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Water Worlds

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WATER WORLDS

The surface that keeps your feet on the ground is a universally understood phenomenon, albeit one that has many different characteristics depending upon circumstances (it may be concrete, marble, shag-pile, sand, rock, soil, wood, etc.). Water is also what might be thought of as 'universal,' but in this case the name describes a substance; in essence it is a relatively simple chemical compound. This substance, unlike practically any other, is entirely familiar to everyone on the planet. Some have too much whilst others have an unfamiliarity that results in expiration. In this sense water is a universal currency. In fact it is universal in the true sense of the word, being spread throughout the Solar System and (way) beyond. In this essay[1] I propose that the relationship we have with water provides an obvious starting point for a process of education whereby inhabitants of the world confront issues of planetary-scale ecological and environmental balance. For most, the plasticity of brain and mind is probably now too sluggish to allow this to happen. I believe instead that the process necessarily has to start with those members of society that are blessed with the blankest of slates, namely youngsters. The hope is that, when they reach adulthood and assume the reins of power, they have an innate understanding of how Mother Nature operates and fully comprehend that this is decoupled from those other humanocentric notions of religion, politics, culture, economics, etc. The power and reach of the Internet is surely key. But I argue that the use of asynchronous, social media tools is not enough. And neither is a worldwide web piled high with relevant (or irrelevant) facts. I suggest that the educational experience itself needs to be globally connected in such a way that involves real-time effort and event-driven activities. But most importantly, it needs to involve a shared understanding of other peoples' environments and aspirations.

Water, Water Everywhere (and Nowhere)

349b2fec-0f7e-bd5f-5bcc-7090d27ae0fb – this is the so-called UUID[2] of water. You can have as much of this water as you want. And if in some way you feel you are about to run out, it is relatively easy to get more. But this is only virtual water,[3] of which more later.

So, what is non-virtual (= real) water? To a chemist using the systematic naming convention of the International Union of Pure and Applied Chemistry (IUPAC) it is oxidane, a compound covered by Materials Safety Data Sheets (it is a chemical, after all) and assigned so-called CAS numbers like 7732-18-5 and 7789-20-0.[4] To a technologist investigating how to power the next generation of motorised vehicles, water is a fuel capable of performing the same function as petrol does in the internal combustion engine.[5] To a gardener, water is what you must add to recently potted seeds in order to effect germination. And members of the public services routinely use water in the war against fire.

Notwithstanding an individual's profession, anyone is likely to reach for a bottle of Evian[6] after a long hard game of squash. That primeval relationship with water as a substance that quenches thirst and sustains life is a phenomenon that is understood by members of the human race (of almost all ages) wherever they are to be found on the planet. So, water provides us with an example of a chemical compound that is universally recognised and understood. As such it

seems like an ideal material to use in the quest to educate on a global scale; and, in particular, as a vehicle for teaching about science, nature and environment.

We know that we have water on Earth.[7] Conventional wisdom states that 'about 1,460 teratonnes of water covers 71% of the Earth's surface, mostly in oceans and other large water bodies, with 1.6% of water below ground in aquifers and 0.001% in the air as vapor, clouds and precipitation.'[8] To put 1,460 teratonnes into perspective it is worth noting that the global mass of the 'water of humanity' amounts to 0.0003 teratonnes.[9] And when we come to thinking about water beyond Earth, it looks like it is everywhere. We know that there were times in the past when water flowed on Mars (Carr, 1995). Indeed, there is definitely water there now, in the form of ice, and probably even as the liquid.[10] A number of the satellites of the outer planets are rich in (water) ice[11] and bodies like Uranus, Neptune and Pluto are composed mainly of ice.[12] Add to that the influence of the 100 billion comets that are present in the Solar System (all of which are examples of dirty snowballs)[13] and water really does appear to be everywhere you look.

Surely the Moon is a dry barren place?[14] 'A significant amount of frozen water has been found on the moon, the United States Space Agency said on Friday [13 November, 2009] heralding a giant leap forward in space exploration and boosting hopes of a permanent lunar base. "Preliminary data from a dramatic experiment on the Moon indicates the mission successfully uncovered water in a permanently shadowed lunar crater," NASA said in a statement. "Yes indeed we found water and we did not find only a little bit but a significant amount," said Anthony Colaprete, project scientist and Principal Investigator for the 79-million-dollar LCROSS mission. The data was [sic] found after NASA sent two spacecraft crashing into the lunar surface last month to probe Earth's nearest neighbor for water. "In the 20-30-meter (66- to 100-foot) crater we found maybe about a dozen, at least, two-gallon buckets of water. This is an initial result," Colaprete told reporters.'[15]

Of course there are places nearby that probably do not contain much water. It is hard to see how water could exist on Mercury.[16] And although water obviously used to be present on Venus, it has now largely all gone[17] (or rather, it is now somewhere else; the laws of physics do not allow water to disappear). There is no water in the Sun, although if its constituent elements somehow became condensed and all of the available oxygen was converted to water, it would amount to 1,000,000,000,000 teratonnes.

