

The ‘Quantum Theory’ of Marxian Political Economy, and Sustainable Development

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Introduction

You may be disappointed to hear that Schrödinger’s wave equation is not about to be solved in order to deduce the states of a politico-economic system – apologies for that. Rather something more modest is proposed, that is, to show that quantum theory provides a much better conceptual paradigm for Marxian political economy than the Cartesian-Newtonian (CN) paradigm, which dominates bourgeois thinking about political economy. It will then be further argued that, if we are to begin to construct an alternative strategy for replacing capitalism with a truly human-based political economy and society, we should adopt this ‘quantum theory’ paradigm. It will also be shown that there is a connection between this mode of thought and the revolutionary developments in the means of production that are taking place at present, namely, information and communications technologies [ICT]. Some ways of initiating aspects of this strategy will then be tentatively proposed, as well as linking to processes that have already begun, with particular emphasis on the centrally important issue for our time, namely, sustainable development

It should be mentioned that a number of other writers have also suggested that quantum theory is a much better model for understanding society and culture than Cartesian-Newtonianism. I refer notably to David Bohm [1], Fritjof Capra [2], and Danah Zohar and Ian Marshall [3], amongst others. However, as far as the author is aware, there has not been an attempt to apply quantum thinking to understanding the processes and concepts of Marxian political economy. Capra discusses problems of understanding economic processes but does not make the explicit connection with Marxian political economy

The Cartesian-Newtonian Paradigm

As is well known Descartes assumed that there was a fundamental divide between mind and matter, that is, between mental and physical processes. The material world was thus conceived of as a machine with mechanical laws governing its behaviour, namely, Newton’s Laws of motion of matter. The mind and its processes were capable of understanding these laws through its own internal laws of reason. Nature was itself also subject to mechanical laws so that all creatures in the living world were complex machines. This paradigm remains central to the bourgeois understanding of the relationship between individuals and society, and between humankind and nature in general.

As Zohar and Marshall [3] point out, using the word 'Mechanism' as short-hand, in effect, for the Cartesian-Newtonian paradigm:

“Mechanism stresses an unbridgeable gulf between human beings and the physical world. Human consciousness has no role or place in Newton’s vast world machine. As the French biologist Jacques Monod describes it, we live ‘like gypsies...on the boundary of an alien world’. This sense of an alien physical realm was extended, in association with Christian influence, to the wider world of nature. Nature is perceived as wholly ‘other’ than ourselves, a force to be conquered and used”

They go on to list the other characteristic features of the Cartesian-Newtonian world of Mechanism [3]:

“Mechanism stresses the absolute, the unchanging and the certain. Ambiguity is an enemy. Newton’s absolute space-time coordinates are the framework for a fixed, predictable and rigidly law-abiding universe. Mechanistic society stresses the absolute centre with power radiating outwards. It stresses fixed role-playing and rigid bureaucratic organisation.

Mechanism stresses hierarchy. It structures existence according to ever descending units of analysis. Molecules are more basic than neurones, atoms more basic than molecules (..and so on). We structure power and authority in the same ladder of ascending and descending authority.

Mechanism stresses isolated, separate and interchangeable parts. Everything in Newton’s universe is ultimately reducible to so many individual atoms and the forces acting between them. Atomism encourages a model of relationship based on conflict and confrontation, on part against part. In our times Hobbes’s mechanistic ‘war of each man against each man’ takes the form of the ultimate conflict. ‘Most obviously’ says Princeton’s Richard Falk, ‘nuclear weapons as instruments for struggle of part against part doom the whole....’

Atomism underlies the modern cult of the expert, the detached individual who is very knowledgeable about isolated bits of information or experience but ignorant of the whole of which these bits are a part. The parts are alienated from each other and from the whole; and the whole is subject to fragmentation. The expert is alienated from the situation or community in which s/he practises her/his expertise.

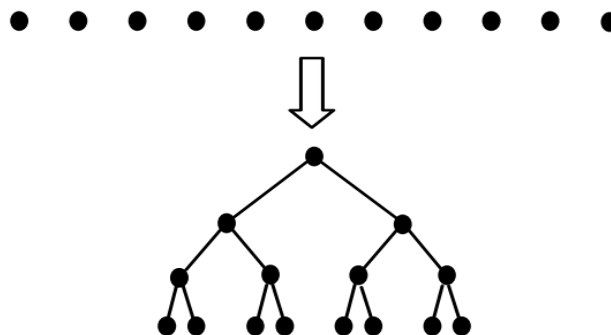
The industrial revolution, and the mass production that followed in its wake, extended this alienation to our understanding of human beings and the nature of our labour. In the vast industrial machine (or large corporate organisation) the individual labourer becomes a ‘factor of production’ [or ‘unit of resource’ to use modern terminology-DH], an objectified unit in the standardised production process. His/her personal and social relationships and anything we might define as spiritual qualities are isolated from the wholly separate and rigidly bureaucratized world of work. Mechanism’s employees are, as Marx pointed out,

alienated both from themselves as wider beings and from the products of their own labour.”

