

## **Science-Based Global Enlightenment in the Quantum-Digital Age (or How to Prevent the Earth from Becoming a Dead Planet)**

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### **Prologue**

The appearance of the human being marks the beginning of the Age of Intellect, when the leading force of development becomes conscious human creativity and the highest level of organization is the culture of human society. Thus, science is the highest level of the hierarchy in the organization of cosmic matter. It is the highest growth point of a growing tree, the leading shoot in the evolution of the universe. This is the significance of the cosmic phenomenon of science as a part of the phenomenon of man (Turchin 1977: 241).

### **Abstract**

*The paper argues that if we are to survive as a species there has to be a new enlightenment, of a global nature that reaches the vast majority of humanity. This is in contrast to the Eighteenth century enlightenment which mainly affected a very small social layer, namely the literate middle and upper class elites. The 18C enlightenment was integrally associated with the emergence of the industrial bourgeoisie and their need to understand the forces of nature so as to release the energy contained in matter and so increase the productivity of labour, as well as to understand how to transform matter into more useful forms. This enlightenment was the long-term consequence of the first ICT of the bourgeois era, namely, printing.*

*The transition from the Descartes-Newton Age to the Quantum-Digital Age can be made possible by the creation of coupled cyclic networks of knowledge and expertise implemented with digital technologies on the Internet that is, modern ICT. These networks will have a local/non-local dialectical structure characteristic of quantum theory-hence the 'quantum-digital age' of the title. Digital systems can supply both the communications and the knowledge-processing, as well as educational instrumentation to make an understanding of the laws of nature accessible to broad layers of the global population and thus become a 'global discourse'. My Physics-is-Fun machine and Playful Learning Matrix is an example of such digital systems.*

*Evolution and Big History 2016 165-183*

*Quantum physics-based systems can also provide the solar technologies necessary to power the sustainable production systems of the new age. Einstein's use of the quantum Planck relationship,  $E=hf$ , to explain the photoelectric effect, rather than his  $E=mc^2$ , is the key to the energy systems of the Quantum-Digital age. Each village or community can have its solar energy plant to provide the power for water pumping, education, and medical facilities. By these means it will be possible to produce an environmentally and economically sustainable world.*

**Keywords:** *climate, solar, quantum, Cartesian, Newtonian, agroecology, capitalism, binary, digital, genetic, enlightenment, global, planet, science, education.*

## **Introduction**

This paper considers the climate crisis as the part of a global environmental crisis, that is, the poisoning of the water, air, and earth leading to massive loss of biodiversity as well as widespread ill-health. With the serious possibility of runaway global warming there is the chance that the earth may become a dead planet.

It also assumes that this death spiral for life on this planet will only be halted if the majority of people in the world demand that it be so. Only then will it be possible to confront the vested interests in the socio-economic system of capitalism that drive this process. The hyper-expansionist (HE), growth-for-growth's-sake economic processes must be replaced by a sane, humane, ecological (SHE) economic system (Robertson 1990). But if the present elites refuse to cooperate then the alternative socio-economic SHE system must be constructed in parallel such that the HE system starts to die. Another way of putting the choice with which we are confronted is to say that we must replace the 'death economy' with a 'life economy' (Perkins 2016). The enormous resources that are present devoted to the military-industrial complexes of many countries but chiefly the US imperialist hegemon, the large-scale subsidies for fossil fuels that cause climate instability, the promotion of agribusiness, and the development of genetically modified crops, can all be diverted to create a Life economy. The latter will mean the cancellation of nuclear weapons programs, the severe reduction of military systems, the development of renewable energy in all its forms, the promotion of sustainable agroecology to produce healthy food and to protect biodiversity.

Of course, this is not an easy task. There will need to be increase in awareness, on a global scale, of the imminent threats to the continued existence of life on this planet. But how does the majority of humankind become aware of the urgency of the environmental crisis? The vested corporate and banking interests have control of the mass media and, in large part, the education system. They can thus, at present, 'manufacture consent' (Chomsky and Herman 1994) for continuing the HE status quo. People have become trapped in a work-consumption cycle, persuaded that they must ever increase their consumption to

be truly happy. Therefore, they must constantly work longer and harder in order to obtain the means to do so. In fact, this process leads to the opposite: unbelievable stress, anxiety, and unhappiness. It will require a major increase in the scientific understanding of our relationship with the rest of nature by the majority of humankind in order to break from the unsustainable HE economic system and create a sustainable SHE future, that is, a new enlightenment.

