Computer Responsibility: A Challenge for Bildung and Science

Gerd K. Hartmann
Scientific co-worker at Max-Planck-Institut fuer Aeronomie
Max-Planck-Str. 2, D – 37191 Katlenburg-Lindau, Deutschland
Tel.: +49-5556-979-336/332/344, Fax: +49-5556-979-240;
Email: ghartmann@linmpi.mpg.de
November 1999

For Prof. Dr. S.K. Solanki on his assumption of the Directorship of the Max-Planck-Institut für Aeronomie

Abstract

The trend toward computerization continues unabated. What opportunities and risks can we observe and anticipate in the social, economic and psychic dimensions? Can we allot responsibility and - in the case of failure - blame to "computer decision systems"? The assumption of responsibility by human individuals will dwindle:

1. the less ideal the essential "tolerance" between humans and machines is (or becomes), e.g. when this is "rationalized away" (as is increasingly the case);
2. the less we do to offset "velociferic" developments (a term coined by Goethe in 1825 from "velocitas" and "Lucifer").

It is a challenge and task for empirical science - or, more correctly, for the community of scientists - to demonstrate what we can reasonably expect from such a symbiosis between humans and machines and what we cannot. Accordingly - and despite the inevitable delay in transforming new knowledge into political reality - it is the task of education (in the sense of *Bildung*) to point up what is desirable and what is undesirable. The preconditions for this are:

a) adequate, distanced reflection on the historical options in Europe ultimately leading to the birth of the computer, options dating back at least as far as the Middle Ages when nominalism began to radically change the complexion of European (intellectual) identity;

b) a (re-)entrenchment of complementarity in our philosophy of things; it is a phenomenon by no means restricted to the discoveries of Niels Bohr for modern physics, it is to be found within and between cultures, notably between the West and the East. Any "re-vision" of cybernetics failing to take this into account is doomed to be blind in one eye. From now on such a revision must contribute more to a dynamic balance of the "Both/And" rather than (as has been the case so far) to a one-sided Either/or.

As long as the trend toward "more and quicker" continues to grow and can be marketed so profitably, the "velociferic" trend will also grow and the question of computer responsibility will find no adequate reflection, let alone an answer. Thus in the highly technologized nation states we must pay greater attention to a more effective form of risk and crisis management.

Contents

1. Introduction

The author of this article regards the Year 2000 Problem (also known as the Millennium Bug or Y2K) as a sufficient reason to engage more thoroughly with the problem of computer responsibility (the term is itself ambiguous), not only in the immediate context but in a longer-term perspective encompassing the full gamut of disciplines, generations and cultures affected by it. The author outlines different approaches and fundamental insights generated by modern physics with a view to demonstrating how crucial it is for us to elaborate new theories for a responsible, (positively) synergistic collusion between humans and machines (notably humans and computers) in the socio-economic-ecological system of the nation state and in the complementary intermesh between symbiosis and competition.

Modern science and technology are mutually interdependent. They have created the computer, the special strengths of which are to be found in the processing of scientific/technical information and in the monitoring of corresponding systems. The computer is an amoral, ambivalent device, which means that it can equally well "serve" moral or immoral purposes, a point borne out by the continuing increase in computer crime. The more it is seen as a means to an end, the less important the question of "its" responsibility becomes. In addition, the computer exerts a high degree of fascination because it a) offers the prospect of total control over a virtual world, a species of control which it is only too tempting to project onto the real world, and b) offers an easy opportunity for "dropping out" into virtual space, thus escaping from a reality which is frequently irksome in the extreme, a species of escapism that can very quickly lead to computer-addiction. For adults and children alike, the computer holds out the prospect of a "partnership" (of a reactive or interactive kind) without the mutual dependence and the complexities involved in human relationships. The ambiguity at the heart of the question of computer responsibility naturally makes the answers to it either formidably difficult to understand or confusingly controversial. It also all but masks a problem of fundamental import which is inherent in all systems. I shall enlarge on this later.

The crucial point is that whatever it is that binds the elements (of a system) into a whole and presents it as an entity to our experiential and cognitive faculties is not (or at least not readily) perceptible (as such). That which relates the complementary "poles" of a system to one another, the things "going on" between them, is frequently all but inaccessible to our powers of reflection.

More than ever before, any kind of organized thought aiming at the cultivation of responsibility, solidarity and hence at the achievement and consolidation of peace must pay special attention to language. Philosophy, at least in the Western tradition, assigns a huge significance to the Word, to everything that happens in our use of speech and language. "**Being that makes itself compre-**

hensible becomes language," modern philosophy tells us. *The model of dialogic communication is the primal phenomenon of speech*. Today, however, in many sectors of life we allow insufficient attentiveness and a lack of stringency in our diction to make being/existence more difficult to understand rather than vice versa. If, as Martin Heidegger suggested, it is genuinely characteristic of the thinking of the past decades that we are "**on the way to language**", then we should expect the very opposite to be the case. While it is true that we can confidently predict the triumph of one language - English - in the future of the sciences, technology and trade, things will surely be very different in the Humanities. The role they play is grounded squarely on *historical awareness* and the indispensable precondition for any activity within that domain is *Bildung*[1]. Given this fact we may reasonably expect more diversity rather than less, for the simple reason that for every individual his/her mother tongue is the "most inhabitable room" in the house of his/her being. The conclusion we should draw from this is that all people whose mother tongue is not English should be brought up to speak (at least) two languages and the information systems at their disposal should be bilingual, especially where those systems extend to subjects belonging to the domain of the so-called Humanities. Both consumer protection and the competitiveness of (say) the German economy could be improved in this way. The enormous growth of (scientific) information (notably through the headlong progress of microelectronics) and declining government support (in the Federal Republic) make one thing abundantly clear: **the fundamental relationship between public science and commercial information economies urgently requires clarification.**

The immense opportunities and dangers implicit in the fast-growing electronic media and the thoroughgoing changes they effect make responsible action a prime imperative. This applies notably to fundamental issues of a long-term nature still waiting to be resolved. A case in point is documentation (in the comprehensive sense of the term), where the necessity of archiving material for quick, qualifyingly filtered retrieval is especially urgent. What this means in concrete terms is making scientific texts and data available in an interactive, user-friendly (convenient), economic way, as is commensurate with the nature of science as something open and available to all. In this context we must not overlook the still largely underestimated problem of "**technical amnesia**", a term referring to the fact that older data have become "illegible" for modern technological devices. Attendant on this phenomenon are ballooning costs and a deleterious amount of time spent on retrieval, in other words precisely the opposite of what we should be aiming at.

