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# le carré bleu



## ART ET SCIENCE

une vision intégrée vers la communauté du millénaire

*english text*

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## ART AND SCIENCE : A INTEGRATED VISION TOWARDS THE MILLENNIUM COMMUNITY

by Paolo and Vittorio Silvestrini

The evolution of humanity is linked to the concept of growth, which in its historical development has been understood primarily as material growth. Now it is clearly emerging in the collective consciousness that continuous quantitative development is not allowed on a limited planet like the earth. Great technological development has supported the exponential growth of money in the world as well as an enormous availability of material resources, greater than at any other time in human history. However, this material growth has been accompanied by an equally rapid growth in pollutants and waste, with increasingly frequent environmental crises that are expected to become explosive in the coming decades.

Moreover, material and economic well-being is not necessarily associated with collective well-being, if it is true that a large part of the world's population still lives in extreme poverty, while another part lives in fear and is intent on defending its privileges, even with weapons.

The scientific debate that considers possible alternative developments for the future of mankind on the basis of very general global considerations began a long time ago on the initiative of the entrepreneur Aurelio Peccei who, together with the Scottish scientist Alexander King and many other cultural figures, founded the Club of Rome in 1968. The basic idea that united the experts of the Club of Rome is that the problems concerning the future of the world cannot be solved separately, but must be tackled through the use of global models in order to be understood in their interconnections. This approach led to the commissioning of a study by a group of experts at M.I.T., which resulted in the publication of a report entitled "*The limits to growth*". The results of that study, although they can be updated to reflect the latest development parameters, are as relevant as ever. First of all, it must be clear that a continuous growth of material goods is not sustainable in a finite system such as our planet; moreover, the current financial economic system of globalisation leads to exponential growth, which has an explosive character. We think that a perception of the explosive nature of the growth we are unconsciously encouraging on a global scale should be part of everyone's immediate experience, and this awareness should be a fundamental point of the educational system, starting from primary school.

One of us (PS) has written a short story entitled "*Pietro il Re e un Dio bizzarro*" (Peter the King and a Bizarre God) , which deals in the form of a tale for children and adults with the mathematical, social and ethical consequences of a system that indefinitely encourages exponential financial growth such as our current model based on GDP as its essential element. Everyone should try to acquire this awareness without assuming that the current model of development is the only one, or the best possible. On the other hand, the use of many essential resources and the production of many pollutants have already exceeded physically sustainable rates, and we are using reserves accumulated over hundreds of millions of years at a dizzying pace. Without significant reductions there will be an uncontrolled decline in industrial production, energy consumption and food production per capita in the coming decades, with a crisis of unpredictable, but certainly undesirable and avoidable, characteristics.

What emerges from the study commissioned by the Club of Rome is fortunately that this decline is not inevitable: avoiding it requires a global change in policy and ways of acting that perpetuate the continued growth of population and production of material goods. At the same time, we need a rapid increase in the efficiency with which energy and material goods are used, and an ecological restructuring of civilisation, according to guidelines that one of us (VS) indicated some thirty years ago, and which can be the subject of further study and the precise contribution of various fields of knowledge in an integrated overall view.

A sustainable society is technically and economically still possible, but requires awareness and will on the part of all.

Humanity could then become aware that a truly sustainable society is more desirable than a society that tries to solve its problems by relying on constant expansion, and in so doing worsens them and postpones them to a more or less near future.

The transition to a sustainable society requires a careful balance between long-term and short-term goals, and an emphasis on fair use, equity, quality of life, rather than quantity of output. It requires humility, maturity, human participation, and wisdom to guide technological development. In short, it requires a radical shift in priorities from the financial aspects and the separation between rich and poor, to those of participation and sharing and respect for all forms of life on the planet.

If we are to imagine a world in which happiness is a right for all, then we must also devise good legislation that makes its realisation possible and supports it.

When relationships are not underpinned by respect and sharing, they become deceptive and self-serving. So far, globalisation has been the competitive accumulation of the 'gross domestic product' economy. Up to now, "well-being" has been an expression of power and personal wealth, exalting selfishness and setting new boundaries of social exclusion.

Now is the time for "being" and "good" to be united for a different value, so that Being means participation in Life and Good is the joy of existing in a common world.

We believe that individual happiness cannot be separated from collective happiness, from respect for everyone and for the living planet, from freedom and the free expression of individual creativity. Evolution driven by new technologies must change course and move towards a qualitative rather than quantitative development of well-being.

We need science to open up to what is not quantitative, to integrate humanistic knowledge, philosophy, the appreciation of beauty, art and every human discipline that enriches our presence on this planet with immaterial goods.

