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H.P. Stapp

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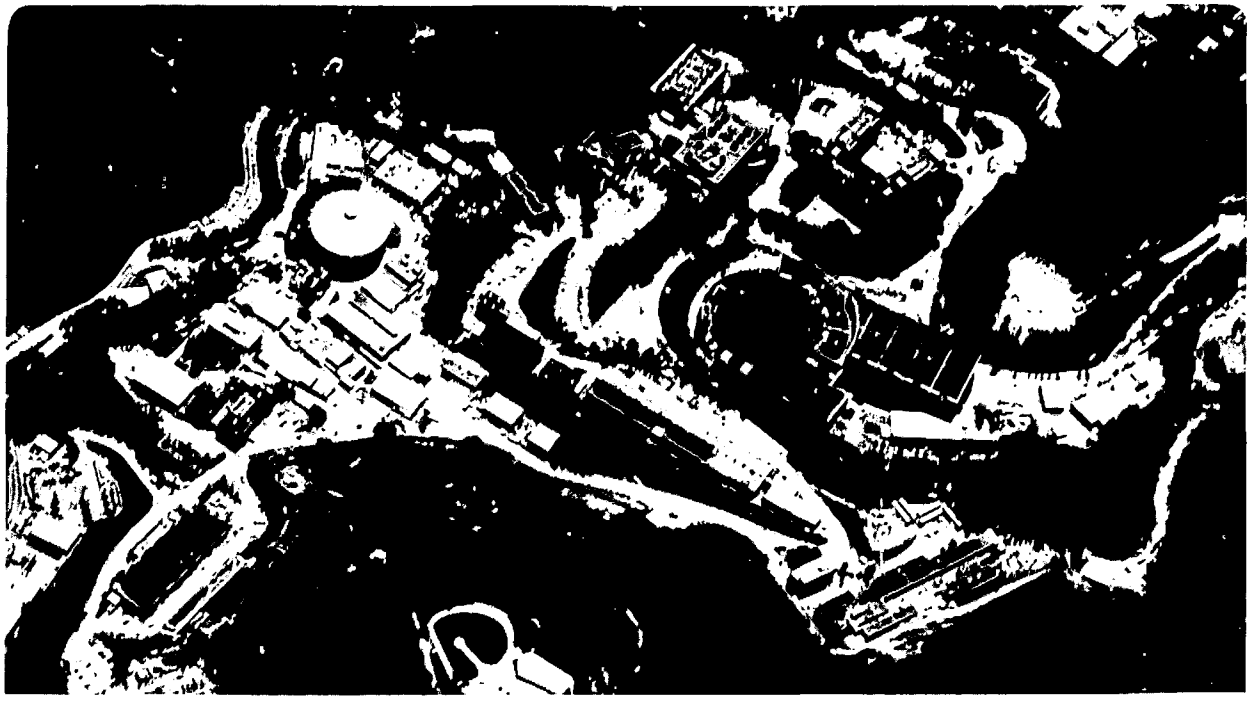

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Quantum Conception of Man. *

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Invited paper for the Third UNESCO Science and Culture Forum — Toward Eco–Ethics: Alternative Visions of Culture, Science, Technology, and Nature. Belem, Brazil, April 5-10, 1992.

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INTRODUCTION

Science has enlarged tremendously the potential of human life. By augmenting our powers it has lightened the weight of tedious burdens, and opened the way to a full flowering of man's creative capacities. Yet, ironically, it is the shallowness of a conception of man put forth in the name of science that is the cause today of the growing economic, ecological, and moral problems that block that full flowering.

How could a shallow conception of ourselves, a mere idea, be the cause of such deep troubles? The answer is this: our beliefs about ourselves in relation to the world around us are the roots of our values, and our values determine not only our immediate actions, but also, over the course of time, the form of our society. Our beliefs are increasingly determined by science. Hence it is at least conceivable that what science has been telling us for three hundred years about man and his place in nature could be playing by now an important role in our lives. Let us look at what actually happened.