The more we open up our perspective to encompass the broader context of the Humanities, the more *inadequate (and irresponsible)* it becomes to rely totally on information processing (documentation) with the aid of computers or Artificial Intelligence (AI). The problems encountered with language computers (translating from one language to another) and partly also with word processors drive the point home very clearly.

In its literal meaning of "love of wisdom", philosophy in its incipient stages was nothing other than a critical and self-critical method of joint inquiry. As such it was the fundamental discipline underlying any form of ordered, systematic thought. Born of an awakening astonishment *that there should be something and not only nothing* (Leibniz), it is infused with an astounding conviction that is anything but self-evident: the conviction that truth can be expressed in words. As Heraclitus put it, ***the word ("logos") is universal**, although many live as if they had ideas, thoughts of their own; though in sleep each turns to his own, in the waking state we have one sole, common world created by logos, and hence it is necessary to follow that commonality.*

In our dialogue with people from other cultures we learn that not all traditions of thought are similarly persuaded that in the waking state we can reliably count on one common world created by

[1] The German term *Bildung* has so far defied adequate translation into other languages. Unlike the one-sided terms "*formation*" in French and "education" in English it stands for a model that extends from the central term "*Bild*" (form, image) to encompass "*Vor-Bild*" (literally "pre-form" but with the operative meanings of example, ideal, form to be emulated) and "*Nach-Bild*" ("post-form" or emulation of the "pre-form").

the word. Their skepticism about language is deep-rooted. The doubts we harbor are restricted to the doubts leveled at assertions expressed in language. Fundamental skepticism, by contrast, relates to the very substance of that which is referred to in an assertion, in other words skepticism presupposes that something has been seen or can be seen. Where nothing can be said, we cannot have doubts. The inverse of this - an insight that has become central to Asian thinking - is the conviction that whatever can be said must always be doubted; **the Tao that is effable is not the true Tao.** It is from this persuasion that the resignation about the possibilities of language derives, an attitude that despairs of the eventuality of the truth becoming word. In the face of the complementarity[2] with which reality confronts us an existential despair can thus take possession of us, making it ultimately impossible for us to choose between alternatives. So it is hardly surprising that among the Europeans of the "old" and "New World", many have lost their implicit trust that *meaning can be made word* in such a way as to justify a wakeful conviction that meaning is *universal*, valid for us all in the same way. It is a species of uncertainty that is becoming more widespread with the greater frequency and intensity of encounters with thinkers from the Asian cultures and their fundamental acceptance of the validity of "complementarity" in all things. These new doubts have yet to achieve the state of rigorous skepticism typical, say, of Buddhist thinking. They are usually less earnest, less far-reaching and committed. Everyone can say and think what they like. Protesting against such lack of rigor will frequently entrain the accusation of intolerance, particularly as we, unlike Heraclitus, are aware of the thousands of different languages in existence, how many different ways and forms of expression there are, how many different modes of giving tongue to our experiences and symbolizing them. Not that this is any justification for saying what happens to come into our heads. (The critical relativization of our claim to the ability to arrive at truth is no justification for a relativization of the claims that truth makes upon us). If we want to make ourselves understood to others, if we want to know and understand those others ourselves, then we cannot be attentive, scrupulous, clear and precise enough in what we say. This is doubly important because, unlike Western philosophy, Asian thinking in general, and Chinese philosophy in particular, does not proceed from the Aristotelian syllogism, the logical and ontological primacy of the equation of truth with non-contradiction, the fundamental **Either/Or**. Whether this is a disadvantage or, as Japanese, Chinese and many Indian philosophies believe, an unexampled boon enabling us to think effortlessly in terms of the **Both/And**, is neither here nor there. It is futile to bewail historical processes that cannot be reversed. But what we make of the outcomes of those processes is a crucial issue. This is doubly true the more fundamentally aware we (must) become of the principle of complementarity, the inevitable uncertainties in the **in-between** of the Both/And, uncertainties that generate both fears and new latitudes and freedoms. Do our fears result from the way we think or do our modes of thought result from our specific fears?

The **in-between** is essential to Chinese, Japanese, Korean and Indian modes of thinking and speech. As its Western rediscoverer Martin Buber tells us, it is essentially prior, it is "there" before we can utter the basic words "I" and "you". In contrast to the use of the term in Husserl's phenomenology, Gabriel Marcel's concept of "**intersubjectivity**" also extends to this concrete inclusiveness of existence, its invariable relatedness, its eventuation and articulation in terms of the vis-à-vis, prior even to factual encounter. For a number of years now we find the idea of **intersubjectivity** turning up not only in the relatively recent branch of philosophy that goes by the name of **Transcendental Pragmatics** (an example of *progress through science*) but also figuring in modern

[2] The present author understands Bohr's use of the term **complementarity** to mean:

- that being things manifest themselves in two different phenomenal forms which are mutually incompatible;
- that the nearer one approaches one of these forms, the further one moves away from the other (more simply: the "sharper" the one is, the more "fuzzy" is the other);
- that the two forms cannot be entirely "unmixed", they are "indivisible" (probably a consequence of temporality, i.e. the finitude of observation time).

physics, or more precisely in the **scientific community of physicists**, albeit in a more restricted sense, namely in connection with the **verification and validation of** (objective, numerical) **measurement data**. This process becomes more difficult the greater the growth and the growth rates of numerical and alphanumerical data (texts) become. At present this growth is exacerbating the **accumulation problem**, the fact that information can be accumulated (indefinitely) whereas human life-time cannot. The accumulation problem is easier to understand than to deal with. For the latter to be a viable proposition we require at all events a **qualifying form of filtering** information, generating from **primary information** (also called potential information) the kind of **secondary information** that can be immediately understood and used. Here the use of EDP systems in a dynamic symbiosis between humans and machines is indispensable. It is a symbiosis requiring constant, ongoing optimization.