So, the cosmos appears to be a place comprised of niches devoid of water[18] and those that are awash with it.[19] As far as we are concerned, an alien looking at the surface of the Earth would see a planet covered with water.[20] So can we harness the familiarity of water to educate 'ourselves,' the world's population of human beings, towards a greater awareness of the relationship between us (selfishly seen as being important) and everything else?[21]

Planet Earth is heading for global catastrophe.
We know this because our governments tell us.

I am not going to take issue with this assertion, even though there are many unresolved problems (and a kind of modern day McCarthyism has driven academic dissent underground).[22] Rather, let us proceed with the notion that 'we' (Homo sapiens, or Homo sapiens sapiens depending on your preference)[23] are currently in our final century.[24]

It is clear from recent political efforts that the generation of people who are vainly trying to engender a sense of global ecological responsibility are really struggling to make any impact.

In some ways it is rather amusing that the global climate change circus has contributed more greenhouse gases to the environment than would have been the case had everyone stayed home and done nothing.

This is ultimately not an essay about 'global warming.' But, nonetheless, here are a few pertinent facts about the place where we live. The climate on Earth has been changing since the planet formed about four and a half billion years ago. There are times when it has been warmer than it is now, and times when it was cooler. And accompanying these swings were changes in the weather patterns; rainy, dry, windy, etc. Sometimes the Earth was baked and parched; other times it was almost globally covered with ice (and, in consequence, a tad on the cold side). Something we know for absolute sure is that the climate will continue to change (no amount of political rhetoric, taxation or control will prevent that). The Earth wobbles (in very predictable ways) on its axis; it has been happening forever and will continue to happen (and is one of the factors that influences climate change). Furthermore, climate change is one of the driving forces behind evolution; we are here because of climate change. And future changes in the climate might ultimately be one of the reasons why Homo sapiens evolves into something else. One thing is fairly certain; no matter what happens, the Earth will remain as an object orbiting the Sun (and more likely than not it will retain a rich flora and fauna).

Before we leave our potted view of the world in sixty seconds it is worth adding the following couple of points for completeness. Firstly, when the Earth first formed it was not a nice place to be. It is widely believed that life actually got started on Earth a number of times; each time it subsequently got wiped out as the Earth was subjected to the planet-wide sterilisations that accompanied the sort of gigantic impacts that were prevalent during the early history of the Solar System. However, we are here and we know that we are here. In other words life did eventually take hold on Earth. The life we see now has direct descendants with a primitive biology that arose at some point following the last of the really destructive impacts. Life (on Earth) has a long history, is incredibly resilient and, it is reasonable to assume, will remain. Or rather, it will remain for as long as the planet stays hospitable. The onset of chaos in the orbital dynamics of the planet may eventually make the survival of life impossible; failing that, the Sun only has another five (or so) billion years to go before it enters a phase of slow stellar death. The outer layers of the Sun will extend to envelope the Earth, which will sort of dissolve into its constituent elements. Ashes to ashes, dust to dust…

Let us just take a moment to pause and contemplate the timescales we have just talked about; 4,500,000,000 years to get where we are now, and 5,000,000,000 years to go. And we are sort of panicking about what will happen within the next 50 years. Of course what we are really worried about is what will happen to *humans*; there is nothing intrinsically wrong about climatic conditions on Earth changing to such an extent that a particular species becomes extinct. This is Darwinism in action.

The issue of planetary stewardship requires a well-developed culture of understanding and respecting nature. We might call this having a 'scientific literacy.' So, what we need ultimately is a cadre of politicians, or other persons in positions of power, control or responsibility, who understand science. They do not have to be scientists. But they do have to appreciate the rudiments of the subject enough to understand the workings of the platform that they sit on. During the recent financial crisis of 2007–8 it came to light that investment bankers were either known as, or otherwise thought of themselves as, 'masters of the universe.'[25] The 'mistresses of nature' would beg to differ. Hubris and vanity on a laughable scale.