The characteristics of the Cartesian-Newtonian world described above also apply to the reality created in the former Soviet Union by Lenin/Stalin Bolshevism. Indeed it is the essence of the party-political structure that was the instrument for its creation and control, as shown in an earlier paper [4]. We should also note that there are elements of CN-type of thinking in the young Marx and Engels in which they talk admiringly, in the Communist Manifesto, about the role of the bourgeoisie in “The subjection of Nature’s forces to man, machinery, applications of chemistry,...” [6], and one of the communists’ demands as being, “Centralisation of all instruments of production and credit into the hands of the State.” [7]

Of course the central contradiction in the Cartesian-Newtonian worldview is that it cannot account for the origin and characteristics of human consciousness. Both founders of this paradigm would have appealed to the metaphysical notion of a ‘God’ who was responsible for human feelings and consciousness, which would be seen as part of God’s creation of the individual ‘soul’. Even today, when the concept of the soul has long since been discarded as scientifically useless, the material basis of consciousness is still a matter of keen debate.

We can represent the Cartesian-Newtonian mechanistic world-view by a simple graph that conveys the essence of this outlook, as follows:



The Cartesian-Newtonian Paradigm

- *Nodes are only localised
- *Hierarchical *Bureaucratic
- * Alienating * Undemocratic

This rooted-tree graph represents the partition of the world into its constituent people-particles, as well as the resulting hierarchical political and social structures of the bourgeois state, and that of its main economic players, the corporations. It is also characteristic of the state and social systems of former Soviet Union and its derivatives.

The Revolt against the Cartesian-Newtonian structures of Corporate Globalisation

There is increasing widespread revolt against the globalised world created by corporate capital and its global institutions such as WTO, IMF and the World Bank. This revolt, intensified after the recent collapse of the credit system, is reflected in rapid growth of the so-called 'Anti-Globalisation' or 'Anti-Capitalist' Movements, in the past decade or so. Those in revolt meet together at the World Social Forum, and include both secular and religiously inspired groups. Understandably these people generally reject the attentions of the sectarian 'all-knowing' Leninist cults, correctly deducing that they are part of the problem. However it is also clear that this movement has no radical and coherent alternative way of thinking about the world and what to do about it. Some elements adopt a New Age mystical philosophy influenced by Eastern religions or even soft versions of conventional western religions. Many have secular eco-philosophies with tendencies towards 'NaturMystik' or Nature mysticism. There is also a dominant anti-science tendency. Science and scientists are blamed for providing the tools for corporate capital and its state representatives to develop the means to grossly exploit humanity, wreck the environment, and create the weapons of mass destruction and for the mass repression of those who object to these activities.

There are a small number of people who adopt a fundamentalist religious or secular response to the horrors of late capitalism such as the Islamic clerical-fascist fanatics behind Al-Qaida, or various eco-fascist type movements. Such a terrorist response of course plays in the hands of the hard-line servants of corporate capital such as the leading western politicians. These gentlemen secretly welcome terrorist atrocities such as 9/11 and its smaller-scale successors - it gives them every excuse to act against, and visit terror, on their real enemies.

Quantum Theory - an alternative to Cartesian-Newtonianism

What is understood by only a very small number of the critics of modern corporate capitalism is that modern physics,¹ and, specifically, quantum theory, provides an alternative paradigm, or framework of thinking, that can help demolish that of Cartesian-Newtonianism in the politico-socio-economic sphere as well as that in physics itself. The works cited and quoted from above are a good starting point for those interested in reading in more depth.

Key Elements of Quantum Theory (QT)

Wave-particle duality

The first thing to note about QT is that it is thoroughly dialectical theory. It contains a number of contradictory dualities most famous of which is the wave-particle duality. According to QT particles such as electrons, protons, neutrons etc can also have wave-like properties. They can give interference and diffraction patterns characteristic of waves. If a stream of electrons is fired at two closely-spaced holes in a barrier common sense tells us that as particles they will pass through either of the

¹ Modern Physics is an ad hoc amalgam of Quantum Theory, Special and General Relativity.

two holes and we would expect to find two patches on a detecting screen behind the barrier corresponding to the two groups of particles passing through the two holes. Instead we obtain an interference pattern characteristic of a wavelike phenomenon such as light. It is as if each electron ‘knows’ that there are two holes, not only the one it actually passes through, and adjusts its path accordingly. Similarly intrinsically wavelike phenomena such as electromagnetic radiation, for instance, light waves, can also reveal particle-like properties such as in the photoelectric effect as explained by Einstein in 1905.² Einstein also later predicted the possibility of lasers, the purest form of light waves, by treating light as particles.