2. Bildung *(education) and responsibility*

Since Socrates at the latest, we know that there is a difference between knowing and being-able, the feasibility of practical application. Feasibility refers us back to the cultural background, i.e. to the traditions handed down to us, and accordingly (at least from the German perspective) to the concept of *Bildung* (education) as understood by Wilhelm von Humboldt and his contemporaries. This German idea of *Bildung* (implying not only the one-sided ideas of form and formation but also the duality of *Nach-Bild* and *Vor-Bild* - pre-form and post-form, example, ideal and emulation of examples and ideals) has so far defied translation into other languages. Today, 200 years after Humboldt's postulation of the ideal of **education through science** we talk of the **progress of science** rather than **progress through science**. Accordingly our concept of ***Bildung*** has dwindled to something more like ***Aus-bildung*** (training), normally implying little more than the inculcation of disposable knowledge (factual knowledge and skills) as practiced in educational establishments in the European mold. Concepts such as "ordering knowledge" (*Ordnungswissen*) and "life-knowledge" so central to the thinking of philosophers like Eric Voegelin and Hans-Georg Gadamer have been relegated to a very minor role. A sea-change indeed!

This splaying of the meanings of knowledge (Wissen) and science (Wissenschaft) which occurred in German (in contrast to Greek) in the 19th century reflects at a semantic level the great temptation we are exposed to: the temptation to count on the knowledge of others instead of knowing and making decisions ourselves. This has been greatly exacerbated by the bureaucratic civilization we have created for ourselves. **Let science and the accountability incumbent on it take the place of responsibility to and for ourselves**. The real problem here is not that this is in itself necessarily reprehensible. **Where science exists we should take advantage of the knowledge it has**. But this is by no means synonymous with letting all decisions depend in the final resort on those who have that knowledge. This is the great delusion of the rationalist tradition dating back to the Enlightenment and still operative in the 20th century, the delusion that there are experts for all the **selective decisions** to be made and for all problems, whether soluble or insoluble. Here we must distinguish carefully between responsibility in the sense of the accountability of science and the specific individual responsibility of the scientist. This indeed calls for a specific *ethic of responsibility* subscribed to by each and every individual speaking in the name of science, in contradistinction to the official function of the expert knowingly incorporated into the political formation of decisions. This latter responsibility is one that the expert shares with each and every one of us, inasfar as we are all citizens, members of the polis, and hence all jointly responsible for whatever happens within the community of which we are a part. We must ask ourselves whether the necessary equilibrium between these different responsibilities has been heeded to an adequate degree and consequently whether we have been mindful enough of the significance of the responsibility each and

every citizen bears for the common weal. The bedeviling factor here is that there are fewer and fewer competent citizens with "official" responsibility (competence = **expertise plus personal/professional identity**) and fewer and fewer officially responsible figures with the necessary competence. The (re)discovery of complementarity should however guide us away from our present very one-sided Either/Or attitude toward these two poles in the direction of a balanced Both/And. The upshot would be a much less in-significant and indifferent code of professional ethics.

The Oriental traditions of philosophy ask whether thinking in the West has always been "**realistic**" (and if not when this tradition dates back to). By "realistic" they mean a mode of thought that proceeds from **objectively observed reality**, with the upshot that it is from the inquiry into reality, the nature, substance and certain objectivity of things that the related questions about identity and the quality of knowledge have resulted. Western thinking has frequently been characterized as based squarely on objective factuality of this kind, from Greek antiquity to the present. Pragmatism, the striving for power, possessions, technical perfection and exploitation are seen as being its riders. Francis Bacon's *quantum scimus, tantum possimus* is quoted as the touchstone for a mentality in which **knowledge is nothing other than power**. Accordingly, this mode of thinking sees itself as a "transcendental", or even as extra-mundane subjectivity, a non-corporeal "cogito" standing in an unrelated and in-significant counter-position to the "world". And the world, seen as Descartes' *res extensae*, is no longer examined for its substance, its **nature** or its specific **qualities** but merely regarded in terms of its technically exploitable "**functions**".

3. Modern science

Writing 82 years after Max Weber's famous lecture on "Science as a Profession", the present author sees **(empirically grounded) science as a contribution to a better understanding of ourselves in relation to the cosmos, and as such a complement to transcendence; it makes techn(olog)ical activity possible and for the scientist represents a challenging and rewarding opportunity for self-presentation.** ***Science thus conceived must not only live with provisional certainties standing out from the determinable (complementary) uncertainty around them but also with (and between) Newton's and Goethe's sorcerer's apprentices.***

It was the Franciscans (the three orders founded by St. Francis of Assisi (1181-1226) who played a major role in radically changing the complexion of European intellectual identity in the Middle Ages. Their form of **nominalism** derived from language a system of mutual intelligence based on common consent and agreement. It was this that paved the way for the possibility of such intensive, specialized learning and training within that system. One of the pillars of the success of the nominalist system was the fact that it homed in on **details**. With this approach it was entirely possible to embark on organized science (in abstraction from the concrete) - empirically, experimentally, positivistically, pragmatically. Europe stands alone in its division of the intellectual activities distinguished by the labels science, art and religion and set off against philosophy. Who would feel qualified to say whether Chung-tzu (4th century BC) or any other Chinese thinker was a religious figure, a "scholar", a thinker or a poet? Only in Europe has science attained to the status of a segregated, autonomous and overweening domain within our culture. In the modern age the whole cultural and civilizational complexion of the history of the world has quite obviously been determined by science.