Water, a Universal Currency

It is hard to conceive of a single substance that is more universally understood than 'water.' Food in its broadest sense does not fit the bill; furthermore, in trying to constrain the nature of food to a narrower definition it is clear that 'food' means different things to different people. Some are omnivores, some do not like peas, some are vegetarians, some are vegans, and so on. In societies where food is plentiful, choice is more prevalent. As such, what constitutes food is likely to be a matter of personal preference. And in societies where food is scarce people eat whatever they can get hold of (which includes other humans).

Air is another 'universal,' but whilst the substance is vital for our continued existence it is difficult to appreciate its presence (although not its absence; but, of course, in normal circumstances this does not happen). If air can be seen it is because it is laden with pollutants, dust or smoke, etc. And if air can be sensed because of its smell then clearly it is impure; besides, it is the smell that is perceived and not the air.

There are other universals such as sand, 'dirt,' vegetation, and so on. But in detail (like air) these are actually quite complex things. In comparison, water is incredibly simple. In its pure state it is a molecule made of two hydrogen atoms and one of oxygen, H_2O. In fact, in western culture at least, we sometimes refer to water as 'aitch-two-oh.' There cannot be many other molecules for which people know the chemical formula. Carbon dioxide, or CO_2, is perhaps a good contender, most especially because of the way it has been demonised in the global climate change debate. But, by and large, few have ever knowingly seen any CO_2. As such, whilst it is a compound that people might have some familiarity with (after all, it produces the hiss when a ring-pull releases the pressure from a can of cola) it is not a universal in the same sense as H-2-O.

A Strategy for the Human Race

Humans originally populated the globe according to necessity, accessibility and environmental suitability. They have subsequently expanded their natural habitat to include the tops of mountains, polar regions, the deep ocean, the atmosphere, space, etc. But no matter how sophisticated they become, their basic physiology requires sustenance in the form of water. Thus, they can still only survive in places where water is available. This involves access either to large, seemingly boundless, natural resources, or careful water management, which, in extremis, involves closed system water/waste re-cycling. Future space missions that aim to extend the reach of humans beyond Earth will have to pay strict attention to the overall water budgets of the adventures. In this regard it would be useful to have identified targets of opportunity in/on which there are appropriate reservoirs of water. Hence the recent (2010) interest in water on the Moon. As space travellers roam the cosmos they will have to plan their journeys to take in the various cosmic oases that exist. Unless, of course, humans decide to try and make the relevant journeys in some alternative way (e.g. a genetic blueprint, a construction machine and a stack of memories stored in some sort of compressed way). At one level this suddenly feels like we have gone off at a tangent into the realm of science fiction, but at another it is entirely relevant and is probably closer than most of us think. Indeed, there are individuals alive today who are taking steps to prolong their current analogue life v1.0 because they believe a fusion of biology, technology and computing is nigh.[26] Maybe they are deluded and it is actually 200 years away, but it is still a blink of an eye in terms of cosmic time.[27] The reason that the possibility of space travel is important is because it forces us to confront our destiny. What does it mean for us to

be part of what is demonstrably a technological civilisation? It cannot possibly mean more and more of the same. If we reduce the issue to management speak: what is the strategic plan for the human race? It certainly does not appear to have an obvious collective vision. Of course many would argue, something along the lines of, we are here to do God's work.[28] Although this would be open to interpretation, it is at least conceivable that said force requires us to spread the word throughout the cosmos.

Some people have too much water whilst others do not have enough. Some people want a different coloured mobile phone.

So, how does all this speculation about space travel relate to water? It does thus: if we decide 'to boldly go,' either as Homo sapiens or Homo silicus, water is likely to be essential. Water the life giver, or water the combustion product of hydrogen.

Of course, there are other visions of the future. Although it is hard for us to believe, or accept, it is likely that the existence of humans will end up being represented by a thin layer of sediment in the geological record of an insignificant planet in an otherwise unexceptional solar system out in the spiral arm of a fairly ordinary galaxy. Indeed, it may be so insignificant as to be missed by future generations of explorers from other parts of the Galaxy. What is the best we can hope for? All of those lovely monumental buildings will be gone, all that angst over carbon footprints will have evaporated into the ether, and the riches of kings smeared out to practically nothing. Our illustrious career will probably be represented by a thin layer of rock rich in trace metals and radioactive elements. If they manage to observe it, the cosmic geologists of the future may be perplexed; they may attribute the layer to some sort of unexplained natural catastrophe.[29]

From today's perspective, the only thing that seems certain is that our future will not be more of the same.

So, how is a discourse of space travel of relevance to present-day children in Africa dying of disease, illness, malnutrition, or because of a lack of access to clean drinking water or appropriate sanitation? Obviously there are no simple answers. In some ways it returns us to the lack of a strategic plan.