The seventeenth century was time of momentous change in men's ideas about the world. During that period thinkers like Galileo, Descartes, and Newton transformed the world, as seen by educated men, from a place where spirits and magic could flourish, to a world of machines: the entire universe came to be viewed as a giant machine, running on automatic, with each of us a tiny cog within it. The symbols of the age that followed were the factory, the steam engine, the railroad, and the automobile. Later on, during our own century, this mechanical age would become transformed in turn by thinkers such as Heisenberg, Schroedinger, and Bohr into the quantum age, whose symbols would be not roaring factories but giant transistorized computers, silently bonding all parts of the planet, with men becoming not so much bodily cogs in a giant machine as mental hubs in a burgeoning network of ideas.

The seventeenth century transition from the medieval to the mechanical age was triggered by a seemingly miniscule change in a single idea: the orbits of the planets were found to be neither circles, nor circles moving on circles, but ellipses. This apparently trivial and recondite detail, discovered by the scientist Johannes Kepler, through laborious analysis of a mass of astronomical data, was the foundation upon which Isaac Newton built modern science, and simultane-

ously discredited both centuries of philosophical dogmas and the methods of thinking that produced them. Painstaking observation of nature, and analysis of the empirical findings, came to be seen as a truer source of knowledge than pure philosophical reflection. That kind of reflection had led to the notion that, because circles are perfect figures, and everything in the heavens must be perfect, all planets must move on circles, or at least on circles compounded. But Newton's laws decreed that the orbits of planets were ellipses, not epicycles, and the entire empire of medieval thought began to crumble. In its place rose another, based on Newton's idea of the world as machine. Later on, when this mechanical idea gave way in turn to the quantum one, it was again a mass of esoteric data, analyzed to reveal a totally unexpected structure in nature, that combined to overthrow a conception of the world that had become by then an integral part of the fabric of human life.

The focus of our interest here is on the relationship between the mental and material parts of nature. Human beings have an intuitive feeling that their bodies are moved by their thoughts. Thus it is natural for them to imagine that thoughts of some similar kind inhabit heavenly bodies, rivers and streams, and myriads of other moving things. However, the key step in the development of modern science was precisely to banish all thought-like things from the physical universe, or at least to limit severely their domain of influence. In particular, Descartes, in the seventeenth century, divided all nature into two parts, a realm of thoughts and a realm of material things, and proposed that the motions of material things were completely unaffected by thoughts throughout most of the universe. The only excepted regions, where thoughts were allowed to affect matter, were small parts of human brains called pineal glands: without this exception there would be no way for human thoughts to influence human bodies. But outside these glands the motions of all material things were supposed to be governed by mathematical laws.

Carrying forward the idea of Descartes, Isaac Newton devised a set of mathematical laws that appeared to describe correctly the motions of both the heavenly bodies and everything on earth. These laws referred only to material things, never to thoughts, and they were complete in the sense that, once the motions of the material parts of the universe during primordial times were fixed, these laws determined exactly the motions of atoms, and all other material things, for the

rest of eternity. Although Newton's laws were expressed as rules governing the motions of atoms and other tiny bits of matter, these laws were tested only for large objects, such as planets, cannon balls, and billiard balls, never for atoms themselves.

According to Descartes' original proposal the purely mechanical laws of motion must fail to hold within our pineal glands, in order for our thoughts to be able affect our bodily actions. However, orthodox scientists of the eighteenth and nineteenth centuries, tolerating no exceptions to the laws of physics, held that each atom in a human body, or in any other place, must follow the path fixed by the laws of physics. This rigid enforcement of the physical laws entailed, of course, that men's thoughts could have no effects upon their actions: that each human body, being composed of pre-programmed atoms, is an automaton whose every action was pre-determined, long before he was born, by purely mechanical considerations, with no reference at all to thoughts or ideas.