Dualities of Momentum-Position and Energy-Time: The Uncertainty Principle

Other pairs of physical properties that are quite separate or independent in the Newtonian worldview such as the position and momentum, energy and time, form contradictory dualities in QT. Attempts to measure the precise position of particle means that its momentum becomes uncertain, and vice-versa. This is the celebrated Heisenberg uncertainty principle. The same is true of energy and time. Thus concepts that are quite separate in Newtonian or classical physics become intertwined or ‘synthesised’ into a new, but contradictory unity.³

The Superposition of States

Another paradoxical phenomenon is the existence of superposition of states. A particle or a system of particles, for instance a molecule, is said to exist in a combination of different states each of which is quite different from the others. A well-known example is that of the benzene molecule that can have two different bonding configurations. Benzene actually behaves as if it is a combination of both, and referred to as having a ‘resonance hybrid structure’. Indeed this principle also applies to the motion of a particle between two points in which the actual path can be seen as a weighted combination of a large number of paths each with a different probability of occurring. No longer do we have a precise and predictable path in space and time as in the Newtonian system but, a fuzzy, un-predictable set of possible paths. There is no definite ‘party-line’ about how to get from A to B.

Probability is fundamental

Probability, chance, uncertainty are the fundamental features of QT. In fact, the amplitude, that is, the ‘height’ of the wave part of the wave-particle is closely related to the probability of event taking place in a particular time interval or of a particle being found in a region of space. Gone are the certainty and predictability of the Cartesian-Newtonian worldview.

Virtual transitions and the state of flux in the vacuum.

In a quantum system a particle can make virtual transitions to the states of energy or momentum when it does not have enough energy or momentum to reach that state,

² In many ways Einstein, with this paper, was the true discoverer of quantum theory as well as Relativity in another paper published the same year, 1905.

³ Relativity also synthesises separate absolutes of space and time into relative space-time. It also creates a new synthesis of energy and matter.

returning back to its original state in a time dictated by the uncertainty principle. Even so called ‘empty’ space or the vacuum is a seething cauldron of virtual particle-antiparticle pairs popping in and out of existence, and zero-point fluctuations of the electromagnetic field. It reveals that nothing is fixed, everything is in flux as Heraclitus realised in ancient Greece.

The role of the observer in the measurement process

One of the paradoxes of QT that is still the most puzzling is the integral role of the observer or the measuring system. This is the phenomenon of the so-called ‘collapse of the wave-function’ whenever a measurement is made. For instance, if a star emits a light-wave at the backend of the universe so that when it reaches us it will cover a sphere with a radius many billions of light years. Yet when we observe the star some of the energy in the wave collapses into a wave-packet or photon that is absorbed by the retinal pigment molecules of the eye. It is as if the observer or measuring system is somehow integral to the quantum processes. This is another example of an important difference between QT and the Cartesian-Newtonianism. As already pointed out the observer is a peripheral irrelevance in this latter system of thought.

In other words we have to live with contradictions and paradoxes; at least, that is how they appear so to us with our CN-conditioned thought processes. But what is a paradox? According to the celebrated American physicist Richard Feynman, “The paradox is only a conflict between reality and your feeling of what reality ought to be”. But those feelings arise from the conditioning of a lifetime.

Is ‘consciousness’ a quantum phenomenon?

More controversially some authors, such as Zohar and Marshall [5], Penrose [8] and others believe that QT is necessary to explain human consciousness itself. There are certainly analogues of brain behaviour in quantum systems such as spin glasses.⁴ However I do not propose to enter this somewhat controversial domain since this would be difficult without recourse to technical arguments in physics, even if I had a definite view. What is clear is that quantum processes are essential for the existence and continuation of life, for instance, in the mechanisms of photosynthesis. Indeed, the whole of chemistry and therefore life itself depends on the quantum processes that bind molecules together and cause them to interact with radiation and other molecules. Life can, in truth, be viewed as a symphonic poem to the creative possibilities of the quantum world of matter and radiation. If matter was actually Newtonian at an atomic level then the universe would be very boring and Newton would never have been around to discover his approximation to its laws, and we to criticise him. (For further reading consult Michael Lockwood, [11])

Local and non-local effects in Quantum Theory

⁴ Zohar and Marshall even believe that the brain is a Bose-Einstein condensate, a quantum system containing a large number of a type of particle called a boson, in which all the boson particles are in the same energy- state. In a real physical system this occurs either close to absolute zero or possibly in a pumped oscillator system, such as the dipole oscillators suggested by Froehlich [9] for biological structures such as membranes and microtubules. Marshall has even suggested that this is the basis of consciousness [10]. However, such views must be considered very speculative.

