The Worldviews group

Perspectives on the World: an interdisciplinary reflection

VUBPRESS

CLEA is an interdisciplinary centre at the Vrije Universiteit Brussel
This volume is part of the CLEA-series on
Interdisciplinary Studies
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First published as *Cirkelen om de wereld, concrete invullingen van het wereldbeelden-project*, 1994, Uitgeverij Pelckmans, Kapellen

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ISBN 90 5487 113X NUGI 611
D/ 1995 / 1885 / 017

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From project to preliminary sketches

We are quickly approaching the end of the millennium and the 'magical' year 2000. Many futurologists in the sixties thought science and technology would offer man unprecedented possibilities for solving his problems. The fall of the Iron Curtain and the implosion of the Eastern Block also created, just a few years ago, grand expectations. The dream did not come true, however. Rather than ending up in a technological paradise and a peace-loving world, we woke up in a torn world with virtually unsolvable environmental problems and agonising social conditions. Although the level of prosperity in the West has increased greatly, the side effects of technological and economic developments can no longer be ignored and the limits to growth are becoming clear. The old dividing lines between the nations, and the suppressed antitheses among ideologies, have reappeared on the surface and are causing extreme tension and conflicts. The general faith in progress has disappeared and important current problems seem insoluble. Fast-paced developments, increased mobility and the growing impact of the mass media have also disoriented many people. The world around them has changed so fast that they have become alienated from it and can no longer find their way. They no longer find anything to hold onto in the traditional ideological, social and political systems, which have lost much of their naturalness, credibility, attractiveness and influence. Even science do not offer intellectuals a satisfactory final answer. The large amount of information that has been collected through specialistic science does not form a coherent whole and leaves the fundamental questions unanswered. We are experiencing the end of the big dreams and the 'great narratives'. It seems that there are no longer clear and generally accepted views about the nature of reality and about man's task in the world. A pluriform society is not succeeding in formulating universally agreed and powerfull answer to the pressing and worldwide problems with which it is being confronted. Many young people can no longer find a place for themselves, lack a project to which

they can dedicate themselves and see no goal for which to live. For this reason, some turn against society or flee from reality.

Our complex and rapidly evolving world is extremely fragmented in the ideological, social, political, cultural and scientific areas. There remains little or no trace of cultural unity. We have to deal with many cultures, subcultures and cultural fragments. The trend of differentiation in science is continuing unabated. The chasm between specialists and the layman is widening, and even specialists are no longer able to have an overall view of their discipline. The rapid changes and the large-scale structures are leading to an increased alienation from the modern world. So many changes have taken place in such a short time that we no longer recognise ourselves in the world. The overview is lost and we become unsure. Questions about values and meaning are no longer given a clear and generally accepted answer by the collective systems from the past which provided a meaning. Meaningful orientations and projects for the future are lacking or are no longer accepted. For many, the world is becoming meaningless and hopeless. All that remains are a number of fragments that have little structure or coherence. When a satisfactory and coherent view of the whole is lacking, the individual is forced to try to find his own way and to make his own choices among the immense and confusing possibilities that are offered. Little time remains for fundamental questions and no unanimity develops around certain insights. Everything seems to end in a chaotic entanglement of contradictory ideas and actions that neutralise each other. This leads to paralysis and indecision. The attitude of the West with regard to the civil war in Bosnia and the peace in ex-Yugoslavia is a painful example. Although a uniformly-thinking society and one single imposed world view are neither attainable nor desirable, the members of a society need to be sufficiently in agreement about a number of points for the society to be viable. In the current fragmented world there is often a lack of the necessary minimum agreement required for urgently-needed common measures to be taken.

Worldviews, a non-profit organisation established in 1990, is unwilling to resign itself to this situation of fragmentation and disintegration and is calling for integrating world-view research. This interdisciplinary project presents itself as a challenge to the entire scientific community, and especially to the members of the group. *Worldviews* wishes to provide a framework in which the world views that are developing in the various fields of culture and science can confront each other.

As is true of many scientists who are unhappy with the disintegration, we are seeking universalising theories. From within our own area of specialisation we were driven to consider the world-view problem and we

tried to form a picture of the whole. Most of us are of the opinion that humankind may not remain passive but that traversable paths to a better world need to be marked out once more. Reliable maps are essential, maps that correctly show the dangerous sandbanks and the safe seaways. The 'maps' that allow people to orient themselves in the world we call 'world views'. Many parts of existing world views have become unreliable or have fallen into disuse. We are therefore of the opinion that a deliberate effort must be made to construct new world views. Not only must this be done individually and spontaneously, but we believe that a concerted effort seeking justification, must be made in unifying research into world views. An attempt must also be made to reach as much agreement as possible. Not everyone in our group agrees to the same extent with this action-oriented view and with the necessity of collective world-view construction in which a wide-ranging consensus is the goal. Some do not share the opinion that the present crisis can in the first instance be reduced to the issue of world views. According to them world views do not necessarily lead to a solution and do not guarantee progress. They blame the current dominant pessimistic atmosphere on economic, political, social and ecological elements rather than on a lack of fairly generally accepted world views. In addition, they point out the danger of domineering world views. Yet, everyone in our group pleads for the creation of a positive climate for personal world-view construction in which enriching confrontations are of great importance.

World views I: from fragmentation to integration

What are world views, from what components are they constructed and what is their purpose? For a comprehensive answer to these questions we refer to *World Views: From Fragmentation to Integration* in which the project of *Worldviews* is introduced.[1] In this introduction we will limit ourselves to a brief summary. A world view can be defined as a coherent whole of concepts and propositions, enabling one to form a global picture of reality which can incorporate as many elements of one's experience as possible. A world view offers clarity regarding man's place in the world, gives insight into the greater relationships, provides man with orientation and calls for responsible action. With the help of a world view, man finds his place in the universe, tries to comprehend the evolution of the cosmos, and tries to give stature to his task on earth. In world views, both societies and individuals find an answer to the deeper-lying questions relative to being human and the world in which we live. Nor

can one evade the intuitive sensing of that which transcends man and the world, and questions of destiny.

One can also characterise a world view concisely as a *model* of total reality viewed as a whole. So a world view is a *reference framework* which must include a place for all our manifold experiences of the world and ourselves. It is a symbolic representation system that should enable us to integrate everything we learn about the world and ourselves into a total concept. This view should provide a coherent picture of the world and should correspond with reality. To be useful in daily life, a world view must be sufficiently comprehensible and reliable. If it contradicts too many elements from our experience, it is no longer of any value to us. A world view throws light on the whole of reality as it is seen within a certain culture. World views help us to find our way in a complex environment and to act in a coherent manner. The questions of purpose, values and meaning that are central to the current crisis form the core of the world-view problem.

Although world views grow organically and historically, they can also be developed. The construction of world views is comparable to the work of cartographers in antiquity and in the Middle Ages. They mapped out the world on the basis of information from sailors, merchants and explorers. This information was often incomplete, inaccurate, contradictory and even fabricated. Gradually, however, the data were put together and a more reliable picture emerged. Analogously, the construction of world views can start from an inventory of existing world-view fragments. They can be found, for example, in philosophies of life, concepts of man and society, ideologies, philosophical systems and even in so-called 'common sense'. The available fragments can serve as a starting point in the construction of new world views. To form adequate world views, the fragmentary data must be integrated as much as possible. Science can make an important contribution. World views may not be in conflict with known scientific facts, but they do not coincide with them. They must also incorporate systems that give values and meaning.

World view or World views?

We continually speak of world views in the plural because a unique and monolithic world view — considering the immense complexity of reality — will remain an unattainable ideal. These world views illuminate various aspects of one and the same reality, and partially overlap each other.

They must be as reliable as possible and they may not contradict each other. As with maps, world views should be in agreement in areas where they overlap. World views can be rightly compared to a set of maps showing the geological, political and economic situation, which are bundled together in one atlas. There are many maps but there is only one world.

The seven tasks of 'World-view construction'

In the construction of world views one can distinguish seven important tasks that correspond with the various components of a world view and that must provide an answer to a number of fundamental questions. First we must design a model of the world. What is the world like in which we live? How is the world structured and how does it function? What are the most suitable metaphors for speaking of the whole? Are mechanistic or organic models to be given preference? An explanation of reality must then follow. Why are the world and mankind as they are? Is a completely different world possible? What general explanatory principles apply? Then come the issues of standards, objectives, the giving of meaning and valuation in relation to all that happens. How do we evaluate and valuate global reality and our place in it? What is beautiful and what is ugly? What do we consider good and evil? The future-related aspects must then be considered. What possibilities does the future hold? How can we deal with the problems that occur? For what may we hope? We also need a model of the acquisition of knowledge. How does knowledge come into being? How do we experience reality? What influences our concept of the world and our place in it? What is good, reliable knowledge? How much confidence can be placed in scientific knowledge? Then an action model is necessary. What can, may and must we do in this world? To what extent can we take hold of this world and partially transform it? What principles must guide our actions? And finally, attention must be given to alternative answers to these questions that are currently in circulation. The existing fragments of world views can be used as sources of inspiration for world-view construction.

From World views I to World views II

The first book was a programme declaration. Actually, it was a 'consensus paper' endorsed by all members of the multidisciplinary and plura-

listic *Worldviews* coorporation. A programme declaration is formal in nature. It is more a statement of 'what should be done' than an attempt to actually carry out the project.

Our second book, *Perspectives on the World: an interdisciplinary reflection* goes substantially farther than a programme declaration. From various standpoints and disciplines, persuasions and backgrounds, we are trying to say something about the one world in which we all live. We are looking at reality from various angles and from different levels of abstraction and are trying to grasp, encompass and comprehend the world by means of different views. In this initiative for collective world-view construction we are trying to take everyone's contribution into consideration as much as possible. Depending on the author, the emphasis is placed more on the physics or on social sciences, on the pure sciences or on the applied sciences, on philosophy or on theology. Because we wanted to allow each author to go his own way, this time we did not strive for a common text that everyone could endorse. Now each one is responsible for his own contribution. Even so, a number of points of agreement can be noticed. Almost everyone, for example, sees reality as a *stratified* system that cannot be understood in a reductionistic manner. All agree that an interdisciplinary discussion is needed. Not all authors have the same opinion about what the discussion should strive to accomplish. Should we try to develop as coherent a system as possible or is it only a help for the searching individual? Some in our group see positive aspects in the simultaneous existence of many world views. Others refuse to abandon the attempt to find a 'view' of the whole that is as adequate as possible. The agreements and differences are examined in detail by Leo Apostel in a 'synthesis chapter'. We consider it worthwhile to discuss our views with each other and to determine exactly where the agreements and differences are found. We realise that we are making ourselves extremely vulnerable to criticism. The present explosion in the social and ideological area and the tidal wave of information make the construction of world views very difficult. The cost of the lack of world views is so high, however, that we wish to make the effort. We do not subscribe to post-modernist pessimism and are attempting to regain a unity of feeling, thinking and acting. Most of the authors have already been working on a synthesis within their own discipline for some time and are trying to transcend the borders of their own field. In the framework of *Worldviews* we are making an effort to engage in dialogue and to reach as high a degree of consensus as possible. Everyone is invited to think and work with us.

World views in practice

It is the intention of Worldviews to undertake research into the construction of integrating world views, in response to the advancing fragmentation in our society. In so doing we would like to take into account recent images of reality as they emerge in the many existing disciplines. In addition to research made by the group itself, Worldviews has set as a goal to stimulate other groups to look into particular themes in the world views issue. The different groups should remain in contact and the various results should be put forward and discussed. In Flanders there are now five groups at work:

1. The Worldviews group
   Members: Diederik Aerts, theoretical physics, University of Brussels, Belgium; Leo Apostel, philosophy, University of Ghent, Belgium; Bart De Moor, engineering sciences, University of Leuven, Belgium; Staf Hellemans, sociology, Humbolt University, Berlin, Germany; Edel Maex, psychiatry and psychotherapy, Riagg Institute, Breda, The Netherlands; Hubert Van Belle, engineering sciences, Bombardier Eurorail, Belgium; Marie-Claire Van de Velde, biology, University of Ghent, Belgium; Jan Van der Veken, philosophy, University of Leuven, Belgium.
2. The Omega group (Managing the Planet Earth)
   Starting from urgent problems in the culture in which we live we want to develop a vision to stimulate a change in mentality in a number of areas of our society and stimulate contributions to this change by means of guiding dialogue regarding concrete processes, products and projects.
   Members: Giedo-Henri De Couvreur, Walter Dejonghe, Lode Devlaminck, Emile Roco, Filip Rollier, Ronny Saelens, Willy Wyens.
3. The 'Art and World View' group
   Books live, three months before they are replaced; galleries close due to reduced purchasing power; musical projects are judged on their sales value by their sponsors. Premature death, caused by the economic paradigm, is creeping into the world of art, like the plague in the Middle Ages, like Aids now. On earth time and space perish. Travel on a human scale (at a walk, hours, days, weeks, miles) is concentrated, rounded off, polished. Works of art from all over the world hang, stand and lie next to each other in one Western city. Multinational art seeks and finds its managers, its gurus, its branch offices. The motto is: practice competition, pursue success. The group tries to invesitigate the relation between art and world views.

Members: Leon Bierens, Johan De Graeve, Paul R. Goris, Patrik Kindermans.

4 The 'meaning of life and World View' group
The 'meaning of life and World View' group, composed, pluralistically and interdisciplinarily of a sociologist, a philosopher, a theologian, an exegete, a lawyer and an engineer, has been meeting for two years. It has found its way through general discussions concerning ethics and the search for meaning of life (which were held as distinct from each other), about meaning of life and religion (in which it turned out that the difference between believers and non-believers is relevant to meaning of life), and about the members' personal patterns of meaning (which were compared). The immensity of the project led to an uneasiness that necessitated a rethinking of the aims, to end up with a feasible undertaking. The group will now mark out sub-areas within which they can work on the relationship between the world view and the meaning of life
Members: Hugo Campo, Werner Fierens, Peter Schmidt, Hildegard Van Hove, Fons Van Nuffelen, Jenny Walry.

5. The DMC group (dynamic material culture)
The implementation of a design methodology in the materialisation of space, whereby time is incorporated into the design. The artefacts, including architectural and urban objects, are created in such a way that they are always mutually adaptable and interchangeable. The exchangeability and interchangeability is to be found on the level of the artefact itself and the position of the artefact in relation to other artefacts (space). DMC wants to try to embed these objectives in an equivalent and meaningful link between theory and practice. Small-scale projects in connection with social housing, the child's creative play capacities, the problem of the environment, are supervised, in order to extend designability into a means for the management of an integrated space as a dynamic system.
Members: Jos Depuydt, Hendrik Hendrickx, Erwin Mlecnik, Dag Thielens and Hedwig Vanwalleghem.

Wordviews is starting to explore international contacts with

1. The Center for Process Studies in Claremont, California
The Center for Process Studies has a long tradition in interdisciplinary research, and they are working on similar issues. It was therefore clear from the moment Worldviews came into being that a fruitful contact should be built up with this centre, particularly since there was already collaboration between the Centre for Metaphysics (Jan Van der Veken) at the KU Leuven and the Center for Process Studies.

2. The 'Fernand Braudel Center' in Binghampton, New York
Immanuel Wallerstein, the director of this centre, has always expressed his enthusiasm and interest in the initiative to Leo Apostel, since the time Worldviews came into being. Worldviews is therefore also very pleased that a cooperation between the two groups is growing. The problems on which Wallerstein is working are also a very important aspect of the world views project.
3. The 'GRIDEP' at the Université Catholique de Louvain.
This research group (Groupe de Recherche Interdisciplinaire, Développement, Environnement, Population), headed by Jean-Philippe Peemans, working in Louvain-la-Neuve, is dealing with a problem that fits directly into the framework of the world view project. They are investigating the topical and burning problems linked to 'development, population and the environment'. The contacts with Worldviews are very fruitful, and Leo Apostel has occupied the Francqui chair there in connection with the world views project.
4. The 'Communications, Identity and Morals' group in Utrecht
This research group has shown a great interest in Worldviews since it first came into being. They are also fundamentally interested in interdisciplinary research, and are conscious of the urgent need for it. Robert Maier and Ed Elbers have actively participated in the two world view congresses, and were also highly motivated to join the research community.

Worldviews wants to stimulate new groups that wish to assist in the project, and to assemble people who would like to participate in one of the existing groups. Anyone feeling himself called to take the initiative in forming a new group, or participating in the movement, may contact Diederik Aerts at the following address:

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The Worldviews group

Note

[1] D. Aerts, L. Apostel, B. De Moor, S. Hellemans, E. Maex, H. Van Belle and J. Van der Veken, *World Views: From Fragmentation to Integration*, Brussels, VUBPRESS, 1994.

Diederik Aerts

The game of the biomousa

A view of discovery and creation

This second book of Worldviews gives the various contributors the opportunity to describe fragments of world views they have formed from the data available to them within their respective disciplines. No branch of science is explicitly devoted to studying world views, however, and there are probably several reasons for this. First and foremost there is so little consensus within the same discipline, that here too very different and generally incompatible fragments of world views exist. On the other hand, there is a certain diffidence, perhaps even a taboo, about putting these fragments of world views, often the subject of enthusiastic discussions over coffee at scientific gatherings, into the form of a text. This diffidence is very marked amongst physicists because they know from experience how quickly, and for various reasons, such an attempt is dismissed as 'unscientific' and 'speculative'. The world view fragment I would like to present here from the viewpoint of quantum mechanics should therefore be looked at in this light. It contains a number of aspects that are speculative and others that are directly based on recent experimental and theoretical data in quantum mechanics. Some parts are almost exclusively the result of the author's own personal beliefs.

1 Quantum mechanics and the space view

Without fear of exaggeration we can say that quantum mechanics differs from all previous physical theories in one very fundamental respect.[1] Until quantum mechanics was developed, a physical theory could, without causing too many problems, be regarded as a description of a part of reality that we can imagine. By this we mean the following: if we describe a classical physical entity using a classical theory, we can always 'imagine' what happens to that physical entity and the description refers to what happens. For example, if we are describing a particle that is

moving through space, we can 'imagine' how this particle moves through space and classical mechanics describes what we have imagined. This no longer seems to be possible in the case of a quantum entity. Quantum mechanics gives us a number of rules that provide us with predictions about the chances of detecting a quantum entity in space; however, we are not able to imagine an object that is moving through space that is also compatible with the chances of detection offered by quantum mechanics.

Recently a lot of experimental and theoretical data has been gathered, which can be used to put forward a new view of the behaviour of a quantum entity. The aim of this article is to examine these data and to attempt to put forward a global view of reality that takes them into consideration. We shall call this global view the creation-discovery view. We shall be forced to abandon an old and profound preconception about the nature of reality if we adopt the creation-discovery view. This old preconception, which hinders our understanding of the micro-world, consists in believing that reality exists within space; we shall therefore refer to it as the space preconception. It does seem to be pre-scientifically a priori to assume that all material objects, both macroscopic and microscopic, are present at any given moment somewhere within our three-dimensional Euclidean space.[2] Recent experimental and theoretical data have shown that it is very plausible to assume that quantum entities can find themselves in states, in which they are not present in space. According to the creation-discovery view, the view we would like to put forward here, space is no longer regarded as an all-encompassing setting. According to this view, detection of a quantum entity is not an 'observation', but rather a 'process', in which the detection apparatus 'sucks' or 'pulls' the quantum entity into space. This conflicts with our intuition since in our everyday reality every material entity has a place at any given moment.

In the creation-discovery view, we assume that the detection experiment contains an element of creation that partly creates the place 'itself'. This means that before the experiment, the quantum entity did not necessarily have a place and that the place is created by the experiment itself. An analogous process can be seen when determining the linear momentum (mass times velocity) of the quantum entity. The quantum entity has no particular momentum before the experiment that results in its momentum being determined.[3]

To show why research in quantum mechanics has led us to the creation-discovery view, we shall briefly outline the latest findings in this discipline.

2 Is Schrodinger's cat dead or alive, or neither?

If we want to use quantum mechanics as a universal theory and also use it to describe the entity comprising the measuring apparatus (a macroscopic entity) and the quantum entity, we find some very peculiar predictions. Schrödinger studied this problem in detail and we would therefore like to consider it from his cat's point of view.[4] Schrödinger devised the following mental experiment. Consider a room in which there is a radioactive source and a detector that can detect radioactive particles. There is also a glass bottle containing poison and a live cat in the same room. The detector is turned on for a period of time, during which it has a 1 in 2 chance of detecting a radioactive particle emitted by the source. If the detector detects a particle, a mechanism is activated that breaks the glass bottle, thereby releasing the poison and killing the cat. If the detector does not detect any particles, nothing happens and the cat lives. We can only learn the outcome of the experiment by opening the door of the room to see what has happened. If we make a quantum description, within orthodox quantum formalism, for the whole system (including the cat), the state of the cat (which we shall call p_{cat}) remains a 'superposition state' of the two states 'the cat is dead' (which we shall call p_{dead}) and 'the cat is alive' (which we shall call p_{alive}) until the very last moment, i.e. when we open the door. To recapitulate, $p_{cat} = 1/\sqrt{2}\,(p_{dead} + p_{alive})$, and this superposition state only ceases when we open the door to see what is happening. A considerable part of the basic problem of quantum formalism can be demonstrated by means of this example; we shall therefore examine it in detail.

If we interpret the state, as it is described by the wave function of orthodox quantum mechanics, as a mathematical object that simply and solely describes our knowledge about the physical system, there is no problem with Schrödinger's cat. In fact, within this 'perception of knowledge view' we can assume that the cat was already dead or was still alive before we opened the door, and that the quantum mechanical change in state only describes our cognisance of this fact. This 'perception of knowledge view' also disposes of another problem: according to quantum formalism, while the door is being opened the superposition state $p_{cat} = 1/\sqrt{2}\,(p_{dead} + p_{alive})$ 'suddenly' changes into one of the component states pdead or palive. This sudden change in state is known in quantum mechanical jargon as 'the collapse of the wave function' and there is a natural explanation for it within the 'perception of knowledge view'. If the quantum wave function does in fact describe our knowledge of the situation, then this knowledge suddenly changes, as does this

wave function, when we receive new information, such as when the door of the room is opened.

The 'perception of knowledge view' therefore assumes that the wave function of quantum mechanics does not describe reality, which is independent of our knowledge of it, but rather it represents the cognition we have of this reality. It follows from this that, if the 'perception of knowledge view' is right, an underlying reality must exist, which is not described by the wave function of quantum mechanics. In the example of the cat, this underlying theory provides a description of the cat's state, dead or alive, irrespective of whether we open the door to find this out. The 'perception of knowledge view' therefore immediately gives rise to the hypothesis of the existence of a 'hidden variable theory', which describes this underlying reality. And it is here that the problem with the 'perception of knowledge view' arises. It can be demonstrated that the probability model of a theory, in which a 'lack of knowledge' about an underlying reality is what causes the probability (a hidden variable theory), always satisfies Kolmogorov's axioms.[5] Since the probability model of quantum mechanics does not satisfy these axioms, this theorem shows that the 'perception of knowledge view' is not right. Recent experiments (concerning Bell inequalities) have confirmed that the hidden variable theory is wrong.

It is now virtually a foregone conclusion that the wave function of quantum mechanics does not describe our knowledge of the system, but represents the actual state of the system, irrespective of whether we know this or not. However, if this is the case, then Schrödinger's cat creates a serious problem. Could it be that, before we open the door, the cat is in a superposition state, neither dead nor alive, and that this state is transformed into a state of being dead or alive by the door being opened? It does seem impossible to us that reality would react to our observations in this way. A reality where a state comes into existence because we take cognisance of it contradicts our everyday view of reality in so many respects that we can scarcely take the idea seriously. Nevertheless it seems to be an immutable consequence of orthodox quantum mechanics, applied to reality as a whole. Recently, with the emergence of the new formalisms, the fundamental concepts of which are much closer to reality, a completely different light has been shed on this problem.

3 *New formalisms and false paradoxes*

The paradox of Schrödinger's cat and many similar paradoxes of quantum mechanics are partly the reason why it is impossible to put forward

a view of reality that is compatible with quantum mechanics. In fact, if the cat only lives or dies when we open the door, then only a subjective world view seems possible. There is a fundamental confusion between discovery and creation involved here. According to our everyday perception of reality, we believe that the cat is already dead or alive before the door is opened, and that finding a dead or a living cat is only a 'discovery' of a reality that already existed. The application of quantum mechanics to this situation forces us to interpret this discovery as a 'creation'. The theoretical advances made in research in quantum mechanics, and more specifically the development of new quantum formalisms, have resolved paradoxical situations such as that of Schrödinger's cat. The conclusion is that orthodox quantum mechanics is not a universal theory, but rather a formalism that is only valid under limited circumstances. Since these findings lie partly at the origin of the development of the creation- discovery view, they will be discussed briefly.

These new formalisms are very general.[6] An entity S is described by means of the collection of its states. A state describes the reality of the entity S. No specific mathematical structure is imposed a priori on the collection of states, as is the case in quantum mechanics (a Hilbert space) and in classical mechanics (a phase space). Furthermore, it is assumed that experiments are carried out on the entity S and the collection of relevant experiments is explicitly examined. Once again no mathematical structure is fixed a priori for the collection of these experiments, as is the case in quantum mechanics and classical mechanics. It is merely assumed that when an entity S is in a particular state and an experiment is carried out, a result is achieved with a certain probability. The original state is hereby changed into a new state. In this way the measurement process can be described in general terms. If no measurement is made, the entity S is still in a particular state, which then changes as time goes on. This dynamic change is described by the Schrödinger equation in the case of quantum mechanics, and by Newton's equations in the case of classical mechanics.

In this new general description it is very possible, even natural, to discern special experiments. Hence the concept of 'classical experiment' is introduced: an experiment devised in such a way that there is always a pre-determined result for every state of the entity S. A classical experiment is therefore an experiment where the result is fixed with certainty, even before the experiment is carried out. Generally speaking, the collection of relevant experiments will include some classical experiments and some non- classical experiments. It is possible to prove a theorem in which the classical part of the description of an entity is kept separate.[7]

The collection of all states can then be described as the union of a collection of classical mixtures, where every classical mixture still contains a collection of microstates that are non-classical. If quantum mechanical axioms are formulated based on this general situation, it can be demonstrated that the collection of states within one classical mixture can be represented by a Hilbert space. The collection of all of the states of the entity is then described by means of an infinite collection of Hilbert spaces, one for each classical mixture. Orthodox quantum mechanics emerges here as a limiting case, in which not a single classical measurement exists, and the representation then gives rise to one Hilbert space. Classical mechanics is the other limiting case, in which only classical measurements exist, and the representation then gives rise to a phase space description. The general situation of an arbitrary physical entity is neither pure quantum nor pure classical and can only be described by means of a collection of various Hilbert spaces. If the measurement process is viewed within this general framework, the problem of Schrödinger's cat disappears. Opening the door is a classical measurement that does not change the state of the cat in any way, and it can be described in this way within this general formalism. The quantum collapse occurs when the radioactive particle is detected by the detector, and this process is non-classical, even in the description within the general formalism.

It's not only the paradox of Schrödinger's cat that is resolved within this general formalism. It is also possible to regard quantum mechanics and classical mechanics as two special cases of a more general theory. This general theory is 'quantum-like' but causes no paradoxes for the measurement process because the measuring apparatus is described within the same formalism as a classical entity and the entity to be measured as a quantum entity. In conclusion we can state that the measurement paradox is due to the structural limitations of the orthodox quantum formalism.