### **The Meaning of the Title**

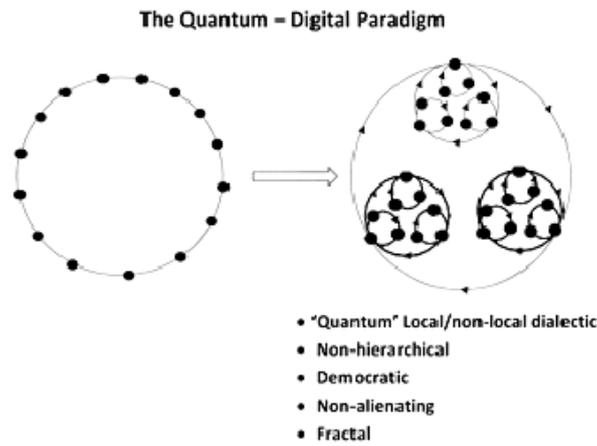
Now let us clarify the meaning of the words in the title:

1. **'Science-based'** means that it is important to distinguish a science-based enlightenment, with its 'critical thinking and testing' method, say, from religious or other mystical forms of so-called 'enlightenment'. We shall assume, after Popper (2004), only concepts and theories that can be tested and, in principle, be shown to be false, ought to be considered 'scientific'. We shall reject the positivist view that scientific theories can be verified or proved.

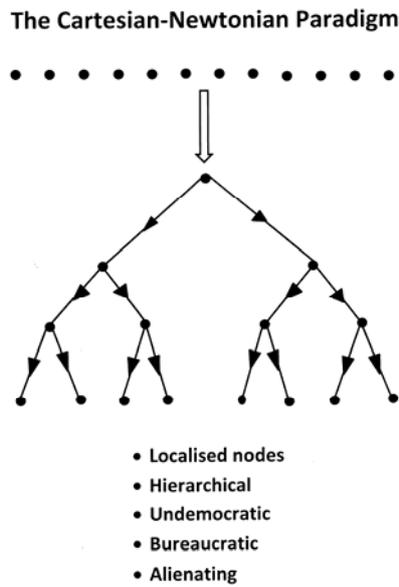
2. **'Global'** means that most of the world's people can become enlightened, in principle, in contrast to the earlier eighteenth century Enlightenment in Europe, which was largely confined to a narrow, privileged social layer.

3. **'Enlightenment'** means something very similar to that of the 18<sup>th</sup> century in that it asserts that the problems of the world can be understood and solved by scientific hypotheses, reasoning and gathering empirical evidence about the world, as opposed to, for instance, trusting in the received 'wisdom' of holy books or holy women or men.

4. **'Quantum'** has several meanings: Firstly, quantum physics provides an alternative paradigm (see Fig. 1), that is, a local/non-local dialectical paradigm to replace the Cartesian-Newtonian local, positivist, mechanistic paradigm (Fig. 2). It is also because the quantum physics of the solid state lies behind new binary Digital Systems (bDS) technology, that is, as we shall argue, the technology that can, in principle, help create a Global Enlightenment. Finally, it is also because quantum physics is the basis of solar photovoltaic energy technologies that will be increasingly needed to power the bDS technology and the energy for new sustainable alternative production processes.



**Fig. 1.** The Paradigm for a Global Enlightenment and Post-capitalism



**Fig. 2.** The Paradigm for the 18C Enlightenment, and a Capitalist or State-bureaucratic system

5. ‘Digital’ is for several reasons:

- *The Quantum binary **digital** system (Q-bDS) of the Universe.* According to leading physicists, the universe itself, including all of its matter and energy,

can be viewed as the holographic projection of binary digital information stored in the quantum fields at the boundary of the universe (Hooft 1993; Susskind 1995). The boundary can be divided in very small areas, each the size of the (Planck length)<sup>2</sup> [ $=Gh/c^3$ ] which is approximately  $10^{-70}$  m<sup>2</sup>. If a quantum field exists in one of these areas then this corresponds to a binary information bit=1. If such an area has a zero value for the quantum field then this has a binary information bit=0. This means the boundary of the universe contains  $10^{70}$  bits per m<sup>2</sup>. As it happens it is easy to show that the total information stored on the boundary is about  $10^{122}$  bits. This turns out to be the information content, calculated independently, of the particles and fields in the bulk of the universe.

To summarise: The universe can thus be viewed as a holographic Quantum binary Digital System (Q-bDS) information processor.

- *The molecular quaternary **digital** system for life (qDS)*. The evolution of the universe eventually produced a molecular digital system based on a 4-letter code, that is, a quaternary Digital System (qDS), for reproduction and operation of living systems, that is, the molecular genetic code of the DNA-RNA-Protein System. This is a 4-letter code for the twenty structural units (amino acids) with a word length of 3 letters (base triplets), that is, a (20, 4, 3) code, and can be shown to be the optimum code that would be selected by evolution (Davies 1995). The reason is that it is the one that gives the greatest rate of change of structure, and can, thus, most rapidly adapt to changes in the environment. It will thus outperform other codes. At first sight, living systems do not appear to be 'digital' but rather to be 'analogue' systems, that is, having, continuous variations in shape, size, colour, and so on. However, each cell contains many tens of thousands of digital-to-analogue converters (DACs) called 'ribosomes'. Thus, living systems carry out many millions of digital-to-analogue conversions (RNA-to-proteins) within each living cell, producing analogue variations in structure, function, and morphology of cells and organisms.

