplification of the Conceptions of Boole's Calculus of Logic' (DNLR).[97] This was then published in the *Memoirs of the American Academy of Arts and Sciences* and also as a book, the first of Peirce's published papers in logic.[98] In 1984, Daniel D. Merrill described this paper as "one of the most important works in the history of modern logic, for it is the first attempt to expand Boole's algebra of logic to include the logic of relations".[99]

However, this seminal paper was not well known, for as Geraldine Brady tells us, "The European mathematical and scientific community would have had little contemporary access to Peirce's paper except through personally circulated copies."[100] Indeed, this is how some leading logicians, such as De Morgan and W. Stanley Jevons, first came to know of Peirce's work. In 1870, Peirce visited Europe for the first time in his capacity as assistant to the US Coast Survey to find a suitable site to watch the eclipse of the sun in December that year. So in June, he was able to meet De Morgan, giving him a copy of DNLR, which was discussed at the Liverpool meeting of the British Association for the Advancement of Science in September.[101]

During the 1870s, Peirce continued to develop his ideas on the algebra of logic, even when working for the US Coast and Geodetic Survey, as it became in 1878,[102] suffering three nervous breakdowns between 1875 and 1877, no doubt partially brought on my overwork, suffering six others in 1879, 1884, 1904, 1905, 1909, and 1911.[103]

Towards the end of 1877, Benjamin Peirce, being concerned for his son's health and salary—limited by Congressional budgets—wrote to Daniel Coit Gilman, President of the newly formed Johns Hopkins University in Baltimore, recommending Charles as head of the department of physics. However, Peirce junior regarded himself more as a logician than a physicist, so wrote to President Gilman in January 1878, asking for the opportunity to develop his sketchy ideas on mathematical logic at what Peirce called "the only real university in America". However, he also wrote that he could not give up his pendulum research at the Coast Survey; he wished to be paid for two jobs, both of which were full-time.[104]

In the event, it took eighteen months for a satisfactory arrangement to be made, Peirce being appointed as a lecturer in logic on 6th June 1879, not as a professor, as he would have liked.[105] As a result, he wrote a major paper on 'On the Algebra of Logic', published in 1880 in the *American Journal of Mathematics*, founded and edited by James Joseph Sylvester (1814–1897), professor of mathematics at Johns Hopkins University.[106] This appointment was renewed annually for the next few years, leading to the publication in 1883 of *Studies in Logic*, by some of Peirce's student, most notably O. H. Mitchell and Christine Ladd, with an important appendix by Peirce on 'The Logic of Relatives'.[107]

As a follow-on to the 1880 paper, Peirce read a paper in October 1884 before the National Academy of Sciences, published in January 1885 in expanded form as 'On the Algebra of Logic: A Contribution to the Philosophy of Notation' in the *American Journal of Mathematics*, intended as the first of two papers for this journal.[108] In the event, this "was to be Peirce's last technical paper on logic to appear in a major scientific journal",[109] although he did have an article published on 'The Logic of Relatives' in *The Monist* in 1897.[110]

The primary reason for Peirce's change of fortunes was his nemesis, Simon Newcomb (1835–1909), a quite different character from Charles S. Peirce, as you can see from the photograph in Figure 9.3. Newcomb, a protégé and friend of Benjamin Peirce, succeeded Sylvester as the editor of the *American Journal of Mathematics* in 1885 and refused to publish the second part of the 1885 paper, "on the ground that its subject was not mathematics".[111]

Without going too deeply into Newcomb's psychology, there seem to be three major influences on his attitude to Peirce. First, not coming from Peirce's privileged background, he resented the advantages that Peirce had been given. Secondly, he was probably subconsciously envious of Peirce's brilliant genius. Thirdly, and most importantly, he was appalled by the way that Peirce married his mistress Juliette, having lived openly with her after he and Zina separated. For as Joseph Brent writes, "For a sanctimonious man of affairs of the period such as Newcomb, for Peirce to have a mistress was both understandable and acceptable if the affair were carried on discretely, but to marry her after such a public liaison was outrageous because to do so attacked the sanctity of marriage."[112]

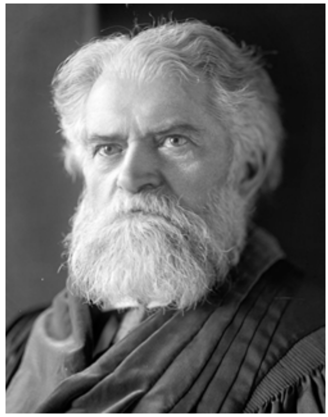


Figure 9.3: *Simon Newcomb*

Newcomb's hostility was to lead Peirce into dire financial straits during the last twenty-two years of his life, not even receiving a pension from his thirty-one years with US Coast and Geodetic Survey. First, Newcomb was instrumental in Peirce's effective dismissal as a lecturer at John Hopkins University in 1884, rather than being offered tenure, as President Gilman had previously seemed to be disposed to do.[113] Secondly, in 1890, Newcomb was asked to review a report that Peirce had written for the US Coast and Geodetic Survey.[114] While two of the three reviewers recommended it to be published, Newcomb rejected this proposal, which was a major contribution to Peirce being dismissed from the Survey in December 1891.[115] Thirdly, when Peirce applied to the Carnegie Institution for a grant to publish his magnum opus in thirty-six chapters, this was rejected on Newcomb's recommendation in March 1903.[116]

So from 1892 onwards, Peirce did not have a regular source of income, being unacceptable to American Academe, despite being the most original philosopher in the history of the United States. At times in the mid 1990s, "he was so poor that he did not eat for days and had no place to sleep, spending days and nights wandering in [New York] city" with the down-and-outs.[117] From time to time, his friends gave him some money, which his closest friend William James (1842–1910) formalized in 1907 by arranging for between fifteen and twenty-five subscribers to donate to a fund raising about $1000 annually.[118]

During this period of near destitution, Peirce did, however, have a few patrons, who gave him work. One was Paul Carus (1852–1919), the editor of the *The Monist* and *Open Court*, founded by his father-in-law, Edward C. Hegeler (1835–1910), who played "the role of Alexander to Peirce's Aristotle," until they fell out.[119] Peirce was to write a number of significant articles on metaphysics and the relationship of religion and science for these journals.

It is easy to see why Carus was sympathetic to Peirce's philosophy, for he "was a follower of Benedictus de Spinoza; he was of the opinion that Western thought had fallen into error early in its development in accepting the distinctions between body and mind and the material and the spiritual." In pursuit of a religion of science, he was a key figure in the introduction of Buddhism to the West, and after a battle for survival, he expected a 'cosmic religion of universal truth' to emerge from the ashes of traditional beliefs, a vision that is about to be realized.[120] I wonder if knew Richard Maurice Bucke (1837–1902), author of *Cosmic Consciusness*, published in 1901, who had a similar vision, many years ahead of his time.

Another patron was Wendell Phillips Garrison (1840–1907), the editor of *The Nation*, who gave Peirce some 230 books to review, with a remarkable breadth of subject matter, from physics and logic to wine and fine food.[121] However, all attempts to find a publisher in the 1990s to publish his *Grand Logic*, later called *How to Reason: A Critick of Arguments*, failed, and this book was left unfinished, along with some other projects.[122]

William James—Peirce's most ardent supporter, although they did not always see eye to eye—was constantly attempting to use his influence to help Peirce along, not always successfully. For instance, in 1898, James arranged for Peirce to give a series of eight lectures, which Peirce originally proposed *On the Logic of Events*. However, James thought these would be too technical for the audience he had in mind, writing to Peirce in December 1897: "I am sorry you are sticking so to formal logic. … Now be a good boy and think a more popular plan out. … You are so teeming with ideas—and the lectures need not by any means form a continuous whole. Separate topics of a vitally important character would do perfectly well."[123]

This seems to have thrown Peirce into some confusion, as he said in the first revised lecture on 'Philosophy and the Conduct of Life', "just as I was finishing one lecture [on Objective Logic] word came that you would expect to be addressed on Topics of Vital Importance, and that it would be as well to make the lectures detached,"[124] changing the title of the lectures to *Detached Ideas on Vitally Important Topics*. In the event, the lectures were titled *Reasoning and the Logic of Things*, given in a private house in Cambridge, for Harvard University would not allow Peirce on the premises, still regarding him as a *persona non grata*.

These lectures were not published at the time, Peirce's manuscripts containing drafts of both the original and given lectures, which the editors of the *Collected Works* in the 1930s were unable to unravel, as Arthur W. Bucks pointed out in 1958 in Volume VIII of the *Collected Works*.[125] In the event, these lectures were not published until 1992 in as close as a way as possible to what was thought to have been actually given. In their introduction to these lectures, Kenneth Laine Ketner and Hilary Putnam said that *The Cambridge Conferences Lectures of 1898* would have been better titled *The Consequences of Mathematics*, for these lectures provide "an admirable popular introduction to Peirce's … application of mathematics to philosophy".[126]

In the exordium for the third lecture titled 'The Logic of Relatives', Peirce reiterated his determination to keep logic separate from psychology, saying, "My proposition is that logic, in the strict sense of the term, has nothing to do with how you think."[127] So even though Peirce's mystical experience of 1892—described on page 121 in Chapter 1, 'Starting Afresh at the Very Beginning'—informed much of his philosophy, he was not able let go of his belief that mathematics is the fundamental science on which all others are built. Even his notion of *synechism* 'continuity', which James asked him to speak about, along with *tychism* 'chance',[128] is based on the mathematical notion of the continuum of the infinitessimals, introduced by Georg Cantor. So even though he sought to be free of a mechanistic worldview, his materialistic conditioning, along with his father's, inhibited him from discovering that psychology is the primary science, and that our thoughts, along with the entire world of form, emerge from the Formless Absolute.

On this point, it is instructive to note that *exordium* is cognate with *primordial* 'first in sequence of time, original; primary, fundamental', both words deriving from Latin *ōrdīrī* 'to begin to weave', from PIE base **ar-* 'to fit together', also root of *harmony* and *order*, with a similar root sense to *Tantra*. So the ancients in both West and East were clearly aware of the Principle of Unity, the fundamental design principle of the Universe, weaving opposites together into a coherent whole. But the Western mind, especially the mathematical one, has great difficulty in assimilating this fundamental principle in consciousness. For instance, on a number of occasions, Peirce emphasized that his view of logic held on to the absolute truth of Aristotle's Laws of Contradiction and Excluded Middle, not unifying opposites in what Heraclitus called the 'Hidden Harmony'.

Given the turmoil in Peirce's life, it is not surprising that his contribution to mathematical logic has been greatly underestimated. As part of a Ph. D. thesis, in the 1990s, Geraldine Brady did some sterling work on Peirce's place in the history of logic, particularly his influence on Ernst Schröder (1841–1902), Leopold Löwenheim (1878–1957), and Thoralf Skolem (1887–1963). As she tells us, Peirce's principal contributions include:[129]

- The calculus of relations
- A lattice-theoretic formulation of Boolean algebra
- Implicative propositional logic
- Quantified propositional logic and Boolean algebra
- Existential graphs
- An axiomatic arithmetic of the natural numbers

There is no need to study these ideas in detail, for they have had very little influence on the evolution of Integral Relational Logic, which is based on a complete break with the past, as described in Chapter 1, 'Starting Afresh at the Very Beginning' on page 35. To the extent that they did influence the development of IRL, the history of mathematical logic can best be seen like the development of an old-fashioned chemical photograph, which is fuzzy at first, eventually reaching clarity when it is fully developed at the Omega Point of evolution at the end of time.

By far the most important aspect of traditional logic is the calculus of relations, for relationships play the central role in the underlying structure of the Universe. The essence of this subject is incredibly simple, far simpler than the mathematicians make it. To illustrate the simplicity of relations, let us take the propositional formula '*X* says that *Y* loves *Z*', where there is a binary relationship between *Y* and *Z*, which we could call *R*, and one between *X* and *R*, a slight modification of an example in Wikipedia.[130] Giving values for *X*, *Y*, and *Z* gives a **relation** in tabular form in Table 9.8 a primal concept in IRL.

Person X	Person Y	Person Z
Alice	Bob	Denise
Charles	Alice	Bob
Charles	Charles	Alice
Denise	Denise	Denise

Table 9.8: *A ternary relation*

However, mathematicians then took over the concept of *relation*, almost completely detaching it from its psychological and linguistic origins. For instance, Wolfram *MathWorld* defines a relation as "any subset of a Cartesian product. For instance, a subset of $A \times B$, called a 'binary relation from *A* to *B*', is a collection of ordered pairs (a, b) with first components from *A* and second components from *B*."[131] In turn, "The Cartesian product of two sets *A* and *B* (also called the product set, set direct product, or cross product) is defined to be the set of all points (a, b) where $a \in A$ and $b \in B$. It is denoted $A \times B$, and is called the Cartesian product since it originated in Descartes' formulation of analytic geometry."[132]

"An illustrative example [taken from Wikipedia] is the Standard 52-card deck. The standard playing card ranks {Ace, King, Queen, Jack, 10, 9, 8, 7, 6, 5, 4, 3, 2} form a 13 element-set. The card suits {♠, ♥, ♦, ♣} form a 4-element set. The Cartesian product of these sets returns a 52-element set consisting of 52 ordered pairs which correspond to all 52 possible playing cards. **ranks** × **suits** returns a set of the form {(Ace, ♠), (King, ♠), …, (2, ♠), (Ace, ♥), …, (3,♣), (2, ♣)}. **suits** × **ranks** returns a set of the form {(♠, Ace), (♠, King), …, (♠, 2), (♥, Ace), …, (♣, 3), (♣, 2)}."[133]

Now, the binary relation is just a special case of an *n*-ary relation or set of tuples, where a tuple is an ordered list of *n* elements $(a_1, a_2, a_3, \ldots a_n)$, distinguished from a set, in which the elements are unordered, unique, and potentially infinite. In general, therefore, a relation in mathematics is a subset of the Cartesian product $A_1 \times A_2 \times A_3 \times \ldots \times A_n$. These are the basic concepts on which Ted Codd based his own definition of relation in the relational model of data, given on page 601 in Chapter 7, 'The Growth of Structure'. However, there is some confusion here in the language. Tuples contain meaningful relationships within them, distinct from relations. So in IRL, we distinguish *relations*, as tables, and *relationships* between the primal concepts of **class**, **entity**, and **attribute**.

As well as defining the concept of relation in the relational model, Codd also introduced some basic operations on these relations in what is now known as relational algebra,[134] distinct from relation algebra, introduced by De Morgan and Peirce.[135] Codd introduced these operations because, while relations are sets, not all operations on relations so viewed are relations. For instance, as Codd pointed out, the union of a binary relation and a ternary relation is not a relation. Hence, "These operations are introduced because of their key role in deriving relations from other relations,"[136] leading to the closure of relational algebra.

When I heard Codd speak about these operations at a one-day conference in London in the spring of 1973, when working in an IBM sales office as a senior systems engineer, it blew my mind. For, although I did not fully understand what he was saying, the potential to use mathematical operators to combine and extract information from databases was clearly the right direction in which the data-processing industry should go, giving it what I thought was a solid theoretical foundation. One example of such a relational operator is called the natural join (⋈), of which the Cartesian product is a degenerate case. The natural join combines information contained in two relations into a third, using equal attribute values in columns in the two relations that have the same attribute name and domain of values. For instance, if R and S are Employee and Department relations, given in Tables 9.9 and 9.10, then $R \bowtie S$ is given in Table 9.11.[137]

Name	EmpId	DeptName
Harry	3415	Finance
Sally	3415	Sales
George	3401	Finance
Harriet	2202	Sales

Table 9.9: *Employee relation*

DeptName	Manager
Finance	George
Sales	Harriet
Production	Charles

Table 9.10: *Department relation*

Name	EmpId	DeptName	Manager
Harry	3415	Finance	George
Sally	3415	Sales	Harriet
George	3401	Finance	George
Harriet	2202	Sales	Harriet

Table 9.11: *Join of Employee and Department relations*

We do not need to dwell on relational algebra any further, not the least because it has little use in the way we humans arrange our ideas. Even Structured Query Language (SQL), the *de facto* standard programming language for managing data in relational database management systems (RDBMS), is only loosely based on relational algebra and something called 'tuple relational calculus'. On this point, in 1991 and 1992, I worked on a product called LanguageAccess at the IBM Nordic Software Development Laboratory in Stockholm whose purpose was to translate natural language questions made to a relational database into SQL. LanguageAccess managed simple questions quite well, but had great difficulty with more complex ones, so development and marketing was dropped.

The only remaining point that needs to be made is that relational algebra is a subset of first-order predicate logic, from which it has also evolved.[138] This brings us to Gottlob Frege's seminal work *Begriffsschrift*, published in 1879, "generally considered the work that marks the birth of modern logic", as Wikipedia says without any citations.[139] However, as Geraldine Brady tells us, there is a common misconception here. For while Frege "has undisputed priority for the discovery and formulation of first-order logic", this does not mean that his influence was immediately felt by his successors. For while Bertrand Russell was clearly influenced by Frege, largely ignoring Peirce, "the central ideas of what we now call first-order logic were fully implicit in the works of Schröder and Peirce from which Löwenheim drew his chief inspiration."[140]

Furthermore, Frege's notation is so obscure, that no one since has attempted to develop it. In the event, the current notation for first-order logic does not come from Peirce, Frege, Schröder, Whitehead, Russell, or any other such pioneer. "It arrives full blown in Hilbert's 1917 lectures, without any reference to anyone."[141]

Nevertheless, Jean van Heijenoort considers *Begriffsschrift* as "perhaps the most important single work ever written in logic. For its fundamental contributions, among lesser points, are":[142]

- The truth-functional propositional calculus
- The analysis of the proposition into function and argument(s) instead of subject and predicate
- The theory of quantification
- A system of logic in which derivations are carried out exclusively according to the form of the expressions
- A logical definition of the notion of mathematical sequence

So what is *Begriffsschrift*? Well, this is usually translated as 'concept writing' or 'concept notation'. However, like Boole before him, Frege saw this endeavour as an attempt to symbolize the way that we human beings think, as the full title of this short book in English translation indicates: *A Formula Language, Modelled on that of Arithmetic, of Pure Thought*. Also, Philip Jourdain translated *Begriffsschrift* as 'ideograph' in a 1912 paper, a translation that apparently Frege approved.Be this as it may, *Begriff* derives from German *begreifen* 'to comprehend', from the PIE base **ghreib* 'to grip', also the root of *grip* 'grasp, clutch', with a figurative meaning 'Intellectual or mental hold; power to apprehend or master a subject'. So a concept is something that can be held in the mind.

Now Frege was not simply representing Aristotle's logic in symbolic form, as Boole had done; he was seeking to employ logic in order to provide a sound foundation for arithmetic. As he said, "My intention was not to represent an abstract logic in formulas, but to express a content through written signs in a more precise and clear way than it is possible to do through words. In fact, what I wanted to create was not a mere *calculus ratiocinator* but a *lingua characterica* in Leibniz's sense."[143] For Leibniz had distinguished two components in his ambitious project to create a mathematical logic. As Jaakko Hintikka tells us:

> On the one hand, Leibniz proposed to develop a *characteristic universalis* or *lingua characteristica* which was to be a universal language of human thought whose symbolic structure would reflect directly the structure of the world of our concepts. On the other hand, Leibniz's ambition included the creation of a *calculus ratiocinator* which was conceived of by him as a method of symbolic calculation which would mirror the processes of human reasoning.[144]

Frege favoured the former approach, replacing Aristotle's subject and predicate with the mathematical concepts of function and argument, introducing quantifiers and propositional functions into logic.[145] As we have seen in this subsection, these eventually evolved into Integral Relational Logic, thereby fulfilling Leibniz's great dream. However, Leibniz's conception of a *calculus ratiocinator*, explored by Vernon Platt in Part I of *Thinking Machines: The Evolution of Artificial Intelligence*,[146] was bound to fail, for no mechanistic, linear process of reasoning can possibly provide us with a valid map of a nonlinear, holographic, multidimensional Universe, being constantly refreshed through the Divine power of Life arising directly from the Fountainhead.