We have decided to call the invitation that is being promoted "*Science and People in the Quantum Revolution*", precisely to emphasise the different vision of the world to which the recent experimental and theoretical developments of Quantum Physics are opening the doors, both from the point of view of application and from the philosophical and ethical point of view. Among other things, quantum non-locality linked to entanglement undermines one of the most radical founding principles of the classical scientific method, called the principle of local realism, and therefore requires a profound revision of the scientific method.

The idea that guides scientific thinking is that there is a latent order, a beauty in the apparent chaotic complexity of the world's manifestation. It is well known that a criterion of mathematical beauty was a guiding principle for the Nobel Prize winner in physics Paul Dirac, the scientist who revolutionised the world view with his pioneering theory of quantum electrodynamics and the subsequent discovery of antimatter. Paul Dirac once said: *"If you are working on a physical theory from the point of view of the beauty of your equations, and if you really have a deep understanding of what it implies, you are certainly on the way to progress. If there is not complete agreement between the results of your work and the experiments, you should not be too discouraged, because the discrepancy may be due to minor features that are not adequately taken into account and that will be clarified with further research developments."* Beauty, and the belief that there is a more or less concealed harmony in every manifestation of natural events, is the guide of both scientist and artist. Naturally, this leads to an extended concept of beauty, not only as a manifestation that is pleasing to the eye according to our patterns of judgement, but rather to the coincidence of beauty and truth, and at the same time justice, truth and beauty, in our imperfect manifestation of Universal Law. The Law thus becomes the human and essentially imperfect element of the representation of the equivalence of Truth, Justice and Harmony. In this Law there is therefore a profound element of humility, which guides artists, like scientists, in their personal search for Truth. Integrating Art and Science therefore means integrating an individual vision of the world with a universal vision of Truth, it means abandoning the egocentric or anthropocentric conception of the universe to achieve a perception of existence that fully respects its own unique and individual essence according to a principle of equanimity, in which every living being plays its irreplaceable role in the unity of the universe, in the beauty of this instant: a fundamental aspect of Truth is in fact the simple recognition that in existence we are all "contemporaries", that we all benefit from this "instant", we are part of it, inseparable from the whole.

Integrating Art and Science means adding something irreplaceable to both art and science, it means discovering a new human discipline towards the path of knowledge that is neither exclusively subjective nor objective. It is a new form of research that is simultaneously subjective and objective, in a coherent superposition of "quantum states" that appear separable and separate only to an old way of thinking.

In Quantum Physics, the coherent superposition of states that appear incompatible according to classical logic is the reality highlighted by an infinity of experiments that are expanding from the microscopic world of elementary particles such as protons, electrons, atoms or molecules etc. to the macroscopic world of quantum computers and everyday life in general, demonstrating that Schroedinger's cat, which is paradoxically both alive and dead, is the hidden truth of our everyday experience. The non-locality of nature and the concept expressed as "*quantum entanglement*" (a term also coined by Schroedinger, whose implications seemed paradoxical to scientists of Einstein's calibre) has also been demonstrated by increasingly sophisticated experiments and is the underlying effect of the quantum computer: exponentially complex systems, apparently separated according to a classical logic of cause and effect, are in reality 'quantum correlated', so that an operation on a local part of the system simultaneously affects the whole complex system in a way that is classically inconceivable, i.e. inconceivable according to the logic with which we are accustomed to interpret reality. In fact, it is certain that the advent of quantum information, which is now just around the corner, will upset our everyday reality and not only the world view of some quantum physicists.

A primary application for quantum computing is artificial intelligence. Artificial intelligence is based on the principle of learning from experience, becoming more accurate with feedback, until the computer program appears to exhibit 'intelligence'. This feedback is based on calculating probabilities for many possible choices, so artificial intelligence is an ideal candidate for quantum computing. It promises to disrupt every field from automobiles to medicine, and it has been said that artificial intelligence will be to the 21st century what electricity was to the 20th.

Another example is the precision modelling of molecular interactions, finding optimal configurations for chemical reactions. Such “quantum chemistry” is so complex that only the simplest molecules can be analysed by today's digital computers. But fully developed quantum computers would have no difficulty in evaluating even the most complex processes.

The implications are more efficient products, from solar cells to medicines, or the production of fertilisers; but especially it will soon be possible to genetically manipulate complex organisms, including human beings, by assessing in advance what the result of local manipulation will be on the overall organic system. It will thus be possible to create GMO humans, called 'replicants' in the pioneering insight of the cult film “*Blade Runner*”.