- *Binary **Digital** Systems (bDS)*. The qDS molecular technology of nature allowed life to evolve further until it produced its own information processor of sufficient power and complexity, the human brain, so that further cultural and socio-economic evolution of *Homo sapiens* could take place. This evolutionary process led to the human invention of an 'artificial' binary Digital Systems (bDS) technology, that is, modern information processing technology. The first binary digital electronic computer operating on Boolean functions was built in England during the Second World War, and was called 'Colossus'. It was used to decode high level messages between Hitler and his generals. Russian readers will be interested to know that one of its first tasks was to decode the Nazi military plan for the battle of Kursk, a decisive tank battle that led to the final Soviet defeat of German fascism. This information was passed to the Soviet military command by sympathisers within the UK intelligence and code-breaking services, although it was said to be against Winston Churchill's wishes.

The first binary digital computers were based on vacuum tubes but they evolved rapidly within a few decades, to become based on the micro- and, now, nano-engineered solid state devices, with billions of transistors per device, each a few 100s of  $\text{mm}^2$  in area. It is interesting to note that the transistors in these devices depend, for their operation, on the same quantum physics that emerged at the creation of the universe.

One of the first tasks of the Quantum-Digital Age (see Fig. 1) is to use the technologies of bDS and qDS to help solve the crisis of the socio-economic system and the environmental crisis that it has produced, and which threatens to create a dead planet.

### **Drivers for Science-Based Global Enlightenment**

1. ***The climate crisis.*** There is a real possibility that the earth will become a dead planet and thus, it will also mean the end of our planet's Big History and, alas, it is Big Historians (Trade Union Climate Summit 2015; Rees 2003; Lovelock 2006). To solve the climate crisis will require an increased awareness of the science of climate change amongst broad layers of the world population through a science-based Global Enlightenment. It will also help to combat the propaganda of the climate change deniers funded, as most of them are, by the fossil fuel corporations. It will also help people to realize that 80 % of fossil fuels must be left in the ground to keep the temperature increase below 2<sup>o</sup> Centigrade.

2. ***The broader environmental crisis.*** This crisis is due to the pollution of the air, sea, and land, and loss of biodiversity. The latter requires that we move from large-scale agribusiness, which destroys biodiversity and contributes to the poisoning of land, air and water, to agro-ecological farming methods already implemented by the small-scale farmers of the developing world. This process will be greatly enhanced by raising the level of scientific understanding of these communities and creating solar-based technologies to increase the productivity of their labour.

3. ***The present unstable socio-economic system of Capital.*** The disastrous instability of the present growth-for-growth's-sake socio-economic system of Capital is closely connected to the environmental crisis as shown with great clarity by Naomi Klein in her recent book (Klein 2014). In this system all the environmental costs of production are said to be 'externalised', that is, ignored. There can be no solution to the crisis unless the system is radically modified or probably replaced by a new system that enables an equilibrium to be established with the rest of nature. One name for the new socio-economic system could be 'The Cooperative Pluralist Commonwealth' (Alperovitz 2011) which will combine, socially, the innovative talents of all of humanity demonstrated even under the rule of Capital. But this creativity will be released from the restraints placed on it by the social relations of Capital such as class divisions,

hierarchies; division of labour, unequal distribution of wealth created by labour, lack of true democracy, *etc.* (see Fig. 2). It can be based on entirely new social principles of equality, mutuality, cooperation, and sharing. The active participation of everyone in the productive processes will require an increased awareness of the scientific principles behind these processes, as well as scientific understanding of how our production systems impact on the rest of the living world. This can be greatly enhanced by use of bDS both to create a self-organising system using the local/non-local quantum paradigm (see Fig. 1) and to monitor the effects on the environment, including other species of the production system.

**The Eighteenth Century Enlightenment.** The technology of printing was the first ICT of the age of Capital which, in several centuries after its invention, led to the Enlightenment of the Eighteenth century (18C).

As already mentioned, we need a new Enlightenment of the vast majority of people of the planet – which can be called a science-based Global Enlightenment (GE). The 18C Enlightenment was largely for a narrow social layer of the educated, literate elite although a small fraction of the emerging industrial proletariat was literate and interested in enlightenment ideas. For instance, in England state police spies reported, at the end of 18C, that ‘every metal-worker in Sheffield has a copy of Thomas Paine's “Rights of Man” on the shelf above his work-bench’. This Enlightenment was made possible by the invention of printing with moveable type by Gutenberg, several centuries earlier. One can consult the two-volume work by US historian Elizabeth Eisenstein, called ‘The Printing Press as an Agent of change’ (Eisenstein 1979) and Marshall McLuhan's ‘Gutenberg Galaxy’ (McLuhan 1962) for accounts of the impact of printing on society and culture.