For the purposes of political economy the most important of contradictory unities found in QT is that of the phenomenon of local and the non-local effects. In many ways this is the core contradiction or paradox of QT. We have already pointed out that particles in QT seem to be aware of their surroundings even though there is no physical interaction as in the two-slit interference experiment mentioned above. It appears that they, nevertheless, ‘know’ of the existence of each other through the wave function. The most disturbing example of a non-local effect is that originally given as a hypothetical experiment by Einstein and his collaborators, Podolsky and Rosen, the EPR experiment, for short. If we prepare two electrons so that in their combined state they are spinning in opposite directions [technically called zero net spin] and then we arrange for them to separate, that is, pursue divergent paths in space such that they could in principle eventually be separated by many light years. If we were to measure the spin of either particle in a chosen direction then it would have equal chance of being found rotating in that direction or the opposite direction. However **after** we have measured the spin of **one** of the particles, and, say found it to lie in our chosen direction we know that a subsequent measurement of the spin of the other particle would have a 100% chance of finding it spinning in the opposite direction. The measurement on one particle appears to affect the state of the other particle even though it might in principle be millions of kilometres away. The particles are said to have remained ‘entangled’. Einstein rejected this possibility which he called ‘spukhafte Fernwirkungen’ or ‘spooky actions-at-distance’ and he remained an opponent of QT for this reason, amongst others, even though he had helped to create it. However, experiments have shown that such ‘spooky’ effects do take place and are deeply part of QT [12]. They are the object of considerable research today, with the hope of producing unbreakable ciphers, and even quantum computers.

What is clear, however, is that, at the heart of QT is that particles are both locally connected through physical interactions with other particles and fields and non-locally connected through the wavelike aspects of quantum reality. One cannot think of a particle as a single isolated entity interacting pair-wise with other particles within range, but rather an entity that is inextricably, by its very nature, connected to the rest of the universe. It, as it were, participates in a ‘universe of discourse’ that defines its being. It is of course true that we do not as yet understand how this can be. We require deeper concepts that will help us to grasp how the paradoxes of QT are possible. But our inability to find these concepts to date is undoubtedly connected with the deep conditioning, to which we have been subjected, through the dominant ideology of Cartesian-Newtonian paradigm.

The Quantum Theory and Marxian Political Economy

As in quantum theory, Marxian political economy has, at its core, two dualities, which can be thought as forming two contradictory unities. They are the dual nature of labour, that is, concrete labour and abstract (universal) labour, and the dual nature of value, that is, use-value and exchange value.⁵ These two dualities are closely related to each other, each duality forming a contradictory or antithetical unity. For Marx in his analysis of the ‘commodity’, which he refers to as “the economic cell-form of bourgeois society”, reveals its two-fold nature due to the fact that it contains or synthesised within it both use-value and exchange-value. He then adds: “Later on, we

⁵ Marx sometimes refers to exchange value simply as ‘value’ to differentiate it from use-value.

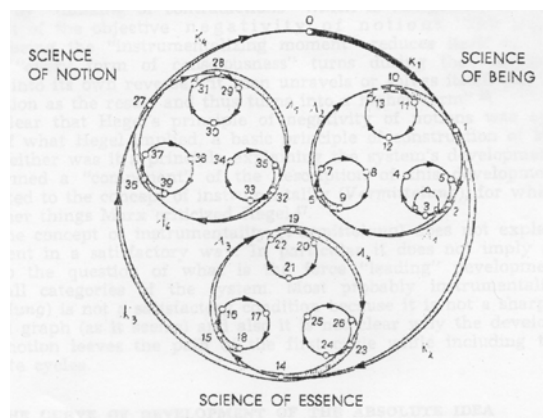
saw also that labour, too,... as it finds its expression in (exchange) value,.... does not possess the same characteristics that belong to it as a creator of use-values.”[13].

A thorough discussion of the dual character of the labour process and its central importance for the whole of Marxian political economy of capital, including its application to imperialism, can be found in “Karl Marx’s Great Discovery” by V. Afanasyev, A. Galchinsky, and V.Lantsov (AGL). According to AGL the relationship between the two dualities is as follows [14]:

- (1) *Marx established that the commodity-producers labour has a two-fold character: on the one hand, it is concrete labour and the source of the commodity’s use-value, and on the other hand, it is abstract labour, and the source of the commodities value. Marx says: “I was the first to point out and to examine critically this two-fold nature of the labour contained in commodities” [13].*
- (2) *At the same time, labour is the basis of all human economic activity so that all economic phenomena...are no more than various manifestations of human labour (its functioning, results and consequences, content and socio-economic form, etc).*
- (3) *Since labour is the basis of all economic phenomena and acquires a two-fold character under commodity production, it follows that all economic phenomena likewise acquire a two-fold character⁶.*

It is well known that Marx was able to discover the two-fold contradictory character of labour because he was steeped in the dialectical thought of Hegel. This is contrast to the eminent economists that preceded him, such as Adam Smith and David Ricardo, who also accepted the labour theory of value. These thinkers, however, were formed by the bourgeois empirical thought within the Cartesian-Newtonian paradigm.