Crisis in the foundations

Now Frege was not only interested in developing a language in which to express a science of pure thought, he also sought to provide arithmetic with a sound foundation through his logic, publishing the first volume of *Grundgesetze der Arithmetik* '*Basic Laws of Arithmetic*' in 1893. In this respect, Frege differed markedly from Peirce. While the latter sought to base logic and indeed all philosophy on mathematics, just as science was so based in his time, Frege sought to base mathematics on logic. Of course, this makes much more sense, for psychology, as the science of mind, thought, and consciousness, must be the primary science, underlying all others.

However, this is not how Frege saw the relationship of logic to psychology, for like Peirce, Frege sought to separate logic, as the science of mind and reason, from psychology. Bertrand Russell agreed with them, both writing to Frege on 16th June 1902:

> For a year and half I have been acquainted with your *Grundgesetze der Arithmetik*, but it is only now that I have been able to find the time for the thorough study I intended to make of your work. I find myself in complete agreement with you in all essentials, particularly when you reject any psychological element [*Moment*] in logic and when you place a high value on ideography [*Begriffsschrift*] for the foundation of mathematics and formal logic, which, incidentally, can hardly be distinguished.[147]

However, Russell also pointed out there was a logical flaw in Frege's reasoning because of the paradoxes that he had found in the concept of 'all classes'. Russell was amazed at Frege's humble reply six days later. In giving permission for his correspondence with Frege to be published, Russell said this about his colleague, who he never actually met: "when upon finding that his fundamental assumption was in error, he responded with intellectual pleasure clearly submerging any feelings of personal disappointment. It was almost superhuman and a telling indication of that of which men are capable if their dedication is to creative work and knowledge instead of cruder efforts to dominate and be known."[148] For Frege wrote to Russell:

> Your discovery of the contradiction caused me the greatest surprise and, I would almost say, consternation, since it has shaken the basis on which I intended to build arithmetic. … It is all the more serious since, with the loss of my Rule V, not only the foundations of my arithmetic, but also the sole possible foundations of arithmetic, seem to vanish. … In any case your discovery is very remarkable and will perhaps result in a great advance in logic, unwelcome as it may seem at first glance.[149]

In the event, Frege did publish the second volume of *Grundgesetze der Arithmetik* in 1903, with an appendix on Russell's paradox, and Russell published *Principles of Mathematics* the same year, with two appendices, titled 'The Arithmetical and Logical Doctrines of Frege' and 'The Doctrine of Types'. In this second appendix, Russell proposed a tentative solution to paradoxes, which he called the theory of types. In this, he distinguished terms and individuals from their ranges of significance, determined, for instance, when grouped in classes.[150]

The problem of formalizing human reason arose because paradoxes were found in set theory, as shown page 236 in Chapter 3, 'Unifying Opposites'. So how could mathematicians recover from this critical situation? Well, at the International Congress of Mathematicians in Paris in 1900, David Hilbert (1862–1943), being deeply concerned about the state of mathematics at the turn of the century, presented twenty-three unsolved problems in mathematics.[151] The second of these was concerned with proving that the axioms of mathematics are both independent and consistent.[152] As Hilbert put it with regard to the axioms of arithmetic, he asked mathematicians "To prove that they are not contradictory, that is, that a definite [finite] number of logical steps based upon them can never lead to contradictory results."[153]

We can well demonstrate that the Western mind's aversion to paradoxes and self-contradictions is deeply embedded in the cultural psyche by A. N. Whitehead and Bertrand Russell's *Principia Mathematica*, an initial response to one of Hilbert's challenges. In their futile search for certainty in mathematics and science, these fellows of the Royal Society wrote this monumental treatise in the second decade of the last century in order to deny the basic principle on which the Universe is designed. They took 360 pages to prove the proposition (*54.43) that would eventually lead to the arithmetical statement '1 + 1 = 2',[154] including several incomprehensible pages on the calculus of classes and relations.[155]

As Russell wrote in 'Reflections on my Eightieth Birthday' in 1952,

> I wanted certainty in the kind of way in which people want religious faith. I thought that certainty is more likely to be found in mathematics than elsewhere. But I discovered that many mathematical demonstrations, which my teachers wanted me to accept, were full of fallacies, and that, if certainty were indeed to be found in mathematics, it would be a new kind of mathematics, with more solid foundations than those that had hitherto been thought secure.
>
> But as the work proceeded, I was continually reminded of the fable about the elephant and the tortoise. Having constructed an elephant upon which the mathematical world could rest, I found the elephant tottering, and proceeded to construct a tortoise to keep the elephant from falling. But the tortoise was no more secure than the elephant, and after some twenty years of arduous toil, I came to the conclusion that there was nothing more that I could do in the way of making mathematical knowledge indubitable.[156]

Russell had first discovered the joys of mathematics as a teenager, when his elder brother began to teach him Euclid's geometry. He was delighted that mathematics could prove things, but his initial hopes of finding certainty in mathematics were crumbled when he was told that he must accept the axioms as true, assumptions that could not be proved. As he said, it was in mathematics that he had hoped to find indisputable clarity, going on to say, "I hoped that in time there would be a mathematics of human behaviour as precise as the mathematics of machines."[157]

To avoid what he and A. N. Whitehead called a 'vicious circle', he thereby defined a hierarchy of types in which "Whatever involves all of a collection must not be one of the collection." As Morris Kline concisely explains, "Expressed in terms of sets, the theory of types states that individual objects are of type 0; a set of individuals is of type 1; and set of sets of individuals is of type 2; and so forth."[158] Whitehead and Russell therefore said that the proposition "all propositions are either true or false" is meaningless and an illegitimate totality because new propositions cannot be created by statements about 'all propositions'.[159]

The upshot of denying the universal truth of the Principle of Unity was fourfold. First, in denying the validity of the set of all sets, Whitehead and Russell prevented people from mapping the Totality of Existence, further fragmenting the mind and reinforcing people's sense of separation from God, Nature, and each other, none of whom exist as independent beings. Secondly, as paradoxes had appeared in mathematics and logic, ignoring them strengthened the gross distortion in our thinking that Aristotle had established with the seventh pillar of unwisdom, leading to delusion and mental disorder. Thirdly, by denying that logic—the science of thought and reason—is a branch of psychology—the science of mind and consciousness—people were inhibited from studying how concepts are formed and organized in the mind through self-inquiry, necessary if we are to answer the question, "Who are we?" Fourthly, to deny self-referential propositions is to stultify self-reflective Divine Intelligence, which distinguishes human beings from the other animals and machines, like computers, and which enables us to resolve all paradoxes and self-contradictions in Nonduality by looking at both sides of any situation.

Paradise denied

It is not surprising that Whitehead and Russell never actually completed *Principia Mathematica*, being exhausted by this twenty-year project, and that almost no one read all 2,000 pages of their treatise. One who did was Kurt Gödel, who in 1931 published a landmark paper called 'On Formally Undecidable Propositions of *Principia Mathematica* and Related Systems I'. Gödel was seeking to solve the second of the problems that David Hilbert had posed in 1900: to prove the axioms of arithmetic to be consistent. Hilbert subsequently added another puzzle: to prove that the axioms are complete, that is, that all theorems within the system are provable from the axioms. He suggested that such a proof theory could be developed through what he called metamathematics, a way of talking about mathematics as a formal system of axioms and rules of transformation—expressible in what are essentially meaningless signs—outside the system.

For instance, the expression '2 + 3 = 5' belongs to mathematics, while the statement " '2 + 3 = 5' is an arithmetical formula" is a metamathematical one. By 1930, mathematicians had proved that the tautological propositional calculus and the first-order predicate calculus are both consistent and complete.[160] However, no one had by then proved that the Peano axioms of arithmetic, the Zermelo-Fraenkel axioms of set theory, and the Whitehead-Russell axioms of *Principia Mathematica* are consistent and complete.[161] This is what Gödel set out to prove.

He did so by an ingenious way of mapping metamathematical statements, such as 'Arithmetic is consistent', to arithmetical expressions that evaluate to finite integers. This mapping technique is today called Gödel numbering. Gödel first assigned basic constants, such as '0', '~', and '(', to the odd numbers 1 to 13 and variables of three different types (individuals, such as numbers, classes of individuals, and classes of classes of individuals) the numbers p^n, where p is a prime larger than 13 and n is the type of variable, 1, 2, or 3.

He then assigned a formula of m signs to a single number a, let us say, calculated as the product of successive primes p_k raised by the Gödel number of each elementary sign, n_k:[162]

$$a = \prod_{k=1}^{m} {p_k}^{n_k}$$

For instance, the formula $(\exists x)(x{=}sy)$, meaning every number y has an immediate successor x, could be assigned the Gödel number $a = 2^8 \times 3^4 \times 5^{11} \times 7^9 \times 11^8 \times 13^{11} \times 17^5 \times 19^7 \times$

$23^{13} \times 29^{9}$,[163] which is about $1.5*10^{86}$. So Gödel numbers can get pretty big pretty fast. They grow even faster when we look at the concept of proof. Just as a mathematical formula consists of a sequence of signs, a mathematical proof consists of a sequence of formulae, going back to the axioms. So Gödel assigned numbers to proofs, just like formulae.

For instance, the statement $(\exists x)(x=s0)$, with Gödel number b, is derivable from the first by substituting 0 for y, substitution being a basic rule of inference, like Plato's particulars as instances of universals. So the formulae with Gödel numbers a and b are a section of the proof that the number 1 exists (a complete proof would need to go right back to the axioms!). So if this part of the proof were at the beginning, it would be assigned the Gödel number $k = 2^{a} \times 3^{b}$.[164] In general, a proof is assigned a Gödel number calculated as the product of a successive list of primes, each raised to the power of the Gödel number assigned to each statement in the proof. Quite amazing!

Now what is even more amazing is that Gödel then set out to prove the metamathematical statement 'This formula is unprovable'. This statement G with Gödel number q is rather like 'This sentence is false', but with a subtle difference, which does not lead to a contradiction. If 'This formula is unprovable' is not provable, then it is true. Conversely, if G is provable, it is not true. But by Aristotle's Law of Contradiction, if it is true, then it is not provable. Hence G is true if and only if it is *not* provable. As Morris Kline puts it, "the arithmetical statement G is true because it is a statement about integers that can be established by more intuitive reasoning than the formal systems permit."[165]

Gödel then went on to construct the arithmetical statement A that represents the metamathematical statement 'Arithmetic is consistent', proving that A implies G. "Hence if A were provable, G would be provable. But since G is undecidable, A is not provable." It is thus not possible to prove the axioms of arithmetic and set theory to be consistent by a method or set of deductive logical principles that can be translated into the system of arithmetic.[166]

In other words, Gödel made a clear distinction between provability and truth; truth is deeper than proof. Provability is an attribute of a mechanistic, linear system of reasoning, while truth is an intuitive, human quality, which machines, like computers, could not understand. In 1961, the philosopher J. R. Lucas wrote a famous article called 'Minds, Machines and Gödel' naturally saying much the same thing, opening with this sentence, "Gödel's theorem seems to me to prove that Mechanism is false, that is, that minds cannot be explained as machines." He based his argument on an intellectual philosophical perspective, rather than a psychological, spiritual, or mystical one based on direct inner knowing of the Divine, using one of his arguments that "human beings are not confined to making deductive inferences."[167]

In other words, Gödel's work shows the invalidity of the fourth pillar of unwisdom, that human beings are machines and nothing but machines. However, some mathematicians and philosophers were horrified by the suggestion that human beings are not just deterministic automata, obeying sets of rigorous rules that could be formally programmed into cybernetic machines, Douglas R. Hofstadter and Daniel C. Dennet calling Lucas's article 'notorious'.[168]

Actually, Gödel's theorems were the first of a number of discoveries that show the limitations of linear reasoning, such as that employed by machines, like computers. In 1936, Alonzo Church and Alan Turing independently extended Gödel's notion that there are undecidable propositions in mathematics, those that can be neither proved nor refuted. In their different ways, they were investigating the capability of mechanistic computability in the horizontal dimension of time. What is now called the Church-Turing thesis states "any calculation that is possible can be performed by an algorithm running on a computer, provided that sufficient time and storage space are available."[169]

Church and Turing were working on the *Entscheidungsproblem*, German for 'decision problem', which went back to the time when Gottfried Leibniz successfully constructed a mechanical calculating machine. Basically, the decision problem asks if there is an algorithm, a mechanical procedure, that can determine whether a particular problem is solvable or not, answering with a yes or no.[170] It does not ask how the problem might be solved if it is solvable; that is another issue.

Church and Turing showed that no such general algorithm exists. In Turing's case, he did this by developing the notion of a universal machine, today called a Turing machine. He then asked the question, "Given a description of a program and its initial input, determine whether the program, when executed on this input, ever halts (completes)."[171] Turing proved that a general algorithm to solve the halting problem for all possible inputs cannot exist.[172]

Church showed, using his lambda calculus, designed to investigate recursive functions, that there is no general algorithm for the decision problem.[173] Turing proved a similar result through his studies of what today is called the Universal Turing Machine.[174] In other words, in linear mathematics, symbolic logic, and computer programming, there are undecidable, incomputable, unprovable, and unsolvable problems, as well as their opposites, which is, of course, an example of the Principle of Unity at work.

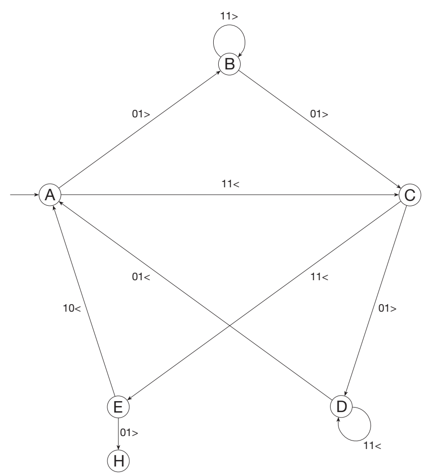


Figure 9.4: *Busy beaver function*

Figure 9.4, shows an example of one of Turing's universal machines, once again showing the ubiquity of mathematical mapmaking, introduced in Section 'Mathematical mapmaking' in Chapter 1, 'Starting Afresh at the Very Beginning' on page 75. Here the nodes are the possible states of the machine, while the arcs are the 'program', the instructions on what the machine should do at each instant in linear time. The Turing machine just consists of a strip of tape that can move left and right and on which symbols are read and written. Each instruction in the program for any particular state is in four parts: read the character at the present position on the tape, write a character, move left or right one position, and change state, all depending on the value of the read character. So the first instruction can simply be expressed as a quintuple: `A 0 1 > B`. This says that when in state A, if 0 is read, write 1, move right, and change to state B.

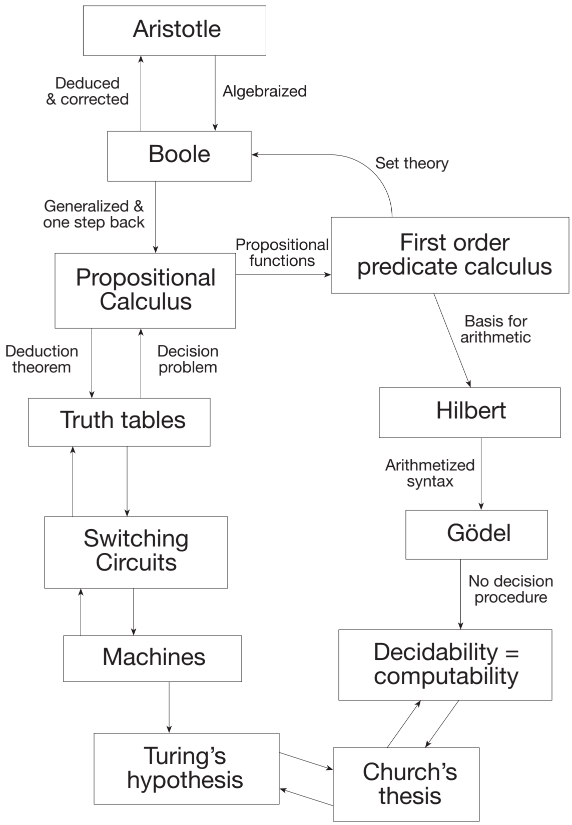


Figure 9.5: *Evolution of either-or formal linear logic*

This particular network is an example of a busy-beaver function, which Tibor Radó devised in 1962 to illustrate the simplicity of a noncomputable function.[175] The purpose of this function in a machine of n states and k symbols is merely to write as many non-blank symbols on a blank tape as possible with as many steps as possible before halting in state H. Because a Turing machine is finite, there is a maximum value for $S(n, k)$ and $\Sigma(n, k)$, the number of steps and symbols for any n-k machine, respectively. However, there is no algorithm or decision procedure that can determine these maxima for any particular machine. So since Radó devised this machine, there has been a competition going on among computer scientists to design a record-breaking algorithm for each n and k. The example above is the current record holder for a 5-state machine with 2 symbols, giving $\Sigma(5, 2) = 4{,}098$ and $S(5, 2) = 47{,}176{,}870$. Heiner Marxen and Jürgen Buntrock designed this machine in September 1989.[176]

What all these results show is that mechanistic computability, decidability, provability, and solvability are inherently limited. Furthermore, whichever way that the mathematicians have turned, paradoxes have been found in mathematics. To try to resolve this dilemma, mathematicians created four quite different solutions, none of which can be said to provide mathematics with a solid foundation. These are the logical, intuitive, formalist, and set-theoretic schools, each of which is a being in IRL, which means that we do not need to go into them any further.[177]

In summary, Figure 9.5 provides an overview of how either-or formal logic developed in the nineteenth and twentieth centuries, summarizing the West's futile attempts to use linear, mechanistic reasoning to develop a precise language as the basis of our thought processes.[178]

The Riemann hypothesis

One unsolved problems in mathematics that is, as yet, unsolved, perhaps because it is unsolvable (who knows?), is the Riemann hypothesis, which was the eighth unsolved problem that David Hilbert presented in Paris in 1900, a problem that included Goldbach's conjecture that every even number greater then two is the sum of two primes, also still unsolved.[179] The Riemann hypotheis, proposed by Bernhard Riemann (1826–1866), has been called the 'greatest unsolved problem in mathematics',[180] without realizing that mathematics cannot answer the Big Questions of human existence, such as what is causing mathematicians and scientists to behave as they do?

Nevertheless, to spur mathematicians along, as if they needed such encouragement, in 2000 the Clay Mathematics Institute (CMI) of Cambridge, Massachusetts named seven 'Millennium Prize Problems', awarding one million dollars to the solution of seven unsolved mathematical problems, including the Riemann Hypothesis.[181]

The Riemann hypothesis well illustrates the evolutionary generalizing power of mathematics and that Western thought has now reached an evolutionary cul-de-sac. So let us spend a moment looking at how it has emerged and some attempts to solve it.

We can best begin with Pascal's triangle, although other mathematicians studied this for centuries before him in India, Greece, Iran, China, Germany, and Italy, illustrated in Figure 9.6. These numbers are the binomial coefficients of the polynomial expansion of $(x + y)^n$, more simply expressed as:.

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1

Figure 9.6: *Pascal's triangle*

$$(x+1)^n = \sum_{k=1}^{n} \binom{n}{k} x^{n-k}$$

where

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

also known as the number of ways of selecting *k* items from a group of *n* items in combination theory, wher *n*! is factorial *n*, defined as the product of all the integers up to *n*. So 3! is 6 and 4! is 24.