In general, a quantum computer can solve exponentially complex problems that cannot be solved by classical computers, with applications in a variety of fields. Such a revolution requires the entire human race to be prepared to collectively manage the infinite possibilities of the near future, which can be used creatively or destructively. It is more important than ever that in this singular transition that is just around the corner, humanity be guided by a perception of Harmony, Beauty, Truth and Justice according to a principle of Equanimity that is increasingly needed.

Entanglement does not deny causality, or the principle of cause and effect, but associates this with a different correlation that cannot be observed locally, which we could call “synchronicity” using a term coined by the great psychologist Gustav Jung. Another term we could coin now to indicate entanglement is “organicity”, that is, something that makes a correlated system organic, not referable to the simple sum of its parts and of the interactions between them, as we can imagine happening in biological organisms in which the whole acquires a unique and unrepeatable identity.

In complex phenomena causality and synchronicity coexist, although one of the two phenomena may be more or less predominant. In general causal relations are more easily identifiable and measurable because they can be described in terms of cause-effect, to which the scientific method has historically given great importance, transferring this emphasis also to common thought which is consequently strongly marked by a mechanistic view of reality. However, the cause-effect principle alone cannot explain the genesis of organic phenomena or other processes in which synchronicity is a fundamental component. In biology, for example, we can explain how many of the chemical and physical processes that sustain and reproduce life take place, but the beginning of life remains shrouded in mystery. In the words of the Nobel Prize winner for Chemistry Ilya Prigogine (who was the first to give great attention to the study of the spontaneous organisation of complex systems): “*The probability that a macroscopic number of molecules will be randomly assembled to give rise to the highly ordered structures and coordinated functions that characterise living organisms is practically zero. The idea of the spontaneous genesis of life in its present form is therefore highly unlikely, even on the scale of the billions of years during which prebiotic evolution occurred.*”

On the other hand, we now know with certainty that entanglement (the experimental evidence for which did not yet exist at the time of Prigogine's quoted sentence) plays a fundamental role in the collective behaviour of macroscopic systems. However, entanglement is not easily identifiable, since it requires an overview and cannot be detected locally.

Here we want to give an example from everyday life to express our thoughts about how a collective behaviour of a complex system can be associated with local relations, and how synchronicity can be indicated in an evolutionary key, in the sense of the probabilistic process described by Prigogine.

I think many have observed the collective figures that flocks of hundreds (or even thousands) of black birds called starlings sometimes perform in the skies over our cities. The movements of this collection of separate individuals appear to us to be so harmonious and synchronised that we are led to believe that there is an “intelligence” guiding the group, a leader from whom the synchronised movement originates. There have been many scientific studies trying to understand how these collective movements can be explained in physical-mathematical terms (e.g. see Attanasi, A, et al., 2014 “*Information transfer and behavioral inertia in starling flocks*” Nature Physics Vol.10, pp.691-696). The system is an interesting example because it is a moderately complex system (a few hundred or thousand elements may seem like a lot, but it is nothing compared to the complexity of billions of elements that synchronise in biological systems) and allows solutions to be found that are currently unapproachable in more complex systems. The result of these studies is in some ways surprising, because it shows that no leader or individual intelligence is needed to perform these complex synchronised figures, but it is enough to assume local relationships between the elements. Each individual has no awareness or vision of the overall flight of the system, but is only aware of the motion of its closest neighbours (usually 6 or 7) and from these it follows a few simple rules to move accordingly: first of all it avoids colliding in flight with neighbouring birds, but at the same time it tries to maintain cohesion with the group, so as not to find itself isolated, and it tries to align itself with its closest neighbours. With these three elements of 'local interaction' alone, we can explain the synchronised collective movements that we observe as a whole. Furthermore, it can be seen from mathematical models how the seemingly chaotic moving system can maintain a high degree of coherence, which can be described by analogy with the low-temperature phase transitions of superfluid helium or superconductivity. The latter phenomena require elements of Quantum Physics to be described, and derive from phenomena of a purely local nature at the same time as the entanglement (or “synchronicity”) we mentioned earlier.

In order to understand how synchronicity could intervene in the probabilistic terms indicated by Prigogine, we need to understand what the evolutionary function of these collective movements is: in the event that the group is threatened by a predator, the movement originates in order to decide in which direction to flee and to ensure that the information spreads rapidly throughout the system through a particularly effective and reliable mechanism that makes predation quite difficult. The hidden purpose of this collective behaviour is therefore linked to the process of evolution of which individuals are not directly aware, but which they follow instinctively. This evolutionary intelligence of the species is specific to the group, and is the result of natural selection.