The most important consequence of this printing ICT was the spread of scientific knowledge for the improvement of human welfare as advocated by Francis Bacon in *Novum Organum* (Bacon 1620) in the 17<sup>th</sup> century. Scientific knowledge was also necessary in order to develop an understanding of the natural processes that were being harnessed by emerging industrial capitalism in the 18C. The ideas of the 18C Enlightenment also led to the creation of bureaucratic structures of the emerging nation states, that is, ‘applied reason’ (Weber 1991: 196) with their top-down, rooted tree-like hierarchies again (see Fig. 2). Similar hierarchical structures were created in bureaucratic centralist socio-economy of the former Soviet Union, sometimes referred to mistakenly as ‘socialism’ or, more jokingly, as ‘actually existing socialism’.

### **Two Stages of Capitalist Development: From Mercantile to Industrial Capitalism**

The first stage of capital system, mercantilism, based on slave labour on plantations, the key technologies were in the field of communication, that is, printing and navigation, and new monetary information systems. Navigation, for exam-

ple, required Newton's mechanics and his theory of gravity to understand and predict the motion of planets. Newton was also in charge of the Royal Mint for producing coinage. The social origins of Newton's mechanics was given in a paper by Soviet physicist and philosopher of science, Boris Hessen (1931). The industrial phase was dominated by control technology, that is, the control of the release of energy from nature so as, in the first instance, to increase the productivity of labour. That meant first the use of water power and then, most importantly, steam power. This latter source of energy allowed factories to be built in any location and operated at any time of the day. The new steam power also helped to increase the speed of circulation of goods, for example, using railways and steam ships. The science of electromagnetic energy systems was developed in the 19<sup>th</sup> century after the advent of steam. Even to this day most electrical energy, except for renewable solar energies, is generated using steam or gas turbines. Electromagnetism had implications for both the distribution of energy for production and transport as well as communication (telegraph, telephone radio and television). It was also important for understanding the forces that held matter together and thus led to possibility of transforming matter into more useful forms, that is, the science of industrial chemistry.

### **The Social Structures in the Age of Industrial Capitalism**

The creation of hierarchical social structures of class societies to maximise the division of labour was based on the Cartesian-Newtonian world view or paradigm. Human thinking and consciousness are entirely separate from mechanistic social practice, that is, a dualist philosophy. Human beings in society can be treated as isolated 'particles' controlled within hierarchical bureaucratic structures necessary for capitalist state to control the overall social and economic system (see Fig. 2). It is also necessary to release the spirit of capitalism within individual entrepreneurs, and increase the efficiency of the economic system of Capital (Weber 1991). It also assumed that human consciousness was completely separate from the material world rather than arising from our social being in that world, as Marx realised.

Hidden within the inventions and systems of industrial capitalism were the seeds of its opposite. Marx saw the revolutionary significance of the creation of machines in his concept that knowledge can become a social force, as opposed to the Cartesian view, and create a 'General Intellect', which is to be found in the 'Fragment on Machines' in the Grundrisse:

*Nature builds no machines, no locomotives, railways, electric telegraphs, self-acting mules, etc. These are products of human industry: natural material transformed into organs of the human will over nature, or of human participation in nature. They are organs of the human brain, created by the human hand: the power of knowledge, objectified. The development of fixed capital indicates to what degree general social knowledge*

*has become a direct force of production, and to what degree, hence, the conditions of the process of social life itself have come under the control of the **General Intellect** and have been transformed in accordance with it* (Marx 1973: 706).

Marx, therefore, decisively breaks from Cartesian Dualism and considers knowledge to be the result of social practice rather than an aggregate of the consciousness and thinking of isolated individuals.

Thus, bDS technology, created by the capitalist economic system, can be thought of as the technology that can fully implement the General Intellect anticipated by Marx. One can consult Paul Mason's new book, 'Post-Capitalism: A Guide to Our Future', for further discussion of the General Intellect, which also discusses the importance of the Kondratieff cycle theory of economic development of capitalism (Mason 2015). This bDS technology is a synthesis of the technologies associated separate phases of the development of capitalism, that is, human and non-human communications and the control of the productive processes. Thus, bDS has had, and is having, revolutionary consequences both within the sphere of economic as well as cultural production. Whereas, as we have noted, it took several centuries for printing ICT to make possible the 18C Enlightenment, the bDS technology of modern ICT is so powerful that it can, in principle, create a Global Enlightenment of the majority in decades rather than centuries. It is also possible to implement a 'Quantum' paradigm using digital technology. This is illustrated by Fig. 1 showing a nested-cyclic graph digital information network, which has been borrowed from a representation of the connection between categories within Hegel's dialectical logic (Sinowiecki 1973). In such a graph information flows through every node. Such networks, implemented with digital systems technology, can dynamically re-configure themselves. These graphs can also be used to model a new system of production system, a problem-solving intelligent network (PSI-net or  $\Psi$ -net), or a network for collective social action.