Now, another fascinating polynomial is the expansion of the power series,[182] studied particularly by Johann Faulhaber (1580–1635), a Rosicrucian collaborator with Johannes Kepler.[183] For instance, as is well known, the sum of the integers from 1 to n is:

$$\sum_{k=1}^{n} k = \frac{1}{2}n(n+1)$$

giving the triangular numbers, 1, 3, 6, 10, 15, 21, 28, 36, 45, 55, …

But what is the polynomial expansion of the general power series?

$$\sum_{k=1}^{n} k^m$$

Well, Faulhaber found expressions for the values of m up to 17,[184] the next three being:

$$\sum_{k=1}^{n} k^2 = \frac{1}{6}(2n^3 + 3n^2 + n)$$

$$\sum_{k=1}^{n} k^3 = \frac{1}{4}(n^4 + 2n^3 + n^2)$$

$$\sum_{k=1}^{n} k^4 = \frac{1}{30}(6n^5 + 15n^4 + 10n^3 - n)$$

Going up to m = 9, this table gives the coefficients for each of the powers of n:[185]

Power	***m*+1**	***m***	***m*-1**	***m*-2**	***m*-3**	***m*-4**	***m*-5**	***m*-6**	***m*-7**
1	1/2	1/2							
2	1/3	1/2	1/6						
3	1/4	1/2	1/4						
4	1/5	1/2	1/3		-1/30				
5	1/6	1/2	5/12		-1/12				
6	1/7	1/2	1/2		-1/6		1/42		
7	1/8	1/2	7/12		-7/24		1/12		
8	1/9	1/2	2/3		-7/15		2/9		-1/30
9	1/10	1/2	3/4		-7/10		1/2		-3/20

Table 9.12: *Polynomial coefficients of expansion of sum of powers*

There seems to be a pattern here, but what on earth is it? The coefficients total one, the first being 1/(m+1) and the second ½. The third coefficient has a value, whose pattern is far from clear. After this the alternating coefficients are zero and the other coefficients alternate from minus to plus. But does this pattern continue indefinitely and what is the pattern that underlies the coefficients? Such a puzzle is not unlike the intelligence tests that teachers set children at school or those that Mensa sets as entry to their exclusive club. Well, like Tycho Brahe, measuring the positions of the stars and planets, Faulhaber did not find the underlying pattern. It was left to Jacob Bernoulli (1654–1705), acting like Kepler to Tycho, whose story we tell on page 916 in Subsection 'The first scientific revolution', to find a generalized expression for these coefficients. Here it is:[186]

$$\sum_{k=1}^{n} k^m = \frac{1}{m+1} \sum_{j=0}^{m} (-1)^j \binom{m+1}{j} B_j n^{m+1-j}$$

where B_j is a Bernoulli number, defined recursively:

$$B_j = -\sum_{i=0}^{j-1} \binom{j}{i} \frac{B_i}{j-i+1}$$

with $B_0 = 1$. Isn't that amazing? Here are the first few Bernoulli numbers:[187]

Number	B_0	B_1	B_2	B_4	B_6	B_8	B_{10}	B_{12}	B_{14}	B_{16}	B_{18}	B_{20}
Value	1	-1/2	1/6	-1/30	1/42	-1/30	5/66	-691/2730	7/6	-3617/510	43867/798	-174611/330

These apparently haphazard numbers, which get larger and larger in absolute terms, are of such central importance in mathematics, Ada Lovelace showed how they could be calculated with Charles Babbage's Analytical Engine, turning Babbage's formulae into tabular form, published at the end of her memoir to Menabrea's 'Sketch of the Analytical Engine' in 1843. Not surprisingly, she did not do so without considerable effort, saying in a letter to Babbage, "I am in much dismay at having got into so amazing a quagmire & botheration with these *Numbers*."[188] This was the first program ever published, much more complex than the initial programs that ran on the first stored-program computers over a century later. Ada has thus been called the world's first programmer, although she was clearly much assisted by Babbage himself.

Now the next step on this process of generalization in mathematics was to consider the power series where *m* is negative, which gives the possibility that even the sum of an infinite series of such terms converges to a finite value. The general formula here is called the Riemann zeta function, which Euler showed could also be expressed as the product of terms involving just prime numbers:

$$\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s} = \prod_{k=1}^{\infty} \frac{1}{1+\frac{1}{p_k^s}}$$

where p_k is the *k*th prime.

John Derbyshire calls this amazing relationship the 'Golden Key',[189] which causes mathematicians to go all a flutter. For primes are the atoms of number theory, all integers being uniquely expressible as the product of prime numbers—the fundamental theorem of arithmetic. But no pattern has been found in the distribution of the primes other than the prime number theorem (PNT), which states that if a random integer is selected in the range of zero to some large integer N, the probability that the selected integer is prime is about $1 / \ln(N)$, where $\ln(N)$ is the natural logarithm of N.[190]

One significant consequence of Euler's product, as it is called, is that for $n \geq 0$[191]

$$\zeta(2n) = (-1)^{n+1}\frac{B_{2n}(2\pi)^{2n}}{2(2n)!}$$

For instance, for $n = 1$, we have, a result that Euler, himself,[192] found:

$$\frac{2^2}{2^2+1} \times \frac{3^2}{3^2+1} \times \frac{5^2}{5^2+1} \times \frac{7^2}{7^2+1} \times \frac{11^2}{11^2+1} \times \ldots = \frac{\pi^2}{6}$$

So we have a surprising relationship between the prime numbers and π, the ratio of the circumference of a circle to its diameter, just one other example where π pops up in the most unexpected places.

Some other consequences of the zeta function fascinate mathematicians when s is negative. Considering just integer values, we have this formula:

$$\zeta(-n) = -\frac{B_{n+1}}{n+1}$$

As B_n is zero for all odd values of n, the zeta function is zero for all even negative integers, known as the trivial zeros. Considering s as a real number, using a more general formula for the zeta function, between these zero points, the function is continuous, swinging increasingly as s grows negatively, being positive between $s = -2(2n-1)$ and $-4n$ and negative otherwise, where $n > 0$, illustrated in Figure 9.7.

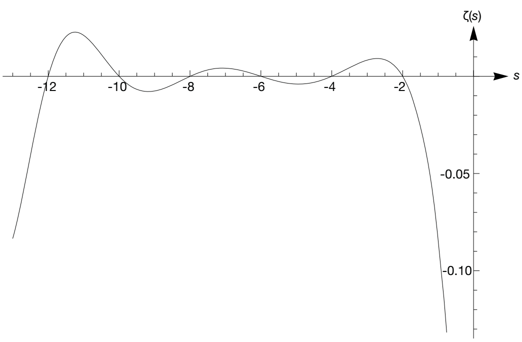


Figure 9.7: *Trivial zeros in Riemann zeta function*

But things get really interesting when s is a complex number of the form $\sigma + it$ It is not easy to visualize the way that the zeta function behaves with complex s as this requires many years of practice,[193] for it requires four dimensions to plot the real and imaginary inputs and outputs from the function.[194] Furthermore, the non-trivial zero points do not have the regular pattern of the trivial zero points, other than that the first few that Bernhard Riemann found lay on a line ½ + it, the first three being (½, 14.134 725 …), (½, 21.022 040 …), and (½, 25.010 856 …).[195] In a paper published in 1859, he therefore hypothesized that all non-trivial zero points lie on this line. This is the Riemann Hypothesis.

In 1900, when Hilbert included the Riemann Hypothesis in his list of unsolved problems in mathematics, it was known that all zero points would fall in a critical strip where $0 < \sigma < 1$, with a critical line at $\sigma = ½$.[196] Then in 1914, G. H. Hardy proved that there are an infinite number of zeros on this critical line.[197] But he did not prove that there are none outside the line and no one has done so since.

However, in 1973, Hugh L. Montgomery, noting that the zero points line up in relatively uniform intervals, far more regular than the primes themselves, found that the differences between the zeros seem to have a distribution given by this formula:[198]

$$1 - \left(\frac{\sin \pi u}{\pi u}\right)^2$$

Now the year before, Montgomery had met Freeman Dyson by chance at the Princeton Institute of Advanced Studies, the latter pointing out that Montgomery's pair correlation conjecture has the same form as the distribution function of the energy levels of subatomic particles.[199] This really got the mathematicians excited, for this similarity seems to indicate a link between the distribution of the prime numbers and quantum physics.

Then in 1996, Alain Connes pointed out another surprising relationship: between his non-commutative geometry, for which he was awarded the Field's Prize, and the Riemann function. This connection opened up a quite new approach to proving the Riemann hypothesis, leading some to speculate that non-commutative geometry could form the basis for the discovery of the fundamental law of nature, one that could explain the creation of the universe. As the commentator on *The Cosmic Code Breakers,* a 2011 television programme on the Riemann hypothesis enthusiastically proclaimed, as the new geometry is closely related to prime numbers, if the secrets of the primes are clarified using non-commutative geometry, then the theory of everything would be solved. The century-long search for the hidden meaning behind the prime numbers could well turn out to be the theory of everything, the Creator's blueprint for the Universe.[200]

Not all mathematicians share this enthusiasm. An anonymous mathematician who doesn't has said, "What Connes has done, basically, is to take an intractable problem and replace it with a different problem that is equally intractable."[201] So it might be that while the Riemann hypothesis could be a true theorem of mathematics, it is not one that can be proved using any mathematical tool, much as Gödel indicated.

Now while this is obviously great fun, for many enjoy searching for simple patterns underlying the world we live in, such pastimes cannot lead us back to Reality. And neither can conventional scientific method, whose evolution we look at next.

The evolution of scientific method

As the way we think and reason determines our behaviour, you might think that science would be interested in addressing this issue. Apparently not so. Despite the great successes that science has made during the past few centuries, there is one question that neither mainstream reductionist science nor its holistic alternative can answer satisfactorily: "what is causing the pace of evolutionary change to accelerate exponentially?" The reason for this is not only because of the assumptions that science makes about the nature of reality; it is also because of the limitations of scientific method itself.

So to understand where we human beings have come from and where we are all heading in such a frantic rush, we need to allow scientific method, itself, to evolve. In this way we can see that while the Unified Relationships Theory is revolutionary in the context of Western civilization, it is nevertheless still scientific. To do this, we need to agree a definition of science.

For me, science is simply a coherent body of knowledge that corresponds to our all experiences whatever they might be and whoever might have them. This means that if our experiences are limited, so is our science. Furthermore, if our knowledge is fragmented, while parts might be cohesive and therefore scientific, the whole cannot be.

Today, what is commonly called science is both fragmented and limited. So until we remove the constraints that we place on our learning, we cannot say that our knowledge is truly scientific. Most particularly, we shall continue to manage our business affairs having very little understanding of what we are doing, a situation that can only lead to catastrophe within a few years.

So how have we reached the perilous situation that we are in today? Well, let us take it that formal science began with Aristotle. As I understand the situation, Aristotle had no conscious method in his scientific inquiries. Starting with some assumptions or axioms, he simply made observations of the world around him through his physical senses and drew conclusions. Apparently, Aristotle did not see the need to test his deductions by experimentation.

This situation began to change in the thirteenth century with Roger Bacon, an English philosopher and Franciscan. It seems that Bacon was the first European to see the need to base our learning on direct experience, rather than the rational deductive methods that the world of learning had inherited from Aristotle.

As such, Bacon was widely known and respected throughout Europe as the *Doctor Mirabilis* (Wonderful Teacher), both for his methods and his discoveries, and for his boundless energy in developing and expressing his ideas.[202]

This situation began to change in 1257, when he was about 37. In that year, Bacon joined a religious order of friars. But his reforming zeal and contemptuous disposition did not go down well with his superiors, who did their best to constrain him.

Bacon felt aggrieved by this behaviour because he thought that his experimental methods served to confirm the Christian faith. So he appealed to the Pope for support. It seems that what Bacon was proposing was a vast encyclopædia of all the known sciences, a project that would be coordinated by a papal institute. So not only was Bacon emphasizing the empirical nature of human knowledge, he could also see the need for the coherence of all our knowledge, principles that are central to the URT.

However, the Pope apparently misunderstood Bacon's proposals, thinking that the project was already far advanced. So the Pope requested to see the results of the project that he assumed that Bacon had been conducting. This put Bacon in a bit of a predicament. Having no other choice, he set out to complete this project on his own, working in secret by papal command without the knowledge of his superiors, a situation that is not unlike my own endeavours to integrate all knowledge into a coherent whole.

Inevitably, these exertions affected Bacon's ability to participate fully in the activities of the friary, which did not please his superiors too much. Eventually, around 1278 he was condemned to prison for "suspected novelties" in his teaching, an example of the challenges faced by evolutionary pioneers within a fearful environment that seeks to restrict creativity.

The next major development in scientific method that we need to consider was introduced by Bacon's namesake, Francis Bacon some 350 years later. I just want to mention two points. Bacon was concerned with two major issues, pure and applied science, the development of knowledge for its own sake and the application of this knowledge for "the relief of man's estate".[203]

In other words, Bacon was the first to put into words the belief that it is the purpose of science to exploit Nature for the selfish desires of human beings. Of course, such a belief could only arise in the West, which is both intellectually and often experientially separate from our Divine Source. Today, this belief has led to ecological devastation, which is leading to the extinction of the human race before we have had the opportunity to realize our fullest potential as a species.

The other major contribution that Bacon made to scientific method was the principle of induction. This concept was necessary in order to describe the essence of the experimental method, just then being fully utilized by Bacon's contemporary, Galileo Galilei. Bacon described the inductive method in Book II of *Novum Organum*, published in 1620. The title of this book is a reference to Aristotle's *Organon*, in which Aristotle had introduced the deductive method of reasoning around two thousand years earlier.

In the *Advancement of Learning*, published in 1605,[204] Bacon argued vigorously "Aristotle's logic was entirely unsuitable for the pursuit of knowledge in the 'modern' age. Accordingly, *The New Organon* propounds a system of reasoning to supersede Aristotle's, suitable for the pursuit of knowledge in the age of science."[205]

The principle of induction in science, not to be confused with induction in mathematics,[206] is very simple. It can be defined as follows:

> If a large number of As have been observed under a wide variety of conditions, and if all those observed As without exception possessed the property B, then all As have the property B.[207]

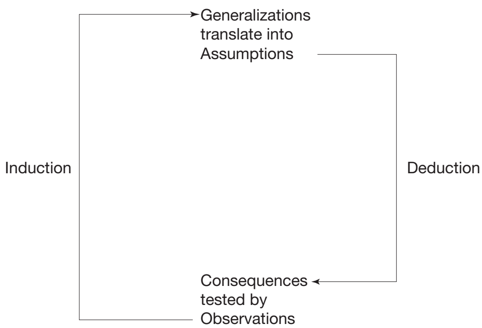


Figure 9.8: *Induction and deduction*

The principle of induction thus leads to generalized statements, from which predictions about particular situations can be deduced. Figure 9.8 shows the cyclical relationship of induction to deduction, indicating that induction does not actually start from observation.[208] This is what A. F. Chalmers calls 'naive inductionism'. For in practice all observation statements are theory dependent. It is not possible to observe anything without some preconceptions of what is being observed.

It was the eighteenth-century Scottish philosopher, David Hume, who first pointed out this serious weakness of the inductive method. If science is to produce certain knowledge, these generalizations need to be true for all time. He raised two problems with this assumption of science, the first logical and the second psychological, which are discussed by Karl Popper. The first of these problems is:

> Are we justified in reasoning from [repeated] instances of which we have experience to other instances [conclusions] of which we have no experience?[209]

The answer is no, however great the number of repetitions. For instance, for those of us who live between the Arctic and Antarctic circles, the sun rises every day, even though on some occasions we don't see it because it is hidden by clouds. But is it reasonable to assume that this process will continue indefinitely? Obviously not. The physicists have estimated that in some four to five billion years the Sun will die along with the Earth.[210] So one day, there will be neither a sunrise nor anyone around to observe it.

David Hume goes on to pose his psychological problem of induction:

> Why, nevertheless, do all reasonable people expect, and believe, that instances of which they have no experience will conform to those of which they have experience? That is, why do we have expectations in which we have great confidence?[211]

His answer to this problem, interpreted by Karl Popper, is:

> Because of 'custom or habit'; that is, because we are conditioned, by repetitions and by the mechanism of the association of ideas; a mechanism with which, Hume says, we could hardly survive.[212]

Hume's attack on empiricism evidently caused a major crisis in the scientific community, for he was questioning the very basis of scientific reasoning. Russell highlighted the issue when he said:

> It is therefore important to discover whether there is any answer to Hume within the framework of a philosophy that is wholly or mainly empirical. If not, there is no intellectual difference between sanity and insanity. The lunatic who believes that he is a poached egg is to be condemned solely on the grounds that he is a minority, or rather—since we must not assume democracy—on the grounds that the government does not agree with him. This is a desperate point of view, and it must be hoped that there is some way of escaping it.[213]

Popper provided the most generally accepted way of escaping the scientific problem of induction. He proposed that while scientific generalizations could not be verified by repeated repetition, they could be falsified. This approach to scientific discovery has had many adherents.

However, A. F. Chalmers has pointed out that this approach is flawed. He states, "Theories cannot be conclusively falsified because the observation statements that form the basis of falsification may themselves prove to be false in the light of later developments."[214] For all observation statements are theory dependent, and when theories change, these observation statements may possibly change.

This is what Chalmers calls 'naive falsificationism'. A more sophisticated approach, proposed by Popper himself, is to view scientific discovery in an evolutionary manner. In this view, Popper called scientific theories or hypotheses 'conjectures'.[215] Science advances by making conjectures that can either be confirmed or falsified by observation. Most particularly, if a bold conjecture can be confirmed or a cautious one falsified, then science can progress. In contrast, as Chalmers points out, "little is learnt from the falsification of a bold conjecture or the confirmation of a cautious conjecture".[216]

However, even this account of scientific method does not satisfactorily describe what happens when science makes one of its major breakthroughs, the classic example being the scientific revolution begun by Copernicus in 1543 with his *Book of the Revolutions of the Heavenly Spheres* and completed by Isaac Newton in 1687 with his *Mathematical Principles of Natural Philosophy*.

When studying this development, Thomas S. Kuhn pointed out that scientific theories need to be seen as a complex structure of concepts, which he famously called 'paradigms' from the Greek word paradeiknumi meaning 'show side by side'. From this, he made a clear distinction between normal science, which works within the context of a particular paradigm, and scientific revolutions, when a radical change is made to the conceptual structures that guide scientific research.

This is what generally happens in what Thomas S. Kuhn called normal science:

> … 'normal science' means research firmly based upon one or more past scientific achievements, achievements that some particular scientific community acknowledges for a time for its further practice.[217]

However, such an approach to science does not satisfactorily describe the process that Copernicus, Kepler, Galileo, and Newton went through in the sixteenth and seventeenth centuries or that of Priestley and Lavoisier in developing the oxygen theory of combustion.[218]

By looking at such examples in the history of scientific discovery, Kuhn saw that such a radical change in world-view comes about as the result of anomalies in the overall structure of existing scientific theories; experience no longer matches the theory, leading to what Kuhn called a paradigm shift or change. Such a transformation is the essence of scientific revolutions, which he described thus:

> … at times of revolution, when the normal scientific tradition changes, the scientist's perception of his environment must be re-educated—in some familiar situations he must learn to see a new gestalt.[219]

Kuhn went on to say that it is as much the consensus of scientific communities that decides what paradigms should be used as rational argument. In other words, Kuhn asserted that science is as much a social activity as an objective, rational process. This observation of the world as it is was not too popular in some quarters. For instance, Imre Lakatos did not like what philosophers call 'relativism', although Kuhn denied that he was a relativist.[220] While supporting the notion that scientific theories are structures, Lakatos sought a way of restoring both rationalism and absolutism to science.

He attempted to do this with the concept of a 'hard core' that scientific research programmes should adhere to. "The hard core of a programme … takes the form of some very general theoretical hypotheses from which the programme is to develop."[221] For instance, "The hard core of Newtonian physics is comprised of Newton's laws of motion plus his law of gravitational attraction."[222] Most particularly, "any scientist who modifies the hard core has opted out of that particular research programme," typically being ostracized by her or his colleagues. It is therefore not surprising that scientists with a spiritual or even mystical orientation have been very careful to keep their experiences secret.

The next player in this game to appear was Paul Feyerabend. Feyerabend was concerned that these hard core paradigms and methods could inhibit the growth of scientific knowledge. In *Against Method*, he therefore proposed an anarchistic approach to learning in which "anything goes".[223]

Most particularly, he wanted to challenge the claim that scientific method is superior to any other method of developing knowledge about ourselves and the world we live in. For if science is to play its full part in the world, we need to look at it in the context of the social environment in which it is taking place. As Feyerabend said, we need to "free society from the strangling hold of an ideologically petrified science just as our ancestors freed us from the strangling hold of the One True Religion!"[224]

In other words, as a growing number of scientists are beginning to realize, if humanity is to resolve the great crisis it is facing at the present time, we need to free science of scientism, a generally derogatory term indicating a belief in the omnipotence of scientific knowledge and techniques.