In Hegel’s thought the finite (local, immediate) is closely connected to the infinite (non-local, universal). The diagram below shows how the structure of Hegel’s dialectical logic can be represented graphically, according to Synowiecki [15]:



⁶ AGL also elaborate all the other dualities of the socio-economic system generated by the fundamental duality of labour: the labour process -the value expanding process (creation of capital); the concentration of production- the concentration of capital; monopoly industrial capital – monopoly bank capital; money as a technical instrument of exchange- money as a general value equivalent, and so on.

Such a graph shows how the categories of this logic can be both local and non-local simultaneously. Topologically, the graph is constructed by folding a circle into sub-cycles, and sub-sub-cycles, and so on. If we imagine that such a graph constitutes a series of processes cyclically connected to form a universal process – in case of Hegel’s system of Logic [16] the coming to be or ‘concretisation’ of the pure idea, P_0 , through series of divisions of the pure idea into Being (Sein), Essence (Wesen), and Notion (Begriff). In the above graph the arcs represent the instrumentalities (Vermittelungen) of the concepts. It is not proposed to delve further into the complexities of Hegel’s Logic but to ‘borrow’ its graphical form to represent Marxian political economy, as well as related matters, such as the possibility of a *global enlightenment*, problem-solving networks of expertise, as part of the route to an ecologically-sound, that is, sustainable development.

Capitalism as a global, non-local system from its beginnings

From his reading of Hegel, it was possible for Marx to grasp that a process that might, at first, appear local, immediate (concrete labour) can also be simultaneously part of in a non-local, universal process (abstract labour). Under commodity production it is the existence of the non-local, that is, global market for commodities that creates this universal or abstract character of labour. As Immanuel Wallerstein [17] and others have demonstrated, Capitalism was, from its inception, a ‘world system’. Labour itself was a commodity, and so African labour power (slaves) could be exchanged for the ironware products of the labour of workers employed by of the Quaker ironmasters of Shropshire (Abraham Derby & Co), through the offices of emerging British imperialism. Similarly, the products of the labour of Chinese peasants (tea) could be exchanged for the products of the labour of Indian peasants in Bengal (opium), again through the helping hand of British imperialism and its gunboats (the Opium Wars). Thus, the recent so-called ‘globalisation’ is merely the final stage in a process that started with the birth of the capital system itself.

The Importance of printing, the first ICT, for the development of capitalism

Of course to establish a universal system of exchange of commodities it is necessary to develop a system of information exchange as well as systems for transporting the goods themselves. This is the importance of the development of printing that allowed dissemination of information about the price of commodities, about the nature of the production processes, conditions of the goods prior to purchase, new techniques of production, scientific and technical developments that might help to reduce cost of production, or make possible the production of new commodities, reduce the transport times and costs, and so on. So parallel with a web of production and exchange of commodities was a worldwide network of information exchange greatly facilitated by the invention of printing.

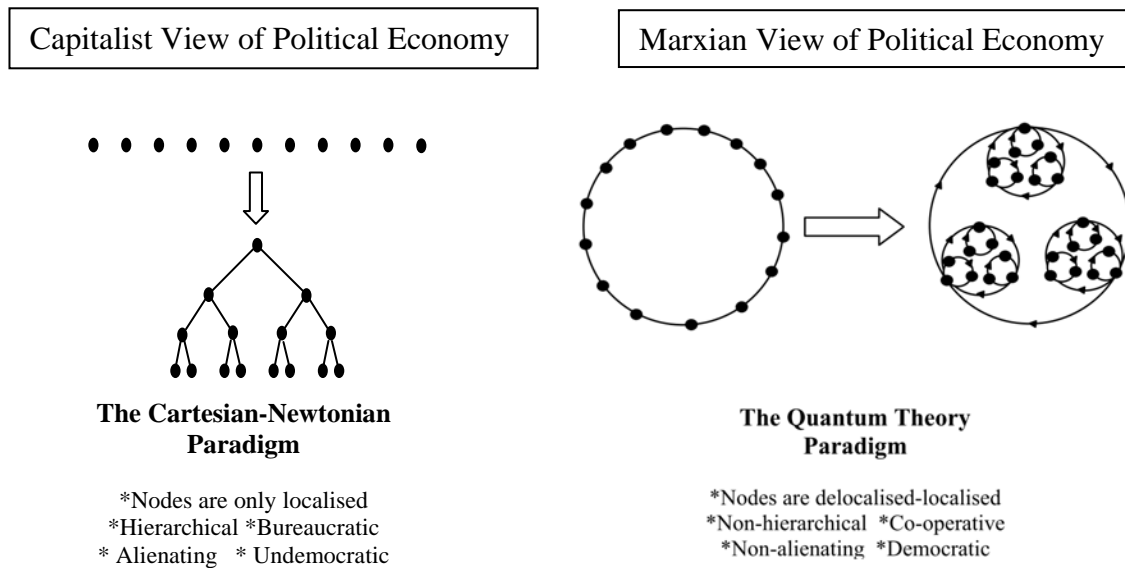
Of course, the creation of exchange value and the expropriation of a proportion of it by the capitalist class, that is, surplus-value, take place behind the backs of the working class. It is the fundamental source of alienation in bourgeois society. The workers must only be allowed to see one half of the process, the exchange of their labour power for wages, a very local process.