4 *The Einstein-Podolsky-Rosen paradox and the quantum-classical relationship*

The perpetual existence of the superposition states, which caused paradox of Schrödinger's cat (the superposition state of the living and the dead cat), was used by Einstein, Podolsky and Rosen to formulate a much more subtle paradoxical situation. Einstein, Podolsky and Rosen considered the situation of two separated entities S_1 and S_2 and the composite entity S composed of these two separated entities. They demonstrated that it is always possible to put the composite entity S into a state such that measurement of one of the component entities determines the state of the other component entity. In a situation involving separated entities, this is a prediction of quantum mechanics that conflicts with the 'separated' concept itself. In fact, in the case of separated entities, the state of one of the entities is not determined by what is done with the other entity, a fact confirmed by the experiments that we can carry out on separated entities.

Once again if we look at this situation from the point of view of the new formalisms, the paradox can be explained. If we consider the situation of two separated entities, it is possible to prove that the entity S, which is composed of the two separated entities S_1 and S_2, never satisfies the axioms of orthodox quantum mechanics, not even if classical experiments are conducted, as was the case in the measurement paradox.[8] There are two axioms in orthodox quantum mechanics (known as 'weak modularity' and 'the covering law' in the jargon), which are never satisfied for the situation involving an entity S composed of two separated quantum entities S_1 and S_2. The shortcoming of orthodox quantum mechanics identified here goes much deeper structurally than the one discussed earlier in connection with the measurement problem. In the latter case it is possible to put forward a solution where one Hilbert space in orthodox quantum mechanics is replaced by a collection of Hilbert spaces. This solution is manageable within the framework of Hilbert space formalism. The inability of orthodox quantum mechanics to describe separated entities lies in the vector space structure of the Hilbert space itself. The two 'bad axioms' are the axioms that give rise to the vector space structure of the Hilbert space and if we remove these axioms in order to describe separated entities, we have to construct a completely new mathematical structure for the state space. This, however, is what recent findings tell us to do and it is the only way to free quantum formalism from EPR-type paradoxes in connection with the description of separated entities. Work is under way on this within the new formalisms.

It is a serious mathematical step to abandon the vector space structure for the collection of states but recent new findings have confirmed the necessity of such a step. The possibility of examining both classical entities and quantum entities from the viewpoint of the general formalism resolves the measurement paradoxes. However, the possibilities as regards description remain polarised between classical and quantum or generally a mixture of both. Very recently we began to explore intermediate regions (between classical and quantum; the so-called mesoscopic

region) from the viewpoint of this general formalism. Once again the same two axioms seem to make a description of intermediate regions impossible.[9] If we formulate a theory without these two axioms, we can describe quantum, classical, a mixture of both, and also intermediate mesoscopic entities, which are neither quantum nor classical. This approach would enable us to describe a continuous transition from quantum to classical.

In conclusion we can state that the orthodox quantum formalism has several fundamental shortcomings, which have now been identified. By resolving these paradoxes, quantum mechanics (more specifically the 'quantum-like' generalised formalisms) is freed from the subjective predictions that were an immutable part of the orthodox theory.

5 *The new experiments*

It is evident to us from experiments that Schrödinger's cat does not live or die because we open the door and that the state of one of the two separated entities is not determined by what is done with the other entity. We have been able to explain these paradoxical predictions of orthodox quantum mechanics as being the result of a structural shortcoming of the mathematical formalism. However, it is not at all evident from experiments what these special quantum effects, connected with these superposition states, where they do exist, actually mean. Some physicists have gone so far as to insinuate that perhaps the superposition states in question do not exist at all and are just mathematical artefacts of the theory. Recent experiments have shown, however, that it is actually possible to prepare quantum entities in these superposition states. We shall briefly mention a few aspects of these experimental results.

In experiments with very low-energy neutron beams, Helmut Rauch and his group succeeded in putting one neutron within a silicon crystal into a superposition state of two states located far apart.[10] In the experiment, the silicon crystal has a diameter of over five centimetres and the two component states are states of a neutron that is located within cubes A and B with edges measuring one millionth of a centimetre. Location A of one component state, which we shall call p_A, is over three centimetres away from location B of the other component state, p_B. The neutron was prepared by Rauch in a superposition state p_{sup} of these two component states, in other words $p_{sup} = 1/\sqrt{2}\,(p_A + p_B)$. If the neutron is in state p_{sup} and detection is initiated in one of the two areas A or B, there is a 1 in 2 chance of detecting the neutron in area A and a 1 in 2 chance of detecting

it in area B. Rauch and his group succeeded in verifying that the neutron was in a superposition state p_{sup} because they conducted additional experiments on the neutron in this state. One of the most fascinating of these additional experiments involved rotating the spin of the neutron. Using a magnetic field located in area A, Rauch rotated the spin of the neutron in the superposition state p_{sup}. The result of a precession over an angle of n degrees through the magnetic field in area A on the component state p_A results in an actual rotation of n/2 degrees, as predicted by means of the superposition principle. A simultaneous rotation over n degrees of the other component state p_B, using a magnetic field in area B, also results in the spin of the neutron in the superposition state rotating n/2 degrees. Rauch conducted all kinds of additional experiments, which all correspond with the quantum description of one neutron in the superposition state of the two component states located far apart.[11] These experiments, and many others, prove the existence of the superposition states in question, and the question we can now ask ourselves is whether we can draw conclusions from these experiments concerning the physical meaning of the superposition state. Before answering this question, we would like to discuss another problem of quantum mechanics that is closely linked with the possibility of suggesting a physical meaning for the superposition states.

6 *The origin of quantum probabilities*

We have already mentioned that the 'perception of knowledge view' is not right and we have also explained how it offered a natural solution for the situation of Schrödinger's cat. The 'perception of knowledge view' did more than provide a solution for Schrödinger's cat; it also presented a simple 'classical' explanation for the existence of quantum probabilities. In fact let us argue once more from the point of view of the 'perception of knowledge view', where the underlying reality is not described by the wave function, but by a hidden variable theory. In this situation quantum probability is the natural result of our lack of knowledge about this underlying reality. This is also how classical probability is explained, so it should come as no surprise to us that the aforementioned theorem exists, in which theorem it is proved that every hidden variable theory gives rise to a probability model that satisfies Kolmogorov's axioms. Kolmogorov did, after all, formulate his axioms for the classical probability theory. Since the probability model of quantum mechanics does not satisfy Kolmogorov's axioms, with the result that the 'perception of

knowledge view' cannot be sustained, we have to look for a new non-classical explanation for the origin of quantum probability. Quantum probability is not the result of our lack of knowledge about a deeper reality, as is the case with classical probability.

It is sometimes suggested that these quantum probabilities are intrinsically part of nature, and we then talk about 'ontological probabilities'. No-one seems to be able to visualise this kind of probability, however; hence it has never gone beyond a vague abstract concept of 'ontological probabilities'. There is a third possibility, though, and we would like to illustrate this by means of an example.

Suppose that we are considering the following experiment: 'We take a walnut from a basket and we crack the walnut in order to eat it.' Let us elaborate on the way in which we crack the walnut. We do not use nutcrackers, but simply take it between both hands and squeeze as hard as we can and see what happens. Anyone who has ever cracked walnuts in this way knows that various things can happen. The first occurrence we want to identify is when the walnut turns out to be mouldy. (1) If a cracked walnut is mouldy, we do not eat it.

Let us now suppose that there are N walnuts in the basket. This means that for a given nut, which we shall refer to as H_k, there are two possible outcomes of our experiment, which we shall refer to as E_1: we crack the nut and eat it, and E_2: we crack the nut and do not eat it. Suppose that of the N nuts in the basket, M are mouldy. The probability that our experiment will result in E_1 for a nut H_k is (N-M)/N, and the probability that our experiment will result in E_2 for the nut H_k is M/N. This probability is the result of our lack of knowledge about the complete reality of the nut. In fact, before we start cracking the nut H_k, it is either mouldy or not. If we could gain this knowledge without having to crack the nut, we could eliminate the probability arising from this lack of knowledge by only considering the nuts that are not mouldy. Classical Kolmogorovian probability theory is based on this assumption about the nature of the probability that exists.

Anyone who has experience of cracking walnuts knows that other things can happen too. Sometimes we destroy the nut by breaking it, so that it becomes mixed up with the broken shell. If that happens, we generally make a quick assessment of how serious the situation is and decide whether it is worthwhile separating the nut from the shell. If it is not worthwhile we do not eat the nut. Hence there are a further two possible outcomes of our experiment: E_3, which corresponds to a 'badly cracked nut', in which case we do not eat the nut, and E_4, which corresponds to a 'well-cracked nut', in which case we do eat the nut. We can again state that for a given nut H_k, the two outcomes are possible and each outcome will occur with a certain degree of probability. We sense right away, however, that this type of probability is different to the previous type because it depends on the way in which the nut is cracked. Unlike the previous case, where M walnuts are mouldy and N-M walnuts are not mouldy, we cannot divide the nuts in the basket 'beforehand' into those that will be 'well cracked' and those that will be 'badly cracked'. This kind of division does not exist because it is created by the cracking experiment itself. We have here a good example of how part of reality is created by the measurement itself, namely the cracking of the walnuts.

The most interesting aspect is that the mathematical structure of the probability model needed to describe the probabilities that ensue from cracking the walnuts well or badly is different from the mathematical structure of the probability model needed to describe the probabilities that ensue from the walnuts being mouldy or not mouldy. More particularly:

- The probability structure that describes the indeterminism that is the result of a lack of knowledge about a more complete reality of the occurrence in question is a classical Kolmogorovian probability model (this situation fits within the 'perception of knowledge view').
- The probability structure that describes the indeterminism that is the result of the fact that while the measurement is being carried out a new part of reality is created, which did not exist before the measurement was carried out, is a quantum-like probability model.[12]

It can also be proved that every quantum mechanical entity can be obtained by means of a model, where the cause of the quantum probability is a lack of knowledge about the interaction of the measuring apparatus with the quantum entity during the measurement experiment, in the course of which a new part of reality is created that did not exist before the measurement was carried out.[13] This is the explanation for quantum probability we would like to advance.

7 *Discovery and creation: the role of space*

Let us assume that we have been able to remove all of the mouldy nuts from the basket, leaving only nuts that are not mouldy. In the jargon of physics, we shall say that each individual nut is in a pure state, with regard to the property of being mouldy or not. In the original situation, when the mouldy nuts were still present in the basket, an individual nut was in a mixed state of mouldy and not mouldy, with weights M/N and

(N-M)/N. In the situation under consideration, we have a basket of walnuts that are not mouldy and with reference to this we would like to introduce the concept of 'potential'. With regard to being mouldy or not mouldy, we could claim for each walnut that it was mouldy or not mouldy before the experiment. With regard to being 'well cracked' or 'badly cracked', we cannot describe the walnut as such before cracking is measured. What we can claim is that each walnut is potentially well cracked (and is then eaten) or potentially badly cracked (and is not eaten).

No-one has any difficulty understanding the example of the walnut. Our proposition is that we should try to understand quantum probability in the same way. The only difference is that the measurements in quantum mechanics, where the second type of probability is introduced (due to the fact that a new part of reality is created during the measurement), are measurements for which such a creation is difficult to imagine. For example, the detection of a quantum entity is just such a measurement: whereas we would intuitively like to consider detection as the 'determination of position', a position that already existed before we began the measurement to determine it, we have to learn to accept that detection of a quantum entity contains an element of creation of the position of this entity during the process of detection. Walnuts are potentially 'well cracked' or 'badly cracked' and quantum entities are potentially within or outside a particular area of space. The experiment that consists in finding the quantum entity within this area of space or not finding it within this area, takes place after the measuring apparatus needed to detect this has been set up in the laboratory, and the interaction of the quantum entity with this measuring apparatus has begun. Before that the quantum entity is potentially present and potentially not present within this area of space.

Note that this explanation for quantum measurements forces us to look at the concept of 'space' in a new way. If a quantum entity, in a superposition state, is only potentially present within an area of space, we can no longer regard space as the stage for reality as a whole. Rather space is a structure that has developed along with the classical relationships between macroscopic physical entities. These macroscopic physical entities are always present within space because space is simply a structure in which they are always present, but this is not the case for quantum entities. In a normal state a quantum entity is not present within space; it can only be pulled in by a detection experiment. This process of pulling into space is associated with the second type of probability (as with the cracking of the walnuts) because the place of the quantum entity is partly created during the process of detection. The neutron in the Rauch experiment is not within space. It can be detected in two different areas of space, A and B, but the fact that this always occurs in these two areas is due to the fact that a detection experiment pulls the neutron into one of these two areas.

The experiments concerning the Einstein-Podolsky-Rosen paradox can also be easily understood within this discovery-creation view. Involved here are two quantum entities S_1 and S_2, which can be prepared in a superposition state p_{sup} of two component states p_{12} and p_{21}. The component state p_{12} is a state where entity S_1 is present within an area of space A1 and the other entity S_2 is present within an area of space A_2, while component state P_{21} is a state where entity S_2 is present within area A_1 and entity S_1 is present within area A_2. These two areas A_1 and A_2 are located far apart (12 metres in the case of the photon experiments) and measurements are carried out within areas A_1 and A_2. These measurements produce results that would seem very contradictory if we were to interpret the situation from the viewpoint of a 'perception of knowledge view' or 'hidden variable theory', where we would assume that the two entities S_1 and S_2 are already present within areas A_1 and A_2 before the measurement is carried out, and we only have a lack of knowledge about exactly where the entities are. With the creation-discovery view, where we assume that the detection measurement involves an essential creation of place, and hence that before the measurement is carried out the two entities S_1 and S_2 are not already present within areas A_1 and A_2, there is no problem interpreting the measurement results.[14]

8 *The creation process: the biomousa*

We would like to try to extend the findings concerning the non-spatial character of quantum entities, and the way in which this is explained in the creation-discovery view, to reality as a whole.

Hence we can distinguish different layers of reality: pre-material layers, the material layer, the biological layer, the social layer and the cultural layer. Note, however, that this is a greatly simplified representation. The localisation process of quantum entities is the bridge between the pre-material and the material layer of reality, and that is the way in which the material entities are rooted in the pre-material layer. Similarly, every layer is rooted in the previous layer (biological in material, social and cultural in biological) and a similar structuring process describes the 'existence' of the entities over the layers. In the creation-discovery view, the entities in the cultural layer (languages, communications

systems, works of art, theories, and so on) are not simply regarded as human creations, but also as new entities for a nascent reality. Things have always happened in this way: what we now call matter was once a vague and rather insubstantial structure. When neutrons, protons and electrons were busy deciding whether to organise themselves into atoms, atoms were world views. When atoms organised themselves into macroscopic matter, this macroscopic matter was a world view. When cells organised themselves into plants, animals and humans, these entities were world views. World views are precursors of reality.

This classification of reality into different layers contains an explicit idealisation because the different layers are not really separated. The material layer is the most important one for our present way of life. It is made up of the organisation of atoms. This organisation is so complex that the atoms, as individual entities, no longer fit into the most fundamental aspects of this reality. According to quantum mechanics, the atoms, and even the initial structures in which atoms started developing material reality, are not in space in most of the cases. The biological layer is the layer of living matter. It is not a fundamental new layer, but rather a choice in favour of the power of perpetuation of macromolecules, which have organised themselves step by step into self-replicating organisms, with the DNA molecule as the basic module. The social layer is the layer where living organisms interact with one another and try out new perpetuating entities: the hunt as the entity that provided food for everyone, the table as the entity where people eat together, and the house as the entity where people live together. The cultural or intellectual layer is the latest and most fragile achievement. In this layer world views provide fresh impetus for developing greater perpetuating entities. Cultural products and the creations of the human mind exist in this layer and are seeking the space, the world view, in which they belong. Individuals who travel between two cultures will not necessarily be present in the reality of a culture, just as quantum entities that travel between two macroscopic entities are not necessarily present in the reality of these macroscopic entities, a reality that we situate within space.

Long ago only pre-material quantum entities existed in a pre-material layer. They organised themselves into matter and space as a meeting place for this matter was created. The same creation process that began in the pre-material layer is now fully under way in the cultural and intellectual layer, and new small phases constantly appear. We shall call this creation process 'the biomousa'.[15]

9 *Entropy and creation: Boltzmann and statistical mechanics*

According to the second law of thermodynamics, the entropy of a closed system cannot decrease. It is often maintained that entropy is a measure of the disorder of a system and if this is so, the second law of thermodynamics seems to be at odds with the idea of a creation process that produces entities with a great power of perpetuation. We would like to examine how this situation arises within the creation-discovery view. First let us clarify the concept of entropy. There appear to be two layers of reality where entropy plays a fundamental part and we shall see that this is no coincidence.

Originally entropy was introduced in the material layer of reality. Ludwig Boltzmann was fascinated by the idea that matter is made up of a vast number of atoms,[16] and he tried to understand some important, and at the time very topical, problems, using this theory as his starting point. The industrial revolution in the nineteenth century had created tremendous interest in the steam engine, more specifically physicists and engineers were working intensively on the problem of converting heat into mechanical work. It was known that mechanical energy could easily be converted into heat, for example by friction, but the reverse process did not seem so simple. Cold water can be mixed with hot water to obtain lukewarm water, but what about the other way round? What were the laws of nature that stood in the way?

The introduction of the concept of entropy shed some light on the subject. Let us consider an example: a drop of hot water has a certain entropy, which we shall call S(hot), and a drop of cold water also has a certain entropy, which we shall call S(cold). If we consider two drops of water, one hot and one cold, then these two drops of water have an entropy S(hot + cold), which is the sum of the original entropies, S(hot + cold) = S(hot) + S(cold). If we mix the drop of hot water and the drop of cold water, thereby obtaining two drops of lukewarm water, then the entropy of these two drops of lukewarm water, S(lukewarm), is much higher than the sum S(cold) + S(hot). By mixing hot and cold water we have increased the entropy, and this is an irreversible process. This principle is expressed in the second law of thermodynamics: in every physical process entropy remains constant or increases. This principle explains why heat can only partially be converted into mechanical work; the concept of entropy was therefore vital for what Boltzmann was trying to understand.

Let us consider for a moment what a drop of water is according to atomic theory, in which Boltzmann firmly believed. The molecules con-

tained in a drop of cold water can occur in many different configurations. They dance about and vibrate and their configuration changes constantly. All of these configurations would look different if we could observe them at microscopic level, but with the naked eye they all appear alike, i.e. like a drop of cold water. When we speak of a drop of cold water, then we are referring to an entity that has many different states at microscopic level, without this changing its macroscopic aspect in any way. Boltzmann's discovery was that entropy is a measure of this indeterminacy at microscopic level.

The entropy of a drop of water is the logarithm of the number of 'microscopic' states that macroscopically give rise to an identical drop of water, multiplied by a constant k, which is known as Boltzmann's constant.

Can we understand this effect of increasing the microscopic states of a mixture? Let us try with the help of an example. Let us assume that we have some red balls and some yellow balls that we can put into compartments. To make the experiment more specific, let us consider a case where we have three different compartments in which we can place the red balls. Only one ball can fit into each compartment and this can result in 23 = 8 different configurations. Let us list the possibilities: (, ,), (, ,r), (,r,), (r, ,), (,r,r), (r, ,r), (r,r,), (r,r,r), where (,r,) means 'first compartment empty', 'second compartment occupied', and 'third compartment empty'. In general, if n compartments are available, this gives us 2^n different configurations. Where n = 2, this gives $2^2 = 4$ configurations; where n = 3, this gives $2^3 = 8$ configurations, which are listed above; and where n = 4, we have $2^4 = 16$ different configurations. It can be seen that if we allow n to increase, we quickly reach a very large number of configurations. For example, n = 25 gives us 2^{25} = 33,554,432 configurations and n = 100 gives us 2^{100} = 126,750,600,000,000,000,000,000,000,000 configurations, which is a huge number.

Let us now assume that we also have yellow balls that can be put into compartments too. For three compartments, this gives eight different configurations once again: (, ,), (, ,y), (,y,), (y, ,), (,y,y), (y, ,y), (y,y,), (y,y,y).

Now let us look at the two entities together, in other words on one side red balls and on the other yellow balls that can be put into compartments. In the case of two times three compartments, the number of configurations possible is $2^6 = 64$. We shall not list them all but instead we shall give an example: (,y, ,r, ,r), a configuration that is the combination of (,y,) and (r, ,r). In this case the yellow balls were not mixed

with the red. If we now consider mixtures, then (r, ,y, ,y,r) is also a possible configuration. How many mixture configurations of this kind are there? Each of the six compartments can either be occupied or not occupied by a red ball or a yellow ball. This gives $3^6 = 729$ configurations, which is much more than the 64 non-mixed configurations. This difference between mixed and non-mixed configurations becomes much greater as the number of compartments increases.

Why do drops not separate out? Boltzmann's line of reasoning went as follows: given that no preferred microstates exist and that the chance that a certain mixture will move towards a particular microstate owing to arbitrary external influences is therefore the same for every microstate, very improbable states will virtually never occur. Let us look at our example again. If every microstate has the same chance of being realised, then this corresponds in our case to 1 chance in 729. The chance of changing into a non-mixed configuration is then 64 in 729 = 0.087, less than one chance in ten. In our example this still amounts to a good chance and in fact in the case of red and yellow balls that are divided between 6 compartments, there will be a fairly probable chance of finding a non-mixed configuration, i.e. only yellow balls in the three left-hand compartments and only red balls in the three right-hand compartments. Let us now try to make our example a bit more realistic in comparison with the actual situation of mixtures of matter. For n compartments, the chance of finding a non-mixed configuration (only yellow balls in the n/2 left-hand compartments and only red balls in the n/2 right-hand compartments) is $2^n/3^n = (2/3)^n$. This chance becomes very small as n increases because the limit as n approaches infinity of this variable is nil.

The number of molecules in a sample of matter may be estimated at about 10^{24} and the number of microstates of this enormous accumulation of molecules, which give rise to the same macrostate, is very large.[17] The chance of changing from a mixed situation to a non-mixed situation is therefore unimaginably small. The same holds for a mixture of two drops of water, one cold and one hot. The configuration of two drops of water divided up into a cold drop and a hot drop exists, but is so improbable that a spontaneous change to such a state never occurs.

Boltzmann's reasoning is the subject of great debate because it is an attempt to explain the irreversibility of certain macroscopic processes starting from reversible microscopic processes. Although this is a very important issue and debate is still raging, we shall see that the problem of irreversibility manifests itself in a much more crucial way in the creation-discovery view. We would just like to note that Boltzmann's reasoning perhaps does not prove irreversibility, but it does enable us to

understand why there is a spontaneous conservation of or increase in entropy before a change occurs in a closed system. The fact that structures we know 'go to ruin', attacked by 'the ravages of time', is an expression of this reasoning. The pyramids of Cheops are silting up because the configuration of stone crystals, built over three thousand years ago by the Egyptians, has a lower entropy than normal desert rock. Mountain ranges are eroded by rain because a sharp mountain peak has a lower entropy than a flat wasteland of rocks and mud. When you go for a walk along the beach, you will never see the sea and wind form a sandcastle as if by magic because a sandcastle has a much lower entropy than a pile of sand. Sugar never spontaneously separates from the coffee in a cup of sweet coffee because the coffee and sugar mixture has a much higher entropy than coffee and sugar separately. If we watch a film in reverse and see how a cigarette 'unsmokes' itself, and how our best friend dives out of the swimming pool onto the diving board, and how eggs jump out of the pan and back into their shell, then we are flouting the second law of thermodynamics.

All entities of the construction process that are fixed in a particular layer of reality are struggling against this second law of thermodynamics. A table has a much lower entropy than a random collection of pieces of wood and iron, and that is the reason why tables do not come into being spontaneously. A hunt, as a social entity, has a much lower entropy than the random actions of a group of people, and that is why a hunt does not arise spontaneously. A book has a much lower entropy than a random collection of sheets of paper, and in turn a sheet of paper has a much lower entropy than a random sample of wood pulp, and that is why no books come into being spontaneously.

Living beings (plants, animal and humans) are entities that offer 'resistance' to the second law of thermodynamics. The way in which molecules are organised within living matter corresponds to a local decrease in entropy. What is the driving force behind this struggle against the second law of thermodynamics? Do we understand this second law enough to be able to formulate a response to this question? To clarify this point, we would now like to study the other layer of reality where the concept of entropy has had success.

10 Shannon and information theory

As already mentioned, entropy is introduced in the material layer of reality. In 1948 Claude Shannon published a article in which he laid the

foundation of information theory.[18] Like Boltzmann in his day, Shannon was interested in an important and topical problem: how can information be efficiently transmitted? In his article he introduces the concept of information content of a message. The length of a message is certainly related to the information content of the message, but it is also evident that messages of different lengths can have the same information content, for example, the same message in different languages. The reason for this is that there is often redundancy, which makes the message much longer than its information content, so that the information content actually depends on what are considered to be permitted messages of a given length. If all the permitted messages of a given length are known and are numbered, there is no redundancy in this numeration and the size of the code number can be regarded as a measure of the actual information content. Hence Shannon defines the information content of a given message as the logarithm of the number of permitted messages. The information content of a message is usually given in bits. A bit is a binary digit. The idea is that the message is translated into a binary alphabet with two symbols 0 and 1 and its length is then measured. If the text I am writing now has an information content of 10,000 bits, that means that if I were to translate the same text into machine language, using only 0 and 1, I would need a string of 10,000 characters to set it down, and this string would be chosen from a possible $2^{10,000}$ of these strings of 10,000 characters.

Can we identify the second law of thermodynamics in this cultural layer of reality? The amount of information in a text is entered by Shannon and corresponds to the entropy of a material substance. The microstates for the material layer are determined by the states of the molecules that make up the sample of matter in question, and the entropy is the logarithm of the number of microstates. In the case of the cultural layer, the entropy of a text is determined by the amount of information needed to store this text.

What would be analogous in the cultural layer with mixing matter in the material layer? We propose the following: suppose that two people want to write a text together, in other words a joint text, and to make the analogy clear, suppose that one of the two people writes in red ink and the other in yellow ink. A non-mixed text is one in which one person has written the first half and the other person the second half. Suppose that we digitise the text and that there are n spaces available. In a randomly mixed text, every space can be empty, or can contain either a red character or a yellow character. This gives 3^n different possible configurations. In 2^n of these configurations, the first half of the text is written by one

person and the second half by the other person. Where a text of n bits is written jointly, the chance of a non-mixed text being spontaneously created in this way is $(2/3)^n$, the same chance of finding a non-mixed configuration in our earlier example of the red and yellow balls that can be put into n compartments. This chance again becomes very small when n is large. Let us look at an example. The text that is being created here takes up 10,000 bits in memory. If this text were to be written by two people, the chance of a non-mixed text is $(2/3)^{10,000} = (1/10)^{18,031}$ (a decimal point followed by 18,030 noughts followed by a 1). We can also express this differently: if a text of 10,000 bits is written and stored by two people, so that the red letters of the first person are still distinguishable from the yellow letters of the second person, this will need a memory of 10,000 bits multiplied by log3/log2 = 1.58, which is equal to 15,800 bits. In general we can say that a text of n bits jointly written by k people will need a memory of n x (log(k+1)/log2) bits. For a group of 10 people jointly writing the text, this gives 3.45 n bits. This example helps us understand what the analogy is with the second law of thermodynamics. Texts are seldom jointly written in such a way that all possible configurations are equally probable. In general, tasks are divided and different sections are written by separate people. Our example, although it clarifies the situation, is therefore a bit unrealistic. Conversations take place in a much more mixed way. The chance that a conversation between several people will deteriorate into a succession of monologues by separate individuals is actually very small. We can generalise this to collaboration on any cultural product and conclude that it is very improbable that such a collaboration would deteriorate into individual actions by the various participants.

Here we encounter the deeper meaning of the second law of thermodynamics. With regard to this we would now like to illustrate the fecundity of our layers perception and our creation-discovery view. In the cultural layer of reality it is abundantly clear that the second law of thermodynamics, as we have illustrated it, is a marked idealisation of a much more profound principle, which is well-known to philosophers, and which we may express as follows: 'The whole is greater than the sum of its parts'.