We can begin to do this by noting that one of the most fundamental assumptions of science is false, articulated by A. F. Chalmers, "I accept, and presuppose throughout this book, that a single, unique, physical universe exists independently of observers".[225] Nor is this all. Karl Popper believed that there is such a thing as objective knowledge without a knowing subject, a belief that shows how far Western philosophy and science has departed from Reality.

This brief history of the struggle to find a sound basis for scientific method overlooks another approach to scientific reasoning, that of hypothesis or abduction, terms introduced by Charles S. Peirce in the 1800s, as we see in Table 1.2, "Approaches to scientific method," on page 123. But, again, abductive reasoning does not lead us to the Absolute Truth, to an understanding of what is causing the pace of technological development to accelerate exponentially.

In order to overcome the problem of scientism and in his attempts to integrate science and religion, Ken Wilber has introduced a radically new approach to scientific method. Following St Bonaventure and Hugh of St Victor,[226] Ken points out that we human beings have at least three modes or eyes of attaining knowledge: "the eye of flesh, by which we perceive the external world of space, time, and objects; the eye of reason, by which we attain knowledge of philosophy, logic, and the mind itself; and the eye of contemplation, by which we rise to a knowledge of transcendent realities".[227]

Ken then goes on to assert that the same scientific method can apply to each of these three eyes, what he calls "the three strands of all valid knowing":

1. Instrumental injunction. This is an actual practice, an exemplar, a paradigm, an experiment, an ordinance. It is always of the form, 'If you want to know this, do this'.
2. Direct apprehension. This is an immediate experience of the domain brought forth by the injunction; that is, a direct experience of apprehension of data (even if the data is mediated, at the moment of experience it is immediately apprehended). William James pointed out that one of the meanings of 'data' is direct and immediate experience, and science anchors all of its concrete assertions in such data.
3. Communal confirmation (or rejection). This is a checking of results—the data, the evidence—with others who have adequately completed the injunctive and apprehensive strands.[228]

Each of these ideas has made a significant contribution to the establishment of a rational way of thinking and learning that can produce a true representation of ourselves and the world we live in. Yes, we need experimentation, yes, scientific theories are structures, yes, there is a danger here that these structures might inhibit our learning, and yes, we need to apply our scientific inquiries to our physical, mental, and spiritual domains, all three.

However, as they stand at the moment, all these different approaches lack the cohesion of Integral Relational Logic. Taking Ken's three eyes of knowing, in particular, he is using his analytical powers to distinguish these different ways of developing knowledge without recognizing that these concepts are subclasses of **Being**, the superclass of all our learning.

Furthermore, why does Ken only accept knowledge as valid that has been confirmed by a consensus? As Alexis de Tocqueville[229] and John Stuart Mill[230] showed in the middle of the nineteenth century, democracies can be tyrannous. So what happens when an individual is a pioneer, exploring ways of learning that have never been tried before? Does this invalidate the experiment if no others in society are yet ready to repeat this experiment in learning?

The surface of things

As axiomatic mathematical proof, deductive logic, and generally accepted scientific methods cannot lead us to Wholeness and the Truth, cannot provide us with a valid picture of the world we live in, it is not surprising that science and medicine, concerned only with the superficial, have also reached an evolutionary cul-de-sac.

To give but one example, scientists assert that they "have found that everything in the Universe is made up from a small number of basic building blocks called elementary particles, governed by a few fundamental forces," as CERN's website tells us.[231] This atomistic philosophy has a long history, going back, once again, to the ancient Greeks, to Leucippus and Democritus some 2,400 years ago. As *Encyclopædia Britannica* tells us, it was Democritus who named the "infinitely small building blocks of matter atomos, meaning literally 'indivisible', about 430 BC", articulating the beliefs of his teacher, Leucippus. (The Greek verb 'to cut' was temnein, the substantive being tomos.)

Even though Ernest Rutherford showed in 1911 that the atom is not actually indivisible, but consists of a nucleus and orbiting electrons, the belief persists in the existence of a fundamental particle that cannot be further subdivided. Indeed, this belief is so strong among the 13,000 particle physicists around the world that they have persuaded governments to build them multimillion-dollar particle accelerators, which they use to study the properties of and interactions between the multitude of subatomic particles that have been discovered in the past one hundred years. At the time of writing, the hunt is on for a 'Higgs boson', supposedly a particle or set of particles that give everything in the physical universe, including us, mass.

For instance, Stephen W. Hawking was reported as saying on BBC radio in December 2006, "scientists still have 'some way to go' to reach his prediction in his bestselling *A Brief History of Time* that mankind would one day 'know the mind of God' by understanding the complete set of laws which govern the universe."[232] He still believes that the giant LHC atom smasher that went into operation in the CERN nuclear physics laboratory in Geneva in 2008 and then broke down is necessary to reveal these laws, which he thinks could be developed within twenty years. Furthermore, he still believes that "Mankind will need to venture far beyond planet Earth to ensure the long-term survival of our species," not recognizing that the human race is not immortal; it is subject to the same laws as any other structure in the Universe.

There seems to be no limit to this tomfoolery. For as soon as one group of scientists claim to have found the ultimate particle, another group will come along to try to prove them wrong.[233] There is no end to this process. It is quite clear that studying physics cannot lead us to Wholeness and the Truth. Because scientists do not accept a holistic science of reason that truly describes how human beings think and learn, they are still leading both politicians and the general public astray.

FERMIONS matter constituents spin = 1/2, 3/2, 5/2, ...

Leptons spin = 1/2			Quarks spin = 1/2		
Flavor	Mass GeV/c²	Electric charge	Flavor	Approx. Mass GeV/c²	Electric charge
ν_e electron neutrino	$<1\times10^{-8}$	0	u up	0.003	2/3
e electron	0.000511	–1	d down	0.006	–1/3
ν_μ muon neutrino	<0.0002	0	c charm	1.3	2/3
μ muon	0.106	–1	s strange	0.1	–1/3
ν_τ tau neutrino	<0.02	0	t top	175	2/3
τ tau	1.7771	–1	b bottom	4.3	–1/3

Figure 9.9: *Part of standard model of fundamental particles and interactions*

Yet it is interesting to note that the standard model of fundamental particles and interactions published by the Contemporary Physics Education Project (CPEP) contains tables just like the basic construct in Integral Relational Logic. Figure 9.9 shows just one of these tables, indicating that all of us, including the particle physicists, use IRL in organizing our ideas. Even in physics, mathematical measurement is secondary to semantic structures.

At the other end of the scale, scientists are searching for the origin of the Universe and forms of life in outer space. It is a fundamental misconception to think that we shall "unlock the secrets of the universe" and discover the origins of humanity by sending multibillion-dollar telescopes into the sky, which is a primary goal of NASA's Origins Program using the Hubble Space Telescope.[234] We can only discover who we truly are as human beings through self-inquiry, by turning the attention inwards rather than outwards. And this endeavour does not cost a cent or a penny.

We can also see that there is no point in searching for life on Mars or anywhere else in outer space. For instance, the mission of the SETI (Search for Extraterrestrial Intelligence)

Institute is "to explore, understand and explain the origin, nature and prevalence of life in the universe".[235] But life is not 'out there'. The search for extraterrestrial intelligence is thus doomed to fail because any hypothetical intelligent being in another part of the physical universe would know that Intelligence is divine, and would not bother trying to communicate with beings who did not know this.

Diving beneath the surface

If we are to escape from the evolutionary cul-de-sac that modern science, mathematics, and logic have led us into, we need to dive beneath the material surface of our lives and look into the depths of the Cosmic Psyche. We need to escape from the prison cells that our egoic minds have incarcerated us in. David Bohm, a friend and colleague of Albert Einstein in the 1940s and 50s, began to show us how scientists can pursue this path as well as the mystics.

Like Einstein, he was particularly interested in Wholeness, not only to solve the mysteries thrown up by the incompatibilities of modern physics, but also because Wholeness is essential in solving our immense social problems. As Bohm said,

> The widespread and pervasive distinctions between people (race, nation, family, profession, etc., etc.), which are now preventing mankind from working together for the common good, and indeed for survival, have one of the key features of their origin in a kind of thought that treats things as inherently divided, disconnected, and 'broken up' into yet smaller constituent parts. Each part is considered to be essentially independent and self-existent.[236]

Regarding the two primary theories in physics, he said,

> Relativity and quantum theory agree, in that they both imply the need to look on the world as an undivided whole, in which all parts of the universe, including the observer and his instruments, merge and unite in one totality. In this totality, the atomistic form of insight is a simplification and abstraction, valid only in some limited context.[237]

In contrast, Bohm had this to say about his scientific colleagues:

> Most physicists still speak and think, with an utter conviction of truth, in terms of the traditional atomistic notion that the universe is constituted of elementary particles which are 'basic building blocks' out of which everything is made. In other sciences, such as biology, the strength of this conviction is even greater, because among workers in these fields there is little awareness of the revolutionary character and development in modern physics. For example, modern molecular biologists generally believe that the whole of life and mind can ultimately be understood in more or less mechanical terms, through some kind of extension of the work that has been done on the structure and function of DNA molecules. A similar trend has already begun to dominate psychology. Thus we arrive at the very odd result that in the study of life and mind, which are just the fields in which formative cause acting in undivided and unbroken flowing movement is most evident to experience and observation, there is now the strongest belief in the fragmentary approach to reality.[238]

In endeavouring to make sense of the paradoxes of quantum physics, Bohm noticed that in "looking at the night sky, we are able to discern structures covering immense stretches of space and time, which are in some sense contained in the movements of light in the tiny space encompassed by the eye."[239] He saw this as evidence of "a total order … contained, in some implicit sense, in each region of space and time."[240] This led him to realize the existence of an enfolded or implicate order, in contrast to the explicate order, which the laws of physics that thus far mainly referred to.[241] In contrast, Bohm proposed that to formulate the laws of physics "primary relevance is to be given to the implicate order, while the explicate order is to have a secondary kind of significance."[242]

Bohm used some physical analogies to explain what he meant:

> A more striking example of implicate order can be demonstrated in the laboratory, with a transparent container full of a very viscous fluid, such as treacle, and equipped with a mechanical rotator that can 'stir' the fluid very slowly but very thoroughly. If an insoluble droplet of ink is placed in the fluid and the stirring device is set in motion, the ink drop is gradually transformed into a thread that extends over the whole fluid. The latter now appears to be distributed more or less at 'random' so that it is seen as some shade of grey. But if the mechanical device is now turned in the opposite direction, the transformation is reversed, and the droplet suddenly appears, reconstituted.[243]

Bohm also uses the hologram as an illustration of undivided wholeness, from the Greek holo 'whole' and *gramma* 'writing', related to grapho 'to write'. "Thus the hologram is an instrument that, as it were, 'writes the whole'."[244] When the image of an object is created on a photographic plate using a laser beam, there is no one-to-one correspondence between parts of the illuminated object and parts of the image of this object on the plate. Rather, the interference pattern on each region R of the plate is relevant to the whole structure.[245] Furthermore, Bohm likened his view of a holographic universe to Karl Pribram's view of the holographic brain.

> Pribram has given evidence backing up his suggestion that memories are generally recorded all over the brain, in such a way that information concerning a given object or quality is not stored in a particular cell or localized part of the brain but rather that all information is enfolded in the whole. This storage resembles a hologram in function.[246]

The theory of the implicate order is also central to the reconciliation of the incompatibilities between relativity and quantum theories: "Relativity theory requires continuity, strict causality (or determinism) and locality. On the other hand, quantum theory requires noncontinuity, noncausality, and nonlocality."[247] Bohm illustrated the relationship between relativity and quantum theories with two cameras at right angles pointing at a fish swimming in a tank, reproduced in Figure 9.10.[248] The television screens linked to cameras A and B show different images of one underlying reality. It is the profound implicate order that is primary; the superficial explicate order of our senses that we look at through our television sets is secondary.

To give this underlying, undivided reality some substance, Bohm introduced the notion of the holomovement, which he liked to an undivided flowing stream, whose substance is

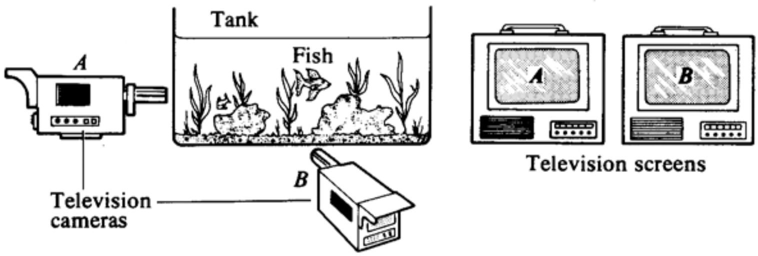


Figure 9.10: *Opposite perspectives of one underlying reality*

never the same, along the lines of Heraclitus, who said, “You cannot step twice in the same river.”[249] He also saw this view as a development of A. N. Whitehead’s process view of reality.[250] As he said, “On this stream, one may see an ever-changing pattern of vortices, ripples, waves, splashes, etc., which evidently have no independent existence as such. Rather, they are abstracted from the flowing movement, arising and vanishing in the total process of flow.”[251] Bohm then went on to say, “Everything is to be explained in terms of forms derived from this holomovement. Though the full set of laws governing its totality is unknown (and, indeed, probably unknowable).”[252]

This statement is very close to the Truth, but not quite. The holomovement still encapsulates the concept of linear time, which we need to transcend if we are to be truly liberated from the bondage of past and future. We can do this by allowing the river to flow into the ocean of Consciousness, a vast ball of water whose origin is the centre of the ocean, illustrated in Figure 4.5 on page 256. In a similar fashion, the quantum physicist Amit Goswami regards Consciousness as the primary reality, but there is no mention of the holomovement or the implicate order in his book, *The Self-Aware Universe: How Consciousness Creates the Material World*.

This view of Consciousness as Reality is somewhat different from that of some other physicists. For instance, Danah Zohar describes underlying reality as a quantum vacuum, the ‘well of being’.[253] Nevertheless, she goes on to say, “The quantum vacuum is very inappropriately named because it is not empty. Rather, it is the basic, fundamental and underlying reality of which everything in this universe—including ourselves—is an expression.”[254]

Another physicist, Mark Comings, has similarly said, “This Quantum Vacuum is more aptly named the Quantum Plenum,”[255] the Latin neuter of plenus ‘full’. He associates the quantum plenum with space, which he says has virtually unlimited potential locked up within it.[256] It seems that by saying that Ultimate Reality is empty, the physicists have been attempting to associate their scientific world-view with the central concept of Buddhism: *shunyata*, ‘emptiness or void’. Yet, Reality, as the union of all opposites, is both Emptiness and Fullness. However, it is vitally important not to be confused by the parallels between quantum physics and Eastern mysticism. Reality is neither space nor time, even though Consciousness has some of the properties of space discovered by physicists.

We can see this most clearly with David Bohm's theory of the implicate order, even though Bohm himself did not completely transcend his conditioning as a physicist.[257] The Unified Relationships Theory embraces the implicate and explicate orders by noticing that structures have both a surface, accessible to our senses, and a depth, which we can call the structure's essence, from the Latin word esse meaning 'to be', which determines their essential nature. The essence of structures can easily be demonstrated with the collection of A's in thirty different fonts in Figure 9.11.[258] We human beings can see that there is a certain 'A-ness' about these characters, which enables us to see the commonality amongst them, different as they are.

Figure 9.11: *Illustration of the essence of structures*

However, when I ran an experiment to see how many of these A's my optical character recognition (OCR) program would recognize, it managed only twelve: 40%. I suspect that even the most advanced OCR program would have difficulty in reading all these A's. The reason for this is that these forms have a deep underlying essence, which resonates with our understanding of what the letter A looks like. We can immediately see forms as wholes, without any need for pattern recognition algorithms, which computers must resort to.

As it is with simple letters, so it is with human faces, which we are able to recognize without any difficulty, complex as they are. In music, poetry, art, literature, etc., it is the essence of these structures that evoke beautiful feelings within us. They cannot be fully appreciated with the intellect, even though the mind likes to analyse these structures to see how a piece of music, for instance, is composed. Analysing structures destroys their essence, which provides us with meaning and value. The essence of structures is not something that can be quantified in monetary terms, for instance. As the saying goes, "The best things in life are free."

This is nowhere clearer than when we are in the wilderness, communing with Nature. For instance, the trees in the forests of Scandinavia are not just there to make houses, furniture, and paper. We can feel the presence of God deep in the forest, far away the madness of the world we live in today.

Going even deeper, all these feelings show quite clearly that all sentient beings have a living essence, called 'the soul' in human beings, which determines our uniqueness. This does not mean that the soul survives death or is reincarnated. For the soul, like everything else in the world of form, is just an abstraction from Consciousness, with no separate existence. Beyond the soul are the female and male principles, which we share with others of the same sex. Ultimately, the Essence of the Universe as a whole is the Absolute, which we can most simply call Love, for God is Love, as John wrote in his first epistle.[259]

This is nowhere clearer than when a woman and man love each other unconditionally. For in their divine lovemaking, two become one beyond all thoughts, the most beautiful meditation that any of us can engage in. These experiences show that we human beings can love each other not only as woman and man, but also as goddesses and gods. For in Reality, there is no separation between the Divine and human. God is everywhere and everywhen, in every nook and cranny. And when we know this deep in our hearts, there is no need for CNN to broadcast such programmes as *God's Warriors*, broadcast in August 2007. All holy wars—wars about the Whole—with then have come to an end and we can live in Peace, perfect Peace.

Notes for Volume Two

Part II. The Unified Relationships Theory

Motto: (p. 471) Fromm, *To Have or To Be?* p. 148, cited at Schumacher, *Small is Beautiful*, p. 80, from Darwin's Autobiography.

1. (p. 472) Watson, *DNA: The Secret of Life*.

2. Extended quote given in Schumacher, *Small is Beautiful*, p. 80, shortened in Erich Fromm, in *To Have or To Be?*, p. 148.

3. (p. 472) Fromm, *To Have or To Be?*, p. 148.

4. (p. 472) Schumacher, *Small is Beautiful*, p. 79.

5. (p. 473) Bohm, *Wholeness and the Implicate Order*, pp. 3–4.

6. (p. 473) Schumacher, *Small is Beautiful*, pp. 79–80.

7. (p. 473) Osho, *Book of Secrets*, p. 141.

8. (p. 475) Maturana and Varela, *Autopoiesis and Cognition*, p. 78.

9. (p. 475) Capra, *Web of Life*, pp. 97–98.

10. (p. 475) Bergson, *Creative Evolution*.

11. (p. 476) Capra, *Tao of Physics*, p. 338.

12. (p. 476) Ibid., pp. 338–339.

13. (p. 476) Russell, *History of Western Philosophy*, p. 13.

14. (p. 477) Koestler, *Ghost in the Machine*, p. 3. Proverbs 9:1 says, "Wisdom hath builded her house, She hath hewn out her seven pillars," but the Bible does not name them. For Koestler,

> the citadel of orthodoxy which the sciences of life have built in the first half of our century rests on a number of impressive pillars [of unwisdom], some of which are beginning to show cracks and to reveal themselves as monumental superstitions. The four principal ones, summarized in a simplified form, are the doctrines:
>
> (a) that biological evolution is the result of random mutations preserved by natural selection;
>
> (b) that mental evolution is the result of random tries preserved by 'reinforcements' (rewards);
>
> (c) that all organisms, including man, are essentially passive automata controlled by the environment, whose sole purpose in life is the reduction of tensions by adaptive responses;
>
> (d) that the only scientific method worth that name is quantitative measurement; and, consequently, that complex phenomena must be reduced to simple elements accessible to such treatment, without

undue worry whether the specific characteristics of a complex phenomenon, for instance man, may be lost in the process.

CHAPTER 5. AN INTEGRAL SCIENCE OF CAUSALITY

Motto: (p. 483) Shortened translation of *Nam et ipsa scientia potestas est* 'Knowledge itself is power' from *Meditationes Sacræ* 'Religious Meditation's 'De Hæresibus' (Of Heresies), 1597.