From the above discussion of the key elements of quantum theory one can see its close conceptual parallel with the elements of Marxian political economy. Both have at their centre the role of contradictory unities. The most important contradictory unity between the local and non-local processes in quantum theory can be compared conceptually to the fundamental contradictory unity of local, concrete labour and non-local, abstract labour in Marxian political economy. A similar comparison can be made for use-value and exchange-value. One might be tempted to suggest a theorem: “If there exists a sufficiently richly connected system of information exchange coupled to a material system of exchange then there will exist a contradictory unity of local and non-local processes”

The revolutionary development of the productive processes - digital ICT

It is also possible to understand the significance of the present revolutionary developments in the productive forces within the capital system, which is both a revolution in the control of production and the productivity of labour, and also in the means of information exchange, that is, the new technologies centred on ICT. These technologies represent a new synthesis of communication and control of production. They had been largely separated into different epochs in the development of capital system, namely the Mercantile Epoch (communication) and the Industrial Epoch (controlled release of Energy).

We can now compare the two paradigms for Political Economy. Below is a diagram illustrating the difference, in graphical form between the Cartesian-Newtonian paradigm and the paradigm of Quantum Theory:



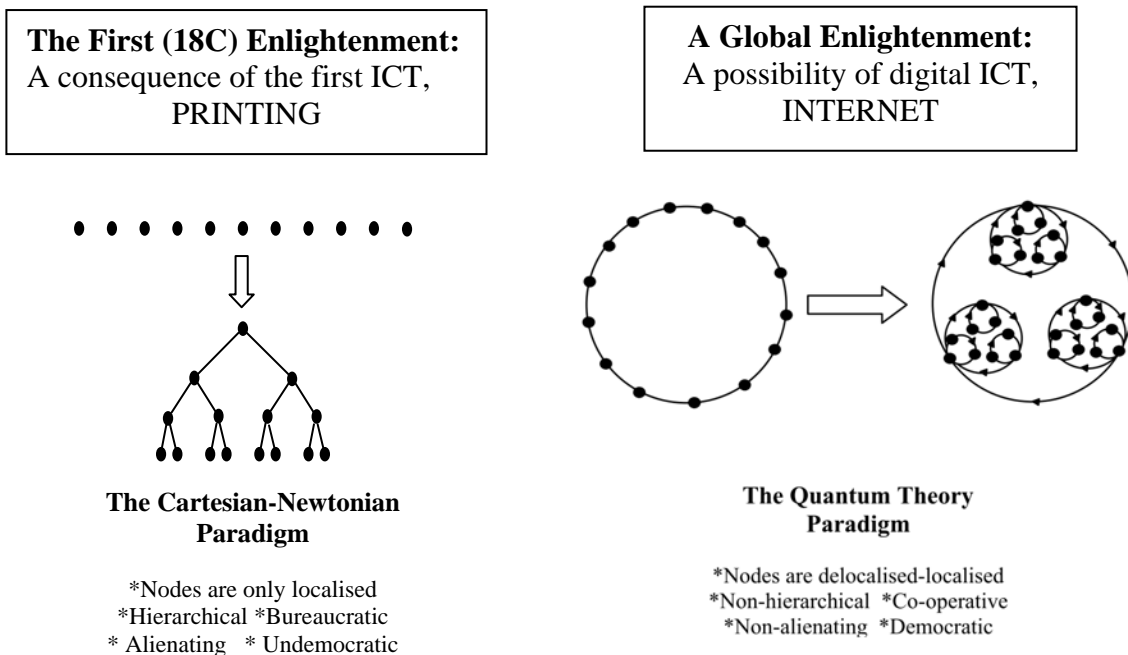
Each node can be considered to represent a labour and value-producing centre involved in the production of commodities. In the capitalist account of political economy the system of labour and the system of values produced by labour are sets of isolated ‘particles’. Those on the lowest tier of the hierarchy, that is, the shop-floor workers, are encouraged to see themselves as a set of individuals (particles) who exchange labour for wages. The fact that extra or surplus value is created by this labour and is channelled upwards to the owners of the capital should be of no concern to the shop floor. The shop floor workers exchange their wages for use-values created by other workers in other workplaces. But they are not encouraged to see this as

anything other than a set of binary transactions. The layers of nodes above the lowest tier are necessary to organise production so that these nodes also partly contribute to the overall value created. However, they also exist to ensure work-discipline and thus have a partly parasitic role essential for the capitalist mode of production.