This conclusion, that human beings are pre-programmed automata, may sound absurd. It contradicts our deepest intuition about ourselves, namely that we are free agents. However, science, by pointing to other situations where intuition is faulty, or dead wrong, was able to maintain, on the basis of its demonstrated practical success and logical consistency, that its view of man was in fact the correct one, and that our feeling of freedom is a complete illusion.

This picture of man led, during the eighteenth and nineteenth centuries, to an associated moral system. It was based on the principle that each of us, being nothing but a mechanical device, automatically pursues his calculated self-interests, as measured by a certain bodily physical property, which is experienced in the realm of thought as pleasure. This principle, which was in line with the commercial temper of the times, was fundamentally hedonistic, though, from the scientific viewpoint, realistic. However, philosophers were able to elevated it to a more socially satisfactory idea by arguing that the 'enlightened' rational man must act to advance his own 'enlightened' self-interest: he must act to advance the general welfare in order to advance, in the end, his own welfare. Yet there remained in the end only one basic human value: no noble, heroic, or altruistic aim could have any value in itself; its value must be rooted in the common currency of personal pleasure. This kind of morality may seem to be immoral but it appears to be the rational outcome of accepting completely the

mechanical or materialistic view of man.

This view of man and morals did not go unchallenged. Earlier traditions lost only slowly their grip on the mind's of men, and romantic and idealistic philosophies rose to challenge the bondage of the human spirit decreed by science. From the ensuing welter of conflicting claims, each eloquently defended, followed a moral relativism, where every moral viewpoint was seen as based on arbitrary assumptions. This pernicious outcome was a direct consequence of the schism between the mental and material aspects of nature introduced by science. That cleavage, by precluding any fully coherent conception of man in nature, made every possible view incomplete in some respect, hence vulnerable. In the resulting moral vacuum the lure of material benefits and the increasing authority of science combined to insinuate the materialistic viewpoint ever more strongly into men's thoughts.

This science-based creed contains, however, the seeds of its own destruction. For behind a facade of social concern it preaches material self-aggrandizement. We are now in the thralls of the logical denouement of that preaching. With the accelerating disintegration of the established cultural traditions, brought on by increased fluxes of peoples and ideas, the demand for satisfaction of inflated material desires has spiraled out of control. This has led to a plundering of future generations, both economically and ecologically. We are now beginning to feel the yoke laid upon us by our predecessors, yet are shifting still heavier burdens onto our own successors. This materialist binge cannot be sustained. Yet the doctrine of enlightened self-interest has no rational way to cope with the problem, as long as each human 'self' continues to be perceived as a mere bundle of flesh and bones. For if we accept a strictly materialistic way of thinking then our own pleasure can be enhanced by ignoring calamities that we ourselves will never face.

Men are not base creatures: all history shows them to be capable of elevated deeds. But elevated deeds and aspirations spring from elevated ideas, and today all ideas, if they are long to survive, must stand up to withering scrutiny. They must in the end be rationally coherent, and consistent with the empirical evidence gathered by science. The mechanical ideas of seventeenth century science provided no rational or intellectual foundation for any elevated conception of man. Yet the ideas of twentieth century science do. Quantum theory leads

naturally to a rationally coherent conception of the whole of man in nature. It is profoundly different from the sundered mechanical picture offered by classical physics. Like any really new idea this quantum conception of man has many roots. It involves deep questions: What is consciousness? What is choice? What is chance? What can science tell us about the role of these things in nature? How does science itself allow us to transcend Newton's legacy? It is to these questions that we now turn.

Science, Tradition, and Values

This is the third UNESCO Forum for Science and Culture. Our focus throughout the series has been on the interplay of science, tradition, and values in mankind's search for a sustainable future. At the first forum, held in Venice in 1986, the spectre of nuclear annihilation loomed as the principal perceived threat to human survival. By the time of the second forum, in Vancouver in 1989, it was the impending disruption of global ecological balances that seemed most critical. Today, in 1992, the nuclear threat may have receded. But the ecological crisis seems to be worsening, and we are faced with problems of socio-economic collapse: in the former Soviet Union and eastern Europe one of the world's two premier socio-economic systems has already collapsed, and in the West and the Third World pressures of ethnic rivalries and economic malaise are tending to make many formerly prosperous and stable countries increasingly ungovernable.