1. (p. 484) Greene, *Elegant Universe*, p. ix.

2. (p. 485) My top priority at this first meeting in November 1980 was to find a concept that would unify the concept of data energy that I had 'discovered' with the material energies recognized by the physicists. So I asked David Bohm, "What is the source of data energy?" He replied, "Energy does not have a source; energy derives from *structure*." This answer was so obvious that I wondered why I had not thought of it myself. However, as I now know, the Ultimate Source of energy is Life arising directly from the Immortal Ground of Being.

3. (p. 485) Hague, Paul, *The Thoughtful Society*, p. 29, spring 1983, unpublished.

4. (p. 487) Balseskar, *Consciousness Speaks*, p. 221.

5. (p. 488) Bell, 'Information Society', p. 168. In *The Coming of Post-Industrial Society,* Bell predicted a vastly different world—one that would rely upon an economics of information, as opposed to the economics of goods that had existed up to then. Bell argued that the new society would not displace the old one but rather overlay it in profound ways, much as industrialization continues to coexist with the agrarian sectors of our society. In Bell's prescient vision, the post-industrial society would include the birth and growth of a knowledge class, a change from goods to services, and changes in the role of women. All of these would be based upon an increasing dependence on science as a means of innovation; as a means of technical and social change (from publisher's blurb).

6. (p. 489) From the movie *The Hitchhiker's Guide to the Galaxy*, a shortening of chapter 25 in Adams, *Hitchhiker's Guide*, pp. 125–131.

7. (p. 489) Adams, *Hitchhiker's Guide*, pp. 135–136.

8. (p. 489) *What is Enlightenment?* Issue 19, Spring/Summer 2001, pp. 112–114. The published replies were from Wayne Liqorman, Satyam Nadeen, and Tony Parsons.

9. (p. 489) http://www.acadun.com/en/Academy/articles/importantspirituelquestions.doc/.

10. (p. 490) Moved Herschel and Milky Way Galaxy to 'Prospects for Humanity'.

11. (p. 492) Propp, *Morphology of Folktale*. Propp (1895–1970) was a leading member of Russian formalism movement, an influential school of literary criticism in Russia from the 1910s to the 1930s. In Morphology he analysed Russian folktales into a sequence of thirty-one functions beginning with 'abstention' and ending with 'wedding'. These roughly correspond

to seventeen steps of the classical spiritual journey in myths and fairy tales, identificed by Joseph Campell in *The Hero with a Thousand Faces*. For a summary of Propp's morphology, see http://en.wikipedia.org/wiki/Vladimir_Propp.

12. (p. 492) The Great Vowel Shift from 1450 to 1750 was first studied by Otto Jespersen (1860–1943), a Danish linguist and Anglicist, who coined the term. In Middle English, long vowels had 'continental' values much like those remaining in Italian and liturgical Latin. However, during the Great Vowel Shift, the two highest long vowels became diphthongs, and the other five underwent an increase in tongue height with one of them coming to the front. Because English spelling was becoming standardized in the 15th and 16th centuries, the Great Vowel Shift is responsible for many of the peculiarities of English spelling. http://en.wikipedia.org/wiki/Great_Vowel_Shift.

13. (p. 492) OED and AHDEL.

14. (p. 493) http://en.wikipedia.org/wiki/Gestalt_psychology.

15. (p. 493) Aurobindo, *Life Divine*, p. 141.

16. (p. 493) **Gestalt psychology**, *Encyclopædia Britannica*, 2008.

17. (p. 493) **Gestalt therapy**, *Encyclopædia Britannica*, 2008.

18. (p. 493) http://en.wikipedia.org/wiki/Gestalt_therapy.

19. (p. 493) Perls, et al, *Gestalt Therapy*, pp. v–vi.

20. (p. 495) http://en.wikipedia.org/wiki/George_Bradshaw.

21. (p. 496) http://en.wikipedia.org/wiki/Traffic_light_control_and_coordination.

22. (p. 497) Morris, *Manwatching*, pp. 24–35.

23. (p. 498) Sissela Bok's parents were both Nobel Laureates, Gunnar Myrdal for Economics with Friedrich Hayek in 1974 and Alva Myrdal for Peace in 1982. So apart from the two daughters of Marie and Pierre Curie, she and her two siblings have been the only children of such distinguished parents. See relevant pages in Wikipedia.

24. (p. 498) Bok, *Lying*, pp. xv–xvi.

25. (p. 498) If I remember correctly, this statement was in the frontispiece of one of my statistics textbooks at university in the early 1960s. However, Wikipedia tells us that this saying cannot be found in Disraeli's writings.

26. (p. 499) Bok, *Secrets*, p. xv.

27. (p. 499) Underhill, *Practical Mysticism*, p. 3 (referenced at http://en.wikipedia.org/wiki/Christian_mysticism). The full quote is: "Mysticism is the art of union with Reality. The mystic is a person who has attained that union in greater or less degree; or who aims at and believes in such attainment."

28. (p. 499) **Pythagoreanism**, *Encyclopædia Britannica*.

29. (p. 499) **Eleusisian Mysteries**, *Encyclopædia Britannica*.

30. (p. 500) This phrase was much used in IBM in the late 1970s as we followed the marketing slogan, “Manage data as a corporate resource.” However, there doesn’t seem to be any evidence that Disraeli actually said this. A search of the Web on 27th January 2010, returned just five sites quoting this maxim, including a British government ministry: the Department of Agriculture and Rural Development.

31. (p. 500) http://nobelprize.org/nobel_prizes/economics/laureates/1996/.

32. (p. 501) Stonier, *Wealth of Information*, pp. 18–19.

33. (p. 501) Alexander, *Gaia*, p. 14.

34. (p. 502) http://en.wikipedia.org/wiki/Advertising and List_of_countries_by_GDP_(nominal).

35. (p. 503) Koestler, *Act of Creation*, pp. 32–33.

36. (p. 503) Ibid., p. 35.

37. (p. 505) Aristotle, *Metaphysics*, 1012b, 34–1013a, 24, pp. 209–210.

38. (p. 506) Aristotle, *Physics*, 193b, 22–194a, 32, pp. 36–38.

39. (p. 506) Ibid., 194b, 23–194b, 36. p. 39.

40. (p. 506) Ibid., 195a16–19, p. 40.

41. (p. 506) Bohm, *Wholeness*, p. 12.

42. (p. 506) Ibid., pp. 12–13.

43. (p. 507) Aristotle, *Physics*, 195b, 31–198a, 13, pp. 42–48.

44. (p. 507) http://www.scimednet.org/mysticsandscientists.htm.

45. (p. 508) Conference Cassettes, ‘The Nature of Energy’, MS48.

46. (p. 509) Sheldrake, *New Science of Life*, p. 71.

47. (p. 509) Keen and Scott Morton, *Decision Support Systems*.

48. (p. 509) http://en.wikipedia.org/wiki/History_of_entropy.

49. (p. 509) In a letter of 26th January 1993 I received in reply to a letter of mine asking for the confusion around the root meaning of *entropy* to cleared up.

50. (p. 510) This meaning does not seem to be explicitly defined in The Holotropic Mind. However, Stan Grof confirmed this meaning when I have a ninety-second conversation with him in 1992 at a conference in Prague organized by the International Transpersonal Association called ‘Science, Spirituality, and the Global Crisis’.

51. (p. 510) http://en.wikipedia.org/wiki/Second_law_of_thermodynamics.

52. (p. 510) It seems that William Thomson, later Lord Kelvin, was the first to propose this hypothesis in the 1850s (http://en.wikipedia.org/wiki/Heat_death_of_the_universe). It is thus appropriate that the absolute temperature scale should be measured in kelvins, one of seven SI base units. A temperature of 0° K is -273.15° C, marking the theoretical absence of all thermal energy.

53. (p. 510) Hill & Thornley, *Principia Discordia*, quoted in http://en.wikipedia.org/wiki/Second_law_of_thermodynamics.

54. (p. 510) http://en.wikipedia.org/wiki/Origin_of_species.

55. (p. 510) http://en.wikipedia.org/wiki/Survival_of_the_fittest.

56. (p. 511) Darwin, *Origin of Species*, p. 73.

57. (p. 511) von Bertalanffy, *General System Theory*, p. 12.

58. (p. 512) Ibid., p. 15.

59. (p. 512) Weiner, *Cybernetics*, p. 11.

60. (p. 512) Shannon, 'Mathematical Theory of Communication', The Bell System Technical Journal, Vol. 27, pp. 379–423, 623–656, July, October, 1948, available at http://plan9.bell-labs.com/cm/ms/what/shannonday/shannon1948.pdf.

61. (p. 512) Ross Ashby, *Cybernetics*, pp. 177–178.

62. (p. 512) Ibid., p. 177.

63. (p. 512) Conversation between Claude Shannon and John von Neumann in 1949 recorded in http://en.wikipedia.org/wiki/Entropy.

64. (p. 512) Weiner, *Cybernetics*, p.132.

65. (p. 513) Prigogine and Stengers, *Order out of Chaos*, p. 12.

66. (p. 513) Reproduced in Maturana and Varela, *Autopoiesis and Cognition*, pp. 59–123.

67. (p. 513) Ibid., Editorial preface, p. v.

68. (p. 513) Ibid., pp. 78-79.

69. (p. 513) Tarnas, *Passion of the Western Mind*, p. 45.

70. (p. 513) Capra, *Web of Life*, p. 97, quoting Maturana and Varela, *Autopoiesis and Cognition*, p. 75.

71. (p. 513) Ibid., pp. 97–98.

72. (p. 513) Gleik, *Chaos*.

73. (p. 513) Waldorp, *Complexity*.

74. (p. 514) Bergson, *Creative Evolution*, p. 87.

75. (p. 514) Teilhard, *Human Phenomenon*, p. 30.

76. (p. 514) Kapp, *Science versus Materialism*, p. 221.

77. (p. 514) Ibid., p. 179.

78. (p. 514) Ibid., p. 6.

79. (p. 514) Ibid., p. 57.

80. (p. 514) http://www.reginaldkapp.org/.

81. (p. 514) http://www.scimednet.org/.

82. (p. 515) Watson, *Double Helix* tells the story of the discovery of the structure of DNA.

83. (p. 515) http://en.wikipedia.org/wiki/Dna.

84. (p. 515) Watson, *DNA*, p. 55.

85. (p. 515) Watson, *Double Helix*, p. 222.

86. (p. 515) Watson, *DNA*, p. 53.

87. (p. 515) Ibid.

88. (p. 515) Ibid., p. 73.

89. (p. 515) Ibid., pp. 74–75.

90. (p. 515) Ibid., p. 75.

91. (p. 515) Ibid., p. 85.

92. (p. 516) Ibid., p. 20.

93. (p. 516) http://en.wikipedia.org/wiki/Eugenics.

94. (p. 516) Watson, *DNA*, p. 20.

95. '(p. 516) James Watson wants to build a better human', http://www.alternet.org/story/16026/.

96. (p. 516) McKie and Harris, Observer, 'Disgrace: How a giant of science was brought low', http://education.guardian.co.uk/higher/research/story/0,,2196657,00.html.

97. (p. 517) Dawkins, *Selfish Gene*, p. 28.

98. (p. 517) Ibid., pp. 15–20.

99. (p. 517) Ibid., p. 192.

100. (p. 517) Ibid.

101. (p. 517) Sheldrake, *New Science of Life*, p. 71.

102. (p. 517) Ibid., p. 67.

103. (p. 517) Dawkins, *Blind Watchmaker*, p. 15.

104. (p. 518) I don't know which edition this was. The article was in an edition of *Encyclopedia Britannica* that I read in the early 1980s in either my parents' rather dated edition or one of the south London libraries that I was using a the time. But they may not have had the most up-to-date edition available at the time.

105. (p. 518) Roszak, *Cult of Information*, pp. 21–33.

106. (p. 518) Ibid., p. 15.

107. (p. 518) Ross Ashby, *Cybernetics*, p. 126.

108. (p. 518) http://www.ccrnp.ncifcrf.gov/~toms/paper/primer/.

109. (p. 518) Ibid.

110. (p. 518) Jones, *Elementary Information Theory*, p. 13.

111. (p. 518) http://www.ccrnp.ncifcrf.gov/~toms/paper/primer/ and http://en.wikipedia.org/wiki/Myron_Tribus

112. (p. 519) Shannon, 'Theory of Communication', p. 12.

113. (p. 519) Ross Ashby, *Cybernetics*, p. 176.

114. (p. 519) Ibid., p. 175.

115. (p. 519) Ibid., p. 122.

CHAPTER 6. A HOLISTIC THEORY OF EVOLUTION

Motto: (p. 521) Teilhard, *Phenomenon of Man*, Foreword, p. 21.

1. (p. 521) http://en.wikipedia.org/wiki/On_the_Origin_of_Species.

2. Editors of WIE, 'The Real Evolution Debate', *What Is Enlightenment?*, Issue 35, January–March 2007, p. 88.

3. Ibid., p. 100.

4. (p. 522) **Smuts, Jan (Christian)**, *Encyclopædia Britannica*, 2008.

5. (p. 522) http://en.wikipedia.org/wiki/Smuts. Einstein also said of Smuts that he was 'one of only eleven men in the world' who conceptually understood his Theory of Relativity.

6. (p. 522) Smuts, *Holism*, p. v.

7. (p. 522) Ibid., p. 99.

8. (p. 523) http://en.wikipedia.org/wiki/Smuts.

9. (p. 524) The word *hologenesis* led me to discover Teilhard's *The Phenomenon of Man* in 1980. I was searching for a generic term for *morphogenesis*, *ontogenesis*, and *phylogenesis*, emphasizing that their common characteristic is the evolution of wholes that are greater than the sum of their preceding wholes. So I naturally coined *hologenesis* and rushed round to my local library to consult the Oxford English Dictionary to see if had been coined before. Indeed it had. As the second edition of the OED records, *hologenesis* is "The name of a theory of evolution first propounded by D. Rosa (in *Ologenesi* (1918)), and later adopted by G. Montandon (in *L'Ologenèse humaine* (1928)) to account for the origin of human races." The OED also provided a citation from Teilhard's book.

10. (p. 524) Wilber, *Up From Eden*.

11. (p. 524) Anne Baring, 'The Great Work: Healing the Wasteland', Mystics and Scientists 28, 'Healing the Spilt: An Alchemy of Transformation' (Moreton-in-Marsh, Gloucestershire: Conference Cassettes, 2005), CD.

12. (p. 524) Arnold J. Toynbee, abridge. D. C. Somervell, *A Study of History* (Oxford: Oxford University Press, 1946).

13. The name *Linnaeus* is a Latinized form of the Swedish word for the linden tree: *lind* (genus *Tilia*), sometimes confusingly called the lime tree in English, for lime is a fruit of various trees in the *Citrus* genus. Until around this time, people's surnames in Sweden were generally patronymic, like *Andersson*. (Some people, mostly women, also have surnames like *Andersdotter* or even *Annasdotter*, a *matronymic*, from www.ratsit.se.) But some people, like the clergy, thought that such names were beneath them. So they adopted other surnames, such as the village or farmstead where they lived, or based on nature, like *Hallenberg* 'raspberry hill' or *Blomkvist* 'flowery twig'. For instance, two brothers of Linnaeus' paternal grandmother took the name *Tiliander* when they, the sons of a farmer, studied to become

clergymen, after the Latin name for the linden tree (www.linnaeus.uu.se/online/life/3_0.html). Linnaeus's father followed his uncles' example, but used Swedish as the basis for his name. When Linnaeus was ennobled in the untitled nobility, he took the name Carl von Linné.

14. The full title was *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis* 'System of nature through the three kingdoms of nature, according to classes, orders, genera and species, with characters, differences, synonyms, places' (en.wikipedia.org/wiki/Systema_Naturae).

15. **zoology**. *Encyclopædia Britannica*, 2008.

16. www.linnaeus.uu.se/online/animal/2_1.html.

17. De Candolle, *Théorie élémentaire de la botanique*, OED.

18. **fungus**. *Encyclopædia Britannica*, 2008.

19. en.wikipedia.org/wiki/Kingdom_(biology).

20. en.wikipedia.org/wiki/Three-domain_system.

21. Virus article at en.wikipedia.org/wiki/Virus.

22. It is far from clear how many different species can be identified. Michael Rosenzweig has said, "Right now we can only guess that the correct answer for the total number of species worldwide lies between 2 and 100 million." (www.sciencedaily.com/releases/2003/05/030526103731.htm).

23. The power of hierarchies in evolutionary processes is well illustrated by Koestler's parable of two watchmakers called Bios and Mekhos, developing an original idea of H. A. Simon. Their watches consisted of 1,000 parts, the one that Mekhos assembled having no hierarchical order; his watches were built rather like a mosaic floor of small coloured stones. On the other hand, Bios constructed his watches with ten subsystems, each consisting of ten subassemblies of ten components. So when he needed to pause in his work, what he had done so far did not disintegrate into its elementary parts. Each level of construction was able to exist as a whole. *Ghost in the Machine*, pp. 45–47.

24. Phylogeny, OED.

25. en.wikipedia.org/wiki/Recapitulation_theory.

26. en.wikipedia.org/wiki/World_population.

27. en.wikipedia.org/wiki/Directed_Acyclic_Graph. If 7 is a man in this example, then 5 and 3 would be women. At the next generation, 11 and 8 would then be a woman and man, respectively. In this DAG, 11 has a child 9 with 8 and another child 10 with 8's mother. This would not normally happen in human society. So we would need to place further constraints on DAGs to represent this situation.

28. Such a dataflow language is used in Front Arena to customize the product, which is designed to handle trades in financial products by investment banks. I worked on the Arena

Dataflow Language (ADFL) when working as a computer consultant for Front Capital Systems in 2002 and 2004. See also Scott, *Programming Language Pragmatics*, p. 6.

29. Dawkins, *Ancestor's Tale*, p. 7.
30. Miller & Wood, *Anthropology*, pp. 73–75.
31. OED.
32. en.wikipedia.org/wiki/Mammal.
33. en.wikipedia.org/wiki/Convergent_evolution.
34. Miller & Wood, *Anthropology*, p. 81.
35. **Mendel, Gregor (Johann)**. *Encyclopædia Britannica*, 2008.
36. Dawkins, *Ancestor's Tale*, p. 193.
37. en.wikipedia.org/wiki/Clade.
38. OED.
39. Wikipedia has a number of articles on this subject, but they are not very clear.
40. www.jstor.org/pss/2446665.
41. en.wikipedia.org/wiki/Clade.
42. www.ncbi.nlm.nih.gov/mapview/maps.cgi?taxid=9606&chr=19&MAPS=ugHs,genes,genec-r&cmd=focus&fill=40&query=uid(12719632)&QSTR=2141%5Bgene%5Fid%5D. But the gene (allele?) for brown eyes appears to be on another chromosome. It is difficult to interpret the human genome project, for it is a mass of confusion, raising more questions than it answers.
43. Dawkins, *Ancestor's Tale*, pp. 194–195.
44. Ibid., pp. 9–10.
45. (p. 538) The theory of punctuated equilibria was first presented at the annual meeting of the Paleontological Society, and the Geological Society of America, at Washington, D. C., on 2nd November 1971, along with a number of other state-of-the-art papers. Eldredge and Gould's paper, 'Punctuated Equilibria: An Alternative to Phyletic Gradualism', is published in Schopf, *Models in Paleobiology*, pp. 82-115.

At the time, the general consensus among palæontologists and biologists was that evolution progresses gradually. But this does not explain why there are large gaps in the fossil record. Eldredge gives an extended description of the theory of punctuated equilibria and how it came about in his book *Time Frames*. As he explains, "once a species evolves, it will not undergo great change as it continues its existence."

In *Ever Since Darwin*, Gould uses the theory of punctuated equilibria to explain the Cambrian explosion of about 600 million years ago, when there was a great acceleration in biotic diversity. Interestingly, on page 129 of this book, Gould uses the S-shape of the growth curve, to illustrate this phenomenon

46. (p. 538) Curiously, the abridgement of this 1116-page book by John Tyler Bonner does not contain a precis of this vitally important chapter.