On the other hand the diagram on the right, the quantum theory paradigm, represents the account of the global capitalist productive process given by Marxian political economy. In this picture we can see that the labour and value produced at each node is connected to all other nodes through the global market exchange system to create both a global (universal) labour and global (universal) value system. Labour carried out locally becomes de-localised; value created locally becomes de-localised through the global market system of capital.

There are several ways that the above diagrams can also be used to illustrate the revolutionary possibilities implicit in the new ICT technologies, created by the capital system to extend and intensify its global activity in pursuit of capital accumulation.

The Possibility of a Global Enlightenment



A significant factor in world politics today is the emergence of various forms of religious fundamentalism, sometimes in defence of pre-capitalist social structures as with Islamic and Hindu fundamentalism, and sometimes providing an ideological basis for a new imperialism as is the role of Christian fundamentalism in the USA. When several forms of fundamentalism clash directly as with Islamic and Judaic fundamentalism (actively supported by fundamentalist Christians) over the future of Palestine then a political solution becomes almost impossible. We must shake our heads in disbelief that such primitive, superstitious beliefs can still grip the masses, despite several centuries of the advance of a scientific understanding of the world.

Nevertheless, a 'learning revolution' based on the advances of the new ICT technologies can eventually lead to a '*Global Enlightenment*' based on a widespread dissemination amongst broad layers of the world population of the 'critical' thinking characteristic of the scientific view of the world. There is an analogy with the

invention of *printing*, the ICT for the inauguration of the modern era, which led, several centuries later, to the 18C European enlightenment amongst the intellectual and social elites who were the only ones who could read and write at the time. This enlightenment took place within the ideological structures of emerging capitalism, that is, within the Cartesian-Newtonian paradigm as illustrated above. The application of this form of hierarchical reasoning led to the creation of hierarchical structures of the state and capitalist corporations as described, and supported, by Weber. [18]

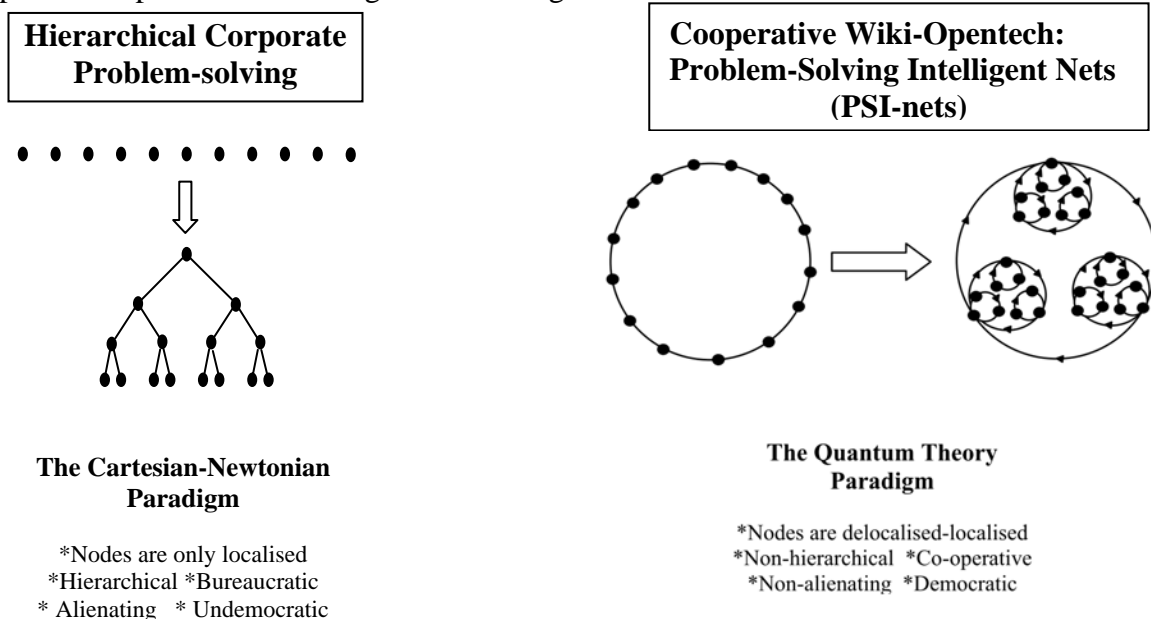
However, a *global enlightenment*, made possible through digital ICT, can be telescoped into decades not centuries and will *not* be confined to intellectual and social elites, but to the broad mass of humanity. During the second decade of the 21st century many villages and communities in the world could have access to a global learning network, mediated by mobile phone technology. They would then be able to download teaching material in their own language, and interact with on-line tutors also in their own language. They could also have available computer-interactive educational technology to enhance the learning process.