Science has been perceived as the major cause of these problems. It gave man the capacity to ignite a nuclear holocaust, to disrupt the eco-system on a global scale, and to effect swift, massive and untested social and economic changes. At a deeper level of causation, science has revised man's basic idea of himself in relation to nature. In traditional cultures nature was perceived as a mysterious provider, to be revered and deified. But Francis Bacon, herald of science, proclaimed a new gospel for the age of science: man, abetted by science was to achieve the *conquest of nature.*

At an even deeper level of causation the Cartesian separation between the minds of men and the rest of nature, which was the key to the seventeenth-century scientific revolution, eroded the foundations of moral thought, and left man adrift with no rationally coherent image of himself within nature. He pro-

claimed himself to be, on the one hand, ruler of nature, yet was, on the other hand, according to the very scientific theories that were to give him dominion, a mere mechanical cog in a giant mindless machine. He was stripped of responsibility for his acts, since each human action was pre-ordained prior to the birth of species, and was reduced to an isolated automaton struggling for survival in a meaningless universe.

In the face of these science-induced difficulties one must ask: who needs science? What we obviously need is strong remedial action - - a curtailing of science-inflated population growth, consumption, waste, and poverty.

But how can the required global actions be brought about? Dire waring have minimal effects on populations inured to media hype. An immediate disaster at one's doorstep might suffice, but by then full global recovery may be out of reach.

To change human actions globally one must change human beliefs globally. Global beliefs, to the extent they they exist at all, are the beliefs generated by science. However, some of the most important science-generated beliefs that now pervade the world are beliefs that arose from science during the seventeenth, eighteenth and nineteenth centuries, and are now outdated. Twentieth century science has wrought immense changes in precisely those beliefs that have in large measure created our present problems.

Science and a New Vision of Nature

Twentieth century science yields a conception of nature that is profoundly different from the picture provided by the seventeenth century science of Newton, Galilco, and Deseartes. Three changes are particularly important.

The first great twentieth century change is the dethronement of determinism. Determinism is the idea that each stage of the coming into being of the physical universe is completely controlled by what has already come into being. A failure of determinism means that what is happening, or coming into being, at certain stages of the evolutionary process is not completely fixed by what has come before. Those aspects of the evolutionary process that are *not* completely fixed by prior developments can be called "choices" or "decisions". They are in some sense "free", because they are not completely fixed by what has come

before.

The second great twentieth-century change is in science's idea of the nature of "matter", or of the "material universe", which I take to be that part of nature that is completely controlled by mathematical laws analogous to the laws of classical physics. The material universe can no longer be conceived to consist simply of tiny objects similar to small billiard balls, or even things essentially like the electric and magnetic fields of classical physics. Opinions of physicists differ on how best to understand what lies behind the phenomena described so accurately by quantum theory. But the idea most widely accepted by quantum physicists is, I believe, the one of Heisenberg. According to this idea the "material universe" consists of none of the things of classical physics. It consists rather of "objective tendencies", or "potentialities". These tendencies are tendencies for the occurrence of "quantum events". It is these quantum events that are considered to be the *actual things* in nature, even though the potentialities are also real in some sense. Each actual event creates a new global pattern of potentialities. Thus the basic process of nature is no longer conceived to be simply a uniform mathematically determined gradual evolution. Rather it consists of an alternating sequence of two very different kinds of processes. The first phase is a mathematically controlled evolution of the potentialities for the next quantum event. This first phase is deterministic, and the laws that control it are closely analogous to the laws of classical physics. The next phase is a quantum event. This event is not, in general, strictly controlled by any known physical law, although collections of events exhibit *statistical* regularities. Thus each individual quantum event creates a new world of potentialities, which then evolves in accordance with certain deterministic mathematical laws. These potentialities define the "tendencies" for the next event, and so on. Each quantum event, because it is not fixed by anything in the physicist's description of prior nature represents a "choice". The critical fact is that each such choice can actualize a *macroscopic* integrated pattern of activity in the newly created material universe of potentialities.