11 Creation and perpetuation in different layers

Every microstate of an entity S, composed of two non-mixed entities S_1 and S_2, is a product state, determined by a microstate of S_1 and a micro-

state of S_2. This is the reason why the entropy of this entity S, composed of two non-mixed entities S_1 and S_2, is given by the sum of the entropy of S_1 and the entropy of S_2. The entropy of a mixture S of two entities S_1 and S_2 is higher than the sum of the entropy of S_1 and the entropy of S_2 on account of the fact that the mixture S has microstates, those which describe a mixture and which are not a product of microstates of S_1 and S_2. The mixture S is actually a new entity that does not simply consist of S_1 and S_2, and this explains the fact that S has states that are not product states of states of S_1 and S_2. The increase in entropy for a mixture is a result of the increase in microstates for this mixture.

When two quantum entities come together new states of non-separated entities are created.[19] This phenomenon is very well described and predicted by the quantum formalism and has now been confirmed by experiment. In this case, however, we shall not discuss a mixture. With a quantum entity in a non-product state, the subentities lose their individuality. The whole cannot be regarded as the combination of its parts and this fact underlies the many paradoxical quantum effects. This phenomenon is also found in other layers: a jointly created cultural product is not a collection of small basic cultural products. The fact that entropy as a concept can be successfully used in two layers is no coincidence and is associated with the special phase in which the creation process of the biomousa takes place in these two layers.[20] Broad interpretations of the nature of reality, which are often derived from the second law of thermodynamics, are therefore highly over-simplified. For example, the interpretation that the phenomenon of mixtures not spontaneously separating would predestine the whole of reality to evolve towards greater disorder and less order is a local conclusion that is also related to the special phase in which this second law manifests itself, and hence does not constitute a truth in other layers of reality.[21]

If we acknowledge that sandcastles are not spontaneously created, we must also acknowledge that people make sandcastles. How should we interpret this? We can now clarify this point. The calculation of the entropy of a sandcastle primarily has to do with how we interpret the sandcastle and what we mean by 'spontaneously'. We are surprised at the creation of the sandcastle only if we look for the creativity required to create it in the material layer. If by 'spontaneously' we mean 'by using creativity in the material layer', then the sandcastle is formed simply as a result of the movement of grains of sand, as small material entities, making use of the random forces that prevail between these grains of sand. If we interpret 'spontaneously' as 'what happens on a beach where people are sunbathing', it is much more probable that a sandcastle

will be created. People are therefore needed to make a sandcastle. But now we have only shifted the question because why are these people there? In order to fit this question into the creation-discovery view, we would first like to examine in more detail the analogy between the two layers in which we identified the entropy law.

In the material layer of reality we would like to characterise three organisation levels of atoms and molecules or ions more generally. A crystal (a solid substance) is an explicitly organised form. All of the particles remain in their 'place' in the same state and can only exert influence and move locally. This produces a very coherent but rigid form of organisation, which, however, has and requires minimum energy. Various types of structure are possible in this organisational form. A liquid is a more implicitly organised form. Forces hold the particles together but each particle can still move individually to a certain extent. There is no coherence between the particles, only attraction. A gas is an accumulation of virtually free particles. The biomousa, however, has not chosen any of these three options. It was not interested in the complete dissociation and excessive vagueness of a gas, or in the wetness and perfect malleability of a liquid, and certainly not in the still, fixed rigidity of a crystal. What kind of backbone does the biomousa have? This question will help us unveil the mystery. There is a fourth way of organising matter. Let us elaborate on this.

The molecule can be regarded as the seed of the crystal. Starting from this molecule there seem to be various ways of building larger structures. We have already discussed one of these ways in detail: that of the crystal. This comprises a constantly recurring pattern of basic structures. Once the periodicity has been established, there is no limit to the size of the crystal. This crystalline mode is averse to any form of creativity. The crystal is like wallpaper with a pattern that is repeated in all directions. Wallpaper is not regarded as an example of creativity in our cultural layer and the biomousa also took the same view in prehistoric times. Although it was fascinated for a time by the creation of the basic molecule, the way of the crystal was not its way. The fourth way is choosing to make creative use of molecules. Complex organic macromolecules are works of art, made by the biomousa, in which every atom and every group of atoms plays a unique and individual part, quite unlike the part played by another group, as in the case of the crystal. The fourth way leads to living matter. It is in fact these molecules that form the basis of the material of living matter. And this is the way that the biomousa has chosen, seeking the power of perpetuation through creativity. The material forms of living beings, the single-cell organisms, plants, animals and

humans, are the creations of the biomousa in the material layer of reality. This way immediately takes us away from reductionist territory. A macromolecule is not a collection of interacting atoms, just as an atom is not a collection of interacting pre-material particles. A macromolecule is a structure, a construction: it is greater than the sum of its parts. It has new states, which are not product states and which cannot therefore be regarded as a configuration of atoms.

Now that we have analysed the various forms of organisation within the material layer, let us return to the cultural layer. The basic entities of the most recent layer of reality are the 'cultural products' in the broadest sense of the term. An entity is situated in the cultural layer because a meaning is associated with this entity; the possibility therefore exists of 'covering' this entity 'with 'symbols' (by introducing symbols in the cultural layer of reality). Symbols originated from sounds and gestures, probably mainly intended as a pure means of communication between humans and animals originally. They gradually became more and more complex and have created their own entities, which are all cultural products. Old material and social entities, such as the table and the hunt and the house, were vested with 'meaning', but the 'force field' of the meaning has also created really new cultural entities: texts, theories, works of art, cultures, and so on. In this sense we could regard 'meaning' as the principal 'force field' of this cultural layer of reality. All cultural products are immersed in this force field but entities in the previous layers of reality do not feel this force.[22]

Let us pick up the trail of the biomousa once again. We want to think about texts as cultural products and we compare them to material entities. They are made up of words, which we can compare to molecules. The atoms are the letters and letters joined up to make a word are molecules. Words can join up to form sentences, equivalent to chemical bonding to form larger molecules. We can construct texts made up of the same sentence or a collection of sentences repeated over and over. This is a crystal text. This is a crystal text. This is a crystal text. This is a crystal text. This is a crystal text. This is a crystal text. This is a crystal text. This is a crystal text. And so on. These kinds of texts are crystals. If through some process or other, for example an error in the software of our word processing program, the words or letters of these sentences got mixed up, then we get texts that are liquids and gases. Thsi la s cr is yext tat. i le s cr axt ysts i taTh. We would not normally identify these kinds of constructions as being texts. Why not? No 'meaning' can be established or passed on because all of the combinations of letters do not result in words, and all of the combinations of words do not result in sentences,

and all of the combinations of sentences do not result in texts. Only those combinations of letters that are arranged in accordance with the 'force field' of the 'meaning' form words, and only those combinations of words that are arranged in accordance with the force field of the meaning form sentences and texts. Once again, meaningful sentences are not a collection of words. They are constructions and structures, which contain new states, which cannot be reduced to the configuration of the words. Shannon's entropy theory does not explore the layer of meaningful sentences.

The same argument applies to material entities. Only those combinations of atoms that are arranged in accordance with quantum mechanical forces result in molecules, larger molecules, and crystals or living matter. And it is only these forms of organisation that support the quantum mechanical force field, and communicate through it, by means of photons. Liquids and gases do not take part in this game, and if we cannot allow random combinations of letters and words to be regarded as sentences or texts, then we should also conclude that liquids and gases cannot be regarded as real matter. They do not take part in the original creativity game. Liquids and gases have only acquired a material aspect by means of the large number of molecules that we find in them at our macroscopic level because disorder is reduced by this large number of molecules and they have become usable 'matter' again for the creation of living matter. Crystals and living matter are real matter. Crystals correspond to texts made up of recurring sentences, whose meaning is no greater than the meaning of just one of these sentences. Meaning remains at a local level and cannot really expand. The way of the biomousa, used by the macromolecules, allows the force field of meaning to expand and create living matter. This living matter corresponds to our texts, which we regard as real and valuable cultural products.

12 The different tongues of the biomousa

We would now like to try to identify the different phases of the journey of the biomousa and we are aware that only a broad outline is possible. The contents of this section therefore have to be regarded as an attempt, using broad metaphors, to speculate in very general terms about the nature of the biomousa.

Suppose that we start with the existence of a collection of basic entities. In the material layer these are the atoms, and for part of the cultural layer they are the letters and words that make up the language.[23]

One particular phase, which we shall call the building phase, is chiefly a construction based on combinations of the basic entities in particular structures. In general there are many possibilities but some will be found to be 'better' than others. The building phase in the material layer consists in constructing large quantities of different kinds of matter, all made up of the fundamental building blocks, i.e. molecules. The building phase of the language part of the cultural layer consists in constructing large quantities of different texts, all made up of the same basic entities, i.e. words. This building phase is explosive and partly destroys the old structures and the old order. The less systematically structures are created, the more these structures obey a kind of second law of thermodynamics. In fact, if molecules are simply thrown together any old how, there is little chance of living matter being produced. If words are simply written down in any old order, there is very little chance that a meaningful text will emerge.[24] Disorder increases, while the entropy view of the mixtures and the increase in disorder provide a good description of this phase.

The second phase, which we shall call the development phase, consists in creating functionally oriented aspects, which have more to do with mutual interaction and interaction with the outside world. Some combinations of basic elements are clearly able to interact with their environment more and better than others. Our ancestors searched for caves to live in and, although a cave as a pure material object is highly improbable, its perpetuation is ensured in the form of a house. The cave 'clicked' in some way or other with the needs of our ancestors. The model of the cave lead to them constructing house-like buildings themselves. In the cultural layer it is likewise communication that will select the texts as being significant. The development phase is still an explosive phase, like the building phase, but it introduces the element of selection, which tempers the constant tendency towards an increase in disorder. In fact, some texts will be preferred to others and in this new classification, the most disorderly texts will have less chance of survival.

We shall call the next phase the structuring phase. The new area is structured. Newly created entities are given a place. This phase corresponds to arranging and structuring particular texts and communications. Cultural elements are assigned a place and the concept of space is introduced. Two very important aspects of the previous phases, creation, which is so essential for exploring all possibilities, and the optimisation of perpetuation and of perpetuation techniques, which often involve copying, or a creative form equivalent to copying, are partly split off and the concept of motion in structured space emerges. Entities

can move in space without losing their individuality. Moving is copying oneself in a 'stable' way and is reversible over time. This structuring phase is well under way in the cultural layer of our reality. People are constantly engaged in assigning cultural products their place and in defining the space in which they can move. If we return for a moment to the material layer, we can see that the structuring phase is already complete here. All material entities are well arranged in space and can move within it and interact with one another. Space as a stage has become separated from time and has produced an illusion of 'reversibility'. Our way of thinking about the universe is determined by space to such an extent that we also see time evolving within this space. But this is wrong of course. We can now understand better why pre-material entities are not present in this space. Space is the stable structure, seeking equilibrium between perpetuation and its need for structure, between creativity and its need for exploration. Creation then partly converted itself into 'motion'. Just as the matter of the ink used to write the letters of a text on a sheet of paper is not present in the cultural space that is now forming in our cultural layer, so too are quantum entities not present in space.

We shall call the fourth phase the potentiality phase. This phase clearly starts building a bridge to another layer of reality. The structuring phase introduced a lot of new and perpetuable structures. These structures have a very low entropy compared to the basic elements but they are highly perpetuable and hence they exist. The benefit of modules is discovered, especially in connection with perpetuation. Modules are larger elements than the original fundamental building blocks, which can be used uniformly and which can easily be copied and hence increase perpetuation. All our modern electronic equipment is based on this modular principle. Mathematical theorems are also modules, however, as are large biochemical molecules and genes. Modules are the first attempts to choose new fundamental building blocks and thereby forget the old ones and incorporate them into an automatic reproductive process that has enormous power of perpetuation and, at the same time, a stable structure. That is why the creation of modules is the first step towards a new layer of reality. In general, however, a new layer is not just created immediately since this is not the purpose but rather the ultimate result of the choice of modules. Why do we call this phase the potentiality phase? With the introduction of modules, the interaction with the space extensively created in the previous phase implodes again. A module possesses a special property in that it contains a lot of potential reality in itself, reality that only becomes existent when the module takes up its place. DNA is a good example of an unbelievably complex module because it has the potential to allow a whole living being to grow, if it ends up in the right place. It is an implosion of external reality because this living being has the potential to remember and pass on information and hence support the building blocks of the new cultural layer.[25] Why do we not regard DNA as the basic element of a first new layer of reality? We could do this, though how we define these layers is of course arbitrary to some extent. Nevertheless we choose not to call this a new layer because it lacks one essential characteristic of a separate layer. Genes have not explored the universe. They have not seen the stars! They have not expanded their space to infinity. However, the stored potentiality, i.e. the plants, animals and humans in material forms, has set to work to reach the stars. To this end, man, and man alone, had to take a new step. He started to digitise his experiences, he introduced concepts or modules of experiences. He began to ensure the perpetuation of these concepts by inventing writing among other things. And his knowledge, which is the power behind this new cultural layer of reality, began to spread out over the universe.

We shall call the next phase the bridging phase. New basic elements are introduced in this phase. These basic elements are separate from the previous basic elements yet are grafted onto them. Initially these basic elements are still modules but then steps are taken to digitise all of the important entities. The new layer of reality now becomes a quantised layer. And we have returned to a building phase.

We can now understand what automation means. The introduction of modules to increase perpetuation implies the introduction of automation. Prototypes are in fact forms of modules too. Real creativity swims ahead of this automation, as it were, like foam on the crest of a wave, and takes place on the edge of the new layer forming. We also believe that every layer goes in search of its past and wants to grasp it again in its entirety. The previous layers did this because, as we know, the four fundamental forces in nature[26] bind all matter and energy in the universe. If we consider the modern quantised view of interaction between entities by means of a force, this interaction is nothing more than the interaction of a force particle: in the case of gravity, the graviton, in the case of electromagnetism, the photon, in the case of weak interactions, the boson, and in the case of strong interactions, the gluon. And in the case of the cognitive force field in which we live, the word.

The highly speculative view we are putting forward here identifies man as the vehicle for the most recent force of nature, the cognitive force, and as the foundation of the new layer of reality, the cultural layer.

13 The project itself

I would like to end my contribution to this second book of Worldviews with a 'personal' reflection about the project itself. The project is sometimes presented as 'an attempt to construct integrating world views' and hence often encounters strong opposition. Some people say that world views cannot be constructed, they can only develop spontaneously. Others see this attempt at construction as a revival of the old Enlightenment belief about the 'explainability of the world'. Yet others find the project interesting but extremely utopian and therefore a priori impracticable. And others have doubts about the importance of world views in the context of the current state of the world.

I believe that these criticisms (and others) are partly justified. The project is utopian, there is no certainty that relevant functioning world views can be constructed, I too believe that the world is only partly explainable (creation and discovery), and the importance of world views in the context of the current state of the world is a hypothesis. Nevertheless I believe that even under these circumstances 'what happens in the Worldviews group and in the subgroups' is necessary and important. This is because I can evaluate what happens, not so much from the viewpoint of a particular research theme (the construction of world views), but rather in the light of my own personal experience. I believe that intellectual fragmentation is now so great (in my own discipline, physicists in a different subdiscipline can barely read each other's articles, let alone understand them), that the best vehicle for any attempt at integration is a specific project, so that efforts do not deteriorate into a talking shop. On the one hand, this project should not be small-scale and quickly realisable because then there is an immediate risk of a new discipline being formed. On the other hand, the project should address fundamental questions in order to achieve a level of analysis that at least equals the depth of existing disciplines. In this respect a conscious effort to construct world views can be a means of healing the pernicious effects of fragmentation.

My response to the criticism that world views can only develop spontaneously is as follows. It is certainly true to say that all previous world views developed spontaneously. Perhaps the time has come, however, for people to tackle world views in a conscious way. Many other spontaneous actions by our ancestors have increasingly been replaced by conscious actions. This increase in consciousness is probably what distinguishes us most from animals, and perhaps the time is right to extend it to the activity of constructing fragments of world views. This, incidentally, would fit into the creation-discovery view I have put forward in this article.

Notes

1 Within the limited scope of this article it is not possible to discuss all aspects of the problems caused by quantum mechanics. We therefore refer the reader to a more detailed analysis by Aerts, D., *De muze van het leven. Quantummechanica en de aard van de werkelijkheid,* Pelckmans-Kok Agora, Kapellen-Kampen, 1993, and to three articles: 1) Aerts, D., An attempt to imagine parts of the reality of the micro-world, published in *Problems in Quantum Physics II;* Gdansk 1989, ed. J. Mizerski et al., World Scientific Publishing Company, and 2) Aerts, D., *Construction of reality and its influence on the understanding of quantum structures* 3) Aerts, D. The entity and modern physics: the creation-discovery view of reality in *The Entity and Modern Physics*, ed. Elena Perruzi, Princeton University Press. These four publications contain more explicit details of many aspects of this article as well as further references to other articles.

2 Classical physics is also based on this intuition and there are various ways of describing the place occupied by a material entity in three-dimensional space. In the case of a rigid body, the position of the mass centre can be considered and the entity can then be described in a relative coordinate system with its origin in this mass centre. In the case of a liquid or gas, continuum mechanics is used, with the liquid or gas being described by means of a collection of points, present in that part of space where the mass density of the liquid or gas is different from zero. A wave, though often spread out, also has a place in our space. Whatever description of whatever entity may be considered in classical mechanics, the entity always has a place.

3 In the creation-discovery view, we no longer see space as an all-encompassing stage on which the whole drama of reality is enacted, but rather as a structure that we, as humans, have experienced, relying on our everyday experiences with the material macroscopic entities around us. We differentiate between the following two characteristics: 1. Every entity can be detected in space; space is therefore one of the structures through which we, as humans, encounter and create reality. 2. Every entity is present in space; space is therefore the stage on which everything real is enacted. The first characteristic is also valid for quantum entities, the second is not. In this way we adopt a new reality 'statute' for space. Space as an 'intermediate' meeting structure and not as an 'all-encompassing' stage. Things make their place rather than simply have one. We can still find evidence in our everyday language of the change in meaning that the concept of space has undergone. We still say that space is the stage on which an event takes place. Events, since we still do not regard them as entities, can apparently still 'find' their place in space, which means that they are not necessarily present in space before they have 'found' that place.

4 See the article by Schrödinger in which he puts forward the famous cat paradox: Schrödinger, E., *Die gegenwärtige Situation in der Quantenmechanik*, Naturwissenschaften 23, 1935, 807, 823 and 844.

5 Kolmogorov's axioms (advanced by Kolmogorov in 1933) are those of classical probability theory, as already specified by Simon Laplace in the previous century. The quantum probability model does not satisfy Kolmogorov's axioms. John Von Neumann was the first to prove a no-go theorem for the hidden variable theories (Von Neumann, J., 'Grundlehren, Math. Wiss. XXXVIII (1952)'); proof of the

impossibility of reproducing quantum probabilities using a hidden variable theory was gradually perfected later (Kochen, S. and Specker, E.P., Journal of Mathematical Mechanics, 17, 59 (1967)).

6 A very general formulation of the new formalisms is that of Charles Randall and David Foulis (Randall, C.H. and Foulis, D.G., 'The operational approach to quantum mechanics', in Hooker, C.A., ed., *Physical Theories as Logico-operational Structures,* Reidel, 1979), and a more physical formulation is that of Piron and Aerts (Piron, C., *Foundations of Quantum Physics,* W.A. Benjamin, Inc. London, Amsterdam, Aerts, D., *Description of Many Separated Entities without the paradoxes encountered in Quantum Mechanics*, Foundations of Physics, 12, 1982, 1131, and Aerts, D. *Quantum structures, separated physical entities and probability,* Foundations of Physics, 24, 1994, 1227) Several other formulations also exist, in which the emphasis is different.

7 Aerts, D., *The One and the Many,* Doctoral Dissertation, University of Brussels, Pleinlaan 2, 1050 Brussels, and Aerts, D., *Classical Theories and non-Classical Theories as special cases of a more general Theory*, Journal of Mathematical Physics, 24, 1983, 2441.

8 Aerts, D., *Description of Many Separated Entities without the paradoxes encountered in Quantum Mechanics*, Foundations of Physics, 12, 1982, 1131, and Aerts, D., 'The description of separated systems and quantum mechanics and a possible explanation for the probabilities of quantum mechanics' in *Micro-physical Reality and Quantum Formalism,* A. van der Merwe et al., eds., Kluwer Academic Publishers, 1988, Aerts, D. *Quantum structures, separated physical entities and probability,* Foundations of Physics, 24, 1994, 1227.

9 Aerts, D., Durt, T. and Van Bogaert, B., *A physical example of quantum fuzzy sets and the classical limit*, in *The proceedings of the International Conference on Fuzzy Sets*, Liptovsky, 1992, Aerts, D., Durt, T. and Van Bogaert, B., *Quantum Indeterminism, the Classical Limit and Non-Locality*, in *The Proceedings of the Symposium of the Foundations of Modern Physics,* Helsinki, World Scientific Publishing Company, 1993.

10 Rauch, H., *Neutron interferometric tests of quantum mechanics*, Helvetica Physica Acta, 61, 1988, 589, and Aerts, D. and Reignier, J., *On the problem of non-locality in quantum mechanics*, Helvetica Physica Acta, 64, 1991, 527.

11 The reader can find a detailed description of this experiment and further references in Aerts, D., *De Muze van het leven. Quantummechanica en de aard van de werkelijkheid,* Pelckmans-Kok Agora, Kapellen-Kampen, 1993, and in Aerts, D., *The construction of reality and its influence on the understanding of quantum structures*, International Journal of Theoretical Physics, 31, 1992, 1815.

12 We cannot demonstrate these two statements within the scope of this article but we can refer the reader to the articles in which these statements are proved and illustrated by means of examples: Aerts, D., *A possible explanation for the probabilities of quantum mechanics*, Journal of Mathematical Physics, 27, 1986, 203, Aerts, D., *The origin of the non-classical character of the quantum probability model*, in *Information, Complexity and Control in Quantum Physics,* eds. Blanquiere et al., Springer-Verlach, 1987, Aerts, D., *An attempt to imagine parts of the reality of the micro-world*, in *The proceedings of the conference 'Problems in Quantum Physics';* Gdansk '89, eds., Mizerski et al., World Scientific Publishing Company, Singapore, 1990, and Aerts, D., *A mechanistic classical laboratory situation that violates Bell inequalities exactly in the same way as the violation by the EPR experiments*, Helvetica Physica Acta, 64, 1990, 1.

13 Aerts, D., *Quantum mechanics, separated physical entities and probability,* Foundations of Physics 24, 1994, 1227.

14 The violation of Bell inequalities is even a natural phenomenon in this creation-discovery view, which can be perfectly imitated by means of macroscopic physical entities: Aerts, D., *An attempt to imagine parts of the reality of the micro-world*, in *The proceedings of the conference 'Problems in Quantum Physics';* Gdansk '89, eds., Mizerski et al., World Scientific Publishing Company, Singapore, 1990, Aerts, D., *A mechanistic classical laboratory situation that violates Bell inequalities exactly in the same way as the violation by the EPR experiments*, Helvetica Physica Acta, 64, 1990, 1.

15 'Biomousa' or 'muse of life'.

16 When Ludwig Boltzmann developed statistical mechanics at the end of the nineteenth century, atomic theory had not yet been proved and was far from being generally accepted. Boltzmann believed in the existence of atoms but many important physicists did not share his view.

17 If we are describing the sample of matter by means of classical statistical mechanics, as was the case in Boltzmann's day, we have to replace the concept of 'number of microstates' with 'volume in phase space'. The scope of this article does not allow us to put forward an exact calculation because we would have to introduce the concept of phase space. Nevertheless, we would like to further discuss a highly simplified (and strictly speaking mistaken) view, where we would simply present the sample of matter as an accumulation of individual molecules and only the number of these molecules would be used in the calculation of the entropy. We therefore assume that the sample of matter consists of 10^{24} spaces, each one of which can be filled by a molecule. To find out what the chance is of a mixed situation changing into a non-mixed situation, we have to calculate (2/3) to the power 10^{24}. The chance is something like 1 divided by 10 to the power 10^{23}, which is an extremely small chance. Let us develop this example further in order to get an idea of how small this chance really is. Assume that every nanosecond ($1/10^9$ seconds) a new configuration of 10^{24} compartments is filled with red and yellow balls, which more or less corresponds to the frequency with which these kinds of changes in configuration could take place for real molecules. For each change in configuration the chance of a non-mixed configuration is 1 divided by 10 to the power 10^{23}. Using probability theory, we can then calculate how many changes in configuration have to take place for there to be more than a 1 in 2 chance of finding a non-mixed configuration at least once. This produces a figure of 0.7 times 10 to the power 10 to the power 23. If we assume that a change in configuration occurs every nanosecond, then we have to wait 0.7 times 10 to the power 10 to the power 23 nanoseconds in order to have more than a 1 in 2 chance of finding a non-mixed configuration at least once. The age of the universe is estimated to be 10 billion years, which is 10 to the power 26 nanoseconds. We would therefore have to wait 10 to the power 10 to the power 22 lifetimes of the universe. This is unimaginable and actually boils down to the fact that the realisation of a non-mixed configuration is so improbable that it will never happen, not even at the level of the age of the universe.

18 Shannon, C., *A Mathematical Theory of Communication,* Bell System Tech. J. 27 (1948); 379.

19 These new states are represented by the functions that cannot be reduced to waves in three-dimensional space; these are the non-local states.

20 This is the phase we call the 'building phase' in the next section of this article.

[21] We should mention that the popular interpretation of entropy as a measure of disorder needs to be refined a great deal. Entropy is a measure of the number of microstates that give rise to the same macrostate and hence it is a measure of the information content of this macrostate. The fact that a situation where there are more microstates corresponds to a situation where there is more disorder is related to the specific phase in which the creation process takes place, and to the various layers that are being compared, and is not a general fact. If, for example, we consider the process of spontaneous crystallisation of a supercooled substance, entropy increases if the process takes place under adiabatic conditions. Using ideas about order and disorder in everyday life, it is difficult to maintain that the crystal is more disorderly than the supercooled substance. The interpretation of entropy as a measure of disorder can be salvaged in this example by assuming that the order we want to consider is made up of two parts: one of a configuration nature and the other of a thermal nature. The configuration-type order produced by crystallisation of the substance is lost because of an increase in disorder, which is caused by the potential energy released (latent heat) being spread over the vibration modes of the crystal. In this way 'disorder' has to be related to both the distribution of the particles in space and the distribution of the energy over the energy levels. This is a very sophisticated way of looking at matter, however, which also depends on the theory that is being used. Another situation where it is clear that disorder and entropy are two different concepts is in the analysis of the behaviour of gravitational systems. Here too we find spontaneous spatial structuring, which means increased spatial organisation, even in the case of a closed gravitational system. Only when the process is looked at in phase space, thus introducing a completely abstract notion of order, can entropy still be regarded as a measure of disorder (cf. Severne, G., 'Irreversibility in the Large', in *Frontiers of Physics Lectures,* Physical Research Laboratory, Ahmebadad, 380 009, India).

[22] In 'Sinn als Grundbegriff der Soziologie', published in *Theorie der Gesellschaft oder Sozialtechnologie* by Suhrkamp Verlag Frankfurt am Main, Niklas Luhmann advances the idea of meaning as a 'force' in the social layer.

[23] The letters and words of the language are of course only the basic entities for a particular part of the cultural layer, while atoms are the basic entities for all entities in the material layer. For the sake of simplicity, we shall confine ourselves to that part of the cultural layer that relies on language.