It is important also to change the way we see the interconnectedness of knowledge as a whole, and the way this knowledge can be used to solve problems. The advent of modern ICT means that we can model the interconnectedness of knowledge by a cyclic graph approach and thus a new paradigm is now possible, as illustrated by the right-hand diagram above

A Quantum Theory Paradigm for Problem-Solving for Sustainable Development

It is now possible to make explicit that which has been hitherto implicit, the unitary character of labour. It is possible for workers to understand the connection between their labour and that of others, to break through the alienated forms of consciousness. It is possible, now, not after a future seizure of state power, to set up a worldwide alliance of producers that can consciously connect their productive activities together, that can access a web of problem-solving scientific and technical expertise.

The new approach to problem-solving for the production of useful technologies for sustainable development can again be illustrated and contrasted with that of the capitalist corporate model using the same diagrams:



As we can see in the QT paradigm, the circle on the right is a topological folding of the circle on the left. The nodes can be considered as problem-solvers within a **Problem-Solving Intelligent network**, that is, a PSI-net or Ψ -net⁷. A ‘problem-solver’ node may be an individual, group of individuals, or else some intelligent software/hardware. In this case of the Ψ -net, they can be thought of as connected by an information channel with a given bandwidth. The original set is partitioned into sub-cycles (or subsets) and further into sub-sub-cycles (sub-subsets) and so on. In such structures information about the activity at each node, the collective activity of each subset (or sub-subsets etc) or the collective activity of the complete set of nodes can be accessed by each individual node. It just requires sufficient bandwidth. With modern technology this is in principle almost infinite (actually terabits/sec and increasing...). The important point is that relationship of each part can be *consciously* related to the whole. This helps to solve the problem of the *alienation* of the isolated problem-solver in the tree-like hierarchies of bureaucratised reason (Weber [18]), as illustrated by the left-hand CN-net. In the latter, the problem-solver usually does not understand how her sub-sub-problem relates to the main problem or the other problem solving activities. Only those in the top layer have an overview.

In the left-hand CN-net all the nodes are localised since they cannot usually communicate with the totality of nodes, only with immediate neighbours in a line of control. In the case of the QT paradigm all nodes can share information with each other and are thus delocalised in the sense that it does not matter which order the nodes are in the circle or sub-circles. During a problem solving operation it can be seen that there is a sense in which nodes become partially localised as one proceeds to the inner cycles as they participate in the solution of a sub-problem or sub-sub-problem, although they never lose their non-local character since they remain connected cyclically. Thus such networks exhibit the fundamental property of local and non-local behaviour characteristic of a quantum system.

Such ‘quantum’ Ψ -nets can dynamically reconfigure themselves in order to attempt parallel, alternative solutions to a problem, so that the final solution may contain elements of several attempted solutions. In this way the networks can be considered to demonstrate the quantum principle of ‘superposition of states’.

It is proposed that productive networks, networks of expertise, and trading networks can all be organised as Ψ -nets. The nodes may be individuals, not-for profit social enterprises, and even a small number of private companies that agree to the principles of the networks.

The alternative networks should concentrate on products suitable for sustainable development, especially so that communities in the developing world can be linked with communities in the developed world. Already people are developing such links through the fair-trading organisations. Communities in the developing world can have access to the same networks of expertise that are available in the so-called developed world. Clearly suitable products are those that increase the productivity of agriculture in a sustainable way, renewable energy products, health systems, and products for enhancing access to learning and scientific understanding.

⁷ ‘ Ψ ’ is also the usual symbol for the wave-function in quantum theory

CONCLUSION: Can ‘quantum’ Ψ -nets be a reality, or are they a fantasy?

Is this is just a dream or fantasy? Not at all- there is the obvious example of Wikipedia. But there is an even clearer example of an informal web of cooperation in which a worldwide internet-based collaboration of software experts gave their time freely to develop a product that is more complex than a Boeing 747 jumbo jet. The product is far superior to that produced by a rival private corporation. I refer to the Linux operating system for computers, which is acknowledged to be more reliable and better performing than its rival Microsoft Windows. Recently an American businessman, who owned a computer data-processing company, was asked by the author what he thought about the method in which Linux was produced. He said, “*It’s an example of pure, goddamned communism as far as I can see*”.

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