### **The Role of Binary Digital Systems (bDS) in the Major Developments of Modern Science**

The binary Digital Systems technology, created by modern science, is also intimately involved in recent revolutionary developments within science itself, of which it is necessary only to consider the most important ones: 1) The decipherment of the molecular genetic code for life (qDS); 2) The understanding of the evolution of the universe, from the Big Bang to the present; 3) Particle physics.

1. **bDS and the genetic code.** It is important to understand the role of bDS in the discovery of qDS. In fact, the creation of the science of molecular biology has at every stage depended upon the availability of digital computers firstly

to calculate or predict diffraction patterns from protein and DNA crystals, then to handle and analyse the data from the various genetic studies culminating in the human genome project. The various spin-offs such as genomic medicine will continue to require the close relationship between the two. Many other branches of medicine also require bDS technologies such as X-ray and Magnetic Resonance Imaging (MRI). The medical systems of the future can be thought of as a part of a synthesis of qDS and bDS.

2. **bDS and Modern astronomy.** At all wavebands, modern astronomy is now inconceivable without bDS. Most if not all large telescopes and telescope arrays use digital imaging cameras and also are operated remotely by computers, which also analyse the data. So the present rapid development of our understanding of the history of the universe is closely linked to the emergence of bDS. Thus, Big History as a subject is itself dependent on bDS.

3. **bDS and Particle Physics.** The operation and analysis of the results from the Large Hadron Collider (LHC) at CERN (*Conseil Européen pour la Recherche Nucléaire*) is inconceivable without bDS. LHC generates about 6 petabytes ( $10^{15}$ ) of data every second which is logged. Some of this data is then rejected as of no importance, and the rest analysed by a global grid of computers. The discovery of the Higgs boson is latest triumph of the LHC, which completes the standard model of elementary particles. CERN itself was also the location for the invention of the World Wide Web.

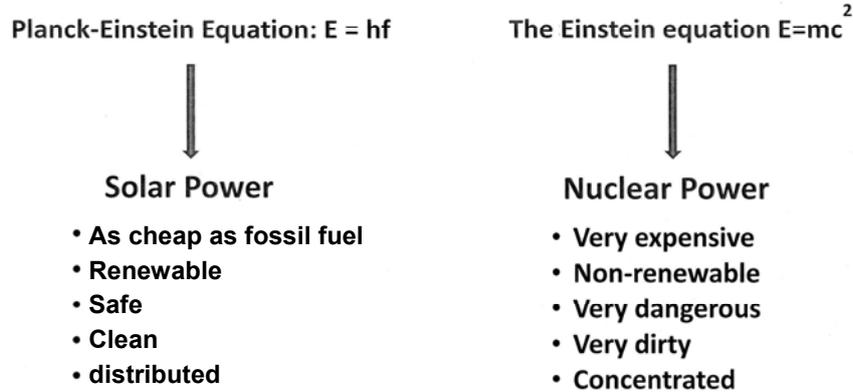
### **Solar Energy and Global Enlightenment**

As has been pointed out by my colleague, Keith Barnham, in his important recent book on the solar energy revolution, *The Burning Answer*, we have to choose between two equations for our energy future (Barnham 2014: 17). The first one is the Planck-Einstein equation,  $E = hf$ , used by Einstein to explain the photoelectric effect, and the second, Einstein's most famous equation,  $E = mc^2$ , that determines the energy released in nuclear processes. Barnham assumes that most fossil fuels will have to be left in the ground if we are to survive as a species and says that nuclear power is too expensive, dirty and dangerous with radioactive half-lives of 100,000s of years or greater (see Fig. 3). So we are left mostly with the various forms of solar energy, especially photo-voltaic (PV), as necessary to power the Global Enlightenment processes. Fortunately, it is an immediately available technology to the 1.5 billion people who are, at present, 'off-grid', and thus do not have access to electricity and would therefore not be able readily to become part of Global Enlightenment. The cost of installing solar PV has dropped by a factor of ten in recent years due to the mass production of solar cells in China. It is now about the same cost to install a kW of solar power as for a kW of fossil fuel power. There are also new types of solar PV cells such as those developed by Keith Barnham's group at Imperial College, London, in association with several other groups. These cells are of 42.5 %

efficiency that is about three times more efficient than the conventional silicon diode technology. These devices use 'quantum well' technology that is also present in the antenna of mobile phones.