The third great twentieth-century change in science is the recognition of a profound wholeness in nature, of a fundamental inseparability and entanglement of those aspects of nature that have formerly been conceived to be separate. The apparent separateness of ordinary physical objects turns out, in this view

of nature, to be a statistical effect that emerges from the multiple actions of many quantum events. It is only at the level of the *individual events* that the underlying wholeness reveals itself.

Science and a New Vision of Man

The most important consequence of this altered vision of nature is the place it provides for human minds. Consciousness is no longer forced to be an impotent spectator to a mechanically determined flow of physical events. Conscious events can be naturally identified with certain special kinds of quantum events, namely quantum events that create *large-scale integrated patterns of neuronal activity in human brains.* These events represent "choices" that are not strictly controlled by any known physical laws. Each such event in the brain influences the course of subsequent events in the brain, body, and environment through the mechanical propagation of the potentialities created by that event.

This revised idea of man in relation to nature has profound moral implications. In the first place, it shows that the pernicious mechanical idea of man and nature that arose from seventeenish century science was dependent upon assumptions that no longer rule science.

Contemporary science certainly allows human consciousness to exercise effective top-down control over human brain processes. Hence the idea that man is not responsible for his acts has no longer any basis in science. Moreover, the separateness of man within nature that had formerly seemed to be entailed by science is now reversed. The image of man described above places human consciousness in the inner workings of a nonlocal global process that links the whole universe together in a manner totally foreign to both classical physics and the observations of everyday life. If the world indeed operates in the way suggested by Heisenberg's ontology then we are all integrally connected into some not-yet-fully-understood global process that is actively creating the form of the universe.

The strongest motives of men arise from their perception of themselves in relation to the creative power of the universe. The religious wars of past and recent history give ample evidence that men will gladly sacrifice every material thing, and even their lives, in the name of their convictions on these issues.

Thus the quantum mechanical conception of man described above, infused into the global consciousness, has the capacity to strongly effect men's actions on a global scale.

Science recognizes no authority whose ex cathedra pronouncements can be claimed to express a divine will. Nevertheless, this new conception of the universe emphasizes an intricate and profound global wholeness and it gives man's consciousness a creative, dynamical, and integrating role in the intrinsically global process that forms the world around us. This conception of man's place in nature represents tremendous shift from the idea of man as either conqueror of a mindless nature, or as a helpless piece of protoplasm struggling for survival in a meaningless universe. Just this conceptual shift alone, moving the minds of billions of people empowered benefit by the physical capacities supplied by science, would be a force of tremendous magnitude. Implicit in this conceptual shift in man's perception of his relationship to the rest of nature is the foundation of a new ethics, one that would conceive the 'self' of self-interest very broadly, in a way that would include in appropriate measure all life on our planet.

Discussion

Varela: How does your picture account for the many levels of structure in brain processing that lie between the quantum events at the atomic level and consciousness?

Stapp: In the first place the quantum events are not at the atomic level. According to Heisenberg's idea, the quantum events, that is the actual events, occur only when the interaction between the quantum system and the measuring device, "and hence the rest of the world", comes into play. The actual events that I am talking about occur at a *macroscopic* level: the whole Geiger counter "fires", or the whole pointer on the measuring device is actualized as swinging to the left, rather than to the right. The quantum events select from among the alternative possible *cohesive macroscopic patterns of activity.* As for the many levels of processing in the brain, these are considered to be mechanical *brain* processes: they are consequences of the quantum-mechanical laws of motion, which determine the evolution of the "propensities" for the various alternative possible quantum events. In most other theories of the mind-brain connection

there is no basis for a fundamental ontological difference between brain processes that are consciously experienced and those that are not. This is because their basic ontological structure is monistic, rather than dualistic, as it is in quantum theory. Quantum theory thus allows for a *fundamental* physical difference between brain processes that are experienced and those that are not.