Modern Europe grew up not only with science but with the implicit faith in what science can do. This faith was born in Europe because modern science (with its own consent) was expected to provide not only an improvement of the external circumstances and conditions of human existence but also a resilient, reliable *Weltanschauuung* supplying sure-fire answers to questions of an intellectual and moral nature: *Bildung* through science.

What we today call science is a product of the modern age, dating back to the 17th century. We call it empirical science, i.e. science based on experience. For the Greeks science required no experience. We know that two and two is four and we know it with a certainty that makes it absurd to go back to experience to prove it; absurd to go around counting things to make sure that we're right. The things we need experience to prove are not the object of supreme knowledge. This was the Greek viewpoint. Galileo was the decisive breakthrough. Here was a man who said expressly of himself and his branch of science - mechanics - *mente concipio*: I grasp in my mind. And he was referring to the pure conditions determining the phenomena of motion in nature - the law of free fall - conditions not observable as such in nature and only provable experimentally when a way was found of creating a vacuum in the laboratory. The powers of abstraction required for these ideas and the powers of construction necessary to isolate the factors involved, measure them quantitatively, symbolize them and relate them to one another were indeed new things destined to bring about a radical change in our relation to the world. Hitherto, human inventiveness had been more a filling-in of spaces that nature had left vacant. Now came a time when human ingenuity learn to transform nature into artificial products and change our world into a huge workshop of industrial endeavor, an unexampled step forward gradually bringing us into new danger zones. Hence the (unforced, appreciative) laughter aroused by Hegel's calm response to the objection that *his theories did not correspond to the facts*: "*Bad luck for the facts!*" Today the laughter at this olympian *bon mot* tends to stick in our throats. As the law of dialectics commands, modern hypotheses (notably the notions generated by *planners and "programmers" with very little contact with the practicalities*) appear to be gaining more and more of an ascendancy over the facts that get in their way. Dialectic processes, hitherto quite literally non-existent, have actually taken on a life of their own quite simply because there was someone there to "think them up". They determine not only our behavior but also the real events taking place in the political and economic arenas. We see this in the desperate attempts made by societies to tame differentiations by incorporating them into new integrations which in their turn lead inexorably to new differentiations. **We now actually have *the systems dreamed up by Newton and Galileo*** and they do indeed appear to obey their own laws to an ever-increasing extent. There seems to be no room in them for human responsibility, at best "interfaces" inserted to adapt automated functions in one system to those of another. In other words, the use of more and more sophisticated microelectronics (computer systems) brings with it a constriction of the scope and time available for political options and the corresponding attempts to keep those options open. Whether and to what extent this is possible will only be clear when we have more reliable information on what is going on. Here lies the **greatest challenge for modern science**, notably for **cybernetics**, the branch of science concerned with the regulation and control of systems and hence the domain to which we look for an answer to the question why, in the systems whose "children" they are, computers have so far almost exclusively been integrated in "positive feedback", which is ultimately bound to make the system in question unstable (undamped). We might call this - in analogy and contradistinction to Goethe's sorcerer's apprentice - the Galileo-Newtonian Sorcerer's Apprentice Syndrome. In the community of peoples, the central issue is invariably rule and subjection, in other words power. Even in Plato's ideal republic the underlying premise is that *it is axiomatic that human needs will never impose any restrictions on themselves of their own accord*. Seen from this vantage it is easier to grasp the way in which, in modern industrial society, the ratio of production to need has more or less been turned on its head: for the health of an economy it is imperative that producers succeed in arousing demand, persuading consumers that they have needs they knew nothing of before. This is modern economic reality. Accordingly, the role of **experts** in modern society is defined by the specific pressures under which science is required to assert itself over and against the interests and needs of society.

It follows from this that in the face of the rediscovery of complementarity, the responsibility of modern science and computer responsibility is probably the biggest single challenge facing education (in the sense of Bildung), not least - in fact precisely because - complemen-

tarity calls in question an essential premise for what German philosopher Hans Jonas (1984) called the "Principle of Responsibility" in his book of the same name. That premise is nothing other than the absolute priority of Being over Nothingness. It is a premise that no Buddhist brought up to think in complementary dimensions could ever subscribe to. A genuinely intercultural dialog is hence more imperative now than it has ever been.

4. Systems and the system concept

It is more essential than we may think to recall the source and the original meaning of the system concept. The Greek word sγstäma means the coordination, unification, concatenation of variegated, individually distinct entities or items to form an organized whole.

General Systems Theory is something different from a theory of systems which, although claiming consideration within the larger context as an analytic method, itself demands to be studied for its premises in the framework of the larger theory. The first (practical) task of such a theory of systems should be to eliminate misunderstandings. The second function should be to formulate epistemological criteria for the necessary distinction of systems. The third task is to bring about clarity on the difficulties peculiar to human thinking when it comes to differentiating between: 1) the realistic system concept; 2) the hypothetical system concept; 3) the concept of systems in a theory of reasoned argumentation; 4) the mathematical system concept. In various dictionaries systems theory is defined a sub-section of theoretical cybernetics examining the relations between interlinked systems or between such systems and their environment and the connections between structure and the modes of functioning (or behavior) of systems. There then follow the customary classifications according to features. The theoretical questions requiring urgent clarification in connection with computer responsibility are usually either passed over or only touched on. The fourth task should be not only to write a thorough history of the system concept but also a history of the wide variety of systems evolving with the concept itself. Here it would be of the essence to pay strict attention to the peculiarities (from an intercultural viewpoint) of our European history of ideas, as they do not figure in other such histories in other cultures. Alfred Locker has ventured to embark on a new, transclassical perspective on General Systems Theory (GST). His Transclassical Systems Theory (TCST) restricts the ideal of what is traditionally held to be "scientific" (i.e. formalization), thus highlighting the unknowable nature of reality (the principle of complementarity). Locker's approach stands in diametrical opposition to the view of systems advanced by Niklas Luhmann.