[24] We would like to mention that in reality this process does not take place in the simplified manner we describe here. Meaning grows when texts are present. Space and spatial forces grow when mixtures of elementary particles are present.

[25] Plants, animals and humans have developed a very complex game, which we call sex, to ensure that DNA always ends up in the right place.

[26] Gravitation, electromagnetism, weak interactions and strong interactions.

Edel Maex

From cell to consciousness: a world of life

The fragmentation of the world view is not equally problematic for everyone. Some are able comfortably to limit their activities to one of the fragments. As a psychiatrist that's not so easy. Psychiatry moves in the border areas of body, behaviour and society. It requires not only a scientific understanding but also therapeutic action, which must constantly be ethically justified. The psychiatrist is pretty well alone with this practical demand for the integration of all these issues. Each branch of science, physiology, pharmacology, the various rival trends in psychology, medical deontology, the applicable legal provisions, all these fragments have their own paradigms, practices, laws. There is no generally accepted model capable of integrating all these aspects.

You can solve this for yourself by barricading yourself somewhere in a corner of the area. Some see the synaptic division as their unique area of action, others define their field as applied philosophy. Any strategy of this sort signifies an impoverishment. Information which cannot be integrated is rejected as irrelevant. Others still, move with apparent ease from one frame of reference to another. To them the crucial question then is: should this phenomenon be explained within a psychological or an organic frame of reference? In this case the question of the relationship between the two frameworks remains in the background.

Where no good instruments are available, one has to make do. This text is the result of a search for a personal, useable model for working and thinking, a better integrated world view that should allow more information to be put in its place and to be used. This text therefore is not so much concerned with the separate sub-areas as with the mutual connections. In this respect I am indebted to many people including G. Bateson, H. Maturana and F. Varela, A. Scheflen, J. Jaynes and D.H. Hofstadter. It is a perilous undertaking, since searching for a world view means by definition that I shall venture outside my speciality. It would be much safer if I could remain in one or other specific area. It is pre-

cisely the problem with world views that by always staying in a limited field we end up with an enormous fragmentation.

The path along which I want to lead you, through the world of the living, is one of increasing organization, an organization that is always shifting to other levels so that new worlds full of possible forms of organization come into being.

Views on the definition of life are fairly diverse. Most writers propose a list of criteria which an organism has to comply with in order to be labelled as 'living'. Metabolism and reproduction play an important part in this. Rather than by using a list of criteria I would prefer to define life (together with Maturana and Varela) by one single organizational principle: living material owes its stability to the fact that it builds and assembles the components from which it is constructed itself.

1 *The cellular level*

The smallest distinguishable unit of life that we know is the cell. Cells are structures built up of components which are themselves not living. A cell forms an enclosed entity, distinct from its environment, but with which it is in contact by means of a membrane. A cell absorbs material and energy from its environment and uses it to create itself. As long as the cell remains in existence it remains distinct from the environment. When the environment penetrates into the cell it disintegrates and its existence as a living unit comes to an end.

Cells reproduce themselves by cell division (*figure 1*). In so doing, two new cells are formed which are genetically identical but which are distinguishable from each other as entities. If you want to see every cell as an individual then a strange situation arises. The original individual ceases to exist without a cell dying, and two new, but genetically identical, individuals come into being without there being any question of a birth. The word 'individual' is more or less unusable at the level of the unicellular.

Even at this level something is needed by way of sexual reproduction. In order to be able to create new forms, a recombination of genetic material is needed. *Figure 2* shows in a diagram how the genetic material is divided, after which the two cells fertilize each other, as it were. Genetic material is exchanged during this process. At this level we cannot speak of a sexual differentiation. One may call the nucleus that remains and the nucleus that is transferred the female and the male respectively. The result is two totally new cells, genetically different from each other and

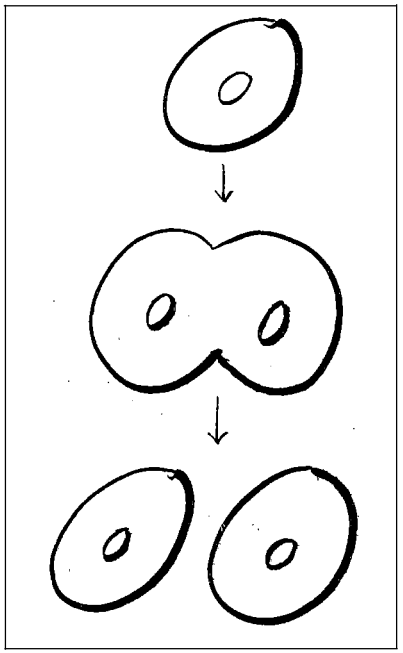

Figure 1 – Representation of cell division among unicellular.

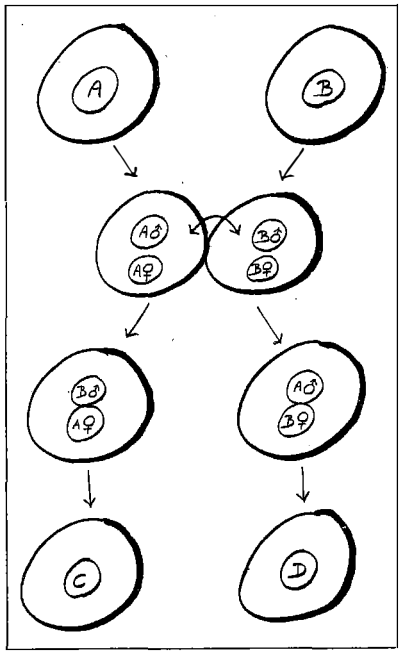

Figure 2 – Representation of conjugation among unicellular.

their predecessors. If you were to think of cells as individuals then it appears that two individuals cease to exist while two brand new individuals appear on the scene.

2 *The metacellular level*

Among the unicellular creatures, the cells that divide will swim away from each other in their environment and have little or nothing more to do with each other. In nature, however, a second-order coupling has arisen by which means cells that divide do not loosen from each other but remain together and form a multicellular organism (*figure 3*). What we have here is an aggregation of cells from the same line of cells. These

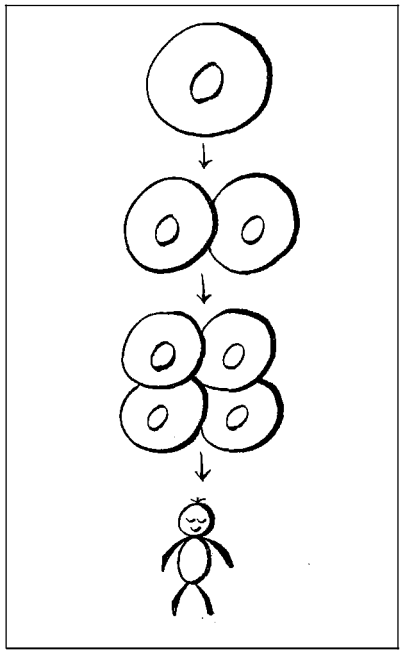

Figure 3 – Representation of cell division among multicellular.

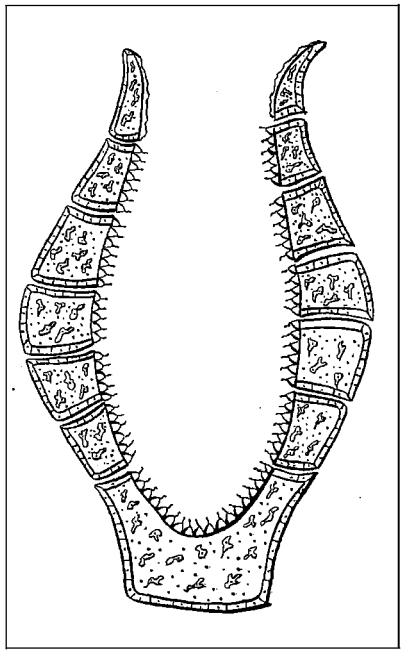

Figure 4 – Representation of the cross-section of a sponge.

cells remain genetically identical but increasingly differentiate and specialize in particular functions.

Figure 4 shows the cross-section of a sponge. A sponge is the simplest multicellular creature we know. All its cells grow from the same original cell. These cells do not remain identical but specialize in various functions. On the outside they form something comparable to the skin, the cells on the inner surface form something comparable to the intestinal mucous membrane, the cells in the middle form a structure that provides strength for the whole fabric. It is still an extremely primitive organization, but there is clear cell differentiation. I avoid introducing the hierarchy of levels as a question of complexity because, for example, the organization of a sponge as an entity in itself is much simpler than the organization of each of its constituent cells.

The fact that cells can link up into multicellular creatures means that a whole new range of biological possibilities arises. New organisms

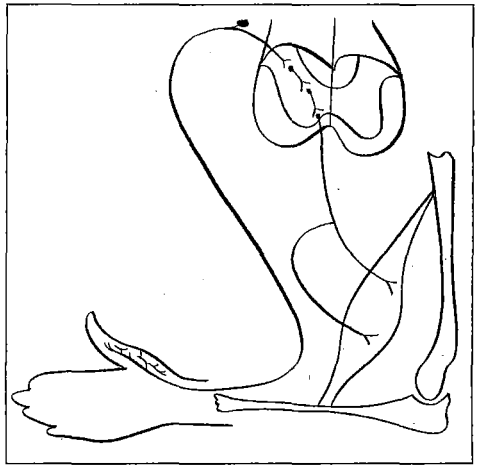

Figure 5 – Showing how the sensonal parts of the hand are connected to the muscles of the arm.

make their entry into the world of biology. The organization of a sponge is still very simple. It is dependent on diffusion for its food. Water has to flow in and then out again in order for it to absorb food. It cannot actively hunt for food. It also has little defence. If a fish begins to nibble at it, it cannot flee or hit back.

In order to make movement possible for multicellular creatures we need a completely different structure which we do not find in the sponge. If a unicellular creature is confronted with a harmful stimulus near its cell membrane, the membrane will contract at that point so that the creature removes itself from that harmful stimulus. The place where the stimulus is received coincides with the site of the motor response.

This would not be sufficient among multicellular creatures. Just like sponges, plants cannot react by moving. This makes them defenceless against certain threats. If you hold a flame under a leaf on a tree, that leaf will burn and the tree will not contract its branch. Animals can do that. If a flame suddenly burns my finger I will quickly pull it away. The point where the signal comes in, my finger, does not here coincide with the position of the motor response, the flexors in my upper arm. If I hold my finger over a candle then it is not enough that the cells in my finger react, I have to pull my arm away immediately. It would be rather inefficient if I had to wait until the muscles in my arm had been warmed up by conduction. I need a structure that links the signal in my hand to the muscles in my arm.

That is the function of the nervous system. *Figure 5* shows how the stimulus in the finger is conducted to the spinal cord along a nerve path

and from there departs, by means of a number of intermediate cells, towards the muscle that makes the arm bend. The nervous system is a link between the sensory and the motor interfaces by which means we are kept in contact with our environment.

The nervous system itself again opens up a whole new range of possibilities. The connection in the diagram is very simple. It is a simple reflex arc. But we can do a lot more with our nervous system. The nervous system permits a great complexity and variation of possible connections of the sensory to the motor. In addition to this one of the properties of the nervous system is that it is plastic, which means it can learn. New patterns can arise in the individual's experiential stock, so that it can learn to adapt to new circumstances.

The large number of possible patterns for the connection of the sensory to the motor can teach the nervous system to distinguish different stimuli and movements ever more accurately from each other. Bateson defines information as 'a difference that makes a difference'. The nervous system creates information, as it were. It permits reaction to a difference with a difference.

This differentiation already begins peripherally in the senses. Some structures react to light, others to sound, others to pressure. In the brain the differentiation goes further. *Figure 6* shows the development of the brain in vertebrates. It is striking that to a great extent the plan remains the same. You see a structure that in fish is no more than an appendage and which among the mammals forms the largest part of the brain. This is the cerebral cortex. Our cerebral cortex is an incredible differentiation structure. It allows us to see the difference between colours, between different directions in movement, between different forms. We can hear the difference between different melodies, between different timbres, between different words. Our vocal cords can produce these sounds in a comprehensible way, and our hands have a fine motor system by which means minute movements can be executed. In addition to this we are able to learn. Anyone who never really listens to classical music will not hear the difference between Bach, Mozart and Stravinsky. If the same person becomes a passionate music lover, after much listening he will be struck by the beauty of a particular rendition of a composition, or by the sound of a single instrument in the orchestra, things he would never have been able to hear before. Anyone not spontaneously moved by a feeling of wonder at this only has to think for a moment of the difficulties encountered in the field of artificial intelligence when it is attempted to have elementary sensory tasks carried out by a robot.

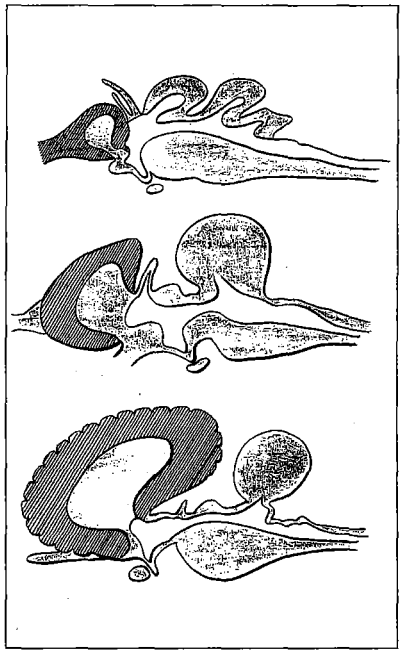

Figure 6 – The structure of the brain a) fish, b) bird, c) mammal.

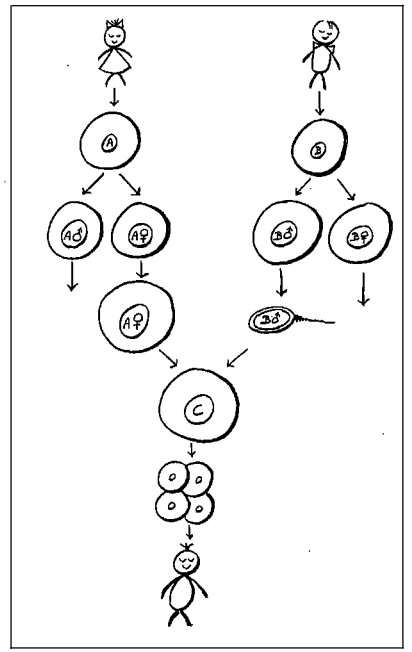

Figure 7 – Representation of sexual reproduction among multicellular..

Cell division, in which the cells remain attached to each other, provides for growth and the differentiation of functions within a multicellular individual. This coupling of cells becomes a living unit in itself, which will reproduce in its own way. In this process the multicellular individual has at its disposal the same processes of cell division and genetic recombination as the unicellular creatures (*figure 7*). On closer examination multicellular creatures also turn out to reproduce by means of cell division. This means that we were all once unicellular. Every one of us began his life as a fertilized egg cell, arising from the merging of an egg cell and a sperm cell, each a carrier of its own genetic information, and were themselves formed by cell division in the parents' gonads. By means of the mechanisms of cell division and cell differentiation this cell has developed into what we are now.

As multicellular creatures we adapt ourselves to the environment, thanks to the plasticity of the nervous system. This learning process is also a limitation. All learning occurs in the expectation of what has once

happened repeating itself. (In a completely unpredictable world learning would be pointless). Learning adapts us to what can be expected. What has been learnt becomes out of date, however, since the environment keeps on changing. This is solved at the level of the species. Bateson expresses it like this: 'By returning to the unlearned and mass-produced egg the ongoing species again and again clears its memory banks to be ready for the new'. From generation to generation we go back to the unicellular level and the one cell starts all over again growing, learning, creating a new structure, again ageing, again dying, but in the meantime producing new cells which will again go to make multicellular organisms. We all tend to see the death of the individual as a terrible disaster, but looked at from the point of view of the species it is essential that we repeatedly go through that cycle and return to the fertilized egg cell 'to be ready for the new'.

3 *The social level*

Multicellular creatures in their turn are in contact with each other. This leads to the social level, as the third level of organization. Multicellular creatures gear their behaviour to each other so that interactive patterns arise. The coordination of their behaviour means they form a group which is in itself a new unit. We again see a world coming into existence here, the world of the social. This again provides a new range of possibilities.

We have said that cells are living creatures. Among multicellular creatures we consider the multicellular individual as a living unit, and not its cells. If someone has a malignant tumour, we shall not hesitate for a moment in removing that tumour to save his life. We shan't be bothered about the life of the tumour cells. An analogous question arises at this level. Multicellular creatures will organize themselves into groups, families, societies. Should we also see this group as a living creature in itself? In his book *Gödel, Escher, Bach*, D.H. Hofstadter has an anteater converse with Aunt Hillary, an ant colony (he introduces his ideas by means of a number of dialogues between fabulous creatures). This ant colony turns out to be a great friend of the anteater. In this fable it is not the individual ant he puts forward as an individual, but the ant colony. The loss of several individual ants is no problem at all for the ant colony. In the fable, Aunt Hillary can easily be a friend of the anteater.

We are here going further than the pure description and arrangement of data. We are faced with an ethical choice. May we see a group, a family for example, as an individual in itself, and sacrifice individual members of the family to preserve the family, as we did with the tumour cells?

If we look at the social organization of multicellular creatures in biology, we see a continuum between two extremes. At one end of the spectrum there are the social insects, like ants, among whom there is a very strict division of roles. If we look at human society we see that a choice has been made for plasticity. Maturana suggests we should not see the greater whole as an individual in itself, but as the environment for the various individuals that create this environment by the coordination of their behaviour. Social organization creates an environment that makes it possible for every individual to prosper. Every form of society limits individual freedom, but without that society, that individual form would not even be possible. This is a choice, and there are other possible options. In a society such as that of ancient Sparta, the relationship between the individual and society was clearly differently defined. By Maturana's definition, a system in which the individual is defined solely in terms of his role in that system is not a social system. So a company where the employee is defined only in terms of his part in production is not a social system, but a large-scale machine with living parts.

In the third order of the coupling of multicellular creatures with each other there arise interactive patterns. A number of these patterns are fixed genetically and we call this instinctive or phylogenetic. But many species of animals, including man, also build up new sorts of interactions with each other dependent on their own histories. We call these interactions ontogenetic. If man has specialized in anything, it is in the variation and plasticity of social interactions. In this way, in the social world, we produce a broad range of behaviour.

We are not used to thinking in patterns. We want to explain everything on the basis of the individual. Bateson points out to us the fact that all the character qualities we attribute to individuals are qualities of relationships. Aggressive, loving, communicative, closed, we attribute them all to an individual, but in fact these qualities describe the relationships between that person and his environment.

Even so it is important, if you wish to understand people's behaviour, to think in patterns of interaction, since in the first place it is these patterns that we learn in the course of our lives. Two basic laws apply here. The first is: *people treat themselves and others as they were treated themselves*. The interactive patterns are learned. It is hereby essential that it is not the role or particular forms of behaviour that are learnt, but that the pattern is learnt. Let's take for example a domination/submission pattern, the caricature of the crawling butler who is humiliated by his mas-

ter but whom, once back in the kitchen, terrorizes the other staff. He has learnt to terrorize by being terrorized himself. As soon as he returns to the upper hierarchical position he automatically switches roles. This way of learning is not by words but by participation. Everything that has been said up to now assumes there is no language or consciousness.

This sounds extremely determinist, as if our behaviour were determined entirely by our history. The second law, however, is: *the individual shows his autonomy in his pain and his desire*. Learning is always an interaction between a pattern and an individual who, from conception, is unique and autonomous. This means that the way someone reacts to that pattern will always remain unpredictable. The fact that someone who is scolded suffers from it shows that he doesn't identify with this pattern so easily and his desire for more respect may direct him towards alternative patterns of contact.

At the time of the drama at the Heizel stadium I saw a man who had been badly abused as a child. During the conversation he burst out: 'How is it possible, all that pointless violence, when I see it on TV it makes me furious, I find it terrible that it's allowed, I'd like to use a machine gun and shoot them all down...' And so he was himself fulfilling the pattern of violence in which he had been brought up, without being aware of it. This illustrates the first basic law, but even so he was the first in that family to question the violence. His suffering under this violence indicated his individuality, not corresponding entirely to the pattern learnt. The motor that ultimately made him escape from the circle of violence that had been handed on from generation to generation lay in his desire for something better. I find it curious to see everyday that people, in whatever pattern they have been raised, are capable of refusing to assume those patterns.

Statistically it is predictable that violence will summon up violence, but at the level of the individual that is not true. An individual reacts autonomously to these patterns and the result of this interaction remains unpredictable. By autonomy I mean here not the autonomy of free will, but that autonomy that springs from the singularity of every living creature. Without this singularity psychotherapy would be pointless.

These patterns do not assume there is consciousness or language. We are not conscious of most of the patterns in which we live, can't be conscious of them, in fact. In order to be conscious of something we have to be able to distinguish it. Most interactive patterns are to us like water to a fish. A Chinese story says: if fish were able to make discoveries, the water is the last thing they would discover. Only on the fishmonger's barrow would they realize what it means to be an aquatic animal. We usually only become conscious of a particular interactive pattern at the moment that it goes astray or when an outsider who is not involved in the pattern is able to point it out to us.

In order to understand an interactive pattern it is important not only to note what is said, but also what happens. To give a slightly caricatural example: a family goes to the child psychiatrist with a fifteen year-old son who's stealing. Both the parents are extremely incensed and condemn the boy's behaviour, but they cannot do anything about it. That is what is said. Language sometimes works like a magician's wand. While he is waving it, he puts the egg in his pocket unnoticed. If you watch what's happening you'll see the following: every time the boy is speaking, telling everything he's been up to, a black look comes into his father's face, but his mother beams... That is not what is said, but it is an interactive pattern you can observe. In the course of the conversations this observation may well take its place in these people's story. A story of two parents who have drifted apart, a father who looks for consolation beyond the home, and a mother who supports her son against a common enemy, father. This throws a completely different light on the behaviour of the boy, something of which no one was previously aware.

Up until now I have presented a hierarchical model. I started with the unicellular creatures, then went on to the multicellular and from there to the organization of groups. Yet it is not a reductionist model. At each level a new world arises which, while needing the previous level, cannot be reduced to it. Social interaction is impossible without brains but cannot be reduced to the functioning of the brain. Until recently, neurophysiologists tended to locate everything in the brain — thought, emotions, sex, aggression... But the only thing one can examine is which pieces of the brain are necessary to make possible certain interactions, such as speaking or loving. The social interactions themselves are not located in the body. They belong to a completely new level with its own properties and characteristics.

4 *Language*

The building up of interactive patterns is something that can occur without language and without consciousness. Language is itself one of these patterns. Language superimposes itself on other interactive patterns as a differentiating structure. It is not the intention to expound a complete theory of language. I would like to touch upon a number of aspects of language which lie within everyone's field of experience.

If we wish to coordinate ourselves with each other as a group, one of the most importa t things involved is attention. We are able to distinguish very well where someone is directing his attention. If someone stands in the street looking into the air, everyone will cast a glance upwards. Attention is pre-eminently communicable. That is also important for survival as a group in an environment where danger threatens. If one member of the group notices the danger, the whole group can react appropriately.

Language also directs the attention. We sometimes have the feeling that animals understand our language. Whether we call this language depends on how we want to define language. Let me give a few examples first. I am in the garden and I throw a biscuit to my dog. I think the dog can see me, but he is occupied with something else and the biscuit remains lying in the grass. I call his name and point to the biscuit. By so doing I am at least attracting his attention. He thinks it's great fun and thinks I want to play with him. He starts playfully biting at my hand. Of course the animal does not grasp what pointing is. There is a very well-known Zen story about pointing at the moon and which says that those who study the sutras are studying the hand that points to the moon and thereby forget the moon. It was the same problem with my dog. But he is a good Zen student because at a certain moment he understands that when I point, he should look in the line projected by my hand. My dog has learnt what the gesture of pointing means. Both calling his name and pointing are interactions which tune the attention of the dog and its master to each other. When I walk the dog I say: 'Come on, we're going for a walk'. Everyone who has a dog will recognize this. The dog goes mad, starts jumping and wagging its tail and if it all takes too long, will even go and fetch the lead. So it understands the word 'walk'. We might call this interaction between my dog and I, language.

And yet language, as it is used in huma communication, is more than that. If I say 'walk' to my dog, I am initiating a behavioural pattern using that sound. At the moment I say 'walk', that pattern begins in the dog and he behaves accordingly. He has a problem if that behavioural pattern is not continued. I cannot talk to my dog about 'we went a walk yesterday' or 'walking is fun'. With people I can talk about without initiating the act of 'walking'. In this case I can even use the word walking to speak of something completely different from walking. Language allows us to direct our attention to something which is not there at the moment. Since we can direct our attention to things which are not present at that moment, we can already coordinate in speech our behaviour towards those things.

The Chinese character for 'calling by name': 名 ming, illustrates this very well. Chinese characters have a sort of popular etymology, which is criticized as unscientific by scholars, but which does give the Chinese the semantic context of the word. The character *ming* 名 is composed of two characters each of which has its own meaning. The character *xi* 夕, a representation of the crescent moon, means evening, darkness. The character *kou* 口 represents a mouth and here signifies speech. The meaning of ming is explained as follows: 'At night one cannot see things and therefore one calls them by their name'. If I want to draw attention to it, I have to give it a name and use that name. That is what our language does. The words allow us to direct our attention and to coordinate our behaviour according to things and patterns which are not present at the time.

In this way, language allows us to partly move away from reality. 'Thinking is internalized action', said Piaget. What we can carry out in reality, we can simulate in language. We make selections from the almost unlimited number of stimuli that we are subject to. We can give this selection a name and then use it to get to work, building up a story, by means of the set of relationships language makes available to us in the form of verbs. In that story we can depart from reality as far as we like. This is a tremendous advantage and a terrible pitfall. There is a popular saying that goes: "If our cat was a cow, we could milk it behind the stove". It's fantastic that our language allows such things. There is nothing one can say against it, but it doesn't get us anywhere. The story is so far from reality that it makes no sense at all. Using language, we can select things from reality and make connections between them, connections which do not necessarily correspond to reality. We can fantasize about wanting to go to the moon. Jules Verne was able to write a novel about it. But we can also keep that thinking very close to reality and actually build a space probe and land on the moon. That is no longer a fantasy. In that case the internalized action is transformed into concrete action. Science has succeeded, incredibly efficiently, in creating stories about reality that work.

Just as a new world arose out of the coupling of cells to form multicellular creatures, just as the nervous system opened up a new world of possibilities, just as we generate a new world through our interactions, language allows us to create another new world of stories.

The formation of concepts is a more fundamental process than language. Some primates even have a concept of self. They can recognize their mirror image as themselves. But in man, the formation of concepts goes hand in hand with language. The concepts and patterns present in language give a structure to our experience and our actions. This is not

an individual process. Language belongs to the community. Language is older than ourselves and from our very beginning it supplies us with common concepts and structures. In this way, strictly individual experiences fall outside the bounds of language. For example, we have no language for the effects of hallucinogenic drugs. Cultures (and subcultures) where drug use is part of the collective experience do have a language for it. But then again, every experience, even though it may be partly structured by common experience, is ultimately strictly individual. The words 'being in love' can never convey the enormous intensity of the emotions one experiences. And yet the poet succeeds in making us feel something of that intensity. He does and he doesn't, since I shall never completely understand what is going on inside him.