**For Planet to survive 80 % of fossil energy must remain in the ground according to 'The Burning Answer'(Barnham 2015)**

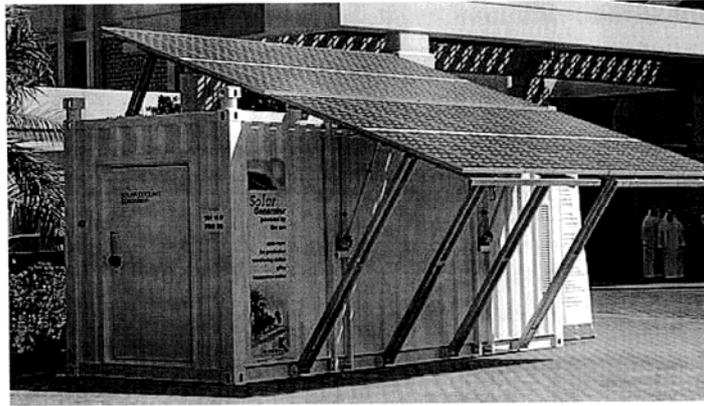
Therefore, we have a choice:



**Fig. 3.** Solar Power versus Nuclear Power

Solar PV is a very flexible energy source and can be converted in liquid or gaseous forms such as hydrogen. It has been shown to be a technology that can regenerate depressed urban and rural areas, for instance, in inner-city Cleveland (USA), Native American communities, and communities in Africa, India and elsewhere.

Most villages in developing countries could be rapidly electrified with this technology in a short space of time if sufficient resources are made available, for instance, those diverted from arms production. This solar energy could be used to create lighting, water pumping from depth for irrigation; education facilities linked to the Internet, medical facilities such as cool-rooms for storing medicines. One example of how this can be carried out is by using solar-powered shipping containers that have been developed in Germany (see Fig. 4). These solar-powered shipping containers can be used either as a medical cool-room for storing medicines and carrying out medical procedures. They can also be used to pump water from depth for drinking, cooking, and irrigation, and also act as schoolrooms linked to the Internet. They can also be used as an agro-ecology laboratory to help small farmers improve their farming techniques.



\*Water pumping for drinking and irrigation    \*Internet- linked Classroom

\* Medical cool-room and facility    \* Field laboratory for agro-ecology

**Fig. 4.** A solar-powered shipping container

Even without a coordinated global plan there is rapid growth in solar PV installation of 20–30 % per annum, albeit from a low base.

Thus, the formula for a stable planet is as follows:

Solar Energy+ binary Digital Systems = Global Enlightenment = a stable planet

### **Science as a Universal Discourse**

Science provides both the technology for creating Global Enlightenment but also its method of critical thinking that can help solve the environmental and socio-economic problems confronting our species.

Digitally-driven mass media has penetrated all aspects of social and cultural life. However, under present dominant socio-economic system this is often used to enable the commodification of all human activities and increase alienation, anxiety, fear and depression. There is, thus, an abuse of this revolutionary technology by the elites, to mislead and misinform the population as well as to manufacture political consent (Chomsky and Herman 1994). The present use of digital mass media through advertising to encourage excessive consumption rather than living within our means is also an abuse of the power of technology. As Benjamin Barber has argued convincingly this consumerism leads to a form of ‘infantilism’ amongst adults, the corruption of childhood, and the decline of democratic participation (Barber 2007). But it is possible to show, using scientific reasoning, that this excessive consumption is completely unsustainable.

For instance, one would need four or five planets if everyone on earth consumed as much per capita as the people in the USA.

However, bDS, the revolutionary product of science, can also provide the means to counteract the abuse of science. Science and its method is the only basis for a Universal or Global Discourse. Religious thinking has signally failed to create such a discourse, producing the very opposite, universal confusion and conflict. Art does have universal aspects such as symmetry and beauty and thus can enhance the Global Enlightenment process, but it is also influenced by local cultural biases. However, the bDS technology allows dynamical networks of social, economic, and cultural actors to be realised on a global basis reflecting the universal discourse of the science that created it.

### **How to Create a Global Enlightenment?**

It is easy to judge that there is a need for a Global Enlightenment but not so easy to map out a plan to bootstrap such a development.

One must surely start with present education system. But this system, at present, is largely in the hands of national and local state bureaucracies, which will be susceptible to pressure from vested interests in the present socio-economic system.

1. **The world university system.** This system already demonstrates a global network of knowledge sharing and collective knowledge creation. Many academics publish papers with colleagues from different countries so that, in many ways, the Higher Education system is a precursor of a Global Enlightenment.

2. **The secondary education system.** The university sectors in every country can also enable the secondary sector to develop global linkages, using the Higher Education network as a template for a schools network. Each University could have its own special department to promote its own Higher Education global links and its links with its local secondary schools. With the university support secondary schools can be helped to develop links with schools in other parts of the world. One approach is to include a module in every school syllabus that treats the environment as a global problem, especially the issue of climate change. This means that every child, from an early age, begins to see themselves as global eco-citizens. Using the Internet and the school twinning they can carry out joint science-environmental projects involving several schools on different continents. This will need, in some cases, the creation of special digital instrumentation to take measurements and provide it, in suitable form, for computer analysis and internet transmission.