4.1 The adaptation problem between humans and machines

As human life-rhythms (each of which will themselves differ) cannot be automatically adjusted to the rhythms of technical processes, there will always be "mishaps" (cases of inappropriate action). We should be careful not to consider this as "error" because we do not (cannot) know what it is precisely that goes "wrong" in such cases. At the same time care must be taken to design functions and devices which leave time for such "errors" to be rectified before they avenge themselves in the form of serious accidents. This whole problem complex is merely an indication of a more general and fundamentally insoluble problem stemming from the fact that the rhythms of living organisms - the repetitions, intervals and pauses that make up the chain of (**qualitatively**) different times in which human beings (and probably all living organisms) experience themselves - cannot be perfectly "adjusted" to the monotonous sequence of uniform, non-qualified (**quantitative**) times constitutive of the "progress" of a machine. In other words there will unavoidably be an "interface"

between the two. The experiences gathered in this connection must not only be ***evaluated*** but also ploughed back into the system ("***in-valuated***"), something which has so far hardly been discussed at all. What we mean by evaluation here is the isolation by a process of abstraction and differentiation of experiences (observations, measurements etc.) from the concrete context (that which is common to all, or the **generality**) in order to analyze them and improve our understanding of them. This requires a certain amount of time, as does the (re-)invaluation of these (specific) findings into the (larger) context, something frequently referred to as integration into the cultural background. These (inevitable) time intervals cause an (inevitable) delay between the analysis of data and their application in practice. This is also known as the **response-time constant** of the system in question.

Naturally, one should (must) attempt not only to **optimize** the system's response-time constant and the indispensable "tolerance" in the interface between humans and machines, but also to **minimize** the human errors, not least via more and improved automation. But we will never be able to "get rid" of them altogether (avoid them). Given the inevitable degree of uncertainty in data obtained by measuring processes and the fact that humans are still better and faster at recognizing complex patterns than computers, however good the automated system may be there must be room for an "overruling" intervention by human agency, even if it is nothing more than a switch for **turning the whole thing off (or on)**. The problem is here to stay; it will be with us as long as there are machines and people who want to use them.

4.2 Effects of velocity and acceleration

The greater the inert mass of a system - frequently commensurate with its complexity - and the higher its velocity (acceleration), the longer is its "brake path" (cars are an obvious instance of this). **This increases not only the (quantitative) accident probability but also the (qualitative) destruction potential.** Preventive action and crisis management are not only determined by the establishment (e.g. measurement) of the quantitative likelihood of damage or accidents but also by the qualitative acceptance threshold in connection with the consequences of that damage (or accident). The increase in the (change) velocity at which a society lives (e.g. exponential growth) foreshortens the future in relation to the past. Our impression that time passes quicker today than it did before is not an illusion. It can be objectified. More and more people fall ill when change velocity (acceleration) gets too high, be it because they then lapse into a species of speed intoxication or because they are "steam-rollered" by events (e.g. at their computer workplace).

In this it is frequent for the means of work (the computer and its programs) to increasingly take on the status of an end in itself (the question of "its" responsibility then becoming proportionally irrelevant). The room for "tolerance" between humans and machines is increasingly being rationalized away, leading to ever greater friction and ultimately frustration, with all the economically negative repercussions this is bound to have. In his book "Why Things Bite Back: Technology and the Revenge of Unintended Consequences" (1996) Edward Tenner describes many such revenge effects, the causes of which have so far hardly been perceived, let alone removed. No doubt the most expensive "revenge effect" (more accurately: the most expensive human error) is the Year 2000 effect (Millennium Bug, Y2K) mentioned at the outset (http://www.utne.com/aY2K.tmpl).

Speaking of his own age, the poet Goethe said: "The deeper mystery behind our ailment is overhaste, the things we pass up for that reason." He identified the problem of speed at an early stage, coining the term "**velociferic**" to refer to it, a blend of "*velocitas*" and "Lucifer". M. Osten has said that Faust's secret motor is above all the **curse of impatience**. Seen thus, our present age is outstandingly "velociferic".

Quotation on the term **"velociferic"**, from Goethe's letters, Hamburg Edition Vol. 4, Letters 1821-1832, 1st. edn. 1967, pp. 158/9 (to G.H. Nicolovius, Weimar, late 1825?). The following passages of the rough draft of the letter were held back by Goethe for later use: *"But how can a*

young man contrive to find reprehensible and damaging what everyone else does, approves, encourages? Why should he not let his own nature go that way as well? I see no alternative but to hold it the greatest misfortune of our age, which leaves nothing to ripen of itself, in the fact that in the very next moment we are devouring the last, frittering our days away within their own compass, living from hand to mouth without ever bringing anything to fruition. Though we have newspapers for every time of the day, it should be easy enough for an astute person to interpolate one or two extra ones in between. Thus everything that we do, pursue, compose, indeed everything we as much as intend, is dragged into the public view. No one may exult or suffer unless it be for the diversion of his fellows; and so it goes, in leaps and bounds, from house to house, town to town, empire to empire, and finally from continent to continent - ***velociferic*** *all."*

5. The rediscovery of complementarity

The term **complementarity** was coined by the American philosopher William James (1842-1919), one of the founders and proponents of pragmatism, who used it to refer to the perspectivity of our images of the world.