Language also allows us to create a concept such as 'society'. The strange thing about such a concept is that I can use it to talk about society as if I were taking up a position beyond society while I am actually a part of it. We can say: "Look, if all possessions were common, such a society would be much better'. That's true. We can imagine possible worlds. Using the concepts and relationships the language supplies us with, we can compose new stories which, like 'our cat that might have been a cow', have an internal coherence, but which do not thereby correspond to reality. In my view the fall of communism was an illustration of this. The organization of a society follows different laws from that of a language. Losing sight of this can lead to painful surprises. The whole question of ecology is also an example of this. Despite the fact that the laws of conservation in chemistry and physics have long been known to us, it has only recently got through to us that a thing like 'throwing away' doesn't exist. Throwing away only means: remove from the field of attention, until it starts to stink and thereby attracts our attention again. Real throwing away only exists in the mind. In addition to this, many of the solutions proposed suffer from the 'cat and cow' shortcoming. They are consistent within themselves but do not correspond to the laws of human behaviour. Well-informed people turn out still to be buying PET bottles.

Language also allows us to talk about ourselves as if we were outside ourselves. Language stabilizes our concept of ourselves. I am the same person I was when I was that child of four, though I am now someone completely different. In this way we create and stabilize identity. In reality we are constantly changing. Even so, our identity remains the same and we are able to build that into coherent stories about ourselves and the other. Language even admits of constructions such as: 'I was no longer myself'. But who is this 'I' who was no longer himself and who is this 'myself' that he no longer was? (And who is the writer of this sentence?)

The concepts of time, past and future are something like this. These are all things that don't exist. The past has gone and the future hasn't arrived yet. But our language allows us to conceptualize time. The past may well have gone, but stories about that past have not. They keep the past captive in the present, so to speak. In this way we can draw a line from the past to the future. The present, the only thing that really is there, is a point on that line. 'Now' becomes a concept in itself and thereby involves an internal contradiction, since the concept comes after the fact. 'If I say now, it's already gone', said Kamagurka, 'now, now, now...' And yet this allows us to make plans. We compose coherent and efficient stories about the future and thereby also a mass of expectations. All these stories make our world a bit more predictable and so more easily manageable. But the violent smash of a car against a tree can bring a sudden end to every expectation.

Stories stabilize patterns, interactions and relationships. In the meantime time passes and the elements of reality to which the stories refer may have long changed or disappeared. Stories outlive reality and with it themselves. Until they depart from the scene unnoticed or in a bloody revolution, 'to be ready for the new'. New stories arise on the fringes and tend to move towards the centre in their turn. What was still revolutionary yesterday now sounds hopelessly out of date.

At this point a warning should be given. When I talk about stories I don't automatically mean a naïve constructivism or a caricatural relativism. Not every story is good, it isn't a question of making up tales. Stories are a product of the community and are preserved in social interaction and at the same time continually adapted.

5 *Consciousness*

Nowhere in what has gone before have we referred to consciousness. Communication, behaviour and even speaking do not necessarily require consciousness. That depends on how we use the term 'consciousness'. When you look more closely at the term 'consciousness', it turns out to fall apart into a multiplicity of meanings which we often readily mix up.

You can say of someone that he lost consciousness, and then he is unconscious. In this sense the question of whether animals have a consciousness is soon answered. My dog can be unconscious too, if he gets a

knock on the head. In neurophysiology the term used for this is 'arousal', the degree of wakefulness, the degree to which we are capable of reacting to our environment. There is a sliding scale from lucid consciousness through somnolence to coma and death. The neurophysiological arousal substrate is to be found in the brain stem. A laboratory animal from whom only the cortex has been removed remains awake but it cannot adequately differentiate a large number of stimuli.

We need the cortex for consciousness in another sense. Being conscious of something means discriminating it with one's attention. Much of the research into the localization of consciousness in the brain is actually research into the mechanisms and structures involved in discrimination and attention.

When we speak of states of consciousness we mean systems of discrimination. We interpret the world in different frames of reference and make other distinctions according to the context we find ourselves in, but also depending on our physiological state. If I am in conversation with someone then I am in a completely different state of consciousness from when I am dancing, entirely absorbed in the music and movement. Alcohol and drugs change my brains to such an extent that I will perceive my environment differently. States of consciousness are world views on a micro scale. My world view and/or my state of consciousness selects and colours my experience, gives it shape and integrates it into the network of other experiences.

A special form of consciousness consists of those discriminations for which we have words. The process of discrimination can also occur 'unconsciously'. We can react to something without being aware of it. For that matter we are not conscious of most of our reactions and reactive patterns. Here we can see that we sometimes reserve the term consciousness for language-linked phenomena. It is only when we ourselves give it a name that we may call it a conscious reaction.

This leads us to the next meaning of consciousness: I consider myself a conscious person, which means I am the author of my own behaviour. If my dog jumps up to me at the table I say: 'He wants something from me. He knows that he sometimes gets something at the table'. I attribute consciousness to my dog because I am conscious myself. Radical behaviourists will also reject consciousness as a way of explaining human behaviour. Freud undermined the status of consciousness by formulating 'the unconscious' to go alongside it as a psychological authority to share in the determination of human behaviour.

My suggestion here is to reverse the whole thing. Consciousness is not an *a priori* certainty but a consequence of a process of attribution.

Just as we attribute consciousness to the dog, we attribute consciousness to each other and thereby to ourselves too. It is a concept we create to explain our behaviour and according to which we then act. The conscious ego is a social creation which makes itself subject and object of countless stories. In this situation, *Cogito ergo sum* is given a new translation: 'I think and in that way I create my ego', Descartes' ego, which can then say, reflecting on itself, with Descartes: 'Cogito ergo sum'.

This conscious ego is not something located in the brain. Neurophysiologically speaking there is no centre, no final destination for representations, no centre of integration and decision-making. Integration takes place in the entirety of nervous system and body. A central ego, a consciousness, can nowhere be detected. There are of course neurobiological conditions that make this form of social organization possible but it cannot be reduced to them alone.

In his *The origin of consciousness in the breakdown of the bicameral mind* (a work in epic style), Julian Jaynes painted a portrait of consciousness. He begins with the primates. When a group of apes moves through the jungle they will always remain in contact with each other by means of their senses. The groups are hierarchically structured. If an ape loses direct sense contact with the group he is lost.

Among men, language developed at a certain moment. Languages admits of something entirely different. Language allows a sequence of orders to be retained even when sense contact has been broken. According to Jaynes, in a primitive society these orders are heard as a hallucination. He states that the auditive hallucination is the forerunner of consciousness as we now know it. The hallucinated order was attributed to the gods. In the *Iliad* and the oldest Bible stories the main characters' behaviour and important decisions were not attributed to an internal process but are represented as the consequence of obeying the voice of a god, actually heard. Members of the same group heard the voices of the same gods. Those orders were not quotations from orders previously given by their leader. We could call them creative hallucinations. The voices of the gods spoke in accordance with a particular pattern, specific to the group, offering a creative response to unexpected problems.

The growth of the groups and contact between various societies meant that obedience and orders became less important. Behaviour was increasingly attributed to the individual himself. Something hypothetical was ascribed to the individual, a consciousness of his own which does not wait for the orders of the gods but thinks up answers itself, which 'orders itself' and is therefore autonomous. The individual must increasingly take decisions himself, and determine the sequence of his

own actions. Acting well becomes a generalized order whereby the individual himself must supply the concrete behaviour. New stories develop around this: what is good, what is rational?

The increase in individual autonomy runs like a thread through the history of Western man and, parallel to this, the history of Western philosophy. The Age of Reason was a crucial and explicit step in this process. It was expected from then on that everybody could think and judge for himself. To have an integrated and autonomous ego is an important social requirement demanded of each one of us. It is assumed that we shall integrate our behaviour into a coherent whole. We are personally responsible for this. This creates a paradox. Autonomy takes on the meaning of: doing what is expected of you of your own free will.

This rational autonomy is something that's learnt. You only have to think of the amount of time schoolchildren have to spend sitting quietly on school benches and it becomes clear what an enormous effort is put into this. Our way of living together is based on it. And yet to a great extent people do not behave consciously or rationally. The concept of 'the unconscious' has been absorbed into our daily language use since the end of the last century. Freud's 'subconscious' arose as an attempt to explain the less rational behavioural patterns as emanating from a more or less integrated centre. It is not a purely non-consciousness but a hypothetical body, attributed to the individual and analogous to consciousness. The ideal of the awakening remains. Freud's adage is: 'Was Es war sol Ich Werden'.

6 *Psychiatry*

Since it first appeared, psychiatry has found itself on the horns of a dilemma. On the one hand it is a branch of medicine, probably the only specialization in which is it something other than the anatomically or biochemically analyzable body that is in question. As such it has to do with suffering and the attempt to remedy that suffering. On the other hand it has always been a body of social control. Until 1948, the psychiatric hospitals in Belgium were under the supervision of the ministry of justice and not health. There are still a great many people who immediately associate the term psychiatry with the normal/abnormal dichotomy.

The origin of modern psychiatry lies in the period when society was undergoing an ever greater integration and in so doing exercised more control over its citizens. The requirement to act rationally and morally, not by order but autonomously, meant that those who were not able to comply with this demand, for whatever reason, fell by the wayside. The streets of the cities were populated with oddballs, 'des aliénés'. In the end they were taken off the streets in their hundreds and locked up without rights. Doctors such as Pinel were concerned about these people, freed them from their chains and were the first to try to grasp the significance of what was taking place. Gradually these oddballs were seen as not simply deviant but as ill. Psychiatry was added to medicine as a new branch, and commenced to occupy itself with an ever broader range of human problems. In spite of this, psychiatry has never been able to rid itself completely of its role in social control. It was also the tradition in medicine to understand and classify the suffering of the ill as deviations from a norm. Diabetes is characterized as a surfeit of sugar in the blood. It is no different in the DSM (Diagnostic and Statistical Manual), the manual of diagnostic criteria for psychiatric disorders. The only (never declared) difference is that the normal level of sugar in the blood is fixed, without a great deal of argument. But what is normal behaviour, what is normal aggression, how much grief is anyone allowed after the death of a loved one? Norms in somatic medicine lie on the second level of organization, that of the multicellular organism, while psychiatry deals to a great extent with the third level, the social, which in man is characterized by a great plasticity and variation. The norms applying at this level are values that are constantly open to discussion (and are generated in that discussion), not measurable averages.

And yet there is an alternative. The creation of norms in somatic medicine is also based on the suffering of the patient. The obvious basic assumption is that these deviations cause suffering, which is true since the body's internal organization can tolerate only very little variation. On the level of human interaction this does not hold good. Psychopathology should also be a science of suffering but cannot then be a science of deviation. But is all suffering therefore the subject of psychopathology? You can consider psychopathological suffering as suffering which is not integrated into the story someone has about themselves, or the story he shares with his environment.

Depression was once defined as suffering without reason. This is referred to as an endogenous depression, which means it's without external cause and comes 'from within'. People who are unhappy while having no reason to be. But who can assume the right to say that someone who is visibly suffering has no reason to do so? 'No reason' actually means: no accepted reason. In my experience, someone who is depressive always has a reason to be unhappy, but it is often something which is not accepted as a reason by that person himself or by his environment.

Here's another simplified example: a fifty-year-old woman is depressive. People say though that she has every reason to be happy, since her husband earns well, her children go to university, she has everything she wants. But perhaps that woman has different expectations in life, expectations she does not admit to herself and which she certainly does not admit to her environment, since after all she has everything she needs to be happy. Her marriage has become a cool business, completely different from what she had imagined on her wedding day. Her husband is only interested in her to the extent of making love to her for five minutes before turning over and falling asleep, only to complain in the morning that his shirt isn't ironed... She can't take this story to anyone, not even herself. This woman comes to the psychiatrist and says: 'I am unhappy, but I have everything to make me happy'. Her suffering is not integrated into her story about herself.

Where suffering is not integrated, an outsider is needed, someone who is not part of the story. If you accept the 'no reason' story, there's an end to it. The therapist's role is, together with her, to arrive at a story in which the suffering does take on a meaning. This may lead to her dealing with certain things in a different way. She may do things with her life that she actually always wanted to but in which she had never taken herself seriously. It may also lead to the perception that nothing can be done about certain things. It is much more human to live with suffering that you can situate than with an incomprehensible suffering that descends on you out of nowhere. Then there is room for sorrow.

Psychiatry also has its somatic aspects of course, but not in a reductionist sense. On the one hand interaction has its neurobiological precondition. Brain damage can fundamentally change someone's interaction with their environment. The same principles apply there as in the rest of somatic medicine. On the other hand, interaction between multicellular creatures naturally has physical consequences. These physical changes may lead to a problematical disruption of the physical equilibrium. A diagnostics which was ideographic (based on the patient's own story) on the interactional level, and functional and nomothetic (based on the physical norm) on the somatic level, would provide psychiatry with a great deal of clarity.

7 *World views*

The story I have sketched up to now is in itself the first step towards a world view. At the same time the story results in a possible definition of what a world view is. A world view is an effective, common story that allows us to gear our behaviour to each other so that we can move in a coordinated way through the multitude of domains in this world.

The problem with science is that it has become so fragmented that we can hardly speak to each other anymore. The objective is dialogue. That's why we always refer to world views and not 'The World View'. It is not our purpose to establish a permanent, monolithic world view. That really would be a disaster.

Just as ethics do not arise out of the conclusions of ethical debate but out of a continuing discussion between various outlooks, the construction of world views is a process of dialogue that never reaches a final conclusion.

8 *Mysticism*

Many people are amazed that spirituality and mysticism do not make up any significant part of *World Views*. Apparently the expectation that the two should have something to do with each other is very much alive. Allow me to give an extremely radical and personal answer to this.

Mysticism and world views have nothing to do with each other. A world view is a story about the world. The fact that something like mysticism exists in this world may be part of that story. Mysticism is the end of all stories, however. All knowledge, including a world view, is based on the expectation that everything that has ever been, will be repeated. In this sense, knowledge is always knowledge of the past. Mysticism is not knowing, not understanding. Meditation, rather than not thinking, is not knowing, and in this state to be open, with open hands, to what now is. Like death and the return to the fertilized egg cell, meditation is a return to a state of not knowing, of 'clearing its memory banks and being ready for the new'.

Mysticism and world views have nothing to do with each other but both are essential. Hereby ends this story.

Staf Hellemans

The many faces of the world
World views in agrarian civilisations and in modern societies[1]

'Our past constraints had limited our options, and our superstitions endowed our constrained options with the illusion of legitimacy. Our new powers leave us free-floating. We may find ourselves in a kind of premiss-less vacuum, with too much power to create, and no reasons for choice in what we create.'[2]

'Point n'est besoin d'espérer pour entreprendre, ni de réussir pour persévérer'
(incorrectly ascribed to William the Silent).

In this chapter I shall be sketching the evolution of world views from the Middle Ages up to today. The starting point is the notion that there have always been many interacting world views. There will then follow a description of the lines of force in, and the relationships between, these world views, a discription which will take us from the pre-modern agrarian civilisations (focusing special attention on the Middle Ages in Europe), over the 'early modern' society between 1800 and 1945/60 to the late modern period from after 1960. This analysis will lead us to the conclusion that, as a mass sensation, the uncertainty regarding world views is a recent phenomenon, characteristic of late modern society. However, since the roots of this uncertainty lie in the late modern society itself, and more especially in its competitive non-segmental pluralisms, we shall have to learn to live with the idea that the construction of world views has become a permanent task for every one of us. I shall start with an analysis of the concept of worldviews, something which

cannot be avoided considering the terminological confusion in this area. Readers who are not interested in this may immediately skip to paragraph 1.3.

1 World views in the plural

It is difficult to speak precisely about world views. The term has a 'catch all' character and is consequently used in extremely divergent ways. In order to achieve a minimum of clarity I suggest making a triple distinction: between individual and collective world views, between primary and discursive world views and between fragments of world views and world views taken as a whole. This distinction appears to me to be a precondition for a sober, empirically oriented analysis of world views aimed at here.

1.1 Types of world views

My conviction is that the first and most important distinction is on the social level. It differentiates the world views of individuals (or people) from those of collective groups.

Individual world views are the sedimentary echoes of the experiences of a person in his dealings with the world (nature, society, himself). The fact that a world view is constructed on the basis of experiences implies that every person has a world view. The construction of world views on an individual level is not a specialist enterprise, demanding special skills, nor is it reserved for intellectuals. On the contrary, it is a natural basic activity for every person, accompanying each of his personal activities such as eating, working, talking, making love and so forth[3]. The individual world view fits a person and changes in line with his personal identity. Because our experiences constitutes the building blockxs of our world views, it also follows that the more varied people's experiences are, the more varied their world views will be (cf. young and old people, employers and employees, men and women). World views differ because they are modified representations of the many ways people live in the world.

Yet it is not only people from different environments, but also each individual person that has to deal with highly divergent experiences during his life. This leaves its mark on the world views of individuals. They are multidimensional, complex and not devoid of internal contradictions, both large and small. We do not actually demand a high level of consistency from our individual world views. Experiences beyond the normal run of things are often cleared aside and, if discerned, we tend to dispose of them as accidents or irrelevant. This escape route is made easier since our actions do not follow directly and linear from our world view, but are only linked to the world view as a whole indirectly by the partial interpretations of the action area and the perception of the present possibilities for action. In other words, the individual world view forms only a moderate unity and is a loosely integrated collection of several fragments of world views. All this ensures that an individual world view is as elusive as a person's identity.

By analogy to individual world views, one can also speak of collective world views, the outlooks and sensitivities regarding the surrounding world that are present in a collective group. Just as there are many individual world views, there are also many collective ones. After all, the collectivity does not exist as a single major unit, but appears to us in many divergent forms: informal sociability forms (family, friends, neighbourhood, and so on), crowds, communities, nations, intellectual movements, social classes, all kinds of association and organisation, societies...[4] The closer and more enclosed a collective group is, the greater the internal interactions are and the more actively the collective proceeds, the more intense will be its influence on the individual world views of the people included in it. Therefore, in every, even slightly complex society many numbers of collectivities can be discerned and so there is a complex process of mutual influence (between families, villages, age groups and professional groups, for example). In the case of collective groups we must also consider that we, individuals as we are, do not perceive these collectivities directly, but perceive them only through individuals already belonging. We can deduce what values, norms and views exist in a collective group, from their behaviour and manifestations. Our deductions are never unambiguous, if only because each person represents the world view of the collective group in his own way. This is why collective world views seem even more internally heterogeneous and elusive than individual world views.

Secondly, by their level, one can distinguish between primary and discursive world viewsof assimilation[5]. Primary world views are the actual world views of individuals and collective groups, as they have arisen and function in daily practice (which of course demands a degree of reflection). Discursive world views, on the other hand, are in-depth theoretical constructions, more or less highly-developed propositions or bodies of ideas. These discursive world views have been explicitly reflected upon and they form the object of argument and counter-argument.

Examples are the stories and writings of philosophical, scientific and religious writers and the programmes and codified texts by all kinds of groups and movements. I consider the primary world views to be more fundamental than the discursive because they are formed more by the whole of life. The story that someone writes about himself, will never completely catch up with the lived life and the lived world view that's grafted onto it organically. In the same way, an organisation or movement's formulated concept of itself is already a selective interpretation of its much more extensive and diffuse primary world view, which is much more directly attached to the manner and operation of its collectivity. Discursive world views are made more explicit and are more consistent, but are also more selective in their reflection and less multidimensional than primary world views.

	Primary	Discursive
Individual	W V of person *x, y, ...*	Theories of individual authors, but also arguments in discussions.
Collective	W V of churches, movements, classes, hobby clubs, groups of friends, ...	Programmes and texts of all kinds of groups

Diagram 1 – Individual and collective, primary and discursive world views.

Finally, as far as content is concerned, one must not confuse fragments of world views with overall world views. The danger is greatest in the area of philosophy. Although a person's choices on the level of the ultimate meaning of life rub off considerably on his world view, there is more to world views than this one area. A world view incorporates every aspect of the world, even the apparently less important moments of daily life (such as notions of time and space, eating and drinking, clothing and hygiene). A world view is an overall view of the world and all its ramifications. In practice, however, and certainly in modern society, we are frequently confronted with views that concentrate chiefly on one area, with what we might call fragments of world views (scientific theories, political programmes, aesthetic trends...). This presents the question of the integration of such fragments into the overall world view.

Considering the overwhelming range and the intermingled existence of world views, there is little hope that the analysis just made will solve

the confusion that so strikes us all in the discussion about world views. Reality remains a mess. At least the analysis permits a little clarity regarding concepts. But its most important inference lies in the necessity of broadening the range of study of 'world views'. My proposal is not entirely new. In fact I am following the pioneers in the history of mentality. Such historians usually use the term collective mentality as a less demanding synonym for what was here apostrophised as a primary collective world view[6].

Nevertheless, in the debates about world views it is commonto be concerned almost always with discursive constructions alone. Such authors give the false impression of drawing up the world view of an entire society, whereas in fact they are discussing the discursive proposals of a number of individual authors regarding questions of ultimate meaning[7]. It's true that the different types of world views are not independent of each other (cf.1.2.). And so we can take the discursive as indicative of the primary, the individual as referring to the collective (and *vice versa*) and the ultimate as crucial for the whole. But in each case the representativeness must be checked. The reductionist method forgets that there are many types of world view and that the actual interaction between levels also has to be examined (for example, how is the discursive ideology of an organisation related to its practical working?).

1.2 The mutual interpenetration of world views

The fact that there are, and have always been, many (types) of world view in circulation in virtually every society means that research into world views is no mean task. The continuous interplay between all these world views makes it even more difficult. This is because world views are not separate entities, independent of each other, but constantly shift in and through each other. Primary world views, for example, form the basis for discursive considerations, while in the reverse process, fragments of discursive world views are again absorbed into the primary (by, for example, the reading of a (popular) scientific or religious book or a newspaper article). Some individuals and collectives have even concentrated on this discursive level (e.g. intellectuals, churches, scientific associations). In this case the links between the two levels become extremely close. So, certainly in modern society, primary and discursive world views are permanently blending into each other.

This almost intimate mutual interweaving — in sociology it is called interpenetration — operates even more intensely between the individual

and the collective level (the latter is a simplification, since, as already mentioned, there are many, intermingled collective forms). The connection is so extensive here that both levels mutually constitute each other. For the sake of brevity I shall only go into the collective contribution to the individual world view.

First of all, our experiences are always interpreted. When denoting experiences, we call upon interpretative tools (language, pearls of wisdom, rumours, legends, pieces of theory), which we have not created ourselves but received from others. It is only by means of these collective interpretative frameworks that we are capable of indicating our own experiences. Not only does the collective sneak into the individual through the instruments of interpretation, but, secondly, the process of our actions itself, as well as our experience is fundamentally socially oriented. In every activity we are continually comparing our own interpretations with those employed in our environment. George Herbert Mead called this mechanism 'taking the role/attitude of the other'. At every contact we step into other people's shoes in order to look at our own behaviour, including our own interpretations, through the other's (critical) eyes. So in the case of advances to the opposite sex we also ask ourselves: does the other person understand my signals? How would I react if I was the other person? Though it must be said that we never really reach that other person; it remains our own interpretation and we frequently misjudge the other's reactions. Nevertheless, it remains that in this way each of us is actually and unconsciously tuning his world view to the guiding interpretations in his environment. We might say that most of our energy and creativity is oriented towards not letting the distance between ourselves and the other(s) become too great.

So the social forms the basis for the make-up of the individual. The individual world views of people who affect us, and the collective world views from our environment leave extremely deep impressions on the picture we have of the world. Anyone wanting to examine the actual state of world views has to start from an abundance of interpenetrating world views.

1.3 The evolution of world views

So it is wrong to imagine the evolution of world views to have started from societies with just one world view — the pre- modern — to societies with many world views — the modern. Even in tribal societies with little internal differentiation the world views of fellow tribesmen differed from each other. The same applies to world views in Medieval Europe, although Christianity was the only religion permitted at the time. Every large social formation has an abundance of world views, which are in complex interaction with each other. The most one can say is that with the increasing population the number of individual world views is rising and, with the internal differentiation of society, the number of collective world views is rising too. But to me such a quantitative growth seems not to be decisive, as will turn out later. So the central question of this article is: given that there have always been many mutually interpenetrating world views, in what way does the contemporary situation with regard to world views differ from that of previous centuries? We will see that the answer lies in the distinction of different forms of pluralism.

Given the abundance and the interweaving, it is impossible to describe one by one the individual and collective, primary and discursive world views in each society. We are therefore limiting our intentions both in time and content. As far as time is concerned, we have decided not to follow the countless historical twists and turns, but are limiting ourselves to cross-sections of three types of society: the agrarian civilisations, in particular medieval Europe, modern society between 1800 and 1945-60 and the present-day late-modern society from 1960 on. As far as content is concerned, we are concentrating on two key issues. First, to trace the important lines of force that run through the many world views in each of the three types of society. Second, to sketch the constellation of world views, the particular nature of the interweaving that exists between world views in each type of society. Special attention will be paid here to the relationship between individual and collective world views.

2 From the societies of hunters and gatherers to the agrarian civilisations

Three main types of society can be distinguished in the history of mankind: hunter-gatherer societies, agrarian societies and modern societies[8].

As the name tells us, in the hunter-gatherer society people lived from hunting and picking the food found in nature. People lived in small, wandering groups (usually between 15 and 50 people) and were connected to adjacent groups by a loose tribal bond. The division of labour consisted chiefly of that between man and woman and so remained limited. They had hardly hierarchy. The nature of their view of the world was

consequently bound to the tribe and genealogy. Their discursive world views were mythical and magical in character and were sometimes highly elaborate.

At the end of the last ice age, about ten to twelve thousand years ago, people in the Middle East began to switch from hunting and gathering to agriculture and stock breeding. This agrarian or Neolithic revolution, as this transition is called, occurred independently in some regions (e.g. in the Middle East, China, Central America). The agricultural techniques then spread from the central area to a larger region by means of diffusion (from the Middle East to Europe between 6000 and 4000 BC). In both cases, the transformation to and the improvement of agriculture went extremely slowly. The 'revolution' took several thousand years.

The most direct effect of this transition to an agrarian society was an increase in population. When one lives from hunting and gathering, the population has to be kept to a limit (the estimate is one person per square kilometre). The active production of food meant that a relatively small area in a fertile region could feed more people than before and thus both the population and its density increased.

The second effect of the agricultural revolution is, if anything, even more important. The slow growth in agrarian productivity meant that farmers now produced more than they strictly needed for their own survival. For the first time, people could live without being exclusively oriented towards the gathering and production of food. This led on the one hand to the beginnings of a division of labour: some people applied themselves to a craft (pottery, forging...), others became merchants (though this remained extremely minimal for a very long time). On the other hand it might also have been that a part of the surplus was appropriated by a rising class of warriors and priests, who began to hold sway over the farmers and craftsmen. One may speak of an agrarian civilisation from the moment when such a class of rulers was able to control a larger area. This latter innovation demanded a thorough military and political reorganisation of society and was accompanied by the spread of towns and the use of writing.

It was by no means inevitable that such agrarian civilisations should have developed. States, with their whole apparatus of civilisation, only developed in a few agrarian societies. This took place as from the fourth millennium BC, first in the Tigris and Euphrates valleys, shortly afterwards in the delta of the Nile, and later on, also in the Indus valley and in Northern China. Their wealth and power impressed their neighbours so much that a new process of diffusion started up, giving rise to a whole new series of civilisations. Agrarian civilisations dominated history

from 3000 BC to 1800 AD (think, for example, of Babylon, Greece, Rome, Byzantium, the Islamic caliphates, the Hindu civilisation, the Chinese empire and a whole series of African kingdoms). Medieval society, which grew up in Western Europe after the fall of the Roman Empire, is an example of such an agrarian civilisation[9].