Now Prigogine's assertion comes into play: if the process of natural selection acted completely at random, the probability of such finely-tuned collective behaviour being generated would be nil even in billions of years of evolution. In this sense we can guess what the effect of synchronicity is, which would be to determine choices not completely at random, but with significantly higher probability towards intelligent evolutionary purpose. Indeed, in all Bell's inequality experiments in Quantum Physics that highlight synchronicity and non-local aspects of reality, one is always dealing with probabilities that cannot be considered as completely determined by chance, as one would expect according to the principle of causality or local realism. We think that the influence of synchronicity on the evolutionary process will soon be formalised in rigorous terms, probably with the advent and diffusion of quantum computers, which are the only tools that can study exponentially complex phenomena with any chance of success.

But how is all this associated with Art-and-Science, which is the subject of this talk? We would like to express our feeling in this regard, which is not rigorous but may be evocative for an individual reflection. Let us start with a simple example. Suppose we listen to a symphony by Beethoven or Mozart, or a sonata by Bach: we will probably first notice a harmony linked to a local relationship of the notes, i.e. the notes next to each other form sequences that appear harmonious, pleasant to listen to. Later, to a more trained ear, a more global harmony will appear, in which even more distant groups of notes are harmonically linked throughout the composition: we may identify, for example, the general tonality, symmetries and appropriate breaks in symmetry, so that the whole will appear to us as increasingly organic.

Finally, we may perhaps notice individual and apparently insignificant details, but which on the whole make the work a masterpiece of perfection, beyond the perfect structure of the mathematical relations that express the various wavelengths of the notes. This unpredictable "quid", this invisible thread that binds the entire work is inextricably linked to the genius of the artist, just as it is naturally linked to the sensitivity of the execution, to the non-mechanical intelligence of the person performing the work at the time. This invisible element, undetectable by measurements or arguments of any kind, is the synchronicity that makes a complex whole a unique and irreplaceable work of art. Not only this, the intuition of the work's irreplaceable majesty also requires the listener's capacity for synchronicity, non-mechanical intelligence, i.e. in no way traceable to mathematical equations, and the mysterious empathy generated between author, performer and listener. That is why each performance is unique and belongs to the magic of the moment, and therein lies the fascination of live concerts. In Prigogine's words: "*Whatever we call reality is only revealed to us through the active construction in which we participate.*"

For us Art is a work characterised by a large component of synchronicity, mastery is that which is mechanically perfect but with a low content of synchronicity. In the same way, intelligence is not a local phenomenon, but an organic phenomenon of synchronicity in which the whole of humanity and even the entire universe participates, and whose mechanical expression is manifested in harmonious local relationships. We would like to quote here a short passage from the book "*The Black Cloud*" by Fred Hoyle (British astronomer and novelist) which describes in his novel the relationship between some scientists and a gigantic living cloud capable of obscuring the sun, a lover of Beethoven's music and endowed with an intelligence inconceivable to the human mind: "*The new ideas, fragile as spring flowers, and easily trampled underfoot by the multitude, find instead a welcome with the solitary thinker. Of all the people who stood waiting for the Cloud's arrival, no one but Kingsley had coherently understood its nature, no one but Kingsley had understood why the Cloud was making that strange visit to the solar system*" (Hoyle, "*The Black Cloud*", ch. IX).

It should be clear from what has been said so far that for us Art and Science are only such through sharing and participation. Art and Science are a collective good to which everyone should have access and in which everyone should be able to participate.

Supporting Art and Science means supporting a principle of equanimity in existence, which concerns not only humanity as a whole but also everything that exists, starting with our planet and every living thing that breathes on it. To find harmony is to recognise the profound interconnection between all parts participating in this complex system, this ecosystem that is life on earth. At this moment in history, the tendency of humanity as a whole is instead to consider Art and Science a privilege for the few, following a criterion that gives so much importance to money, that intrinsically favours an uneven distribution of wealth and that gives power to those who are less connected to the criterion of synchronicity. This kind of emphasis on the accumulation of wealth in the hands of a few is producing unsustainable growth whose effects are overwhelmingly coming to light in their destructive nature. Humanity's growth in wisdom and consciousness has failed to follow technological growth and the power and responsibility that this brings; power that can be used creatively or destructively according to choices that depend on our responsibility. It may be that humanity is destined to disappear and that evolution is guiding the vital energy towards higher forms of awareness and intelligence as imagined in Doyle's "*Black Cloud*", which moves through interstellar space in search of its twin, but it is certain that now what little intelligence we have we can and must use it in a path of awareness towards the recognition of the principle of synchronicity that Quantum Physics, like many other human disciplines, have been indicating to us for some time. We can all participate and make a contribution, each according to our own unique and irreplaceable inclination and individuality. Art and Science therefore includes every aspect of human knowledge, in humility and mutual respect.