The term was introduced into physics in 1928 by the Danish physicist Niels Bohr (1885-1962), albeit with a different meaning. It proceeds from what Bohr calls the very fundamental experience that we are all both actors and spectators in the drama of life. The present author understands Bohr's use of the term complementarity to mean:

- *that being things manifest themselves in two different phenomenal forms which are mutually incompatible;*
- *that the nearer one approaches one of these forms, the further one moves away from the other (more simply: the "sharper" the one is, the more "fuzzy" is the other);*
- *that the two forms cannot be entirely "unmixed", they are "indivisible" (probably a consequence of temporality, i.e. the finitude of observation time).*

In Bohr's terminology, the structure of the object finding expression by virtue of being experienced and described in complementary terms can be designated as an "individuality" or a "whole". The question to be addressed under the heading of "complementarity" is that of the relation between self-knowledge and the knowledge of objects. One of Bohr's finest achievements was the realization that matter and energy can be observed both as waves and as particles, although waves and particles have mutually exclusive characteristics.

In the last four decades, biology, language philosophy and history have shown that comnplementarity holds good not only for quantum mechanics but universally. Its implication for physics is that we ourselves are only a part of the physical universe which physics sets out to describe. Thus complementarity represents a new challenge for modern-day science. In other words, **complementarity is a given which needs to be firmly established in our philosophy of things and in many cases replaces the principle of Either/Or by that of Both/And.**

Whereas Niels Bohr regarded complementarity largely from an epistemological vantage, Wolfgang Pauli in his correspondence with Bohr insisted on the ontological implications. Pauli's thoughts give rise to the following considerations:

a) As reality presents us with complementary phenomena logically incompatible with one another, it hence contains contradictions, i.e. cannot be described fully in rational terms. One characteristic of Western thinking is to reduce the irrational elements of reality, to get rid of them in one way or another. Pauli calls this the suppression of the irrational. His arguments about irrationality of reality draw less on the concept of complementarity than on the idea of "**statistical causality**". He replaces the causality principle of classical physics with that of statistical causality or "statistical correspondence".

b) Kant's philosophy was influenced by the ideas of Isaac Newton. If, as Pauli suggests, we take complementarity as sufficient justification to replace strict (absolute) causality by statistical causality, this will have an impact on Kant's philosophy. Kant assumed that the world of phenomena studied by empirical science is "closed" in the sense that all events have causes originating from the "world" of phenomena. But if causality is only valid in statistical terms, the question of the causes behind individual events remains unresolved. The causes behind any given event are partly irrational, i.e. rational analysis wil not find adequate causes for it in the world of phenomena. It is as if the event is partly influenced by supernatural forces. This makes Kant's complete unmixing (separation) of phenomenon (event) and noumenon (the thing in itself) - i.e. the knowable and the unknowable - impossible. This dissociation ultimately led to an ever more stringent "*unmixing*" of (modern) science and religion, fostering the impression that the latter only answers questions from another world. Statistical causality restores the "indivisibility" of the two.
c) "Materialist" philosophy regards the wave function as an element of reality comparable to atomic particles. But in the Copenhagen interpretation of quantum mechanics the wave function is merely symbolic and describes the knowledge of the observer. For Wolfgang Pauli mind and matter are complementary expressions of reality which are mutually exclusive and cannot be translated one into the other. They are complementary in the same sense in which descriptions in locative and impulse space are complementary in quantum mechanics. The interreaction between mind and matter (between consciousness and the external world) determines the nature of the observation. In order to attain a better understanding of empirical knowledge, we need a clearer image of the relation between mind and matter, i.e. of the psycho-physical problem. Wolfgang Pauli found the idea of "psycho-physical parallelism" unsatisfactory as it is rooted in Descartes' dualistic view of the world in which mind and matter are regarded as two different "substances". Pauli substitutes **complementarity for dualism**, demonstrating that the knowable and the unknowable cannot be "unmixed", i.e. are "indivisible". In so doing Pauli takes a "new" perspective on the indivisibility of wholes. ***"Indivisible" as a designation for a whole which cannot be sundered is also to be found in the writings of the Austrian novelist Robert Musil. It refers to a wholeness that cannot be encompassed and totally discerned. Theories of wholeness are justified in that they enjoin us to regard complex functions, instances of genuine symbiosis, an organism, person or culture "in the whole" or "as a whole"; but they are inevitably incomplete (imprecise). The all-encompassing whole - the universe - cannot be perceived fully and as such by us, its inmates***.

5.1 Examples of complementarity

<u>Taoism (4th/3rd centuries BC)</u>
The Tao that is effable is not the everlasting Tao.
The name that can be named is not the true name.
The nameless is the origin of heaven and earth, the named the mother of all things.
Hence: Constantly-without-desire affords in-sight into the mystery; constantly-in-desire affords contemplation of its manifest forms.
These two (the mystery and its manifestations) appear as one but are called different. Their as-one may be called the primal mystery.
The gate of all mysteries leads from the mystery to the deeper mystery.

The word "Tai c'hi" means "origin" in the precise sense of the pre-temporal and initial emergence from the nameless primal depths. This emergence is a bipolar motion which is one in itself. In the midst of the dark force lies the eye of light, in the midst of the lucent force the eye of night and between the two primal forces oscillating into and out of one another there emerges from the encompassing circulation the line of the path which both sunders and unifies the two: **Tao**.

Thus being emerges as the "coming-into-being" of being things from the "nothingness" of pure transcendence. This dynamic unity of Yin and Yang does not materialize as origin; Tao, which circumscribes and permeates them, is essentially (here both Lao-tzu and Chung-tzu and the bipolar traditions stemming from them are unanimous) transcendent. For while Man orients himself to the earth, the earth to the heavens, the heavens to Tao, Tao follows only itself. Or again: Tao brings forth one, one brings forth two, two brings forth three, three brings forth all beings - and all beings bear the passive Yin and the active Yang. The mediating breath effects the harmony. For the neo-Confucian Cheng Ming-tao, Tao is the quintessence of all agency; also all agent things are Tao. Another neo-Confucian, Cheng Yi-chuan, declares: without Yin and Yang there is no Tao. Thus both polarities form the one, Tao. Yin and Yang are the agent forces in nature. Tao is supernatural, i.e. "transcendent". It is the genuinely indeterminable in all determinations and through it the complementary determinations become possible in the first place. Meditative thought has always conceived of the overt and the covert as one, as the Tao-te-ching testifies.