3 *Scarcity and the cellular structure of agrarian civilisations*

World views express and interpret the world in which people live. Agrarian civilisations differ fundamentally from modern societies. The world views held by people then, and the relations between those world views, were consequently also different from ours, to the point of incomprehensibility. Let us therefore, in a first round, departing from a number of important features of such agrarian civilisations, try to map out the basic characteristics of the world views of the time[10]. The sketch has two limitations. Firstly, history has produced many and moreover highly divergent agrarian civilisations whereas here only their common features appear. Secondly, although the sketch is intended to be general, most examples will come from the Middle Ages, of which I have more particular knowledge. By way of advance support, the basic characteristics of agrarian civilisations and world views seem to me to be based on five elements: scarcity, (horizontal) segmentation, hierarchy, tied individuality and stability (stagnation).

3.1 Scarcity

Pre-modern societies were marked first of all, and one might say above all, by scarcity. Though productivity was higher than in hunter-gatherer societies and the first, still primitive agrarian societies, people produced barely enough to survive. It is estimated that in the early Middle Ages the harvest only produced two to four times the volume of the seed used[11]. Bad harvests were common and sometimes led to starvation. As a result nine out of ten people in the agrarian civilisations were occupied in agriculture. The dynamism of the Middle Ages is demonstrated by, among other things, the fact that this proportion had decreased to 85% by 1300 and to 80% by 1500, meaning that first 15% and then 20% were freed for non-agrarian activities (nobles, clerics, merchants, craftsmen, service staff, warriors etc.)[12]. By comparison, these days, in the industrialised

world, only 5 to 10% of the population works in agriculture. In addition to periodical food shortages, the population was also plagued by illness and epidemics. Many died before reaching adulthood and the adults were never very sure whether they would survive to the next year.

These painful and uncertain circumstances naturally penetrated deep into the people's world views ('more parents were lost through death than are lost through divorce today'[13]). Survival was the first commandment. Death was familiar and was very close at hand. It struck unexpectedly, so that long-term objectives were seldom achieved (thus the large sums of money that the emperor Charles V had spent for the election of Pope Adrianus VI in 1522 were wasted when the pope died the following year). The relationship with nature was intense: man was entirely at its mercy. Nature could be magnanimous, but also mysterious, vengeful, capricious. Fatalism and magic rituals to influence this unapproachable nature were therefore widespread among the farmers[14].

3.2 Horizontal and hierarchical segmentation

The basic structure of agrarian civilisations is cellular in two ways. Underlying it there is the horizontal segmentation of local communities, in which the farmers and the simple craftsmen lived — by far the largest part of the population. At the top, these local entities were vertically capped by a ruling class, usually large landowners and clerics, who had mutual contact and who lived off the surpluses of these local entities (see *diagram 2*)[15]. The scarcity and insecure existence stimulated this kind of cellular structure. The limited technology and infrastructure also meant that all transport and every form of communication beyond the local occurred with the greatest of difficulty, particularly over land. Transport using draught animals went so slowly that they would have used up the equivalent of their maximum load in food within 150 kilometres[16].

The basic cells were the local agrarian communities. They were highly inwardly oriented. The villages were to a large extent independent economically: the local community usually produced what it consumed itself. Politically speaking they were excluded from the running of the agrarian civilisation. Local worlds generate locally-oriented world views. And therefore the loyalty of the inhabitants of the village was particularistically oriented towards their own village or area — a disunity that works against them during rebellions against the ruling elite. Segmentation is also the key word with regard to culture: 'Each village, district, province or marketing area would have its own spirits, deities or patron saints, holy places, festivals, ancestral customs, weights and measures, dialect, types of clothing...'[17].

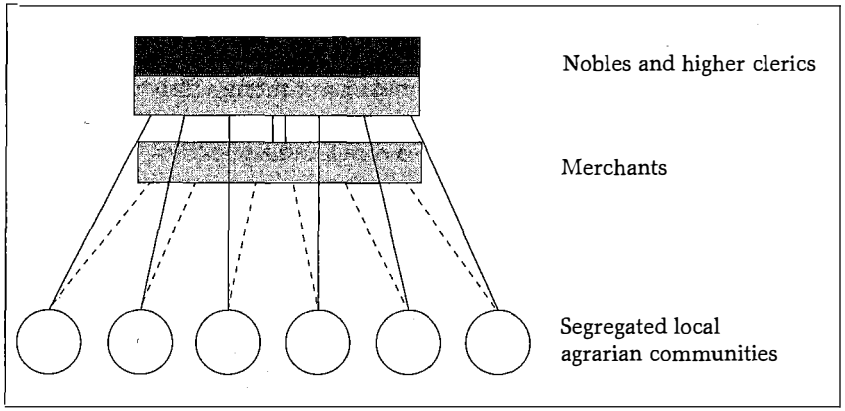

Diagram 2 – structural model of agrarian civilisations.

Civilisation only enters the game in the second section, along with the hierarchy. The agrarian communities, which made up part of a civilisation — there were also villages and regions that were able to preserve their autonomy, particularly in inaccessible areas, such as mountainous regions — were held together loosely at the top by a military and religious elite. In contrast to the local communities and in spite of the difficulties mentioned before, this elite did have to maintain a great deal of horizontal contact in order to avoid the civilisation rapidly falling apart — a danger that was constantly present. This ruling elite formed its own society above the local communities: they looked down on the plebs, embodied a separate ethos, often spoke a different language, emphasised the differences in status and so forth.

So the degree of penetration from above to below was very low in the agrarian civilisations. The local communities were usually badly informed about the world and the civilisation under which they lived. Seen from the other side, the elite was not usually interested in the cultural integration of the subjected population (cf. Christ's words: 'Render therefore unto Caesar the things which are Caesar's;' — he only demanded taxes, not cultural integration — 'and unto God the things that are God's'). An exception has to be made for the clerical elites of some of the great religions (Christianity in particular), who did try to integrate the ordinary people into the one true religion and to this end were sometimes able to

mobilise the worldly elite (cf. the systematic missionary zeal of Christianity in the early Middle Ages and the compulsion to conversion of the conquered peoples under Charlemagne). Even though penetration was greater in these cases, the difference between the world of the clerical elite and that of the local communities remained enormous. The so-called 'great' tradition, the intellectual elite's discourse-oriented culture, which was more formally and doctrinally organised (consider scholasticism and humanism in Europe), was a world away from the numerous 'small' traditions of the farmers and craftsmen, which were handed down informally and orally and which were full of heathen and local customs[18]. Even though the Catholic church organisation had no equal in the world of the agrarian civilisations, Rome was still a long way away, in a different world which only filtered through sparingly to the countryside[19].

3.3 A 'tied' individuality and the longing for stability

Scarcity and the cellular structure of the agrarian civilisations had repercussions on the position allotted to the individual. To use Schmid's words, a tied individuality was predominant[20]. The people mainly derived their identity from their to a particular group. This was in the first place the family, and then local community, the trade and the class. People who did not clearly belong to one family and group were pariahs. In this uncertain world, the tied people were able to fall back on the informal group: this formed not only their living unit, but also the working unit, the provider of physical security, the smoother of the path to the starting of a family. This bond gave the group a basis of trust that could be put to good use in the hard struggle for survival. It did mean that individual wishes were secondary to and were defined by the collective interests: '...an individual who defined his own purpose in life without regard for the collectivity (family, village, religious community and/or polity) to which he belonged was not a romantic hero, but rather a misfit or a cancerous element. Society was holistic rather than individualistic (as sociologists put it): the individual existed for the benefit of the overall group, not the other way round'[21]. So groups like this functioned as 'total institutions', into which people were admitted not just partially (e.g. only in connection with work) but for almost every aspect of their lives. One basic role (e.g. noble lord, farmer's wife, servant) provided the framework for their actions in the most varied situations: as a believer, in questions of marriage, in political and military affairs... How differently it works these

days, with our tendency to separate the different roles we play. On Sunday morning a minister has to wait his turn like everyone when he goes to the baker. All this did not exclude the possibility of people with strong personalities, then as now, making their mark on events (cf. the great painters of the time, who had to comply with numerous conventions). The only difference is that now we also try to look for the social settings in which to pursue the realisation of our desires and ambitions, whereas in the agrarian civilisations these locations were prescribed.

And finally, in comparison with our rapidly changing society, agrarian societies and civilisations were characterised by a high degree of stability. Of course there were constant changes — and pre-modern societies and cultures also have a history — but the changes went slowly and were fairly inconspicuous to the people at the time. The way of living and working together, the religious ideas and practices, the dependence on nature, the hierarchical division of society, even the disputes between villages and families were for a long time handed down from generation to generation. The people saw their world primarily as having settled into an eternal order, in a timeless stability. The dominant attitude was conformism, which offered a support against the uncertainties of the world, just like the group-attachment. The slow pace of social change and the lifelong fulfilment of one basic role meant that individual experience confirmed rather than questioned individual and collective world views. In this way the basic currents of the world views remained beyond suspicion to their holders. However uncertain and capricious (terrestrial) life was, it had always been that way, with the exception of a mythical primeval age and the end of the world. People had little doubt about this.

4 World views in the christian middle ages

World views in the Christian Middle Ages (6th century to 15th century) had the same characteristics as the agrarian civilisations I have just described. In this section I would like briefly to indicate the specific elements of the Middle Ages and at the same time shed light more especially on the relationship between the many world views. Since, as already mentioned, the collective appears in many guises, I shall distinguish three levels: the level of the macro-social collective, the collective world views on a intermediate level (locality, group or class) and the world views on an individual level. This distinction will be employed again in the analysis of world views in early and late modern societies.

4.1 Christendom as the overarching worldview

Even though world views were highly varied in the Middle Ages, it is not unimportant that all these world views on a macro- social level had a common focus in Christendom and the Catholic church[22]. Christendom and the Church functioned as an umbrella ideology and institution, accepted by all members of medieval society. There were other civilisations with a (religious) ideology comprising virtually every member (e.g. Islam, Hinduism). Latin Christendom, however, was striking in its especially close-knit and hierarchical organisation, which it was able to build up independently of politics, and for its consequently cohesive emphasis on dogmatic orthodoxy. The extent of this was unrepeated elsewhere. The church acted with corresponding intolerance to non-orthodox movements and other religions but the intention to convert the ordinary people was also particularly pronounced. The great tradition and the smaller traditions did not stand alongside each other, but permeated each other deeply. It demonstrates that working on and the spreading of discursive world views can affect decisively the ordinary people's view of the world, not only in modern society with its science and mass communication, but also in pre-modern societies.

Nowadays the image of the thoroughly Catholic Middle Ages has been questioned and we have become aware of the many heathen and non-Christian elements in the religious experience of medieval man. In this way, one rightly takes account of the fundamentally segmented nature of pre-modern societies. Nevertheless, the systematic missionary zeal emerging from the great tradition resulted in the same God being honoured throughout the whole of Europe, more or less the same holy days were celebrated (Christmas, Easter, etc.), the same sort of religious literature was read, the same prayers (the ten commandments...) were recited. In the other direction, the Church, driven by its missionary urge, tolerated the Christianisation of a whole pantheon of gods and pre-Christian customs so that the Christian world was enriched by an inexhaustible series of devils, angels and saints. This kind of syncretism — the blending and merging of elements from diverse traditions — is also familiar from other civilisations. In this way a mixture of Confucianism, Buddhism and Taoism slowly came about in China. In Europe, however, this syncretic incorporation of the small traditions took place within and under the protection of a clerical umbrella organisation that was actually constantly trying to clear them out again.

The result of all this was that the Latin Church not only defined for medieval man the identity of Western Europe and the truth regarding this world, but that it was also able to do this in concrete terms: what one had to believe, which standards applied to marriage and reproduction, how the world came about (the Genesis story) and what was its destiny (the Last Judgement), that the Church was established by God as a guiding hand in this historical process for the world. God was close at hand in the mind of the average medieval man. He was continually sending signs to the world (eclipses of the sun and moon, natural disasters, epidemics) and actively intervened in events. The world was dangerous, but was supported by God and was geared to man. In this way, people in the Middle Ages received a relatively specific outlook, by which means they were able to interpret the many contradictory things that happened in the world, as well as lending their own actions a certain orientation. These features formed the common Christian framework which they then fleshed out according to their local traditions, social origin and individual nature. The 'calm self-assurance' regarding these main features made it possible for the theologians to discuss endlessly what are to us mostly unimportant details[23].

4.2 Cellular pluralism

Like the other agrarian civilisations, the Middle Ages appear to us, within the general Christian framework, to have been a patchwork of group cultures[24]. There were a multitude of local communities and regions, each with their own language, customs, costume and history which coloured the world view of the inhabitants. The differences between the countryside and the town were considerable. In the towns lived the manifold corporations of artisans and merchants, which each had its own profession-bound culture, ethics and world view. Beyond this, the estate to which one belonged determined what one might or might not do — this applied in particular to the two highest estates, the nobles and the clerics, who had a greater capacity for horizontal communication at their disposal. These group cultures were usually strongly inwardly oriented, unfriendly towards outsiders and tended to reject newcomers and innovations. In a world full of danger, where one often had to rely on one's own defences and force, the closeness and conservatism of one's own group culture guaranteed, like an island of trust, a minimal security of existence (both moral and material).

The cellular structure of medieval society is striking, and more so because of its political divisions. It is wrong, however, to exaggerate the closeness of the cells and to dismiss them as a part of a stagnating soci-

ety. After all, the bonds between the group cultures were legion. Medieval people knew themselves to be part of European Christendom. In this situation the Church acted as an active cultural integrator. These groups were also in contact with each other, by various means including political channels, trade and pilgrimages[25]. And this contact actually steadily increased during the Middle Ages. That brings us to a second point. The Middle Ages were highly dynamic compared to other agrarian civilisations. The roots of this dynamism lay to a great extent in the abundance of group cultures, which, since unlike China there was no inhibiting political centre, allowed an urban commercial capitalism to develop and later led to the breakthrough into modern society[26]. There was also something restless about Christendom. People were constantly experimenting with renewal (monasticism, the mendicant orders, the numerous heresies, 'modern worship', reformation, etc.). However, the pace of change remained so slow that in terms of people's experience of it, things still appeared timeless. This was even true in times of crisis which were interpreted apocalyptically, as the beginning of the end of the world. Finally, it appears from the many, sometimes bloody differences of opinion (conflicts between rival towns, the crafts and the patricians in the towns, farmers' revolts, heresies), that the group cultures did not live alongside each other entirely indifferently. It goes without saying that the world views specific to territory, group and class played a large part in this. The universalist undertone — the equality of men before God — which, despite all the alterations to the medieval class hierarchy, Christendom carried with it from the cradle, was also important in the rebellions by the lower levels of the population. The couplet 'When Adam delved and Eve span, who was then the gentleman?', sung during the English farmers' revolt in 1381, has many variations[27]. In spite of the tensions resulting in many ways from cellular pluralism, the groups did not intend to abolish this pluralism. The point of the conflict was usually the balance between them. As long as the end of the world had not yet started, the division of the world into different regions, groups and estates was accepted. It appeared to be derived from the natural order of society and unavoidable. Cellular pluralism was not considered intrinsically contradictory. The specific ideological content contributed by a particular group or estate did not question one's own ideological content as such, but rather placed it in a framework. The idea of equality is a modern one, also in the field of world views.

5 *Unification and individualisation in modern society*

In the period from 1500–1800 a transition was made from an agrarian to a modern society in Europe. Academics no longer consider it so self-evident that this transition loose should have taken place, or that it should have been in Europe. According to many researchers a transition like this even verges on the miraculous[28].

Modern societies and world views are completely different from their agrarian predecessors. For this reason I shall again begin with a sketch of the major lines of force which structure modern societies and world views. In so doing I am following the five basic characteristics as already used (cf. 3 above). In modern societies scarcity is made to retreat to a certain extent, segmentation dwindles to insignificance in the face of a process of unification that permeates everything, the hierarchical system of estates as principle of societal organisation vanishes, giving way to functional differentiation, the tendency to stagnation turns into compulsion to grow and the 'tied' individuality is replaced by the ideal of the 'autonomous' individual.

5.1 The suppression of scarcity

In pre-modern societies scarcity was so dominant that a long life was the privilege of only a few. In modern society, by contrast, child mortality has dropped considerably and life expectancy has increased markedly. For this reason a new (relative) security has been able to grow in recent decades: we bank on becoming old. The reality of the Bible saying, that death strikes unexpectedly, like a thief in the night, an event, therefore, for which one must always be prepared, has lost a great deal of its force. One can tell from this how much man's power has increased. Whereas in the early Middle Ages the inhabited places were scattered like islands in a sea of unspoilt nature, today some natural parks are screened off from the crushing mill of civilisation. The enormous rise in production and income and the benefits of the welfare state — unemployment benefit, health insurance and pensions — now offer the majority of the population a high level of guaranteed consumption. We should not underestimate the impact on our world views of these 'achievements', of which we are still only half conscious. They have not defeated scarcity, but it has been pushed back and, in the case of the economy, is even an energising source of growth.

5.2 A unified world

The breakthrough of the medieval agrarian civilisation into the post-1800 modern society also meant that the previously rather closed local communities were absorbed into a more unified, horizontally more strongly integrated society. This transition is traditionally described using the terms 'Gemeinschaft' to 'Gesellschaft'.

This unification occurs on many planes. There is an extremely striking and far-reaching economic integration of people, capital, land and goods into national and international markets. In politics the law is laid down by centralised states and national democracies that penetrate deep into the daily lives of the people. Culturally speaking people also turn more towards the translocal level as can be seen in the establishment of national education systems and the spread of standard languages, reading matter and ideological trends. In this way arise the national states and the world society of the West. This literally and figuratively penetrative society is no longer reserved for a small elite, but now reaches every population group. We are all active as producers and consumers, as citizens, as art-lovers, as newspaper readers and so forth, in very large settings. We look towards the level beyond the local just as self-evidently as our forefathers in pre-modern societies managed on a local level.

This unification was made possible by the improvement in means of transport (cf. the prominent role of the railways in 19th-century industrialisation) and, later, the growth of the mass media. More specifically, it is embodied in the booming of both organisations and markets. Organisations and markets have become the main media through which people are acting beyond the local level. Think, for example, of the competition between companies (organisations) on an economic market that involves everything and everyone, of the rapid expansion of the state machine, by which means the state, for the first time in history, has the final responsibility for the care of the whole of society, or of the extent of associational life in civil society.

5.3 From specialised 'total institutions' to selective specialities

I have described the agrarian civilisations as characterised by a cellular pluralism. As well as the local agrarian communities, the guilds in the cities and the upper estates also functioned as cells, as total institutions. They made their mark on every aspect of life. Entry into such specialised groups was difficult, and usually took place by birth or marriage,

combined with tests of skill. The artisan and merchant guilds were like corporations. The clergy was a particular estate, organised within the Church. The knights were allied to each other by family ties and feudal bonds. The unification and mobility of modern society destroyed such divisions. The French Revolution abolished both the medieval system of estate and the guilds. Instead, a far reaching functional differentiation came to the fore.

Considered from a macro-social point of view, functional differentiation consists of the building up of broad, but specialised societal sub-systems (such as economy, politics, science, art, education, etc.) where in each case one central function determines the operation of the whole arena. Seen on the meso-social level, functional differentiation leads to the formation of large numbers of specialised organisations (business in firms, schools, medical institutions, leisure organisations, political parties, etc.). On an individual level the one basic role is abandoned for the many roles, which we only intermittently play (employer or employee, consumer, citizen, family-member, art lover, believer, etc.) and which we now keep separate from our person(ality). It is by means of such roles that people participate in the functionally differentiated sub-systems[29]. The breaking down of traditional barriers of access on the one hand (the extension of the franchise, for example) and the generalisation of education on the other mean that in theory everyone has access to all fields. This makes the culture more unified, since it is less divided into all kinds of totalising group cultures. Specialisation is now launched and exercised on the basis of one such widely spread standard culture. It is primarily oriented towards intrinsic-functional requirements and does not demand a separate class and group culture as much as it did before. This development towards selective-functional specialities advances the translocal communication between the specialists. Also the more the liberate standard culture — as the foundation for the efforts toward specialisation — reaches the whole population, the less relevant specialisation becomesas a social basis for the formation of inclusive groups.

But although cultural differences are decreasing on a social level, as far as content is concerned the gap between specialist and layman is certainly not diminishing. This applies particularly to the intrinsic specialisation in science and art, which have affirmed themselves as autonomous functional areas in modern society (science for science's sake, art for art's sake). In science the specialists began free experimentation, resulting in an enormous growth in knowledge, but also in a fragmentation of science into disciplines and subdisciplines and in an extremely rapid turnover of scientific theories. In art, beauty and the artist have

become emancipated from their patronisation by the layman. The avant-garde took shape and the layman had to look on and possibly admire. Religion may in the coming decades also go in directions where many ordinary mortals may no longer be able to follow.Not only have the churches lost a lot of their impact on the ordinary people but they are also losing ever more control over the seekers (cf. the increasing cross-fertilisation of diverse religions, rituals and forms of meditation on the one hand and the return to fundamentalist sects on the other). Constant innovation is taking a central position in the three cases, even if only in an embryonic state in religion. Only a limited, initiated in-crowd can follow these developments, and then only in part. Cultural unification on the level of the living environment is linked to cultural alienation at the expert level.

5.4 *Change as a constant*

We saw that pre-modern societies changed at a slow pace and that culturally speaking they emphasised stability. Modern society, by contrast, changes at high speed and then underlines the changes too. Modern society is a society of growth. A well-known example is the passage from the Communist Manifesto in which Marx and Engels celebrate the middle-class revolution: 'Constant revolutionising of production, uninterrupted shifting of all social conditions, everlasting uncertainty and movement distinguish the bourgeois epoch from all earlier ones. All fixed, frozen relations... are swept away, all new-formed ones become antiquated before they can ossify. All that is solid melts into air, all that is holy is profaned, and man is at last compelled to face, with sober senses, his real conditions of life and his relations with his kind.'[30] This speaks of a feeling of liberation with regard to the past, a feeling that was to continue to resound up to the revolt of the nineteen sixties. It is paradoxical that the importance of history, of the everpresent change, was discovered in the 19th century at the moment when the past was becoming less decisive in the options of the present day (see the philosophy of Hegel and the sociology of Spencer, the breakthrough of geology and the theory of biological evolution). Historical reconstruction keeps the past at a distance and selects from it those things that are considered relevant from a contemporary point of view.

The consequences for world views are drastic. In contrast with the more static world views of the pre-modern societies change has now to be built into every world view as a fundamental fact. And more than

this, the continual changes in society enforce permanent adjustment, if not fundamental reassessment of the existing world views.

5.5 *Individualisation*

In the agrarian civilisations, people derived both their material security and their identity primarily from their membership of a group. In modern societies this bond between the individual and the group has become looser. This can be seen very well in the way the population is represented politically. To the extent that groups were represented at all in earlier times, it was done by the most prominent members of the group (the *pater familias* for the family, dignitaries for the town, the lord for the rural area). Nowadays the composition of parliament is no longer determined in advance by the hierarchical position held by the members at their home base. In addition to this, all the citizens of a country now have the right to vote, and they are not considered as part of their social context, but count purely as individuals, each with one vote. At the beginning of this century the conservatives trying to resist the universal franchise, were protesting vehemently against this quantifying abstraction.

So in modern societies the accent has been shifted, to the point of the mythical, to the separate individual, who has to seek out his own path, while moving to and from between several groups. Where one wants to live, whether and with whom one will marry, which belief one wishes to profess, and so on. The options for choice have become much greater and the responsibility for these choices falls more and more on the individual himself.

5.6 *New world views in a changed world view constellation*

As a consequence of all these trends, the world views formed in the Middle Ages, with their static Christian framework and cellular pattern, were undermined. The entirely different nature of modern society generated completely different world views. The 'calm self-assurance' of medieval man was no longer to return[31]. Contingency — that things can be different from the way they are — became the basic experience in modern society. The unification of the world continually confronts us with views and customs that differ from those that are dear to us. The expert cultures and the many changes in modern society force us into permanent reconsideration of the choices made. Individualisation

means that every individual now considers himself equal and therefore interchangeable with others, and asks himself: 'Why am I as I am, and act as I do, while he/she is and acts differently?' Not only do world views become more precarious in this way, but the constellation of world views also changes. In the new situation, the unity of church and society, the upholding of a relatively concrete, and if need be, enforceable religious/ideological unified framework for the whole society, is no longer possible. At the macro-level, it is replaced by a collection of scarcely binding, general background ideas. At the meso level the well-ordered cellular pluralism is also broken open. In its place there comes a discussant, competitive pluralism, in which each option is in the end individually justified.

In fact it took until after the Second World War before these consequences became clear in all their radicalism. This because the trends are not unequivocal. Science thought for a long time that it was at last bringing the truth to light (cf. the 'sober senses' in the quote from Marx-Engels). Historicisation was only admitted into the ideology of progress in a weakened form. The system of estates made way for the modern class structures, which are more vague, but equally hard to avoid. The unification of society and the organisational revolution made it possible for individuals to become, much more insistently than before, to organisations, movements and states(due to the triumph of the pre-modern tendency towards segmentation, totalitarianism is a genuinely modern phenomenon). In this way new certainties were temporarily able to take the place of the old. First of all I shall describe the situation of world views in this first 'early modern' period, located between 1800 and 1945/60. Then I shall explore the changes that have occurred in the post-1960 late-modern society.

6 *New certainties in a changing world (1800-1945/60)*

6.1 The idea of progress, as a new background ideology

In the 19th century, people were at odds with each other in many fields. Christianity was no longer generally accepted. A lot of people were also distrustful of a number of fundamental features of modern society (philosophical pluralism, class conflicts, etc.). However, the idea that mankind was progressing — 'We have come a long way and we are on the right track' — was generally shared, though it was professed more

enthusiastically in liberal and socialist circles than in conservative. So, the idea of progress followed the Christian world view as the overlying background ideology.

However, in comparison with the concrete world view of the Middle Ages, incarnated in an institution (the Church), this world view of the progress of mankind was more vague and therefore less well-orientating. Precisely what was progressing, and what deficiencies should be corrected, was usually the point of conflict and therefore had to be decided at an intermediate or personal level. Nevertheless, the idea of progress removed a part of the disquiet that modern society generated. The changes in the Western world, as well as the presence of divergent cultures and worlds outside Western Europe could be arranged in a reassuring order from traditional to modern. Faced with the many problems in modern society(the severe social discrepancies, the still enormous illiteracy, etc.) people could still to hope that progress would provide a solution.

6.2 The power of new intermediate structures to form world views.

The breakthrough of modern society was linked to the dissolving of numerous former associations: class distinctions and the guilds were abolished, religion came under pressure to secularise, craft production was displaced by industrial production, local village communities were broken apart, etc. This process of modernisation did not only destroy old relationships. The burgeoning modern society also created new traditions and relationships. Examples of this are social classes, nationalist feelings, large social movements, the nuclear family with its division of tasks between the worldly man and the domestic woman, the belief in objective science in the service of progress.[32] New world views and new, though less stable, certainties were able to attach themselves to all this. As already mentioned, scientists still cherished illusions,towards revealing the eternal truth. The class cultures, particularly those of the workers and the bourgeoisie, provided the groundings for identity formation: people belonging to these classes were handed down sets of values and behavioural pattern which could barely be transgressed (f.e. the bourgeois sexual and marital morality). Differences in working conditions, the spatial segregation between workers' districts and bourgeois residential areas, the limited opportunities for promotion among workers and their children emphasised the reality of these class boundaries. To illustrate the power of these new structures to form world views, I would like to go deeper into the way individuals were absorbed into large social movements.[33]

6.3 Competing segmented pluralism

In the more unified modern society, where the mass of the people had begcome a force to be reckoned with, it became easier to activate and mobilise large groups of people over a longer period of time. In this way large social movements emerged in the 19th and also in the 20th centuries (e.g. the liberals, socialists, Catholics, communists and ethnic movements).