Varda: What empirical evidence is there that quantum theory is important in brain processes that are directly connected to consciousness?

Stapp: Chemical processes are essential to brain operation, and hence a quantum description is mandated. In fact, quantum mechanics is essential to any understanding of the properties of materials, be they inorganic, organic, or biological. Classical ideas do not suffice to explain properties of materials, and properties of various materials play an essential role in the functioning of the brain.

Varela: The microscopic atomic properties lead to macroscopic properties, such as electric pulses along neurons, that can be described classically. What empirical evidence is there that a classical description is inadequate for describing those brain processes that are directly connected to conscious process?

Stapp: The processes that can be described classically can also be described quantum mechanically, and the latter description is it fundamentally better because it fits onto the lower-level chemical processes in a rationally coherent way. Thus one *can* use a quantum description, and at least in principle, *should* use a quantum description, because it is universal, or at least *can be* universal: classical physics is known to be inadequate in some respects: it is known to be nonuniversal.

The quantum description is not only required to explain the underlying atomic and chemical processes, it is fundamentally richer also in the treatment of macroscopic properties, as the theory of consciousness described here shows.

As Quine has emphasized, theories are underdetermined by data. In order to have any hope of achieving a reasonably unique understanding of nature we must insist upon the unity of science, and strive for a coherent understanding that covers the entire range of scientific knowledge. It is only if science can give us a *unified* comprehension of nature that we can turn to it with any confidence for an understanding of our place in nature.

McLaren: You say that a quantum jump selects one of the alternative possibilities, and that this selection is not under the strict control of any known law of nature. And certain of these jumps control the course of brain activity. My question is this: Are not these jumps arbitrary, and if so are we not back in a random universe?

Stapp: These jumps are not strictly controlled by any *known* law of nature. And *contemporary* quantum theory treats these events as random variables, in the sense that only their statistical weights are specified by the theory: the specific actual choice of whether this event or that event occurs is not fixed by contemporary theory.

The fact that contemporary physical theory says nothing more than this does not mean that science will always be so reticent. Many physicists of today claim to believe that it is perfectly possible, and also satisfactory, for there to be choices that simply come out of nowhere at all. I believe such a possibility to be acceptable as an expression of our present state of scientific knowledge, but that science should not rest complacently in that state: it should strive to do better. And in this striving all branches of scientific knowledge ought to be brought into play. There is currently in science a movement toward fragmentation, reflecting the departmentalization of our universities, whereby each discipline within science asserts its autonomy: its right to stand alone as an independent field of study. I believe this movement to be retrograde: that science can succeed in creating a unique plausible picture of all of nature, including ourselves, only by accepting the scientifically established results from all the fields and insisting on a rationally coherent theoretical understanding of all scientifically acquired knowledge. In this broader context the claim that the choice comes out of nowhere at all should be regarded as an admission of contemporary ignorance, not as a satisfactory final word.

Contemporary science certainly *allows* the choices to be other than "pure random". Indeed, in a model of the quantum world devised by David Bohm these choices are deterministically controlled. The basic question, however, is whether there is a rationally coherent possibility that is both compatible with all scientifically acquired data, yet intermediate to these two alternatives possibilities of "pure chance" and "pure determinism".

The philosopher A.N. Whitehead speaks of such an intermediate possibility,

which is closer to the intuitive idea that our choices are, in some sense, *self-determining*: namely that they are conditioned by what has come before, yet are not strictly determined by the past, but are nonetheless not without sufficient reason. I think such a possibility is open, but to give this logical possibility a nonspeculative foundation will require enlarging the boundaries of scientific knowledge.

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