47. (p. 539) I got this idea from one of Arthur Koestler's books, but cannot now find the exact reference for it. This is not to disparage the great contribution that the Arabs made to human learning during the first millennium.

48. (p. 539) Bannock, et al, *Dictionary of Economics*, article on logistic curve, p. 282–283.

49. (p. 539) Waddington, *Tools of Thought*, pp. 64–79.

50. (p. 541) Jantsch, *Self-Organizing Universe*, p. 70.

51. Victor Venge, 'The Technological Singularity', available at http://mindstalk.net/vinge/vinge-sing.html.

52. Kurzweil, *Are We Spiritual Machines?*, p. 11.

53. Moore, 'Cramming more components onto integrated circuits'.

54. Moore was speaking at the 50th anniversary meeting of the International Solid-State Circuits Conference in San Francisco. Report by BBC Online.

55. Moravec, *Mind Children*, p. 1.

56. Moravec, *Robot*, pp. 125–126.

57. Rees, *Our Final Century*, p. 19.

58. (p. 534) Attenborough, *Life on Earth*, p. 20.

59. (p. 535) Russell, *White Hole in Time*.

60. (p. 535) Russell, *Waking Up in Time*, p. 4.

61. (p. 535) Russell, *Waking Up*, p. 7.

62. (p. 535) Russell, *Awakening Earth*.

63. (p. 535) Russell, *Global Brain*, p. 80.

64. (p. 536) *Money as Debt* video, http://video.google.com/videoplay?docid=-9050474362583451279.

65. (p. 536) Psalms, 90:10.

66. (p. 536) Rouse Ball and Coxeter, *Mathematical Recreations and Essays*, p. 317. This story was originally told by de Parville in *La Nature*, Paris, 1884, Part I, pp. 285–286. In 1883, the French mathematician Edouard Lucas invented a puzzle, called the Tower of Hanoï, based on this ancient story. There are several virtual versions of this puzzle available on the Web.

67. (p. 537) Kasner and Newman, *Mathematics and the Imagination*, p. 153 says that it would take 58,454,204,609 centuries plus a little over 6 years to complete this task. Curiously, this is 10 times longer than the calculation I did in Mathematica.

68. (p. 537) Kasner and Newman, *Mathematics and the Imagination*, p. 33. They devote a few pages (pp. 30-35) to the problems even scientists have in understanding very large numbers. Larry Page and Sergey Brin, the founders of Google, tell us that Kasner's nephew's name was Milton Sirotta. They named their search service after this number, to reflect "the com-

pany's mission to organize the immense, seemingly infinite amount of information available on the web". (http://www.google.com/intl/en/corporate/history.html).

69. (p. 538) James Robertson is a leading advocate for an increase of seigniorage, reducing the influence of the banks on all our lives. See http://www.jamesrobertson.com/article/free-lunches.htm for a speech he gave on this subject in Mansion House in London in 2000, printed in Resurgence.

70. (p. 538) Paul Grignon, *Money as Debt*, film at http://video.google.com/videoplay?docid=5352106773770802849.

71. (p. 543) See, for instance, Knight, *Blood Relations*.

72. (p. 543) http://en.wikipedia.org/wiki/Gregorian_calendar.

73. (p. 543) http://en.wikipedia.org/wiki/Julian_calendar.

74. (p. 543) http://en.wikipedia.org/wiki/Roman_calendar.

75. (p. 543) http://en.wikipedia.org/wiki/Common_Era.

76. (p. 543) http://en.wikipedia.org/wiki/Buddhist_calendar.

77. (p. 544) http://en.wikipedia.org/wiki/Islamic_calendar.

78. (p. 544) http://en.wikipedia.org/wiki/Chinese_calendar.

79. (p. 544) http://en.wikipedia.org/wiki/Jewish_calendar.

80. (p. 544) White, *History of the Warfare of Science with Theology*, Vol 1, Part I, p. 8.

81. (p. 544) http://en.wikipedia.org/wiki/Ussher_chronology.

82. (p. 544) Fischer-Schreiber, *Encyclopedia of Eastern Philosophy and Religion*, article on yuga, p. 435.

83. (p. 545) Ibid., In *Bhagavad Gita*, p. 124, Eknath Easwaran refers to the four yugas together as one yuga, not mentioning the term *mahayuga*.

84. (p. 546) Ibid., article on *kalpa*, p. 171. This article says that a kalpa is a day and a night in the life of Brahma, while the Bhagavad Gita clearly indicates that this is actually two kalpas.

85. (p. 546) http://en.wikipedia.org/wiki/Mahabharata.

86. (p. 546) Easwaran, *Bhagavad Gita*.

87. (p. 546) See, for instance, http://www.mayacalendar.com/descripcion.html, and many other sites.

88. (p. 547) Calleman, *Theory of Everything*, p. 25.

89. (p. 547) Calleman, *Mayan Calendar*, p. 76.

90. (p. 548) Calleman, *Everything*, p. 25.

91. (p. 549) http://en.wikipedia.org/wiki/Maya_calendar.

92. (p. 549) http://edj.net/mc2012/fap9.html.

93. (p. 550) Calleman, *Mayan Calendar*, pp. 233–238.

94. (p. 550) You can calculate the correlations between the Mayan and the Gregorian calendars on the Internet at http://www.pauahtun.org/Calendar/tools.html.

95. (p. 550) Whatever dates we choose for the end of the Mayan calendar, they all correspond very closely to the vision I have had since 1979. For when I was then engaged in marketing decision support systems and personal computing for IBM (UK), I saw quite clearly that the invention of the stored-program computer is incompatible with both capitalism and communism and both would self-destruct within about thirty years, when my children would be in their late thirties, presumably bringing up children of their own.

96. Russell, 'Singularity in Time', pp. 20–21.

97. McKenna, *Invisible Landscape*, pp. 95–99.

98. T. McKenna, *True Hallucinations*, p. 165.

99. McKenna, *Invisible Landscape*, p. 121.

100. H. Wilhelm, 'Time in the *Book of Changes*', pp. 214–216.

101. http://en.wikipedia.org/wiki/Shao_Yung.

102. H. Wilhelm, 'Time in the *Book of Changes*', pp. 216–218.

103. McKenna, *Invisible Landscape*, pp. 141–143.

104. Ibid., pp. 144–143.

105. Ibid., p. 126.

106. Ibid., p. 154.

107. Ibid., pp. 171 and 179–180.

108. Ibid., p. xxv. The software plus extensive documentation is available from http://www.fractal-timewave.com/.

109. Ibid., pp. 146–149.

110. Matthew Watkins, 'Autopsy for a Mathematical Hallucination?' http://www.fourmilab.ch/rpkp/autopsy.html.

111. Peter Meyer, 'The Mathematics of Timewave Zero', Appendix in McKenna *Invisible Landscape*, pp. 211–220.

112. Using DOSBox (http://www.dosbox.com/)

113. 'Dynamics of Hyperspace: A Dialog between Ralph Abraham and Terence McKenna', 1983.

114. John Sheliak, 'A Mathematical and Philosophical Re-Examination of the Foundations of TimeWave Zero and Novelty Theory'.

115. Peter Meyer, 'History of the Timewave Zero Software' and 'The Four Number Sets'.

116.

117.

118.

119. (p. 550) http://sundin.web.surftown.se/mayacal/content/articles/differences.htm.

120. (p. 559) I met Nick in April 2000, when we both gave a talk at the continental meeting of the Scientific and Medical Network in Växjö in southern Sweden.

121. (p. 559) Long, *Origins of Man and the Universe,* 'Genesis of the gods', pp. 26–32.

122. (p. 562) Lane, *Industrial Revolution*.

123. (p. 562) http://en.wikipedia.org/wiki/Small-Scale_Experimental_Machine.

124. (p. 562) http://en.wikipedia.org/wiki/EDSAC.

125. (p. 562) http://en.wikipedia.org/wiki/Berners-Lee.

126. (p. 563) Gleick, *Chaos*, p. 174.

127. (p. 563) Turchin, *Phenomenon of Science*.

128. (p. 563) Elisabet Sahtouris, 'A New Model for a Living Universe: Evolution as Creative Response to Crisis', Mystics and Scientists 28, 'Healing the Spilt: An Alchemy of Transformation' (Moreton-in-Marsh, Gloucestershire: Conference Cassettes, 2005), CD

129. (p. 563) Teilhard, *Human Phenomenon*, pp. 216–218.

130. (p. 565) Russell, T*he Global Brain Awakens*.

131. (p. 565) Teilhard, *Human Phenomenon*, p. 172.

132. (p. 565) Ibid., p. 173.

133. (p. 565) Ibid., p. 174.

134. (p. 565) Ibid., p. 214.

135. (p. 565) Ibid., p. 265.

136. (p. 566) Ibid., p. 181.

137. (p. 566) The Alliance for a New Humanity is one of many organizations seeking to fulfil its mission: "To Connect people, who, through personal and social transformation, are committed to creating a just, peaceful, and sustainable world, reflecting the unity of humanity." http://www.anhglobal.org/.

138. (p. 566) http://en.wikipedia.org/wiki/Homo_habilis.

139. (p. 566) http://en.wikipedia.org/wiki/Homo_erectus.

140. (p. 566) http://en.wikipedia.org/wiki/Homo_neanderthalensis.

141. (p. 566) http://en.wikipedia.org/wiki/Homo_sapiens.

142. (p. 566) http://en.wikipedia.org/wiki/Homo_sapiens_idaltu.

143. (p. 566) http://en.wikipedia.org/wiki/Cave_drawing.

144. (p. 566) http://www.evolve.org/pub/doc/index2.html.

145. (p. 566) http://barbaramarxhubbard.iamplify.com/.

146. (p. 566) Barbara Marx Hubbard, 'One with the Process of Creation'.

147. (p. 567) Wilber, *Up from Eden*, p. 12.

148. (p. 567) Wilber, *Sex, Ecology, Spirituality*, pp. 203–208.

149. (p. 568) Toynbee, *Brief Study of History*, abridged by D. C. Somervell, Table I, 'Universal States', p. 561.

150. (p. 568) Ibid., p. 246.

151. (p. 568) Capra, *Turning Point*, p. 8.

152. (p. 569) Ibid., p. 466.

153. (p. 570) Willis Harman, 'Charting Paradigm Shifts'

154. (p. 570) http://oneminuteshift.com/videos/marilyn_schlitz_video/next_scientific_revolution.

155. (p. 570) Titmuss, *Gift Relaionship*.

CHAPTER 7. THE GROWTH OF STRUCTURE

Motto: (p. 571) Teilhard, *Human Phenomenon*, p. 183. This is an edited quotation. The full section is: "Evolution is an ascent towards consciousness, as we have seen and acknowledged. This is no longer contested, even by the most materialistic, or at least agnostic, of humanitarians. Evolution must culminate ahead in some kind of supreme consciousness."

1. (p. 572) Ibid., p. 216–218.

2. **abacus**, *Encylopædia Britannica*, 2008.

3. (p. 573) **History of Computing**, *Encylopædia Britannica*, 2008.

4. (p. 573) Ibid.

5. (p. 573) Pratt, *Thinking Machines*, Chapter 5 'Leibniz: Mechanizing Reason', pp. 70–80.

6. (p. 573) **History of Computing**, *Encylopædia Britannica*, 2008.

7. (p. 573) Babbage was the Lucasian professor of mathematics from 1828 to 1839 (*Encyclopædia Britannica*), although he never resided at the college nor taught there. Nevertheless, he received between eighty and ninety pounds a year, quite a tidy sum in those days (Morrison, *Charles Babbage*, p. xv).

8. (p. 574) This conversation is recorded in Morrison, *Charles Babbage*, p. xii. However, what Babbage actually wrote was somewhat more prosaic: "We [Herschel and I] met one evening for the purpose of comparing the calculated results, and finding many discordances, I expressed to my friend the wish, that we could calculate by steam, to which he assented as to the thing being within the bounds of possibility." (Hyman, *Charles Babbage*, p. 49) John Herschel was the son of William Herschel, the man who discovered the planet Uranus. John, who had been a student friend of Babbage ten years earlier, went on to have distinguished career in astronomy himself.

9. (p. 574) The method of differences is based on the fact that in any polynomial of degree *n*, the *n*th order of differences is constant. For instance, to use an example that Babbage gave in his autobiography, if we want to construct a table of squares of the integers, we first take the differences between the squares and then take the differences between these differences, as Table N.1: shows.

This table then gives the starting values for each column, which can be set into the machine. It then becomes possible to calculate squares indefinitely simply by the process of ad-

Number	Square	First difference	Second difference
1	1		
		3	
2	4		2
		5	
3	9		2
		7	
4	16		2
		9	
5	25		

Table N.1: *Method of differences*

dition. Babbage's prototype had provision for just two levels of differences, so was very limited in its capabilities.

10. (p. 574) Moore, *Ada, Countess of Lovelace*, pp. 43–44.

11. (p. 574) A Swedish engineer Georg Scheutz and his son, Edvard, did manage to construct a Difference Engine with four levels of differences and fifteen decimal places, which could also print results. It was completed in October 1853 after some twenty years of effort and was well received by Babbage, who by that time had long left work on his own Difference Engine.

It was not until 1991 that the Science Museum in London built a Difference Engine with seven levels of differences to Babbage's specifications using construction techniques available to Babbage at his time. The purpose was to demonstrate that this machine could have been built and to celebrate the bicentenary of Babbage's birth. Doron Swade, who masterminded this project, tells the story in Swade, *Difference Engine*, pp. 221–307.

12. (p. 574) Pratt, *Thinking Machines*, p. 93

13. (p. 575) Ada Byron married Baron King on 8th July 1835 at the age of nineteen. (p. 72) She became Ada Lovelace when her husband was elevated to the Earldom of Lovelace on 30th June 1838 to celebrate Queen Victoria's coronation. The reason for this honour does not appear to be because of any merit on his part. It was just that Ada's first cousin once removed, Viscount Melbourne, happened to be prime minister at the time

14. (p. 575) Morrison, *Charles Babbage*, p. 252. This book contains a reproduction of the memoir that Ada Lovelace wrote in 1843 (pp. 225-297).

15. (p. 575) Moore, *Ada, Countess of Lovelace*, p. 363.

16. (p. 575) See Carroll and Tober, *Indigo Children*.

Ada suffered from both mental and physical disorders throughout her life, some of which, at least, were probably not unconnected. She had periods of both mania and depression, what today would be called a bipolar disorder. This was not helped by the fact that her parents were utterly incompatible, separating when she was just one or two months old. She was then brought up by a domineering mother and forbidden to know anything about her illustrious father, aided and abetted by a coven of her mother's closest friends, who Ada called the Furies. Ada, a free spirit, found their surveillance intolerable (Wooley, *Bride of Science*, p. 119).

There is also evidence of mental disorders in the rest of the family. Her father's maternal grandfather committed suicide, her paternal grandfather was known as 'mad Jack', and her father, the poet, was a mad genius, who may have had an incestuous relationship with his half-sister. Ada would clearly have been a classic case study for one of Bert Hellinger's family constellation sessions, which look deeply into how our family relationships affect the way we behave and view the world (Hellinger, *Love's Hidden Symmetry*).

Ada was very well aware of her genius, that she could see a whole that even Babbage could not see. This led her to write what Doran Swade calls "her sometimes imperious notes" (*Difference Engine*, p. 165). She also got quite cross with Babbage for mislaying what she called "this first child of mine" and for making changes to her style of writing. See Woolley, *Bride of Science*, pp. 265-277 for a most understanding description of how Ada saw these notes and herself in relationship to her contemporaries.

17. (p. 575) Hyman, *Charles Babbage* , pp. 181–182.

18. (p. 575) Menabrea, 'Notions sur la machine analytique de M. Charles Babbage'. Menabrea went on to become prime minister of a united Italy.

19. (p. 575) Woolley, *Bride of Science*, p. 278.

20. (p. 575) Morrison, *Charles Babbage*, p. 254.

21. (p. 576) Kurzweil, *Spiritual Machines*, p. 294

22. (p. 576) Morrison, *Charles Babbage*, p. 252.

23. (p. 576) Ibid., p. 243.

24. (p. 576) Ibid., p. 284.

25. (p. 576) Dorothy Stein, who wrote a biography of Ada in 1985, found the error. The original French said, "*le cos* n = ∞" instead of "*le cas* n = ∞". Ada translated this as "when the cos of n = ∞", which does not make sense, instead of "in the case of n = ∞" (Wooley, *Bride of Science*, p. 276).

26. (p. 576) Babbage's son, Henry, built a prototype of the mill, which is now in the Science Museum in London. See Pratt, *Thinking Machines*, p. 114, for a photograph of this device.

27. (p. 576) Swade, *Difference Engine*, pp. 308–310.

28. (p. 576) Method for Automatic Execution of Calculations with the Aid of Computers', patent application, dated 11th April 1936, translated and reprinted in Randell, *Origins of Digital Computers*, pp. 163–170.

29. (p. 576) Ibid., p. 160.

30. (p. 577) Ibid., pp. 191–210.

31. (p. 577) Ibid., pp. 359–373 contains a description of this machine

32. (p. 577) Ibid., pp. 299.

33. (p. 577) Pratt, *Thinking Machines*, p. 167.

34. (p. 577) Morrison, *Charles Babbage* , p. 250.

35. (p. 577) Randell, *Origins of Digital Computers*, p. 376.

36. (p. 577) Ibid., p. 376.

37. (p. 577) Ibid., pp. 383–292.

38. (p. 577) Pratt, *Thinking Machines*, p. 169. A brief description of this machine is given in Randell, *Origins of Digital Computers*, pp. 415–416. It seems that the machine, experimental as it was, could perform divisions to 39 significant binary places, calculate the highest common factor of two numbers, and factorize an integer.

39. (p. 578) Ibid., p. 169. This machine is described in Randell, *Origins of Digital Computers*, pp. 417–429.

40. (p. 578) http://www.cl.cam.ac.uk/UoCCL/misc/EDSAC99/.

41. (p. 578) **History of Computing**, *Encylopædia Britannica*, 2008.

42. (p. 578) http://edition.cnn.com/TECH/computing/9904/30/1952.idg/.

43. (p. 578) **History of Electronics**, *Encylopædia Britannica*, 2008.

44. (p. 578) **transistor**, *Encylopædia Britannica*, 2008. The engineers were John Bardeen, Walter H. Brattain, and William B. Shockley.

45. (p. 579) Gordon E. Moore, 'Cramming more components onto integrated circuits', Electronics, Volume 38, Number 8, April 19, 1965.

46. (p. 579) Kurzweil, *Spiritual Machines*, pp. 20–25.

47. (p. 580) Moore was speaking at the 50th anniversary meeting of the International Solid-State Circuits Conference in San Francisco. Report by BBC Online.

48. (p. 580) Martin, *After the Internet.*

49. (p. 581) Baron, *Computer Languages*, p. 203.

50. (p. 581) Ibid., p. 170.

51. (p. 581) By the early 1970s, the mainframe business was known as IBM and the seven dwarfs, because IBM held something like 80% of the market share at one time. The seven dwarfs were Burroughs, Control Data, General Electric, Honeywell, RCA, NCR, and UNIVAC.

52. (p. 581) Ibid., p. 106–108.

53. (p. 581) http://en.wikipedia.org/wiki/History_of_IBM_mainframe_operating_systems.

54. (p. 582) Böhm, Corrado and Giuseppe Jacopini (May 1966). 'Flow Diagrams, Turing Machines and Languages with Only Two Formation Rules'. Communications of the ACM **9** (5). Actually, this paper was published in Italian the previous year (Yourdon, *Program Structure and Design,* p. 146).

55. (p. 582) Yourdon, *Program Structure and Design*, p. 146.

56. (p. 582) Ibid., p. 147.

57. (p. 582) Ibid.

58. (p. 583) Dijkstra, 'Letters to the editor: Go To Statement Considered Harmful', *Communications of the ACM* March 1968, Vol. 11, No 3, pp. 147–148.

59. (p. 583) Wirth, Niklaus, 'Program Development by Stepwise Refinement', *Communications of the ACM* April 1971, Vol. 14, No. 4, pp. 221–227.

60. (p. 584) Baron, *Computer Languages*, p. 346.