3. **Primary school system.** Secondary schools can link with primary schools and help them form links with other primary schools across the world so even at very early age children will be encouraged to think of themselves as participating in global friendship and be part of a global community.

In both Secondary and Primary schools each school can have cross-curricular core theme about our common environment and its problems. This theme will especially encourage students to see themselves as part of a same species rather than just members of a special national, ethnic, or cultural sub-groups. It can also help introduce the idea of the inter-connectedness of all human knowledge, and thus an underlying principle of Big History. They can be introduced early on to the idea that science is a universal language or discourse which will also help them see themselves a part of a single species. There will, of course, be opposition to this approach due to the role of education, traditionally, in inculcating the acceptance of the status quo, loyalty to local, national, and ethnic identities.

4. *Special bDS educational technology.* It is possible to create computer-linked **digital** instrumentation for teaching science that can overcome the problems of understanding that are largely of a social-cultural origin. An example would be my Physics-is-Fun Workstation (PFW) (see Fig. 5). Physics is the basis of the natural sciences but it is also often one that presents difficulties for many children, creating a barrier for progress to higher education in other applied sciences from medicine to engineering. Thus, it may be a step in the creation of a global learning network as part of the development of Global Enlightenment to create a computer-interactive workstation for learning physics in a fun way, and that can also be mass-produced. The PFW is designed to be connected to a microcomputer so that students can study the motion of vehicles on an air-track using an easily understood method for measuring the position and velocity of the vehicles at closely-spaced space intervals. A light beam from a slit source of light falls on a photocell and is interrupted periodically by an optical grating attached to the moving vehicles, so that a sharp, square voltage pulse is given for a movement of a repeat spacing of the grating. The time between the pulses is measured to microsecond accuracy by digital circuitry which allows the average velocity of the vehicle over the repeat-spacing to be measured. Counting the data pulses measures the relative position of the vehicle(s) and summing the successive time intervals measures the total time elapsed. These measurements enable position-time and velocity-time graphs to be displayed on the computer screen. By fitting a smooth curve (cubic B-spline) to velocity-time graphs it is possible to obtain the acceleration-time profile of the vehicles and thus measure various forces, such as electromagnetic and elastic forces. It is also designed so that students can create their own projects and test their understanding. They can also collaborate with students in other countries, sharing data and comparing results (Hookes 1997).

Such digital educational technology can provide a means of breaking through the barriers to understanding of scientific ideas and concepts. It makes it possible for a student to almost *immediately* see the connection between their 'sensuous practice' of doing experiments, and the representation of the results in graphical and, then, algebraic forms.

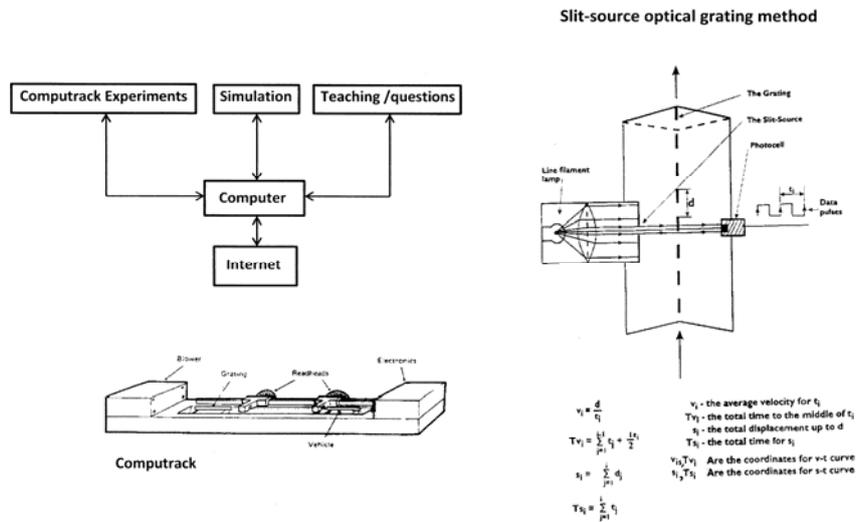


Fig. 5. The Physics-is-Fun Workstation (PFW)

## How to Fund the Solar Energy for Science-Based Global Enlightenment?

There are several possibilities:

1. *Use the funds created under Copenhagen Climate Change Accord.* These funds were promised under the Copenhagen Accord for developing countries to mitigate or adapt to the effects of climate change – they are supposed to reach US\$ 100 billion per annum by 2020. Installing solar technology in every village is a major step in helping countries to develop in a sustainable manner. It would also help in making scientific understanding accessible to all people.