Buddhism

Nagarjuna, the founder of Marayana Buddhism (2nd century BC), also guides us to insight into complementarity when he says: "**Samsara** (the career of the soul returning to its origins) and **Nirvana** (emptiness, the wind of the void) are one (indivisible)". The redeeming knowledge is: *We are in Nirvana, emptiness is the sole reality.*

Christianity

At the Council of Chalcedon (451 AD) the "apostolic" creed - *vere homo et vere deus*, true Man and true God in one - was given its critical conceptualization. *With four negations - "**unmixed, unseparated, untransmuted and undivided**" - the Council attempted to establish the oneness of God and Humanity in Jesus Christ and make the mystery "comprehensible".*

The contradictions, apparent or real, are obvious. Yet the theologians of the fifth century were sanguine that they could present this paradox to the thinking of faith as a **dogmatic *symbolum fidei***. Themselves profoundly convinced of the verity potential of communal thought guided by the consensus of believers, they were willing to confront Christian identity with this highly astute formulation of the genuine existential potentiality of Man made flesh in Jesus Christ.

This is not to gainsay that these differentiations of the complementary paradoxes had no grounding in the classical reasoning of the time. "Unmixed" rejects the idea of a unity being formed out of two things, a unity in which all differences are dissolved so that the unity results from an undifferentiated blend in the same way as an alloy is produced by the fusion of two metals. "Unseparated" militates against the idea of a duality that does not genuinely merge to become one. "Untransmuted" forbids any associations of magical transformation or transubstantiation potentially permitting the idea of an (at least temporary) "now this, now the other". And "undivided" similarly precludes any notion of "in part this, in part the other". Wherever mixtures take shape, segregations occur, change materializes, we can rightly ask after origin, evolution, agency and ultimate determination. **But the non-composite Indivisible is always given**. It does not stem from some precedent event bodying it forth. As such it reveals how the other ontological characteristics are to be conceived of: as the authentic quiddities of this "Two in One". The existence of a human being is characterized by this re-jection of duality: now this - now that, part this - part that. And implicit in the message of all this is that God does not cease to be God when He becomes flesh; the Absolute does not cease to be perfectly absolute when it stoops to an existence in the Relative, in "conditioned Becoming", whatever the causal connections may be.

In everyday life

Living with others as the others' other is a basic human injunction in all things, whether of minor or major moment. **We are all others and we are all ourselves.**

We must learn to respect and acknowledge others and otherness. Implicit in that is learning to be wrong. When we engage in play, we must learn the ability to lose. This starts at the age of two, if not earlier.

6. Summary

The trend toward computerization continues unabated. What opportunities and risks can we observe and anticipate in the social, economic and psychic dimensions? Can we allot responsibility and - in the case of failure - blame to "computer decision systems"? The assumption of responsibility by human individuals will dwindle:

1. the less ideal the essential "tolerance" between humans and machines is (or becomes), e.g. when this is "rationalized away" (as is increasingly the case);
2. the less we do to offset "velociferic" developments (a term coined by Goethe in 1825 from "velocitas" and "Lucifer").

It is a challenge and task for empirical science - or, more correctly, for the community of scientists - to demonstrate what we can reasonably expect from such a symbiosis between humans and machines and what we cannot. Accordingly - and despite the inevitable delay in transforming new knowledge into political reality - it is the task of education (in the sense of *Bildung*)
to point up what is desirable and what is undesirable. The preconditions for this are:
a) adequate, distanced reflection on the historical options in Europe ultimately leading to the birth of the computer, options dating back at least as far as the Middle Ages when nominalism began to radically change the complexion of European (intellectual) identity;
b) a (re-)entrenchment of complementarity in our philosophy of things; it is a phenomenon by no means restricted to the discoveries of Niels Bohr for modern physics, it is to be found within and between cultures, notably between the West and the East. Any "re-vision" of cybernetics failing to take this into account is doomed to be blind in one eye. From now on such a revision must contribute more to a dynamic balance of the "Both/And" rather than (as has been the case so far) to a one-sided Either/or.

As long as the trend toward "more and quicker" continues to grow and can be marketed so profitably, the "velociferic" trend will also grow and the question of computer responsibility will find no adequate reflection, let alone an answer. Thus in the highly technologized nation states we must pay greater attention to a more effective form of risk and crisis management. The refusal to look the "Year 2000 Problem" (Millennium Bug, Y2K) in the face shows this with startling clarity, notably in the Federal Republic.

In all those instances prompting us to make a concerted effort to think things through jointly, we should attempt to proceed from the precedent and underlying problems and thus to identify both what we have in common and where we differ, learning in the process not only to tolerate the latter but **to actively acknowledge it**, i.e. to acknowledge others and otherness. This will be easier for us once we have firmly entrenched the complementarity of human existence in our thinking. This also applies to the "world ethos" (common to us all) called for by Hans Küng (1996).