61. (p. 584) Stein Krogdahl, 'The Birth of Simula', http://heim.ifi.uio.no/~steinkr/papers/HiNC1-webversion-simula.pdf.

62. (p. 585) Winston, *On to C++*, p. 49.

63. (p. 585) McGregor and Sykes, *Object-Oriented Software Development*, p. 18.

64. (p. 585) Alexander, et al, *Pattern Language*, and Alexander, *Timeless Way of Building*.

65. (p. 585) See, for instance, Gamma, el al, *Design Patterns*.

66. (p. 587) **Encyclopædia Britannica**.

67. (p. 587) http://en.wikipedia.org/wiki/Decision_table.

68. (p. 587) Co-author with Larry Constantine and Glenford Myers of one of the seminal papers on structured design: W. Stevens, G. Myers, L. Constantine, 'Structured Design', *IBM Systems Journal*, 13 (2), 115-139, 1974.

69. (p. 587) Developer of the Soft Systems Methodology.

70. (p. 587) Authors of *Structured Systems Analysis: Tools and Techniques*.

71. (p. 588) Downs, el al, *SSADM*, pp. 17–89.

72. (p. 588) http://en.wikipedia.org/wiki/SSADM.

73. (p. 588) National Institute of Standards and Technology, 'Federal Information Processing Standard (FIPS) for IDEF0', 21st December 1993, p. 7.

74. (p. 588) Ibid., p. 5.

75. (p. 589) Ibid., p. 10.

76. (p. 589) http://en.wikipedia.org/wiki/IDEF.

77. (p. 589) http://en.wikipedia.org/wiki/Peter_Coad.

78. (p. 589) Coad & Yourdon, *Object-oriented Analysis*.

79. (p. 589) Coad & Yourdon, *Object-oriented Design*.

80. (p. 589) Booch, Object-Oriented Design.

81. (p. 589) Rumbaugh, et al, *Object-Oriented Modeling and Design*.

82. (p. 589) http://en.wikipedia.org/wiki/James_Rumbaugh.

83. (p. 589) Ibid.

84. (p. 589) http://en.wikipedia.org/wiki/Ivar_Jacobson.

85. (p. 589) Jacobson, et al, *Object-Oriented Software Engineering*.

86. (p. 589) http://en.wikipedia.org/wiki/Objectory_AB.

87. (p. 589) http://en.wikipedia.org/wiki/Rational_Software.

88. (p. 589) Booch, et al, *UML User Guide*, pp. 449–456.

89. (p. 590) **History of Publishing**, *Encylopædia Britannica*, 2008.

90. (p. 590) **papyrus**, *Encylopædia Britannica*, 2008.

91. (p. 590) **History of Publishing**, *Encylopædia Britannica*, 2008.

92. (p. 591) **papyrus**, *Encylopædia Britannica*, 2008.

93. (p. 591) **History of Publishing**, *Encylopædia Britannica*, 2008.

94. (p. 591) **parchment**, *Encylopædia Britannica*, 2008.

95. (p. 591) **History of Publishing**, *Encylopædia Britannica*, 2008.

96. (p. 591) **paper**, *Encylopædia Britannica*, 2008.

97. **papermaking**, *Encylopædia Britannica*, 2008.

98. **Herman Hollerith**, *Encylopædia Britannica*, 2008.

99. **Jacquard Loom**, *Encylopædia Britannica*, 2008.

100. (p. 591) **History of Computers**, *Encylopædia Britannica*, 2008.

101. (p. 592) *Think*, September 1989, pp. 41 and 44. (This was a special edition of *IBM's* house magazine, celebrating 75 years of the company's existence.)

102. (p. 593) These initials are as follows: HFS (Hierarchical File System), FAT (File Allocation Table), NTFS (NT File System), HPFS (High Performance File System), and UFS (UNIX File System).

103. (p. 593) For a description of data independence, both physical and logical, see Date, *Database Systems, Seventh Edition,* pp. 19–20 and pp. 295–295, respectively.

104. (p. 594) Bachman, Charles W., 'Software for Random Access Processing', *Datamation*, April 1965, pp. 36-41.

105. (p. 595) These two DBTG reports for the CODASYL Programming Language Committee were published in October 1969 and April 1971. Interestingly, there were thirty-eight members of the two committees, of which only four were on both. One wonders how they could have maintained any continuity in these circumstances.

106. Date, *Database Systems, Fourth Edition,* (1986), Chapter 23, pp. 541–583 describes IDMS, as an example of the network approach.

107. Date, *Database Systems, First Edition,* (1975), p. 240.

108. Engles, R. W., 'An Analysis of the April 1971 Data Base Task Group Report', pp. 69–91 in E. F. Codd and A. L. Dean, *1971 ACM SIGFIDET Workshop*.

109. Date, *Database Systems, First Edition,* (1975), p. 228.

110. Finkelstein, *Information Engineering,* p. 17. BOMP stands for Bill of Materials Processing.

111. Date, *Database Systems, Fourth Edition,* (1986), Chapter 23, pp. 541–583 describes IMS, as an example of the hierarchical approach.

112. (p. 596) Finkelstein, *Information Engineering*, p. 17.

113. (p. 596) Koestler, *Ghost in the Machine.*

114. Wilber, *Sex, Ecology, Spirituality.*

115. Capra, *Web of Life.*

116. Date, *Database Systems, First Edition,* (1975), p. 144.

117. (p. 598) Ibid., p. 145.

118. (p. 598) Codd (1969).

119. Codd (1970).

120. (p. 599) COURSE # and TITLE and EMP # and NAME are repeating groups.

121. (p. 600) In particular, there was a tendency to view the relational model as just another approach, like the network and hierarchical ones. This gave the impression that the three approaches were the same kind of thing, which they are not, as Chris Data points out on page 166 of his *Relational Database Writings* (1991–1994).

122. The 'Great Debate' is documented in *ACM SIGMOD, Workshop on Data Description, Access and Control*, Volume 2 called *Data Models: Data-Structure-Set versus Relational*, edited by Randal Rustin. The event, which was attended by more than 160 participants, was held in Ann Arbor on 1–3 May 1974.

In essence, Charles Bachman argued that the network and relational approaches are simply a matter of style, like two sides of the same coin. Ted Codd refuted this by saying that there is a fundamental difference between the two approaches. However, as the debate focused attention on technical details rather than on foundational matters, this point does not come out clearly. See http://www.sigmod.org/publications/dblp/db/conf/sigmod/sigmod74-2.html.

123. Ashenhurst, Robert, 'A Great Debate', *Communications of the ACM*, June 1974, Volume 17, Number 6, p. 360.

124. Finkelstein, *Information Engineering,* p 17.

125. Ted Codd, in particular, had a great struggle with IBM management in getting the relational model accepted. In 1975, he wrote to an IBM manager suggesting that the company should seriously consider the relational model as part of the company's long-term database strategy. He received a reply, given on page 167 in Chris Date's *Relational Database Writings*

for 1991-1994, that showed that the manager had very little understanding of the foundational significance of relational technology.

Codd showed the frustration he had endured over many years when he dedicated his book on the Relational Model in 1990 “To fellow pilots and air crew in the Royal Air Force during World War II and the dons at Oxford” for “These were the source of my determination to fight for what I believed was right during the ten or more years in which government, industry, and commerce were strongly opposed to the relational approach to database management.”

126. http://en.wikipedia.org/wiki/Oracle_Corporation.

127. http://en.wikipedia.org/wiki/Oracle_Database.

128. In 2006, the last year I have the figures, Oracle was 196 in the Fortune 500 list, not far behind Apple Computer, as it was called then, which was no. 159. In terms of profits, assets, and stockholders’ equity, it was nos. 55, 168, and 92, respectively, well ahead of Apple Computer on all counts. (Fortune, Europe Edition, April 17, 2006, Vol. 137, No. 7.)

129. http://en.wikipedia.org/wiki/IBM_DB2.

130. http://en.wikipedia.org/wiki/Sybase.

131. (p. 601) As the relational model of data became the ‘flavour of the month’ in the 1980s, Ted Codd was led to question whether DBMSs were really relational, as many claimed. In 1985, he specified twelve basic rules that a DBMS should follow if it is to be truly relational (‘Is your DBMS really relational?’ *ComputerWorld* , pp. ID/1-9, October 14, 1985 and ‘Does your DBMS run by the rules?’ *ComputerWorld*, pp. 49–60, October 21, 1985). He concluded, “No existing DBMS product that I know of can honestly claim to be fully relational.”

Five years later, in The Relational Model for Database Management, Codd listed no fewer than 333 characteristics of the relational model, not all of which were even agreed by his fellow mathematicians, including his closest associate, Chris Date.

132. (p. 601) Codd, ‘Relational Model of Data’, p. 379.

133. Date, *Database Systems*, seventh edition, p. 123.

134. This obvious example is given in Date and Darwen, *Foundation for Future Database Systems*, Second edition, p. 15.

135. (p. 602) The fact that a database can be seen as a repository of true propositions in logic is not generally the way that databases are presented to students. One exception to this is Hugh Darwen, who teaches this approach to his Open University students in the UK. See Chapter 1 in Date’s *Relational Database Writings*, 1994–1997, pp. 279–287.

136. (p. 603) Chris Date emphasized that relation-valued attributes do not violate a fundamental principle of the relational model provided they are encapsulated in Chapter 6 in his Relational Database Writings from 1989–1991. Since then, this notion has been further devel-

oped in the attempts to unify the relational model of data with object-oriented modelling methods.

137. Rather confusingly, entity types are sometimes referred to as entities in the literature, with entities then being called occurrences of an entity.

138. Date and Darwen, *Foundation for Future Database Systems*, pp. 371–375.

139. http://en.wikipedia.org/wiki/Sql#Data_definition.

140. SQL was initially called Structured English Query Language (SEQUEL) to manipulate and manage data stored in System R, a database system built as a research project at IBM San Jose Research. The acronym SEQUEL was later changed to SQL because 'SEQUEL' was a trademark of the UK-based Hawker Siddeley aircraft company.

141. Sowa, 'Semantic Networks', *Encyclopedia of Artificial Intelligence*, p. 1493.

142. Ibid., p. 1494.

143. (p. 604) Reproduced in Heijenoort, *From Frege to Gödel*, pp. 1–82.

144. Chen, 'Entity-Relational Model', *ACM Transactions on Database Systems*, Vol 1. No. 1, March 1976, pp. 9–36.

145. Sowa, 'Semantic Networks', *Encyclopedia of Artificial Intelligence*, p. 1496.

146. Martin and Finkelstein, *Information Engineering*.

147. Federal Information Processing Standard (FIPS) for IDEF1X, 21st December 1993.

148. Barker, *CASE*METHOD™: Entity Relationship Modelling*.

149. (p. 606) Ibid., p. 4–6.

150. (p. 607) Ibid., p. 3–4.

151. (p. 607) Hay, *Data Model Patterns*, p. 14.

152. Booch, et al, *UML User Guide*, p. 106.

153. (p. 610) Halpin, *Information Modeling*, pp. 106–107.

154. Ibid., p. xxiv.

155. Ibid., p. 409.

156. (p. 612) http://en.wikipedia.org/wiki/IBM_Generalized_Markup_Language.

157. Goldfarb, *SGML Handbook*, back dust cover.

158. Ibid., p. xiv.

159. Ibid.

160. http://en.wikipedia.org/wiki/HTML.

161. http://en.wikipedia.org/wiki/XML.

162. Barker, *CASE*METHOD™: Entity Relationship Modelling*, p. H-1.

163. (p. 614) Hay, *Data Model Patterns*, p. 256.

CHAPTER 8. LIMITS OF TECHNOLOGY

Motto: See note 13.

1. Pratt, *Thinking Machines*, p. 1.

2. Gardner, *Mind's New Science*, p. 37.

3. Turing, 'Computing Machinery and Intelligence' (Mind, LIX, No. 236, 1950), reprinted in Hofstadter & Dennett, *The Mind's I*.

4. Turing, 'Computing Machinery', 53.

5. Turing, 'Computing Machinery', 57.

6. Haugeland, *Artificial Intelligence*.

7. Birnbacher, 'Artificial Consciousness', pp. 489–503.

8. Levy, *Artificial Life:*.

9. Swade, *The Difference Engine*.

10. Woolley, *Bride of Science*, p. 267.

11. Turing, 'Computing Machinery', p. 63.

12. Lovelace, notes on 'Sketch of the Analytical Engine, p. 284.

13. Charniak and McDermott. *Introduction to Artificial Intelligence*.

14. Keen and Scott Morton, p. 87.

15. See Nagel and Newman, *Gödel's Proof*, for a simplified description of Gödel's theorems.

16. Lucas, *Minds, Machines, and Gödel*.

17. Searle, 'Minds, Brains and Programs'.

18. See, for example, Hofstadter, *Gödel, Escher, Bach*, Hofstadter and Dennett, *Mind's I*, and Dennett, *Consciousness Explained*.

19. Penrose, *Emperor's New Mind*, p. 581.

20. Apple, *Human Interface Guidelines*.

21. IBM, *CUA Guidelines*.

22. Open Software Foundation, OSF/Motif™ Style Guide. Perhaps there is also a design guide to the UNIX Common Desktop Environment (CDE), which encompasses Motif design principles.

23. *Visual interface design for Windows*, by Virginia Howlett, leader of user interface team for Windows 95 seems to be one of the first. Today, a search on the Internet will find many more.

24. Later, Babbage's son had a cut-down version of the central mill of the Analytical Engine constructed. This is now in the Science Museum in London. (See Pratt, *Thinking Machines*, p. 124.)

25. See, for example, Weizenbaum, *Computer Power*, pp. 51–59.

26. This diagram is taken from Weizenbaum, *Computer Power*, p. 80. In turn, this was derived from figures 3.2–3.5 in D. C. Evans, 'Computer Logic and Memory', Copyright © 1966 by *Scientific American*, Inc., all rights reserved.

27. Whitehead and Russell, *Principia Mathematica*, pp. 91–97.

28. Sheffer, 'A Set of Five Independent Postulates for Boolean Algebras', pp. 486–488.

29. Nicod, 'A Reduction in the Number of Primitive Propositions of Logic'.

30. http://en.wikipedia.org/wiki/Sheffer_stroke.

31. Kilmister, *Language, Logic and Mathematics*, p. 55. If I had known about the Sheffer stroke in 1980, when I began to integrate all knowledge into a coherent whole, I might never have developed relational logic. For I began by experimenting with the various dyadic operators in Boolean logic. Most particularly, I was attempting to create asymmetrical patterns from symmetrical ones. This turned out to be impossible, leading me eventually to the Principle of Duality and the Principle of Unity. Although I still have most of my early writings, I did not keep these very first attempts at creating a universal logic. This is a pity, for it would have been most interesting to see exactly what was going on in my mind at that time.

32. Hofstadter, *Gödel*, pp. 285–288.

33. Tanenbaum, *Structured Computer Organization*, p. 10.

34. A description of the way that APL, a high level programming language, was amazingly implemented in microcode was described in 'An APL Emulator on System/370' by A. Hassitt and L. E. Lyon in *IBM Systems Journal*, No. 4, 1976, pp. 358–378.

35. Vanhelsuwé, et al, *Mastering Java*, p. 16.

36. Tanenbaum, *Structured Computer Organization*, p. 10. This is one of the most elementary principles of computer science, yet it is ignored by virtually all scientists working in the field of artificial intelligence.

37. Baron, *Computer Languages,* p. 127.

38. Rose, *APL: An Interactive Approach*. This book seems to be out of print and so I don't have the exact page reference.

39. Functional programming languages, the most mathematically pure languages, such as ML and Haskell, beloved of academics, could possibly be included here. But I have not studied these in any detail as they do not anything to the reasoning.

40. REXX has many of the characteristics of a dynamically active language, but it does not have some of the characteristics of the other four languages described here. I have therefore left it out of consideration here.

41. An exception was HyperTalk, which has an edit script command which can be used within utility programs for helping the programmer to find scripts quickly rather that searching through cards in stacks. This is necessary because scripts are properties of various types of object and can sometimes be difficult to find in a large and complex system. Another exception is REXX, which can stack XEDIT editing instructions on the CMS stack, and then dynamically invoke the editor.

42. Ryle, *Concept of Mind*, pp. 28–32.

43. Aristotle, *Metaphysics*, Book XII, viii, 4, 1073a4, p. 153.

44. Aquinas, *Summa Theologiæ*, p. 12–14.

CHAPTER 9. AN EVOLUTIONARY CUL-DE-SAC

Motto: Koestler, *Ghost in the Machine*, p. 165

1. Aristotle, *Metaphysics*, Book XII.

2. There are several translations of Heraclitus' fragments on the Web. The only one I have found that translates the Greek word *logos* as 'Logos', rather than 'account' or 'word', is by William Harris at http://community.middlebury.edu/~harris/Philosophy/Heraclitus.html. This translation is almost identical to the fragments that Osho used in his discourses on Heraclitus, published as *The Hidden Harmony*.

3. Kahn, *Heraclitus*, p. 85 and Osho, *Hidden Harmony*, p. 70.

4. Osho, *Hidden Harmony*, p. 147.

5. Kahn, *Heraclitus*, p. 35.

6. *Encyclopedia of Philosophy*, article on 'Heraclitus of Ephesus', p. 477.

7. Aristotle, *Metaphysics*, p. 163.

8. Ibid., p. 161.

9. Osho, *Hidden Harmony*, p. 147.

10. Kilmister, *Language, Logic and Mathematics*, p. 15.

11. Aristotle, *Prior Analytics*, p. 197.

12. Euclid, *Elements*, pp. 153–155.

13. Kline, *Mathematics*, 'Preface'.

14. Stewart, *Modern Mathematics*, p. 286.

15. Schumacher, *Guide for the Perplexed*, p. 15.

16. Boole, *Laws of Thought*, p. 1.

17. Leibniz, *Logical Papers*.

18. MacHale, *George Boole*, p. 19.

19. George Boole, 'On a General Method in Analysis', *Philosophical Transactions of the Royal Society of London*, Vol. 134, pp. 225–282, 1844.

20. Kline, *Mathematics*, pp. 90–91.

21. Boole, *Mathematical Analysis of Logic*, Slater introduction, p. v.

22. MacHale, *George Boole*, pp. 51, 57, and 64–66.

23. Ibid., pp. 52–54.

24. Ibid., pp. 2–3.

25. Ibid., pp. 17–22.

26. Ibid., pp. 61–62.

27. Boole, *Mathematical Analysis of Logic,* Slater introduction, p. vii.

28. MacHale, *George Boole*, pp. 105–106.

29. Ibid., pp. 252–276.

30. MacHale, *George Boole*, p. 68.

31. Boole, *Laws of Thought*, pp. 27–29.

32. Ibid., p. 33.

33. Ibid., p. 238.

34. Ibid., pp. 31–32.

35. Ibid., pp. 47–51.

36. Boole, Mary, 'Indian Thought', p. 952.

37. MacHale, *George Boole*, pp. 131–132.

38. Boole, 'Indian Thought', pp. 947–967.

39. MacHale, *George Boole*, p. 105.

40. Boole, 'Indian Thought', p. 950.

41. Ibid., p. 954.

42. Ibid., pp. 953–954.

43. Ibid., p. 950.

44. Ibid., p. 948.

45. Ibid., p. 951.

46. Ibid., pp. 952–953.

47. Ibid., p. 948.

48. Ibid., pp. 954–955.

49. Ibid., p. 959.

50. Ibid., p. 956.

51. Rota, *Indiscrete Thoughts*, p. 4.

52. Dummett, *Frege: Philosophy of Language*, p. xii.

53. Russell, B. 'Experiences of a Pacifist', p. 33.

54. Monk, *Bertrand Russell: Spirit of Solitude*, pp. 12–13.

55. Monk, *Bertrand Russell: Ghost of Madness*, pp. 500–502.

56. Hodges, *Alan Turing*, pp. 487–492.

57. Houser, et al, *Studies in the Logic of Charles Sanders Peirce*.

58. Brady, *Contributions of Peirce etc. to First-Order Logic* and *From Peirce to Skolem*.

59. De Morgan, *On the Syllogism*, introduction by Heath, pp. vii–viii.

60. Ibid., pp. ix and xxiv.

61. De Morgan, *Formal Logic*, p. 1.

62. De Morgan, *On the Syllogism*, introduction by Heath, p. xxiv.

63. *The Penny Cyclopædia of the Society for the Diffusion of Useful Knowledge*, Vol. XII, 466/1, 1838, article on **induction (mathematics)**. Wikipedia says that De Morgan wrote this ar-

ticle, using the term *mathematical induction* for the first time in English: “An instance of mathematical induction occurs in every equation of differences, in every recurring series, &c.,” from OED.