2. *Create a Global Enlightenment Trust – GET.* The software and hardware created for implementing Global Enlightenment can be assigned to GET under a ‘creative commons’ license. It can be considered Open-Source or Open-Tech as illustrated by the creation of the LINUX operating system. The funds can also generate from IPR lodged with GET by inventors who support its aims, namely, to save the planet from a heat death. For instance, the IPR for the PFW would be held by this trust. Another example is the Japanese scientist/engineer who invented the blue LED, a major breakthrough in creating white-light LEDs, which are many more times efficient than filament bulbs, donated some of the money he eventually obtained from his invention to help create an organization called ‘Engineers-without-Borders’.

3. *Individual donations.* If the GET is successful in promoting Global Enlightenment, that is, it takes off, it is not difficult to imagine that it would even-

tually attract, say, 10 million supporters amongst the so-called 'Golden Billion' of the world's population, that is, 1 % of those with disposable income. An important section would be the knowledge workers, about 40 % of workers in advanced economies, who can most readily appreciate the dangers of global warming. They would, thus, understand the need to avoid the tipping point for runaway warming, which could lead to a dead planet. If each of the 10 million gave a donation of US\$ 10 per month then there would be a monthly income of US\$ 100,000 000 or US\$ 1.2 billion annually. This would be sufficient to electrify 20,000 villages a year through solar PV to provide pumping for clean water, lighting for night time study, medical cool rooms, and access to the Internet for science education using, for example, the solar-powered shipping containers mentioned above.

### **Conclusion**

In order to create a science-based Global Enlightenment we will require a major cooperative action on a global scale, especially among scientists and engineers. This is not at all an impossible vision, giving the nature of the threat to life's continued existence on this planet.

As Rifkin has pointed out (Rifkin 2009), human beings have an intrinsic feeling of empathy for others. Such a view is opposed by those who represent the views of the 1 % who benefit from the HE economic system. As they would have it, humanity is composed of aggressive, greedy, competitive individuals who have no concern for others apart from than themselves and their immediate family. This view is very rarely challenged in the main stream media (MSM), and often revealed in comments about the intrinsic wickedness of 'human nature' promoted by some religions. But if it were the case then war would be popular, which it is most certainly not. Most people prefer to cooperate with each other and help each other. The greedy, aggressive, competitive individual is distinctly unpopular in the workplace or any other social context.

### **Cooperation as a key principle in the evolution of the Universe**

It can be shown that 'cooperation' rather than 'competition' is a leading or a key principle in the universe, from its earliest beginnings when two UP quarks cooperated with a DOWN quark to form a stable proton, to the cooperative processes that led to evolution, and later the development of language for social cooperation that enabled our species to emerge from the hominin genus (Hookes 2014). The role of various information technologies can help explain the increasing tendency of our species to form larger and larger cooperating social groups. It can be argued we are, at present, stuck in an evolutionary halfway house between the pursuit of individual goals that is 'individualism' within subgroups of our species which is preventing us from reaching a higher

level of species-wide cooperation. This transition requires, as in similar earlier transitions within biological and social evolution, the emergence of new information technology to enable or stabilise the transition to a higher level of cooperation. That information technology has now arrived in the form of binary digital systems technology, and the transitional form in which it can operate can be identified as the Global Enlightenment.

Modern science shows us that we are one species. The spread of science and the scientific method of critical thinking and testing will help us to realise this understanding in practice. It will also show us how to resolve the critical problems of the environment and the socio-economic system of Capital that has created these problems.

I wish to conclude with advice from one of the greatest scientists of all time, and with the words of a popular song from my home town of Liverpool. Each captures the essence of what I have been trying to say:

*A human being is part of the whole called by us the Universe, a part limited in space and time. She (or he) experiences herself, her thoughts and feelings, as something separated from the rest, a kind of optical delusion of her consciousness. This delusion is like a prison for us, restricting us to our personal desires, and to affection for a few persons nearest to us. Our task must be to free ourselves from this prison by widening our circle of compassion to embrace all living creatures and the whole of nature and its beauty (Albert Einstein).*

Perhaps, we can also agree with the words of a popular song from my Liverpool school contemporary:

### **Imagine**

By John Lennon

Imagine there's no heaven	Imagine no possessions
It's easy if you try	I wonder if you can
No hell below us	No need for greed or hunger
Above us only sky	
Imagine all the people living for today	A brotherhood of man
	Imagine all the people sharing all
	the world, you
Imagine there's no countries	You may say I'm a dreamer
It isn't hard to do	But I'm not the only one
Nothing to kill or die for	I hope someday you'll join us
and no religion too	And the world will be as one
Imagine all the people living life in	
peace, you	

You may say I'm a dreamer  
 But I'm not the only one  
 I hope someday you'll join us  
 And the world will be as one

**Another, Globally Enlightened World is Possible!**

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