In contrast to the cellular pluralism found in pre-modern societies, these movements were intrinsically competitive towards each other. They fought each other, sometimes to the death (e.g. the struggle between the pillars or political camps, the communist revolutions and the fascist counter-revolutions). Every movement hoped in the end to win this struggle over the character of modern society and to be able toorganise modern society according to his views in a new and permanent way. There would then again be, so they thought, a concrete world view shared by the whole of society. In most countries this struggle was carried on within democratic limits. In a few cases, however, in totalitarian states, some movements tried to push their project for society (world view) through by means of violence, with disastrous results (e.g. Franco's Spain, Nazi Germany, Communist Russia).

Internally, the sturdiest of these large movements functioned in the same way as the pre-modern collectivities associations once did, as total institutions. But they now achieved this by modern means, especially by extensive mobilisation and the creation of organisations. By means of the development of the movement's organisations in various fields, under the auspices of the movement itself, and the formation of a pronounced subculture (own values, behaviour, symbols, festivities), they tried to involve the rank and file more closely in the movement, to guide them from the cradle to the grave. This was particularly successful after 1880 in the more collective-oriented movements such as Catholicism, Socialism and Communism. In the Netherlands and Belgium this modern form of segmented pluralism has become familiar under the name *'pillarisation'*. In so doing the movements had to compete against the unifying tendencies of modern society. In fact, the enclosure of the movement's rank and file into a segment only succeeded in part: only a part of the rank and file gave itself over to the movement as militants, and whole areas of society such as economics and science did not allow of division in conformity with the movements. Even so, the results were impressive. The large movements have dominated a large part of the social and political stage for a century and a half. Never before in history had so many people been so intensively socialised into the collective world view of a movement (primary as well as discursive).

The movements put a great deal of energy into this socialisation process. As far as discourse was concerned, the movement's intellectuals, who, like the other militants, dedicated themselves to the movement, assisted in making the movement's ideas and aspirations more explicit in theoretical terms and in developing them further. They functioned as 'organic intellectuals' (Gramsci) and 'collective philosophers' (Apostel) in a way that is no longer possible. These individuals did not produce theories purely under their own name. Rather, they carried out their intellectual production in the name of the movement and were sometimes even under the control of the movement's organisational élites. Typical examples of this are the neo-Thomist Catholic theologians and the party ideologists in the former social democracy and in communism.

Notions of the movement's discursive world view were then passed on in a translated and adapted form by the officials and militants to the rank and file, not without mixing them up with ideas picked up elsewhere and also with their own aspirations. This process of handing down on and adaptation can be considered as a modern version of the dialectics between the large and the small traditions.

What particularly astonishes us, who today treat every organisation (church, party, union, etc.) with distance, is the eagerness with which the following responded to what was offered. According to me, the reason for this great submissiveness lies in the fact that the ordinary people saw the then new mass organisations as suitable channels to connect their local meaning systems and habits to the rapidly changing macro-world. That is why the mass organisations and movements had much more significance for their following then than they possibly could have now. Ideologically speaking through their publications, meetings and lectures, and through their daily operations, these massorganisations were able to give the ordinary man contemporary and yet familiar interpretations, by the use of which he could situate himself in the huge, apparently chaotic modern world. Materially speaking, they acted as intermediaries through which the fruits of modernisation could be handed down (cf. the success of consumers' cooperatives, the spread of amateur dramatics, brass bands, health insurance associations, tourist associations and so on). It should not surprise us, therefore, that these organisations and movements significantly affected the world views of their following, to whom they were able to offer such a great deal. Some militants were even prepared to die for their movement.

7 After 1960: the construction of world views on shifting grounds

7.1 A second wave of modernisation

World views correlate to the worlds they represent. When the worlds change fundamentally, the world views will also change. Though already germinating in the fifties, it was primarily in the sixties that a fundamental change struck society again . It did not go so deep as the transition from the agrarian to the modern society, but even so it can be considered as a caesura in modernity — it is therefore that I prefer to speak of high(or late) modernity than postmodernity. After all a number of key institutions and ideas built up in the first phase of modernisation that were now declining or were being called into question: social classes, the nuclear family and the relationship between the sexes, the large social movements, the idea of progress, etc. With regard to this the German sociologist Ulrich Beck speaks of a second wave of modernisation, the modernisation of modernity[34].

The ideology of progress, so characteristic of primary modernisation, lost its cogency as a result of these changes. New dangers such as nuclear war, ecological destruction and genetic manipulation increase the sensitivity to failure caused by man. The continuing brutality, the persistence of wars, the appearance again and again of new forms of totalitarianism and dictatorships focus the attention on the darker sides of modern society (cf. the commemoration of its repressive aspects at the celebration of the second centenary of the French Revolution). The economic and political rise of the Third World brought an end to the West's exclusive domination and raises the question of the profile of a world society beyond the West alone. Together with the economic and political crises in which the West has been struggling since 1973, these developments have led to the ideology of progress to an abrupt end (compare the punk slogan 'no future' of the seventies to the 'flower power' of the hippies in the late sixties). Existentialism, the fashionable philosophy immediately after the war, had, intellectually, already buried the idea of progress. Today it is no longer a question of intellectual scepticism, the cultural self-confidence of large parts of the population of the West seems to have suffered a shock. For the first time in European history the belief in the future — before 1800 mainly conceived as transcendent, after 1800 primarily as immanent — is on the wane, and on a massive scale.

Even those large movement's world views, which played such an important role on an intermediate level after 1800, have declined in recent decades. In Western Europe, the states and the nationalist sentiments woven around them in the 19th and first half of the 20th century, have to a great extent lost their sacral aura. The segmented class cultures are also in retreat. It's true that social origin still exerts influence — and social inequality is still maddeningly, tangibly present. But the collective impulse and the prescriptive force that emanated from such class cultures has mostly disappeared. A comparable verdict applies to the large social movements. The former following show greater detachment (cf. diminishing church attendance, increase in the number of shifting voters). The views of the movements receive less response and the movements' organisations limit their scopes to their more specific, less ideological tasks (f.e. socialist trade unions).

On a micro-level, this tendency towards turbulence in the social (macro and meso) context takes on the form of a radicalised trend towards individualisation. One can no longer follow in the footsteps of an earlier generation. Every individual is now obliged, searching and groping, to give shape to his own path through life, using the means available to him. In theory this creates higher degrees of freedom, but also the problem that, particularly when things are not going so well, one is thrown back on one's own resources. Late- modern society generates mobile individuals, in a geographic and an economic sense, but also in political, social and cultural senses.

7.2 A time of unceasing construction of world views

The disappearance of the world views formed during primary modernisation, and of the social structures on which they rested, does not mean that the individuals now tinker with their world views purely in their own name, in a social vacuum. Just like before, the construction of world views, like all human activities, remains pre-eminently a social occupation. It is mainly the degrees of freedom, and the associated degrees of uncertainty, with which this construction occurs, that change. Let's look for a moment at what elements for individual and collective construction of world views are currently available in society, and how individuals make use of them.

The downfall of the ideology of progress does not as yet mean that there is no longer a common (Western) background ideology. On the contrary, the advancing of world society makes it more probable that a com-

mon culture will emerge which will provide the essential connections between the many individual and group world views. This common background culture comprises on the one hand suppositions regarding the common presence of skills such as the use of writing, traffic orientation, mass culture and consumption, easy dealings with numbers of strangers (or semi- strangers) and suchlike, and on the other hand a number of common values and aspirations like human rights, individual freedom, the 'pursuit of happiness', the value of material well-being and the environment, and so on, which are considered fundamental to the behaviour of Western man. This shared Western world view is in fact for a large part a generalisation of the 19th-century ideology of progress (cf. the Parsonian concept of 'value generalisation'). It makes several corrections, in particular questioning the too beatific idea of progress, and adds a few new suppositions and values, such as general literacy and the commitment to a pure environment. This Western — and, by degrees, broader than Western — overarching background culture induces a minimal feeling of solidarity, of belonging to a common culture and civilisation. But it will also be clear how vague and how little binding this generally shared world view is, especially when one compares it to the overlying world views in pre-modern civilisations such as the Christian Middle Ages. The presuppositions and values remain extremely general. They do not form a unit, rather a sum of dissimilar and interchangeable elements. In contrast to the ideology of progress, the elements do not any longer allow themselves to be integrated into a reassuring story with a barbarous beginning and a blissful end.

As we have said, it is especially on the intermediate level that a number of striking social structures, which once made one feel obliged, have lost strength (nationalism, class culture, socialisation in large movements). The problem, however, is not that no more orientations for life are offered on an intermediate level. Not only do many traditions and institutions which arose or developed fully in modern society continue to exist in an altered form (the ideal of the nuclear family, the democratic constitutional state, the importance of a good education). But in addition the new structures also offer values by which individuals orient themselves (new social movements, for example, the much greater value, compared to before, that people attach to leisure activities as a medium of expression and formation of identity). One might reverse Lucebert's dictum, that everything of value is defenceless, to say: anything that's in any way lasting inevitably produces values and attachments.

What is new is that the particular offer available can more easily be circumvented than before, including, for example, the ties with specific organisations and social movements, with the family origins, with the religious conviction in which one was brought up, with the place one lives. Instead of being immersed from the very beginning and in a variety of ways in one class structure and/or one large movement, the individual is now permanently confronted with all kinds of interpretations and lifestyles, partial or otherwise, which can no longer be assembled under one denominator or in one fixed perspective. Without wishing it, we are constantly confronted with numerous world views (particularly by means of television). This fleeting and varying acquaintance puts our world view into perspective — although selective strengthening also occurs — and often does not give us the time to integrate in a solid, assuring wayone of the world views or fragments offered.

In this way, seen from an individual point of view, the weight of current world view construction comes to rest much more on the frail shoulders of the individual, nowadays celebrated for his autonomy. Of course, in earlier days, world views were as much the product of construction as they are now. What has changed is that in late-modern society we are so very conscious of the inescapability and the omnipresence of the construction aspect. Just like in the past, people build up their world views on the basis of their experience of life. However, whereas in the past stable social contexts led to an over-accumulation of experiences which for the most part repeatedly endorsed the existing world view, we now get an under- accumulation because the experiences are always new and changing. The varied and changing lives in late-modern society generate world views of the same nature. The result is a multiplication of world views — every life becomes fundamentally self-willed, a personal work of life and art that is continually changing. The unceasing offering of new meaning systems can, depending on the circumstances, be felt to be either enriching or paralysing (cf.7.3). However, this situation of competing non-segmented pluralism, of permanent confrontation with many varied world views, each precarious in itself, can no longer be reversed.

7.3 Exploring options and boundaries

In recent years the dominant trend has been to grieve for the loss of the earlier certainties and to focus particularly on the negative aspects of the current quest for meaningful world views or fragments. This is a one-sided attitude which, insofar as the today's sombre mood is attributed to the lack of fixed world views, puts the cart before the horse. The cause of the sombre mood in the West lies after all not in the absence of unques-

tioned world views, but in the crisis in Western modernity itself: the economic crisis and, linked to it, a political crisis raise doubts about future prosperity; the ecological problems of the growth society, indicate that man cannot go on like that forever; the rise of the Third World appears threatening to many people. This general feeling of unrest and distrust rubs off on the field of world view construction. What a difference from the sixties! At that time there was, perhaps even more than now, the conviction that new ideas were on their way and the entrenched old had had their day. In the optimistic atmosphere of that period, however, it was mainly the opportunities for positive development offered by the active construction of world views that people had in mind. A detached attitude towards given interpretative frameworks was then mainly experienced as a liberation from the yoke of traditions and celebrated under the names of dialogue, exploration of the future, pluralism and suchlike. The greater realisation of the constructed and temporary character of world views that has occurred in recent decades need not therefore necessarily be considered as a burden. It provides both positive opportunities for active construction as well as the uncertainty of having to live without a definitive truth. Which side predominates depends on the social conditions and the individual position in which the 'constructors' lives.

As well as work on favourable psychological and social conditions, an important basic requirement for the creative and unconstrained construction of world views appears to be the creation of a cultural infrastructure with regard to world views and of a positive climate for discussion. Now the inescapibility of construction has been recognised in wide circles , these individual attempts should also be supported from an institutional level. More particularly, mediation should be stimulated between the need for interpretation at an individual level on the one hand, and the available interpretative frameworks on the intermediate and macro levels on the other. The group*World-views* considers it as one of its basic tasks, but it is also a new job for the churches, free masonry and cultural and scientific organisations. They should make available to the searching individual a range of overall scientific theories, religious and meditative approaches and forms of expression, from which the individuals can choose, and by use of which they can enter into a confrontation with themselves and the world. These groups must also create internally a tolerant climate in which quests of this sort, which necessarily demand dialogue, can thrive. World view mediation of this kind will not diminish the abundant number and the precarious and unfinished character of world views in our late-modern society. But it does increase the chance that a person who actively engages himself in the construction of world views will experience this as an enrichment of his life. Non-cellular pluralism, in which various outlooks are constantly competing with each other, is not an evil that is to be resisted — that only results in suppression (cf. the totalitarian states). On the contrary, it forms the medium par excellence in late-modern society both for exploring and sounding out, in a well-considered and revocable way, of the many options that are individually and collectively available, as well as for learning to accept the non-fixed boundaries, against which we inevitably clash, both in ourselves and in the world.

Notes

1 With thanks to Dirk Maetens, Hildegarde Van Hove and the members of *World-views* for their comments on previous versions of this article.
2 Gellner, 1992: 181.
3 Cf. the term 'spontaneous world view' in Apostel, Van der Veken, 1991: 56.
4 For one of the many classifications, an impossible task, see Gurvitch, 1968.
5 I have taken as my inspiration the analogous distinction that Habermas makes between communicative action and discourse, see extremely concise Habermas, 1971: 23-26.
6 See Vovelle, 1985, p.19-32.
7 See, for example, the excellent book by Wildiers, 1989.
8 Gellner in general, 1988.
9 Mann, 1986, describes their history.
10 Here I have relied mainly on Gellner, 1983 and 1988 and on his students Hall, 1985, Mann, 1986, and Crone, 1989.
11 Mann, 1986: 265.
12 Crone, 1989: 15-16.
13 Crone, 1989: 116.
14 Fumagalli, 1992: 25-83.
15 See Gellner's 'agro-literate polity' model, 1983: 9-10 and developing this further, Hall, 1985: especially 28-30, 51-53, 71-72, 96, 140).
16 Mann, 1986: 135-137.
17 Crone, 1989: 92.
18 Burke, 1978: 23-29.
19 Delumeau, 1985: 237 e.v.
20 Schmid, 1967.
21 Crone, 1989: 108.
22 What follows is heavily influenced by the reading of Delumeau, 1985 and Gurevich, 1988.
23 Wildiers, 1989: 47-101.
24 Burke, 1978: 29-58.
25 Burke, 1978: 52-58.
26 Mann, 1986.
27 Burke, 1978: 53-54; Crone, 1989: 75-77.

[28] See 'The European Miracle' by Jones, 1981; Gellner, 1988.
[29] For all these points, see Luhmann, 1982 or Mayntz, et al., 1988.
[30] Marx, Engels, 1848: 34.
[31] Wildiers, 1989: 48–49.
[32] Beck, 1986:12-20.
[33] See in extenso Hellemans, 1990.
[34] Beck, 1986.

Bart De Moor

World views, science and technology

What is the role of science and technology in constructing world views? That is the question explored in this article. The first step will be to attempt an analysis, in which we examine how science and technology have resulted in the present-day post-modern technotope. The second step will be synthesis, in which we shall attempt to distil those elements and characteristics from science and technology that are useful and relevant for constructing world views. It may already be evident that this can only be regarded as a tentative start to a broader research programme, the various aspects of which will have to be explored in more detail in the relatively near future.

To clarify our understanding, it may be useful to briefly remind ourselves of the seven components of a world view, as described in the first book on *World Views*[1]. Every world view *describes* the world: what is the world we are living in, how is the world structured and how does it function? A world view also tries to *explain*: why is the world as it is? Furthermore, a world view contains elements that relate to *assessment* and *appreciation*. All this should enable the *future* of the individual and of mankind to be evaluated (rational futurology). World views have both a *cognitive* and a *practical* aspect. The cognitive aspect concerns the way in which we go about acquiring knowledge and the way in which we deal with knowledge. The practical aspect describes what actions we can take and how an integrated action model is part of a world view. Since each world view is in itself fragmentary, there is a need for confrontation with other world views. In other words, an *atlas* of world views is required.

This article is organised as follows: paragraph 1.1 is a concise description of how a rift occurred in recent times, the result of which was that science and technology came to exist autonomously. This, in our view, is the origin of the post-modern technotope in which we live today and which is described in paragraph 1.2. The central idea we wish to put for-

ward in paragraph 1.3 is that science and technology, in particular, act as a catalyst in the creation and development of our present-day world and world views. Technology has become *the* driving force behind cultural, social, political and economic changes. Technology creates two opposing forces: increasing globalisation and, diametrically opposed to this, increasing individualisation. There is no turning back, however, and this aspect, i.e. the totalitarian, compelling nature of science and technology, is still underestimated today. In paragraph 1.4 we reflect on post-modernism in science.

In the second half of this article we try to show that, although science and technology *in se* have irrevocable consequences, nevertheless we have to be smart enough to turn certain elements into tools that can be used to construct world views. This situates technology within the traditional dialectic of good and evil. On the one hand, technology traps us in a regrettable uniformity. On the other hand, technology spreads power and knowledge, so that technology itself becomes more accessible for everyone, thus encouraging fresh debate. It is this form of persistent excitation that can lead to a 'better' world. This will be discussed in more detail later.

It is not our intention here to advocate a method of constructing world views based purely on scientific research. This kind of scientism produces an inadequate world view, as substantiated in paragraph 2.4. We would argue, though, that most types of world view construction are not scientific enough. Often the opportunities that science and technology offer us are insufficiently exploited, out of ignorance. Without wishing to go into the subject too deeply, we describe various views and concepts that are substantially based on mathematical system theory.

In paragraph 2.1 we first of all invalidate the sometimes exaggerated assessment of the impact of post-modernism and all things associated with it. Paragraph 2.2 examines the principles of induction and deduction as the driving force behind the development of new models and theories. The conclusion that constructing world views is a way of building models of the world is developed in paragraph 2.3. The world view project will be discussed from this point of view.

The concepts used here are neither new nor original. What is new is the fact that we attempt to apply these insights to the construction of world views by *scaling them up*. Not everyone agrees with this inductive method of working. Nevertheless, this kind of approach is particularly inspiring and produces interesting insights.

1 The post-modern technotope

This section describes how science and technology came to exist autonomously and how a post-modern technotope developed out of them. We discuss the totalitarian characteristics of the technical and scientific bulwark and describe some post-modern features of science.

1.1 The ontotheological schism

> Dieu? Je n'ai pas besoin de cette hypothèse!
> LAPLACE (?)

Two important rifts resulted in what we might call the ontotheological schism. The roots of science and technology as we know them today can be found in this dual rift. It is our conviction that the rift cannot be mended and that we should make no attempt to do so. The *World Views* project should in no way be interpreted as such an attempt. On the contrary, we shall demonstrate that science and technology can play a vital role in the construction and conception of world views.

In ancient times the world formed an all-encompassing whole. The *physis* of the Ionian philosophers, the *kosmos* of the classical Greeks and the *natura* of the Romans had physical, human and divine aspects. A new element was introduced, however, with the Christian God. He was placed outside creation as a Creator, which gave rise to a divine sphere clearly separated from nature. This caused the first rift in the all-encompassing whole. Fifteen hundred years later the second rift occurred: the individual as an interpreting being becomes separated from what henceforth would be called objective physical nature. Man as an individual henceforth places himself at the top of a scale of values and from there determines values and meanings. This so-called objective reality was described and explained by science, which came to regard itself as being more and more independent of other ways of describing reality such as theology, for example. Henceforth, science was synonymous with objectivity. This increasing autonomy created much tension. One only has to think of Galileo and his problems with the Church, or the witticism by Laplace (?) in reply to Napoleon: 'Dieu? Je n'ai pas besoin de cette hypothèse!' (God? I have no need for such a hypothesis!).

Every attempt by neo-Aristotelians, neo-Platonists, neo-Thomists, baroque (to heal the culture-religion rift once again), humanists, and so on to make the ontotheological schism whole again ultimately failed. At

the end of the sixteenth century theology finally conceded and yielded its grip on science forever. Culture followed in its wake. At the end of the eighteenth century the dream of a synthesis between art and knowledge also vanished.

The tide could no longer be turned because science and technology had also gained a real hold on society. James Watt invented the steam engine and Adam Smith's 'invisible hand' shed a different light on economic relations. The political world followed and a new phase was heralded in with the concepts of Liberty, Equality and Fraternity, inherited from the French Revolution.

It was now impossible ever to return to a single world view.

1.2 Post-modern fragmentation

> All concepts fail...
> PAUL VAN OSTAIJEN

Basically we all agree that we live in turbulent times. Our prosperity, or at least the pursuit of it, is based on *big money, big labour* and *big economic expansion* but nevertheless has shaky foundations. It is sometimes said that we live in a post-modern age. Herman De Dijn speaks of 'the post-modern man who tries to live and survive in a world without ideals, without a grand future, thrown upon his own resources in the midst of a culture descending into confusion, and striving for whatever the market extols as a must or the 'in' look'.[2]

It is difficult to put into words exactly what post-modernism is. There are no generally accepted concise definitions. The following elements recur, however: there is an uncontrolled pluralisation of cultures and of culture fragments, the time of great stories is over, ideologies have become inflationary, there are increasingly differentiating trends and divergences in the sciences, people's sense of values and ethics is declining, commitment in the visual arts, music and literature is waning, and so on. Now that communism has collapsed, the emptiness of former capitalist societies provokes a variety of reactions ranging from a superior sense of relativity, to cool cynicism, to a fanatical wish to hold onto 'old values'. The result is a narcissistic attitude to life, the youth culture of MTV, amorality and ambiguity where extolled 'virtues' such as tolerance and pure indifference can co-exist. Post-modernism is characterised by a tendency towards globalisation and individualisation. Rock music as a mass culture allows individual perception ('I'm dancing with myself').

Software is commercially available and exchangeable but allows you to create your own (virtual) world where cyberpunks live in cyberspace. In all these areas people are frantically pursuing instant pleasure.

Within the socio-economic framework, we are witnessing the transition from man as producer (from labour to goods) to man as consumer (from goods to services). This leads to problems precisely because work has until now been one of the guiding principles of our society. 'We now know that we no longer live to work, but our society is far from being organised around the idea that we work to live.'[3] The crisis we are now going through is not therefore one of means but one of ends. This is also the theme of Hans Achterhuis' book *Het Rijk van de schaarste*, in which the Dutch philosopher describes how in modern times certain relationships have been reversed.[4] In a traditional society man was a creature with finite needs and infinite means to fulfil those needs. Now there seem to be finite means available to satisfy seemingly insatiable needs.

Science and technology have undoubtedly contributed to the various elements that we have classified under the category post-modernism. Our world is no longer a biotope, but a *technotope*, where science and technology encroach on our daily lives. Technology creates two opposite trends, summed up in the commercial slogan: Think Globally, Act Locally (known as glocal).

In the first place there is globalisation, in which technology is the catalyst for a unified world culture. Hence the *Global Village Concept* of CNN is the modern version of 'The world is our village': the media as a window on the world. This global information is available to all and leads to uniformisation: take for example the worldwide trends in fashion, film and architectural styles and music, particularly rock music. The result of globalisation is that the individual citizen lives on a patchwork quilt of different worlds (the village or town, the region, the country, the linguistic, cultural or religious community, the continent, the world), each of which claims a bit of his identity.

On the other hand, technology increases the freedom of the individual. Examples include democracy, increased mobility ('my car means freedom'), telecommunications, the opportunities for leisure activities to fill free time that is largely created as a result of technology, and so on. Technology not only enables us to explore the earth and the universe, it even opens the door to virtual worlds, limited only by our own imagination (virtual reality and engineering, multimedia, etc.).

1.3 The tyranny of technology

> Alas, however hard we struggle against this raging monster,
> resistance is futile.
> LEONARDO DA VINCI

Science and technology have something compelling about them. We are not sufficiently aware that the technotope is the only possible world for us, that there is no other choice. In this sense technology has totalitarian characteristics. We shall briefly describe these.[5]

1. In what we might describe as classical metaphysics, a thing is perfect when it stands alone or refers exclusively to God. This is not so in the case of technological developments. Here, the more complex an invention or a technical object is and the more tasks it can do, thereby referring to as many other technical objects as possible, the more perfect it is. The more references to other technical objects that are possible, the more perfect the technical invention is. A multidisc CD Dolby stereo system with twenty four controls, each with five functions, on a trendy operating panel is much more sophisticated and perfect than a record player where only the volume can be adjusted. An ultramodern digital telephone exchange is more perfect than the manually operated switchboard of eighty years ago because its capacity (i.e. the number of connections possible with this kind of communication equipment) is several orders of magnitude higher. This aspect of technology is extremely important if we are to begin to understand its totalitarian nature.

This kind of interdependence is also inherent in science too. What makes a good scientific article? One where the impact factor, i.e. the average number of quotations from the work in publications by other scientists, is high. The more fundamental a scientific discovery is within its own discipline, and preferably in other disciplines as well, the better it is.

Networks are spreading in society too: power and hierarchy have been greatly weakened. Instead a network of contacts, information and relationships has formed. This, too, is a symptom of technologisation. The most influential figures are no longer the 'rulers of the earth', the traditional world leaders and politicians, but rather the *lobbyists*, an activity that has developed into a respectable profession (the modern version of a mercenary). Power no longer resides in knowledge, but in the hands of those who can find their way through the barter trade of vested interests.

2. A second characteristic originating from science and technology, which characterises our social world more and more, is the highly rationalised practice of cool economic efficiency. The tendency to list, systematise and organise is inherent in science as we know it today. Ptolemy's 48 star systems, Mendeleev's periodic table, the multiplicity of elementary quantum particles, the Human Genome Project: all of these strengthen our belief that nature and the world are highly structured and are based on principles of efficiency and effectiveness. This is the economic rationality of Leibniz: we live in the best of all possible worlds, created by God at minimum cost...

This process of objectivation results in what some call the flaying of society and what others call control. It results in bureaucracy in the civil social order. The French philosopher Michel Foucault pointed out that the compelling power of rationality, efficiency and technology results in *the homo docilis*: someone whose papers are in order is a good citizen. It results in quality being defined in terms of mathematics. Count the world, ban the stories! A good scientist is one who has many publications to his name (who ever reads them...?). From a social point of view, society is degenerating into a meritocracy, in which every fact and every action is examined for its merit, economic or otherwise. In medicine this leads to biocracy. The objectivation of the human body deteriorates into a therapeutic determination, where patients' lives are senselessly made dependent on machines or where 'scientific' experiments (such as artificial insemination of sixty-year-old women) conflict with 'ethical' objections, which become increasingly eroded and vague in the face of advancing science and technology. In almost all social functions the philosophers, visionaries, prophets and utopians have been replaced by lobbyists, technocrats, marketing experts and PR men.

The increasing hold that technology has on our daily lives has also drastically altered how we deal with time and how we perceive time. In the technical world, time is 'won', people are into time management and speed is idolised. The annoying thing is that speed 'implodes': speed only has meaning when the others, the competitors (literally, those who strive with you — or at least try to), are slower. So ever faster, ever more efficient is the message. As Lewis Mumford once said: 'The clock, not the steam engine is the key machine of the modern industrial age'. Punctuality has become an imperative virtue. Transgression can have serious consequences. not only from an organisational point of view but also socially and emotionally.