Note

Hans Küng puts it thus: "*World ethos is not a new global ideology, nor is it a unified global religion above and beyond all other religions, nor (least of all) the supremacy of one religion over all others. What I mean by a world ethos is the basic consensus on binding values, incontrovertible standards and fundamental personal attitudes.*" This implies that the underlying "binding (basic) values" should lead to an agreement on rules and priorities the observance of which must be guaranteed by law. But this takes too little account of the fact that the degree of human peace-ability is determined both by the in-compatible that exists in other people(s) and cultures and by the com-

patible, the things we are willing to espouse as common to us all. In fact we cannot identify what is common to us all except against the backdrop of difference and distinction. Therefore we must not only actively entrench the awareness of complementarity in our thinking but also, with "sensible as opposed to vapid optimism", make the corresponding (existential) decisions and do our best to exploit the (positive) synergies of complementarity. Contributing to this is a prime task of **exemplary élites, "human catalysts" and a "sound" middle class** (sound here meaning competent, aware of responsibility, willing to accept responsibility, motivated, committed), notably in the framework of **genuine intercultural cooperation.**
"Tolerance should really only be a provisional cast of mind, it must lead to acknowledgement. To tolerate is to offend." (Goethe)

7. Acknowlegement

The author thanks the managing director of MPAE, Prof. Dr. V. M. Vasyliunas, for supporting this research project. He thanks especially his friend, Prof. Dr. H. A. Fischer-Barnicol, for very important contributions and intensive dialogues since 1980. Because of his sudden death in April 1999 several manuscript drafts remained only fragments, especially the one on complementarity. He thanks the friends and colleagues from the University of Mendoza (UM) for 15 years of very good and successful co-operation, especially for the work and discussions in context with the project ECOVILLA, which was conceived in the environmental institute IEMA of UM at the end of the 80ties. He thanks friends and colleagues in Santiago and Concepción (Chile) for more than 10 years very good Co-operation. He thanks the friends and colleagues from the Institute of Meteorology and Geophysics (IMG) of the university Graz for more than 30 years of successful Co-operation, together with the ECCA[3]-team members. He thanks the international MAS team members – especially the ones from MPAE for more than 15 years of friendly and successful Co-operation. He thanks the German Aerospace Centre (DLR) for funding the research project Fkz. 50 EE 98038 and in this context Dr. G. Schneppe for more than 10 years of very successful and friendly co-operation.

8. Scientific Curriculum vitae of the author

Gerd Karlheinz Hartmann, born in 1937 in Eschwege, Germany, studied physics from 1957 to 1964 at the Georg-August-University in Göttingen, where he received his PhD. in 1967. Since 1965 he has worked as a scientist at the Max-Planck-Institut für Aeronomie, D-37191 Katlenburg-Lindau. For over ten years he concentrated his activities on studying the upper atmosphere using satellite (radio) beacon signals.
Since 1967 he has been dealing also with general and specialized information and documentation problems, from the viewpoint of large volumes of time dependent and space dependent data, especially of the type collected in his research projects. At present he works as a consultant on several national and international committees and holds lectures and seminars throughout Europe, and especially in the USA., in Argentina, and Chile, countries he has often visited in the course of his scientific projects.
From 1975 to 1978 he was the provisional director of a division of the institute, the Institute for Long-term Control of Geophysical Environmental Conditions (ILKGU).

[3] Ecotoxicological Risk in the Caspian Catchment Area, EU-Project: INCO-Copernicus No.: IC15 CT96-016, Principal Investigator (PI), Dr. L. Weissfolg, UFZ, Leipzig, Germany; e-mail: lw@theo.uoe.ufz.de

Since 1979 his main area of specialization has been studying the lower atmosphere by means of microwave radiometry. He is the Principal Investigator of the **M**illimeter Wave **A**tmospheric **S**ounder (MAS) experiment which as a joint enterprise of Germany, Switzerland, and the USA has been flown as core payload of the NASA ATLAS (Atmospheric Laboratory for Applications and Science) Space Shuttle Missions (ATLAS-1 (1992), ATLAS-2 (1993), ATLAS-3 (1994);
(http://www.linmpi.mpg.de/english/projekte/masnew)
Since 1980 he is "consultant" for information problems of the Institute of Intercultural Cooperation/Intercultural Research" (ICC/IIR: Heidelberg/Zürich/Pernegg). In the 80ties he travelled on behalf of that institute to India and Asia, especially for discussing his concept of the (intercultural) information system OCIR/VIGRODOS. He participated in and contributed to international conferences on problems of intercultural understanding and cooperation.
1986 he became guest professor and guest lecturer for filter and information theory at the University of Mendoza, Argentina. This task was extended in 1988, now also including problems of conserving utilization of the environment (sustainable development). In this context he is the international coordinator of the environmental program PRIDEMA started by the University of Mendoza (UM) in 1988.
1991 he became full professor at the engineering faculty of UM for "remote sensing for a conserving utilization of the environment" (sustainable development) and also "external scientific director of the institute for environmental studies (IEMA) of UM. In December 1991 he received the Dr. Luis Federico Leloir Award for international cooperation with Argentina in the domain of environmental research from the Argentinean minister for Science and Technology, Prof. Dr. R.F. Matera.
Since 1995 he works on the "value added validation" of remote sensing data from the Earth's atmosphere and he was manager of an international experiment proposal for the investigation of the MARS atmosphere - in context with the MARS EXPRESS Mission of the European Space Agency (ESA) - , till it was cancelled because of funding problems in summer 1999.

1. Gerd. K. Hartmann, Pfarrer Opielka Str. 9, D-37434 Bilshausen; Tel.: +49-5528-8347
2. Dr. G. K. Hartmann, Max -Planck -Institut für Aeronomie; Max-Planck-Str. 2,
   Katlenburg -Lindau; Tel.: +49 -5556 -979-336/332/344 Fax: +49-5556-979-240
   E-Mail: ghartmann@linmpi.mpg.de
3. Prof. Dr. G. K. Hartmann, c/o.: Universidad de Mendoza, IEMA, Perito Moreno 2397,
   5501 Godoy Cruz, Mendoza Argentina, Tel: +54 -261 -4392939 / 4200740, Fax: +54-261-
   4392939; E -Mail: epuliafi@um.edu.ar