Every individual can make a contribution, and every individual contribution has consequences on the collective global system that can be very significant. Individuals can regain full confidence in the power of their own choices, without necessarily feeling like a small insignificant part of a huge system, whose inertia seems to be completely beyond the control of individuals.

At this point, we would like to quote Richard Buckminster Fuller, the great American architect and designer, a pioneering advocate of sustainable development: "*Think of the Queen Elisabeth: the whole ship and its rudder. And then the fact that there's a little thing called a trim-tab. It's a miniature rudder, and it's the movement of that little flap that creates the pressure that turns the rudder. It requires almost no effort.*" So we told ourselves that the small individual can be a trim-tab in the big ship that is the global eco-system of life on earth!

We invite everyone to start thinking about a new value system to guide our lives. A system that is radically different from the current one, in which we feel trapped in a spiral of unsustainable economic growth. It must first be clear that continued economic growth in a finite system such as the earth is mathematically unsustainable. The emphasis that economic governance places on percentage growth of gross domestic product, finance, spreads, and debt interest leads to exponential growth in production and consumption. This growth is mechanically associated with the concept of well-being.

We think that this association must be radically challenged.

It is time to change the roots of the system. It is time to think of a radically new vision of the world, in which we can use our knowledge and intelligence not so much to increase material goods, but to make better use of resources for a humanity that knows how to make the most of the qualities that guarantee real wellbeing, in harmony with all our relationships. A humanity that respects and values individual creativity, which is unique and irreplaceable, and which recognises the need for harmonious relationships for real well-being. The time has come to grow in intangible values such as awareness and knowledge for an active participation in life while respecting the planet that sustains us. The time has come to recognise the importance of freedom, love and responsibility towards future generations. We are convinced that from this chaos a new vision of the world and of humanity can take shape, which can replace the current one that is heading towards an inevitable decline.

In order to be viable, a new vision of the world must first of all be conceivable: hence our invitation to everyone to try to think of a different future from the one that awaits us by mechanically continuing along this path. It will not be easy, and the change will have to be pondered carefully, with intelligence and courage. It is clear to us that this effort requires the participation of everyone.

We have total faith in human intelligence and creativity, and this is why we are so irreducibly optimistic: the current situation of degradation could be a wonderful opportunity for growth towards real well-being, made up of freedom, love, mutual respect and responsibility.

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*Le Bulletin of the Atomic Scientists*, fondé par Albert Einstein, J. Robert Oppenheimer, Eugene Rabinowitch et des scientifiques de l'université de Chicago, marque l'horloge du Jugement dernier : combien de minutes ou de secondes restent avant l'heure X, fixée en 1947 à sept minutes avant minuit. La fluctuation du bilan annuel, désormais marqué par moins de deux minutes, n'est pas seulement le résultat de la prolifération des armes nucléaires, des tensions entre les grandes puissances, des pandémies, de la consommation des ressources naturelles enregistrée par l'Overshoot Day ou de l'accélération du changement climatique. Il imbrique toutes les actions humaines et appelle au « développement durable ».

Un changement de cap est de plus en plus urgent.

Le développement technologique impétueux d'aujourd'hui s'accompagne de l'exaltation de capacités autodestructrices, non pas tant parce que l'on diffuse des outils prêts à générer des catastrophes planétaires immédiates, mais parce que des comportements - habituels et répandus - compromettent les équilibres qui sont à la base de notre survie.

La violence croissante du changement climatique est évidente. Tout aussi évidente est la baisse continue de la qualité écologique des nouveaux milieux de vie, qui ne sont pas rares aujourd'hui à produire de l'insécurité, à ralentir l'économie, à réduire les relations sociales et le bien-être des communautés. Le « développement durable » - un terme inconnu il y a seulement quelques décennies - est désormais un impératif. La « *Déclaration des Devoirs des Hommes* » sur l'habitat et les modes de vie respectant la diversité (Le Carré Bleu, 2008) appelle chacun à ses responsabilités.

Vittorio Silvestrini est un physicien de renommée internationale, fondateur de la Cité des Sciences ( Le Carré Bleu n.3/4-1997 )- il a reçu en 2006 le « *Prix Descartes pour la communication scientifique* » - et a édité ce texte avec Paolo (son fils, autre physicien distingué) pour Le Carré Bleu. Il voit dans la dialectique entre l' « *Art et Science* » les signes possibles du changement de mentalité indispensable pour tenter de faire reculer les aiguilles de l'horloge du Jugement dernier.



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