3. A third characteristic ensues directly from the first two: following on from ontological interdependence and the tendency towards efficiency comes uniformity and the increasing uniformisation of the world around us. For example, the globe is organised into time zones, there are only a limited number of types of power points worldwide and computer compatibility is a must. Conformism is essential. The way in which multinational companies operate is a good example of this. Solidarity and uniformity of personnel is the aim while standard behaviour is called for in order to perform well and efficiently. Independent thinking is taboo and, above all, ideas must be kept simple ('Keep it simple!'). There is also increasing evidence of this trend in society where large and inspiring projects are now outdated. Successful political parties are those with a simple message that can be expressed in slogans and one-liners.

4. A fourth characteristic is the conclusion that science and technology sustain each other. Science gives rise to new science, technology gives rise to new technology, science stimulates new technology and vice versa. We should at once scotch a persistent misconception that assumes there is a causal link extending from science to technology but not the other way round. Many scientific discoveries (for example in cosmology or high-energy physics) would simply be impossible without technology. The reverse is also true: many technical achievements are impossible without scientific insight. The forces that drive, draw and compel people to achieve more, better and more radical results in the 'positive' sciences and in technology are unknown in the fields of philosophy, ethics, morality, literature... or at any rate they are not in evidence to the same exponential degree. Every scientific breakthrough immediately raises a number of questions. Every answer to these questions raises still more questions and so it continues. The same is true of technology. An interesting technical achievement (such as the transistor) is immediately used in dozens of other applications (telephones, TVs etc.), which in turn... and so on. Science and technology have no external objectives; their only aim is their own perfection. There is opposition to this. Ecologists are resisting morbid ecologically[6] destructive tendencies and the further development of a society that is being forced structurally and economically into unbridled dynamism (for example the belief in an economic growth model).

5. A fifth — and somewhat unexpected — characteristic of the growing technologisation is the increasing tendency to believe in and have faith in what others do and in what we are told. After all, it has become impossible — even for scientists, and even for scientists within their own discipline — to examine every claim that is made by others. Are you sure the earth revolves around the sun? Probably. But have you proved it yourself?

In our daily lives we are also — perhaps unconsciously — confronted with a wholesale faith in both technology and the people who control technology, in other words 'resting easy' about things without understanding why. In our daily dealings, are we not entirely at the mercy of the kindness of others (a trust that is sometimes betrayed and then relatively quickly forgotten...)? Do we not rely on the train arriving on time? Or that our plane will land safe and sound? Do we not drink the water that comes out of the tap without giving it a second thought?

Anyone who with the best will in the world still cannot adopt this belief and faith in science and technology will end up suffering from technophobia. But even if we do not suffer from such an extreme form of a-technologitis, science and technology do give rise to a feeling of individual helplessness, which used to be much less common among ordinary people. We are dependent on power producers for electrical power, we have long since been dependent on others for our food supply and even where leisure activities are concerned, we think that we are dependent on television. The individual has become powerless and realises this himself to a greater or lesser extent, especially when he sees TV pictures (and not just in the evening, but every hour of the day) that vividly show harrowing famine, increasing environmental pollution, street crime, the civil war in former Yugoslavia, and so on. A kind of tyranny of current affairs develops, which dulls long-term thinking or even completely eliminates it and ensures that we cannot see the wood for the trees.

Moreover, technology can create potential global differences. Differences in environment, living conditions, food shortages and food supplies, water, comfort, wealth and poverty are well known and create tensions that encourage migration. The three cultural revolutions (rural, industrial and information) now rule the world. While in some parts of the world farmers are still ploughing the land, elsewhere unskilled labourers, sometimes even children, are chained to the production line while here teleworkers sit at home and map out their future on a computer screen.[7]

1.4 Post-modernism in and as a result of science and technology

The conclusion to the previous paragraph is that science and technology behave like a runaway train that cannot be stopped. The vast inertia of

the scientific and technological complex creates various effects, even within science itself, which could be labelled post-modern. In the first place there is scientific research for the sake of research. Under the influence of the various self-fuelling mechanisms described above, there is a risk that scientists will indulge themselves in no-strings-attached activities that swallow up millions[8], with research being conducted purely for the sake of it. The saying *publish or perish* is not just a witticism; it is a serious fact. The result is an increasing divergence within science itself, a tremendous specialisation that certainly poses an enormous intellectual challenge but is not bound by any need for human or social relevance. Many scientists devote themselves to seeking solutions to problems that they think are of enormous importance (and that they themselves have formulated in many cases). Science is full of examples of trivial subjects that have been the object of intensive study. The perception of the importance of a problem is a predominantly subjective matter.

The philosophy of science follows the same trend. Feyerabend's subtle 'Anything goes!' opens the way for a defeatist *laissez-passer* mentality, where anything goes 'in the name of science'. The subtlety lies in the fact that Feyerabend advocates keeping an open mind as regards types of knowledge other than the purely scientific (see also paragraph 2.4) and that there are actually no 'objective' standards against which the 'truth' can be measured. Not everyone understands the concept in this way, however.

Research as an independent activity where social relevance is of secondary importance also carries risks. Science is often used as a forceful argument but in an *à la carte* fashion: selective use is made of arguments that suit a particular purpose. Is there, for example, conclusive proof that there is a link between chlorofluorocarbons and the hole in the ozone layer? Or are we accepting a suspicion as a fact? It might perhaps be a good idea to allow CO_2 levels to rise via the greenhouse effect because plant growth in the Third World would thrive better as a result.[9] One of the greatest challenges facing us in the future is that of 'science sharing' to prevent a new kind of illiteracy arising.

2 *World views as models of the world*

In the second half of this article we shall attempt to demonstrate that the construction of world views is analogous with the way in which models are constructed in science. We shall therefore try to make the most of this analogy between scientific models and theories about world views.

First of all we shall invalidate the impact of post-modernism somewhat. We shall then take a concise look at the inductive-deductive pump that is a feature of scientific research. The main characteristics of models are transferred to world views in paragraph 2.3. Paragraph 2.4 examines a Gödelian trait in science, from which, among other things, an ethical deficit arises.

2.1 Is post-modernism a thing of the past?

Post-modernism is an elusive label that is eagerly used to classify certain present-day cultural phenomena. It is a disjointed collection of symptoms and characterisations, which are employed just a bit too readily. We can therefore ask ourselves whether we do not show post-modernism too much respect and whether we do not overestimate its impact. Is post-modernism not an aversion to what is called modernism, rather than the dawning of a new age? Gerard Bodifée calls post-modernism a trap for Western philosophical uncertainties.[10]

'The modern programme is not so much outdated as incomplete,' according to Louis Dupré.[11] The great philosophical ideas and schools of philosophy of the past have a permanent meaning because they not only reveal the various facets of reality but also change them. It is true that the time of the great stories is over, in the sense that history has clearly taught us that blind faith in just one great story is totally inadequate and can sometimes have an unhappy ending. Communism has collapsed, yet it has taught us enduring lessons about our own socio-economic system; certain aspects of communism have become integral to the way we act and think. The Enlightenment is not a thing of the past either. Yet we recognise that there is more than Reason and Progress.

The *Worldviews* project wants to be characterised within this context. Some people object to such an ambitious utopian venture. They maintain that *Worldviews* would be an outstanding exponent of post-modernism because we want to construct not one but several world views, for example. Nothing could be further from the truth and this interpretation is somewhat gratuitous. *Worldviews* is not a club where you can make free and arbitrary use of all kinds of ideologies and schools of philosophy. The plurality, the interdisciplinary nature and the versatility of the world views we want to construct have everything to do with the power and robustness required. We shall return to this point later. Each of the world views is essential in terms of how it complements (and at times overlaps) each of the other world views.

2.2 Models

> Models are a matter of inspiration,
> Not deduction.

Scientific research amounts to nothing more than constantly constructing models, which are inspired, confirmed or invalidated by experiment and/or observation. Models can be verbal, mental or intuitive; in modern science, however, mathematics is the ideal language. The ancient Greeks were interested in numbers, ratios, geometric figures and the like with models preferably based on aesthetics (ratios) and geometry. The Renaissance brought us the mechanistic determinism of Newton, Leibniz and so many others, in which man acts as observer of the great mechanical clock of the universe. Mathematics became part of scientific research once and for all: Newton and Leibniz invented differential and integral calculus in order to make mechanical mathematical models. With the advent of quantum mechanics, chance and the theory of probability also found their way once and for all into the bastion of mathematics. One of the conclusions is that science is not about nature but about the interaction between man and nature. Man is not an external observer; the experimenter is always involved in and even determines what is being observed. And in the light of the most recent insights in physics, concepts such as entropy, dissipative systems and deterministic chaos have secured a place amongst the latest scientific theories.

What is remarkable is that all these theories and insights can be expressed in the language of mathematics with the same relative ease. Hence chemical reactions are preferably expressed in reaction formulae, physical laws are described using mathematical expressions such as Newton's second law of motion, $F = ma$, or Einstein's mass-energy equation, $E = mc^2$.

An important insight gained since Newton's time is the fact that systems and models are dynamic. This means that their behaviour changes as a function of time. A key point here is the notion of the *state of a system*. The state is the minimum information that is needed, given the inputs of the system, to clearly determine the outputs. In other words, in addition to input and output variables, a system also has so-called 'internal' variables, known as states. Knowing the inputs does not provide sufficient information to calculate the output. The internal variables also have to be known, for example the initial state or the state at a time chosen as reference. One object that may serve as an example is the car. When the engine is cold, the car reacts differently when the accelerator pedal is pressed than when the engine is warm and the accelerator pedal is pressed by the same amount. The system is the same (the engine), the input is the same (the amount by which the accelerator pedal is pressed), but the output (for example the acceleration the car undergoes as a result of pressing the accelerator pedal) is different in both cases because the state of the engine is different in both experiments. We actually come very close to what mathematicians and physicists mean by the concept of state in the everyday language we use. When we inquire about the condition (state) of a patient or the situation (state) in Angola, we are trying to assess, on the basis of this information, how things will develop in the next few hours. This concept of state was only fully developed in the mathematical system theory devised after 1960, although it has played a more or less explicit part in physics since Newton in the seventeenth century and the development of thermodynamics in the nineteenth century.

The conclusion is that in order to fully characterise a system, not only do we need a model and the inputs that will be applied, we also need to know the state (initial or otherwise) of the system. It would take us too far to examine the mathematical formulation here.

Systems without inputs also exist, so-called autonomous systems. Even if we have a good mathematical model of such a system, we still need to know the initial state in order to simulate the output of the system reliably. Here, however, we come up against the first fundamental limitation of mathematics (or of nature?). Relatively simple autonomous systems exist — so-called non-linear mathematical equations — which require infinitely accurate knowledge of the initial state to enable the behaviour of the system to be calculated accurately over an infinitely long period of time. In other words, if we only have limited accurate knowledge of the initial state of such a system (which is always the case in practice), then the behaviour of that system can only be calculated over a limited (finite) period of time, even if the model equations are known exactly and an ideal computer is used that makes no calculation or rounding-off errors. A system that displays this kind of behaviour (among others) is called chaotic. It should be stressed here that systems like these are completely deterministic, in other words no chance factors are involved. Only our limited knowledge of the initial state throws a spanner in the works and means that the accuracy of the predicted behaviour of these systems decreases over the period of time to which the prediction applies. We do not have to look far in nature to find examples of chaotic systems. A sun with two orbiting planets that move in its gravitational field is an example of a chaotic system (the famous 'three-body problem'). This view, which began with the work of Poincaré at the

beginning of this century, seriously discourages the belief in the power of mathematical models. It deals a severe blow to the mechanistic determinism of the mathematical rationalists, who thought that everything could ultimately be explained by means of mathematical models. As we shall see later, it also implies a limitation of the rational futurology for which we wish to use world views.

Making models is constructive work. A model is made, based on every possible source of information, including experimental data.[12] An attempt is made to find qualitative links between the different variables and, if possible, to translate these into quantitative terms. Within the field of science, this modelling process often follows a fixed pattern[13], the basic elements of which are: the hypothesis, the assumptions postulated, the observations, in other words the information gathered as a result of the hypothesis, and the idea of falsification, which Popper introduced into philosophy. We can represent this principle in the form of a high-level computer program as follows:

Repeat an infinite number of times

1 Formulate-refine the hypothesis as long as it stands up
2 Repeat until the hypothesis is falsified:
  a Refine the experiment.
  b Check whether the information obtained invalidates (falsifies) the conclusions that can be deduced from the hypothesis.

Scientific research proceeds in exactly the same way. First, a given hypothesis is formulated, which is true as long as it is not invalidated by counter-arguments that can be verified experimentally. The hypothesis can be refined an infinite number of times; the experiments can also be continually improved, made more accurate, and so on.

This process, in which a theory comes under attack, proceeds in an extremely fair manner, in the sense that the scientific theories themselves have to supply the arguments that could invalidate them. Let us take as an example Newton's findings that the planets move in an elliptical orbit in a plane with the sun at one of the foci. This consequence of Newton's theory of gravitation can be invalidated if an example is found of a planet that, for example, does not move in a closed orbit in a plane. Just such a planet was found in our solar system: Mercury. The 'rosette'-shaped orbit that Mercury describes (in other words it does not move in a closed orbit since the planet does not return to the same place after a period of time) is, incidentally, accepted as one of the

'proofs' (experimental verifications) of Einstein's general theory of relativity.

Consequently we can never know for sure whether a scientific theory is 'right'. Every theory is 'true' and 'valid' until it is demonstrated by means of scientific arguments, preferably supplied by science itself, that it is 'wrong'. It is a bit like the legal principle, which states that the accused is innocent until proven guilty (the difference being that the accused is not expected to put forward arguments to prove his potential guilt). This scientific game is therefore not so much aimed at proving that theories are right (although every 'confirmation' is of course gladly accepted), but that hypotheses (theories) are wrong! According to Popper: 'Irrefutability is not a virtue of a theory, but a vice!'

The process outlined above contains two kinds of logic: firstly deductive logic, which involves reasoning from the general (the hypothesis) to the particular (the conclusions and verifiable consequences...). Secondly inductive logic, which involves formulating a new or refined hypothesis from particular observations. There is a great deal of philosophical (and emotional) debate about this last step in particular ('scaling up'), which dismisses induction as a principle.[14] Often deduction prevails for some time before any inductive steps are taken. A good example of this is found in modern physics, where scientists have such great faith in mathematics that research is mainly conducted with a pen and paper (and computer), based on axiomatic deduction, before any conclusions are verified (or rather falsified) experimentally.[15] Mathematics is of course an important tool and for those who can handle the subject it can be particularly inspiring because the deductive manipulation of formulae and laws, where the rules and principles of calculation are strictly observed, results in new laws and insights, which can then be verified again experimentally. Whereas deduction is mechanistic (research is even conducted on 'automatic proofs' by computers), induction calls for more creativity and is the real driving force behind scientific progress. For example, the formulation of 'theorems' does not require any formal logic (although it helps of course), but is a seemingly inexhaustible source of new findings (take for example the Riemann hypothesis or Fermat's Theorem in number theory).

In a certain sense the dynamic nature of science and technology is embodied in the aforementioned computer program. The mechanism of deduction-induction is like a pump that drives scientific effort, sometimes to unprecedented heights (and sometimes to horrendous depths). In particular, the fact that elements have to be found that invalidate a given hypothesis livens things up quite a bit. You can never rest on your

laurels for long. This 'restlessness' that characterises science and technology is fundamentally a good thing. It guarantees perpetual mistrust, which ensures that scientific pronouncements are of a high quality. It also ensures that questions, theorems and hypotheses are constantly formulated, examined, validated or invalidated. (This aspect can also be taken amiss, however, and become associated with the totalitarian nature of science and technology, which we have already described.)

What we have just described as the agitation within science and technology can also be associated with the concept of *persistent excitation* in mathematical engineering.[16] We described earlier how dynamics and the concept of state are essential elements of mathematical models. It can happen that not all states are excited in a dynamic system and that, consequently, they cannot be observed in the outputs. It is a bit like seven sleeping dogs that are there in the dark, but you notice nothing unless they wake up and start barking. Careful analysis of the noise will then reveal that there are seven of them. In engineering practice this is called the condition of persistent excitation or of sufficient stimulation. The dynamics of a system can only be modelled if the dynamics can be observed sufficiently.

Let us look at an example in engineering practice. Suppose that we want to create a model of the suspension of a car by carrying out measurements — using accelerometers — of the acceleration of the car. If a flat, straight stretch of road is used and the car is driven at a constant speed, not much acceleration will be measured (the suspension is not activated) and, consequently, nothing can be discovered about the characteristics of the suspension. The car needs to be driven relatively 'wildly', in other words speeding up and slowing down (pressing the accelerator pedal more or less and braking) and, for example, zigzagging about (only a thought experiment is involved here of course). Only then will the car's suspension be sufficiently activated and we will be able to find out more about the stiffness of the suspension and such like from the acceleration measured. It is evident that the inputs of the system (in this case the accelerator pedal, the brake and the steering wheel) must create sufficient stimulation for the dynamics of the system to be apparent in the outputs.

By scaling up we come to the same conclusion for the success of scientific research. Important discoveries are sometimes made by accident because the experimental conditions (the 'inputs') are not right for stimulating the phenomena one is seeking (as a result of errors in reasoning or because one fails to realise how the experiment should be excited). Sometimes, however, effects are seen that were not expected immediately, precisely because the experiment has excited 'modes' other than those planned. In other words, in science the right experimental conditions have to prevail in order to arrive at particular conclusions. The experiment must have sufficient persistent excitation.

2.3 *A model is not the system*

> Ceci n'est pas une pipe.
> RENÉ MAGRITTE

The relevance of the insights just described, in terms of constructing world views, is embodied in our conviction that world views are models of the world. Herein lies their strength, but also their weakness. If the concepts and characteristics of models, which we discussed earlier, are scaled up to the level of world views, an interesting characterisation of world views emerges, which sometimes goes further than anything previously found.[17]

World views can be constructed using a technique based on the principle outlined above, in which hypotheses are formulated, possibly experiments are carried out or available data is analysed, and then world views or elements of world views are eliminated (falsified) because they are inconsistent with practical experience. This is almost an ideological attitude of course. But what a challenge!

A model of a system or of a physical phenomenon is not the system itself, just as Magritte's painting of a pipe is not a real pipe. Modelling a system or phenomenon always involves *a priori* choices. The colour of a rocket is not important in the description of its trajectory, but it may well be relevant to its identification. A model is therefore always made with a specific purpose in mind, which is implicitly or explicitly expressed in the choice of model.

The same applies to world views. A world view is always constructed with a specific purpose in mind. As a model, it reduces reality to those aspects that are important for the purpose of the model. World views are not constructed at random to explain 'everything'. Each world view in itself can, however, describe and possibly explain a relatively large or small chunk of reality.

The same is true of world views that people want to use to assess the future of mankind and the world. Not only is there an inherent mathematical limitation on our ability to do so (think of the deterministic chaos described earlier); the world view that we use for our rational futurology will also depend on what we actually want to predict.

Engineers are very familiar with the reducing character of the model concept. When a model is defined, the inputs and outputs are carefully specified beforehand, and possibly also the states that are to be included in the model. Every dynamic element not included in the model is regarded as uncertain and an attempt is made to have an indicator for this uncertainty (for example, a worst case scenario of what can go wrong). Of course this is partly based on *a priori* assumptions (and a great deal of experience), which can, however, be subsequently falsified! In addition to deterministic inputs, which can be freely manipulated, other inputs are also possible, which are not under control. These are called disturbances. When an engineer defines a model, all he does is divide up a given system into desirable dynamics and undesirable elements (uncertainties), and the input signals into manipulatable (deterministic) inputs and disturbances. This division is fairly arbitrary and in many cases proceeds by trial and error. Furthermore, the way in which it is carried out depends on what one intends to do with the model. Engineers know this only too well because they realise that models that are used for accurate simulation (models based on physical laws for instance) can be completely different from models that are used to make predictions, which in turn can be quite unlike models that are used to devise a specific regulating measure.

This reducing character of models is therefore the reason why one single model is never enough. In order to cover the full 'work range' of a system using relatively simple models, several models have to be used, which preferably overlap one another partially. This is sometimes called overlapping parameterisation. Scaled up to world views, we come up against the fact that not one, but several world views are required (an *atlas* of world views).

There are other rules of thumb in engineering pragmatics that are useful in constructing world views. With most models, accuracy (of the prediction for example) has a price, namely that the model is very sensitive to minor variations. In engineering terms, there is a 'trade-off' between performance on the one hand and robustness on the other. Unlike pure scientists, whose prime consideration is consistency in the model, the engineer's is objective, is more pragmatic: the model, the solution, the technical discovery has to work in a real situation. This means that people will be more inclined to sacrifice some accuracy if the system or model designed is sufficiently robust (for example so that small changes in certain parameters do not result in sudden, abrupt discontinuities).[18]

This kind of qualification also applies to world views. World views should not be constructed to describe, explain or predict with complete accuracy. World views should consequently be devised with a due sense of engineering pragmatics. A world view should not be 100% accurate (impossible in any case), but it should be good enough for the purpose for which it is constructed.

The part played by science in all of this is obvious. Science acts first and foremost as the sensor through which the world makes itself known to us. The measurements provided by science — the scientific theories — serve as experiments for constructing world views. Science provides the material from which theorems and hypotheses concerning world views can — inductively — be formulated. Science not only serves as our window on reality, it can also be the means of invalidating certain world views or elements thereof. The world views to be constructed should not only be true to science. They must be such that they do not come into conflict with it as this would result in them being falsified.

It is perhaps less obvious to argue that world views should, of necessity, be dynamic. If the language of mathematics cannot be used, it is not obvious how dynamics can be described (in other words the way in which the state of a system changes). Yet dynamics is one of the fundamental characteristics of the modern world. And we are increasingly aware of this fact. Much of what we say and do nowadays takes future generations into account, for example when we talk about environmental issues or solidarity with future generations as regards social security. These are dynamic elements that people take into account more than they used to.

In the first part we explored in detail the interconnective nature of our technotope and the driving (= dynamic) character of science and technology. We also implied that this inherent restlessness was fundamentally a good thing. Certainly as regards the construction of world views, science provides permanent persistent excitation. The 'pumping' action of constant questioning, the formulation of hypotheses and theories and the constant search for falsifying elements, with the accompanying scientific debates, ensure spontaneous stimulation. In principle this simplifies the construction of world views because the dynamic relations that make up a world view are to a large extent made explicit in the scientific research (just as the suspension of a car is indicated by measuring the acceleration, if there is sufficient excitation). For example, we can argue that what science says about mankind now is particularly relevant to the responsibility of mankind. It makes us realise that we should use all the knowledge and resources we have to prevent us from sawing off the branch on which we are sitting.

It is important therefore to ensure that there are always sufficient sources of persistent excitation, otherwise the world views we construct will be extremely unreliable. If there is no persistent excitation, dynamic models turn into static models, which are unable to cope with sudden changes in an effective and robust manner. Galbraith describes a particular lack of persistent excitation as 'the culture of contentment'.[19] A large number of people have become relatively well-to-do and have come to regard this as a personal merit (the aforementioned meritocracy). This predominantly middle-class group comprises contented individuals and is large enough to ensure that a poorer underclass continues to be invisible. This contentment results in a lack of persistent excitation, which continues to corroborate existing wrongs (as long as they are not *too* visible or annoying...). As a result, the culture of contentment is not able to seek long-term solutions.

Science itself is not immune to this danger either. In Thomas Kuhn's view, science evolves in accordance with social patterns, with originality threatening to become sidelined.[20] Most scientists adapt their behaviour to prevailing fashions, publish in scientific journals that are 'in' and settle down to a cosy existence that is far from being persistently exciting and eventually gives rise to erroneous world views. Researchers who gnaw away at the edges of the current paradigms are censured by their colleagues. Only when the growing pressure becomes too great because of the number of scientists who 'rebel', or — as more frequently happens — because of a scientist who blows the top off the scientific world with one brilliant insight, only then is the current paradigm replaced by a new one.

2.4 Science is not a world view

> J'ai cherché la vie.
> Je n'ai trouvé que la Science.
> ANONYMOUS, UCL CAMPUS

Relying on the seven components of a world view, we can immediately get rid of some candidate world views. Religions, for example, can contain elements of a world view (such as value judgements and giving meaning to life) but because they are less descriptive and explanation is not their immediate aim, they do not satisfy all of the criteria that a complete world view has to meet.

For similar reasons science and technology of themselves are insufficient to construct just one world view. Science is limited. Of all the things that affect us, it can only satisfy one need and that is our curiosity.

Science also raises questions and problems, which it cannot solve on the basis of its own dynamics. In other words, science and technology have a Gödelian trait.[21] One illustration of this is the so-called ethical deficit that coincides with the current developments in science. Never has there been so much social debate about ethical and moral issues such as abortion, capital punishment, biogenetics, etc. There are ethical commissions not only for biomedicine but also for economics and engineering. Science creates certainties, increases freedom, but ironically it is then that doubt creeps in. If I *can* do that, what should I do? The price of scientific certainties, of the ability to determine the future ourselves, the price of purposefulness is doubt: what should we choose? Our freedom is a terrible burden to bear, says Bodifée. Much-needed moral reflections cannot keep up with the driving rhythm of technical and scientific developments. We can ask ourselves whether we — as scientists — should not consider building in voluntary rest periods — moratoria. Ethical reflection is based on something other than pure verification/falsification as is the case in research. Even a proper precedent can offer little consolation here. It is evident, therefore, that science and technology are not in themselves able to fill the ethical deficit, the meaning of human existence and human progress.

We should not run the risk of a new schism developing, with science and technology splitting off from the rest (something which has happened several times already: for example, the development of the atomic bomb, where the moral implications were left to non-scientists, or some imposed biogenetic experiments). Science split in this way would be inhuman in its triumph. The rift would be at least as great as the onto-theological schism.

Notes

1 Apostel & Van der Veken, 1991: 29.
2 De Dijn, 1993: 15.
3 Rosseel, 1993.
4 Achterhuis, 1988.
5 Taken from IJsseling, 1993, among others.
6 From the Greek *oikos* (home, surroundings) and *logos* (word, discourse).
7 Toffler, 1993.
8 Also encountered in the cultural world incidentally.
9 Sombroek, 1993.

10 Bodifée, 1993.
11 Dupré, 1993.
12 Only artists seem to turn the definition the other way around: in their case the model is the thing that is modelled, i.e. reality.
13 Bohlin, 1991.
14 The arguments use this very principle, however. It is stated that inductive inference sometimes results in failure. It is concluded from this that as a principle it is not valid, which in itself is a form of induction!
15 It was once a different story. In the seventeenth and eighteenth centuries, for example, experiments were carried out and then a mathematical description/explanation was sought.
16 Engineers who work in system theory sometimes get frustrated because they are not always taken seriously mathematically speaking. On the one hand they are reproached by mathematicians for not being rigorous enough while other engineers accuse them of being too mathematical and hence too theoretical. That is why they themselves describe their discipline as *mathematical engineering* or *engineering mathematics* depending on whom they are talking to.
17 Apostel & Van der Veken, 1991.
18 The branch of mathematics that studies such questions of structural stability is René Thom's catastrophe theory.
19 Galbraith, 1992.
20 Kuhn, 1962.
21 In Kurt Gödel's work published in the thirties, Hilbert's idyllic dream of basing mathematics on logical deduction alone was killed off instantaneously. Gödel demonstrated that in a consistent logical system, there are always well-formed propositions whose truth cannot be decided within the same system. This implies that the possibilities of formal logical deduction are limited. In other words, the price of consistency is incompleteness. This is good news and bad news at the same time. The bad news is that we will never be able to prove everything. The good news is that scientific research and our creativity in this field need never come to an end.