64. Pólya, *How to Solve It*, p. 114.

65. De Morgan, *Formal Logic*, pp. 243–244.

66. Euclid, *Elements*, Volume 2, Book IX, proposition 20, pp. 412–413.

67. Brent, *Peirce*, pp. 209–211.

68. Peirce, *Writings of Charles S. Peirce*, introduction by Fisch, pp. xv–xvii.

69. Brent, *Peirce*, p. 35.

70. Ibid., pp. 60–63.

71. Ibid., pp. 36–37.

72. http://www.universetoday.com/77525/nebular-theory/.

73. Brent, *Peirce*, pp. 131–132, quoted from Peirce, B., *Ideality in the Physical Sciences*, p. 9.

74. Peirce, B., *Ideality in the Physical Sciences*, p. 7.

75. Peirce, *Writings*, Volume 1, 1857–1866, pp. 1–3, ‘My Life’, 1859.

76. Ibid., p. 163.

77. Ibid., pp. 163–167.

78. Brent, *Peirce*, p. 100.

79. Peirce, *Collected Papers: Simplest Mathematics*, ¶¶ 4.12–4.20, with editors’ note p. 13, and Peirce, *Writings*, 1879–1884, pp. 218–221, MS 535.

80. Peirce, *Collected Papers: Simplest Mathematics*, ¶¶ 4.264.

81. Ibid., ¶¶ 4.227–4.322, MS 429.

82. Ibid., ¶ 4.229.

83. Ibid., ¶¶ 4.258–4.261.

84. Clark, ‘Peirce’s Iconic Notation for the Sixteen Binary Connectives’ p. 305.

85. Peirce, *New Elements of Mathematics: Mathematical Miscellanea*, pp. 272–275.

86. Post, ‘General Theory of Elementary Propositions’, pp. 267–269.

87. Wittgenstein, *Tractatus Logico-Philosophicus*, ¶ 4.31, p. 38.

88. http://en.wikipedia.org/wiki/De_Morgan%27s_laws.

89. http://en.wikipedia.org/wiki/Modus_ponens.

90. Nagel and Newman, *Gödel’s Proof*, pp. 48–49.

91. Ibid., p. 49.

92. De Morgan, *On the Syllogism*, p. 208. De Morgan’s two references to the first mention of relations are on pages 56 and 107.

93. Ibid., p. 119.

94. Kline, *Mathematics*, p. 186.

95. De Morgan, *On the Syllogism*, p. 119.

96. Brent, *Peirce*, p. 242.
97. Ketner, et al., *Bibliography of the Published Works of Charles Sanders Peirce*, p. 7.
98. Peirce, 'Description of a Notation for the Logic of Relatives'.
99. Peirce, *Writings*, 1867–1871, p. xlii.
100. Brady, *From Peirce to Skolem*, p. 23.
101. Brent, *Peirce*, p. 79.
102. http://www.lib.noaa.gov/noaainfo/heritage/coastandgeodeticsurvey/index.html .
103. Brent, *Peirce*, pp. 120 and 366.
104. Ibid., pp. 120–121.
105. Ibid., pp. 121–125.
106. Peirce, 'On the Algebra of Logic', 1880.
107. Members of Johns Hopkins University, *Studies in Logic*.
108. Peirce, 'On the Algebra of Logic', 1885.
109. Brady, *From Peirce to Skolem*, p. 113.
110. Peirce, 'The Logic of Relatives'.
111. Peirce, *Writings*, 1879–1884, p. xl, Introduction by Nathan Houser.
112. Brent, *Peirce*, pp. 153 and 151.
113. Ibid., pp. 150–151.
114. Ibid., p. 197.
115. Peirce, *Writings*, 1879–1884, p. xli, Introduction by Nathan Houser.
116. Brent, *Peirce*, pp. 279–289.
117. Ibid., p. 249.
118. Ibid., pp. 306–307.
119. Ibid., p. 223.
120. http://en.wikipedia.org/wiki/Paul_Carus, Tweed, *American Encounter with Buddhism*, pp. 65–67.
121. Brent, *Peirce*, p. 231.
122. Ibid., pp. 228–230.
123. Peirce, *Essential Peirce*, 1893–1913. note 15, p. 505.
124. Ibid., p. 30.
125. Peirce, *Collected Papers: Bibliography*, pp. 287–288.
126. Peirce, *Reasoning and the Logic of Things*, p. 2.
127. Ibid., p. 141.
128. Ibid., p. 26.
129. Brady, *From Peirce to Skolem*, p. 9.
130. http://en.wikipedia.org/wiki/Finitary_relation.

131. Weisstein, Eric W. ‘Relation’. From *MathWorld*—A Wolfram Web Resource. http://mathworld.wolfram.com/Relation.html.

132. Weisstein, Eric W. ‘Cartesian Product’. From *MathWorld*—A Wolfram Web Resource. http://mathworld.wolfram.com/CartesianProduct.html.

133. http://en.wikipedia.org/wiki/Cartesian_product.

134. http://en.wikipedia.org/wiki/Relational_algebra.

135. http://en.wikipedia.org/wiki/Relation_algebra.

136. Codd, ‘A Relational Model of Data for Large Shared Data Banks’, p. 383.

137. http://en.wikipedia.org/wiki/Relational_algebra.

138. Ibid.

139. http://en.wikipedia.org/wiki/Begriffsschrift.

140. Brady, *From Peirce to Skolem*, pp. 2 and 6.

141. Ibid., p. 7.

142. van Heijenoort, *From Frege to Gödel*, p. 1.

143. Ibid., p. 2.

144. Hintikka, *Lingua Universalis vs. Calculus Ratiocinator,* p. ix

145. van Heijenoort, *From Frege to Gödel*, pp. 1–2.

146. Pratt, *Thinking Machines*, pp. 9–90.

147. Van Heijenoort, *Frege to Gödel*, pp. 124–125.

148. Ibid., p. 127.

149. Ibid., pp. 127–128.

150. Russell, *Principles of Mathematics*, p. 523.

151. Gray, *The Hilbert Challenge*.

152. The first of these problems was concerned with proving that the continuum—the set of the infinitely many real numbers—is the next infinite cardinal after the countable set of natural numbers, $\aleph_0$. In mathematical symbolism $c=\aleph_1=2^{\aleph_0}$. This was known as the continuum hypothesis: there is no infinite cardinal between $\aleph_0$ and $\aleph_1$. As a natural extension of this, the generalized continuum hypothesis states that no infinite cardinal exists between $\aleph_n$ and $\aleph_{n+1}$. In the event, in 1940, Gödel proved that the generalized continuum hypothesis is consistent with the axioms of set theory. That is, the generalized continuum hypothesis cannot be disproved whether the axiom of choice is used or not. (Gödel, K. (1940). The Consistency of the Continuum-Hypothesis. Princeton University Press.) Then in 1963, Paul Cohen proved that this hypothesis could not be proved either. In other words, the generalized continuum hypothesis is independent of the axioms of set theory. (Cohen, P. J. (1966). Set Theory and the Continuum Hypothesis. W. A. Benjamin.)

153. http://en.wikisource.org/wiki/Mathematical_Problems.

154. Whitehead and Russell, *Principia Mathematica*, p. 360.

155. Ibid., pp. 205–215.

156. Russell, B., 'Reflections on My Eightieth Birthday', p. 53.

157. Russell, B., 'Why I Took to Philosophy', pp. 19–21.

158. Kline, *Mathematics*, p. 221.

159. Whitehead and Russell, *Principia Mathematica*, p. 37.

160. Kline, *Mathematics*, p. 260.

161. Gödel, *On Formally Undecidable Propositions of* Principia Mathematica, p. 37.

162. Ibid., p. 45.

163. Nagel and Newman, *Gödel's Proof*, pp. 72–73.

164. Ibid., pp. 73–74.

165. Kline, *Mathematics*, p. 262.

166. Ibid., pp. 262–263.

167. Lucas, 'Minds, Machines and Gödel', pp. 43–45.

168. Hofstadter and Dennett, *Mind's I*, p. 470.

169. http://en.wikipedia.org/wiki/Church-Turing.

170. http://en.wikipedia.org/wiki/Entscheidungsproblem.

171. http://en.wikipedia.org/wiki/Halting_problem.

172. Perhaps the simplest example of a noncomputable function is one introduced by Tibor Radó in 1962 in a paper called 'On Noncomputable Functions'. In what has come to be known as the Busy beaver problem, Radó defined an n-state Turing machine whose purpose is to write as many 1s on a blank tape consisting only of 0s and then halt. Surprisingly, there is no algorithm that can prove what the maximum number of 1s is for a particular n-state machine. I first explored this function using Turing's World, a program developed by Jon Barwise and John Etchemendy of the Center for the Study of Language and Information at Stanford University. Unfortunately, this program does not work under Mac OS X, so it is now defunct. However, you can try out the Busy beaver problem and other Turing machines at http://ironphoenix.org/tril/tm/.

173. Alonzo Church, 'An unsolvable problem of elementary number theory', *American Journal of Mathematics* (58, 1936), pp. 345–363.

174. A. M. Turing, 'On Computable Numbers, with an Application to the Entscheidungsproblem', *Proceedings of the London Mathematical Society*, (Series 2, Volume 42, 1936), pp. 230-265.

175. http://en.wikipedia.org/wiki/Busy_beaver.

176. http://www.logique.jussieu.fr/~michel/ha.html#tm52.

177. Kline, *Mathematics*, 216–257.

178. Kilmister, *Language, Logic, and Mathematics*, p. 120.

179. Gray, *Hilbert Challenge*, p. 10.

180. Derbyshire, *Prime Obsession*.

181. http://www.claymath.org/millennium/.

182. http://mathworld.wolfram.com/PowerSum.html.

183. http://en.wikipedia.org/wiki/Johann_Faulhaber.

184. http://en.wikipedia.org/wiki/Faulhaber%27s_formula.

185. http://www.trans4mind.com/personal_development/mathematics/series/sumsBernoulliNumbers.htm.

186. http://en.wikipedia.org/wiki/Bernoulli_number.

187. http://mathworld.wolfram.com/BernoulliNumber.html.

188. Woolley, *Bride of Science*, p. 269.

189. Derbyshire, *Prime Obsession*, p. 105.

190. http://en.wikipedia.org/wiki/Prime_number_theorem.

191. http://en.wikipedia.org/wiki/Riemann_zeta_function.

192. http://mathworld.wolfram.com/RiemannZetaFunction.html.

193. Derbyshire, *Prime Obsession*, p. 216.

194. du Sautoy, *Music of the Primes*, p. 85.

195. Ibid., p. 99.

196. Derbyshire, *Prime Obsession*, pp. 190–191.

197. Ibid., p. 233.

198. Hugh L. Montgomery in *The Cosmic Code Breakers: The Struggle to Prove the Riemann Hypothesis*, television programme produced by NHK, 2011.

199. Freeman Dyson in *Cosmic Code Breakers*.

200. Commentator in *Cosmic Code Breakers*.

201. Derbyshire, *Prime Obsession*, p. 321.

202. **Roger Bacon**, *Encylopædia Britannica*, 2008.

203. Quinton, *Francis Bacon*, p. 30.

204. Bacon, *Major Works*, pp. 120–299.

205. Bacon, *New Organon*, p. xii.

206. The OED does not attempt to improve on the definition of mathematical induction given in the seventh edition of *Algebra*, published in 1875, by Todhunter: "We prove that if a theorem is true in one case, whatever that case might be, it is true in another case which we may call the next case; we prove by trial that the theorem is true in a certain case; hence it is true in the next case, and hence in the next to that, and so on; and hence it must be true in every case after that with which we began".

For instance, suppose we want to find a formula for the sum of the first n integers. We first sum the first few integers, obtaining this series of numbers: 1, 3, 6, 10, 15, 21. We can observe a pattern in this series. Each term is half the product of two numbers: 1x2, 2x3, 3x4, 4x5, 5x6, 6x7. We therefore surmise that the general formula for the sum of the first n integers is n(n+1)/2. We than add n+1 to this formula, and obtain $(n^2+3n+2)/2$, which equals (n+1)(n+2)/2, which satisfies the general formula. We then observe that the formula is correct for n=1. It must therefore be correct for all values of n.

207. Chalmers, *What is This Thing Called Science?*, p. 5.

208. George, *Precision, Language and Logic*, p. 72.

209. Popper, *Objective Knowledge*, p. 4. Hume's scepticism about the principle of induction is given in Hume, *Human Understanding*, pp. 108–118.

210. Davies, *God and the New Physics*, pp. 200–201.

211. Popper, *Objective Knowledge*, p. 4.

212. Ibid., p. 4.

213. Russell, *Western Philosophy*, p. 646.

214. Chalmers, *Science*, p. 63.

215. Popper, *Conjectures and Refutations*.

216. Chalmers, *Science*, p. 55.

217. Kuhn, *Scientific Revolutions*, p. 10.

218. The Copernican revolution of the sixteenth and seventeenth centuries is well known (see, for instance, Koestler, *Sleepwalkers*). However, the story of the discovery of oxygen is less well known. Although C. W. Scheele, a Swedish apothecary, was probably the first to prepare a reasonably pure sample of oxygen, as he did not immediately publish his work, it was an Englishman, Joseph Priestley, who is generally credited with the discovery of oxygen in 1775. Priestley's work greatly influenced that of the Frenchman, Antoine-Laurent Lavoisier, who created the concept of oxygen.

However, Priestley could never accept Lavoisier's oxygen theory of combustion. To Priestley, oxygen was dephlogisticated air. He was not able to make the fundamental paradigm change that was to lead to the chemical revolution, begun by Lavoisier (Kuhn, *Scientific Revolutions*, pp. 53–56).

A similar situation holds today. There are many scientists who are mystics, who know the Divine in their own direct experience. Yet they are not yet able to free themselves of familiar paradigms that would enable them to see Reality as a complete Whole.

219. Kuhn, *Scientific Revolutions*, p. 112.

220. A relativist is one who adheres to the doctrine that there are no absolutes, that knowledge is only of relationships, relative to particular situations and contexts.

221. Chalmers, *Science*, p. 80.

222. Ibid., p. 81.

223. Feyerabend, p. 19.

224. Ibid.

225. Chalmers, *Science*.

226. Wilber, *Marriage of Sense and Soul*, p. 18.

227. An essay on these three eyes was first published in *ReVision*, vol. 2, #1, 1979, republished in *Eye to Eye* (1983). This theme was then further developed in *The Eye of Spirit* (1997) and *The Marriage of Sense and Soul* (1998).

228. Wilber, *Marriage*, pp. 155–156.

229. de Tocqueville, *Democracy in America*.

230. Mill, *On Liberty*.

231. http://public.web.cern.ch/Public/Content/Chapters/AboutCERN/WhyStudyPrtcles/WhyStudyPrtcles-en.html.

232. http://www.telegraph.co.uk/core/Content/displayPrintable.jhtml?xml=/news/2006/11/30/uhawking130.xml&site=5&page=0.

233. It was for this reason that I abandoned physics as a sixteen year old. On the wall of the physics laboratory at school, there was a poster showing the subatomic particles that had been discovered until that time. But I could see that we could never know when we had reached the end of this quest because the human mind is capable of analysing structures ad infinitum. So it was quite clear to me that physics could not form the basis of all science. I therefore studied economics rather than physics as the required subsidiary subject at university, which was an even greater disaster.

234. http://origins.jpl.nasa.gov/about/index.html.

235. http://www.seti.org/site/pp.asp?c=ktJ2J9MMIsE&b=178899.

236. Bohm, *Implicate Order*, p. xi.

237. Ibid., p. 11.

238. Ibid., pp. 14–15.

239. Ibid., pp. 148–149.

240. Ibid., p. 149.

241. Ibid., p. 150.

242. Ibid., p. 150.

243. Ibid., p. 149.

244. Ibid., p. 145.

245. Ibid., p. 146.

246. Ibid., p. 198.

247. Ibid., p. 176.

248. Ibid., p. 187.

249. Osho, *Hidden Harmony*, p. 208.

250. Whitehead, *Process and Reality*.

251. Ibid., p. 48.

252. Ibid., p. 178.

253. Zohar, *Quantum Self*, p. 124.

254. Ibid., p. 207.

255. http://harmoniccontinuum.50megs.com/custom3.html.

256. Mark Comings, 'The Courage to Change: An Exploration into Time, Space, Light and Mind', DVD (Sirius Media, 2005).

257. Private conversation with David Bohm in Prague in April 1992 at a conference organized by the International Transpersonal Association called 'Science, Spirituality, and the Global Crisis'.

258. These fonts were distributed with the CorelDraw program that I used when working for IBM in a software development laboratory on a beautiful island in the Stockholm archipelago in the early 1990s.

259. John I, 4:16.

Index of Word Roots

This Index of Word Roots points to the pages in the main body of the book where the roots of words are specified, the ones in bold font indicating the glossary, where more detailed etymologies are specified, wherever possible going back to Proto-Indo-European (PIE) roots. This Index, like the Glossary, is work in progress. There is still much work to do before we can define a coherent set of words that are based on the seven pillars of wisdom, rather than the seven pillars of unwisdom, on which Western civilization is based.

A

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Index of References and Influences

This Index of References contains pointers to all the authors referred to in this book, together with the titles of their own books, articles, and other media. The page numbers marked with an *n* are pointers to references to the end notes. It is planned to add cross-references from these notes pages to pages in the main body of the book in due course, a considerable undertaking. This Index also includes references to influential figures in the history of ideas not directly associated with a particular work.

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General Index

This General Index contains pointers to topics, subjects, concepts, sections, subsections, and all other key points not included in the Index of Word Roots and Index of References. Generating an index for all knowledge in all cultures and all disciplines at all times, past, present, and future, is one of the greatest challenges in writing this book, greatly testing the clarity of both the content and structure.

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Panosophy: The Theory of Everything

This second volume in the *Wholeness* trilogy describes the Unified Relationships Theory (URT), the much sought-for, but maligned Theory of Everything. The URT is alternatively called panosophy, 'a universal, cyclopædic work embracing the whole body of human knowledge', the Philosophers' Stone, Holy Grail, and Apotheosis of human learning, thereby healing the fragmented mind in Cosmic Consciousness.

Panosophy is a coherent body of knowledge that describes all the forces in Nature—both psychospiritual and physical—within a single, all-encompassing framework, called Integral Relational Logic (IRL), the subject of the first volume in this trilogy.

Most significantly, the URT explains what is causing scientists and technologists to drive the pace of evolutionary development in the noosphere at exponential rates of accelerating change, a subject not on the agenda of any university, research institute, technological research and development division, or governmental agency in the world.

The principal reason for our ignorance is that evolution has been more divergent than convergent during the past fourteen billion years since the most recent big bang, leading society today to become divided into religious and national factions, academic specialization, and the division of labour in the workplace.

As a consequence, our minds have become fragmented, preventing us from understanding what is happening to humanity at the present time. We have thus been led to believe that we humans are separate from the Divine, Nature, and each other, leading Western civilization, in particular, to be built on seven pillars of unwisdom: misconceptions of God, Universe, Life, humanity, money, justice, and reason. How we could adapt to unprecedented rate of evolutionary change we are experiencing today by rebuilding society on the seven pillars of wisdom is the subject of the third volume in the *Wholeness* trilogy.

Paul Hague was born near London in the middle of the Second World War and was educated mainly as a mathematician. He then spent his business career in the information technology industry, mainly with IBM in sales and marketing in London in the 1960s and 70s and in software development in Stockholm in the 1990s.

In 1980, realizing that the materialistic, monetary global economy is incompatible with the invention of the stored-program computer, he set out to explore how we could realize our fullest potential as a species after the collapse of capitalism at the beginning of this century.

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