So, how is a discourse of space travel of relevance to present-day children in Bangladesh dying of disease, illness, malnutrition, or through the horror of being swept away by flooding? Obviously there are no simple answers. In some ways it returns us to the lack of a strategic plan.

Meanwhile, in a shopping mall somewhere in the land of excess, a petulant teenager demands a new mobile phone[30] because the one they already have is the wrong colour.

Education, Education, Education[31]

My thesis is extremely simple. Education. But, not education in any traditional pedagogic sense; rather, a bottom-up form of education that harnesses the power of some of the world's most creative people – children.[32, 33]

And the education I have in mind is one that is less about rote learning of facts and figures but more about a process of shared understanding of the world's local issues. In this way the Kings and Queens of England, for instance, might be considered important provided that a group of

educators/learners think they are, and an appropriate case is made and accepted. Likewise, the colour of a mobile phone.[34] But, a far more appropriate starting point is provided by the subject of water, a substance, as argued previously, that is known to everyone on the planet.

So, rather than trying to unite people through, say, a common religion (with a set of beliefs, principles, practices, etc.), the objective would be to unite people through a consolidation of perspectives on a common phenomenon. Water poured from a receptacle falls to the ground. Indeed, this happens wherever you are on Earth.[35] Furthermore, if you reduce the temperature, water freezes and forms ice. And this happens at 0°C, or does it? It actually depends on its purity.[36] Heat water up and it eventually boils; but this does not necessarily happen at 100°C. It depends on altitude, for instance.[37] Drinking water has a pH value of about 7, and so on.[38]

But these are very sciencey facts. And suggesting a worldwide campaign of teaching about science is hardly novel in an educational sense. One could argue that all of this information is 'out there,' all that is required is a computer or mobile device of some sort, a connection to the Internet, and the URL for Wikipedia.[39] The problem is: in the affluent west, science is considered a bit boring by many youngsters, and in places where they have to think about where the next drink of water is coming from, the subtleties of the hydrogen bond[40] hardly seem important.

The kind of education that is required for a successful, global, technological civilisation is one that considers the world as a holistic whole. In other words, an education that produces citizens who understand their own local actions in a global context.[41] And the way to achieve this is to plan for the future. To some extent this means giving up on those adults of the world who find themselves where they are because of the actions of previous generations, and concentrating instead on a future generation of adults. The key thing is to instil a sense of common purpose amongst the populations of the world. But this should come from an interaction between young people rather than from top down preaching. We see today the effects of adults scaring their children to death with stories of upcoming global catastrophe.[42] Well-meaning, but the wrong approach. The goal is necessarily long-, not short-, term. Provide the educational medium for youngsters now, reap the benefits in 50 years' time when they are fully in charge. The benefits, of course, are for Homo sapiens as a whole, not necessarily for individual classes of people alive now.

Pause for Breath

Naïve, irresponsible, summer of love; all of the above. Admittedly a plan for worldwide education of children all sounds a little bit like a hippie ideal. And may be challenged as otherwise being open to the most heinous of manipulation, resulting in indoctrination of the worst kind.[43] But, in any case, why now?

The now question is easy to answer in the sense that one could have had the vision 50 years ago, but there was at the time no effective way to deliver it. Now there is. The fascinating thing about the Internet is that in a very short space of time people have come to see access to it as a fundamental human right.[44] A connection to the Internet is becoming (or indeed, has become) something that is as important to our survival as is access to clean drinking water. We could be very frightened by that, or we could celebrate our collective ingenuity. But it is not just about being 'connected to the Internet.' It is, of course, how the connection and its associated technologies are used. Whilst most of us feel no need to understand the intricacies

of how information actually flows into and out of our computers/devices,[45] we can nonetheless all appreciate the creativity of how it is used (or, of course, the destructivity).

Facebook, Twitter, Flickr, LinkedIn, Last.fm… [46]

With the rise of social networking tools available through on-line means there exists the possibility of establishing a globally connected community of practice. Is this enough? Of course not. Otherwise a fully working understanding of glocalization would have already happened. Could it be made to work? It seems unlikely that on their own, vehicles like Facebook,[47] Twitter, [48] Bebo,[49] etc. could succeed because they do not provide enough depth to the conversation that needs to take place. At another extreme, blogging, with its capacity for unlimited depth and analysis, can be, frankly, a bit boring (one assumes it provides great therapy for the writers, but there is often not a great deal of interest for the readers).[50] I contend that what is required is for the community at large to experience the lives of others. In an ideal world of zero emissions and teleportation this would simply involve the practice of being physically present at many different parts of the globe. This would allow people to experience at first hand what it is like to look out over a searing hot and parched landscape, where livestock expire through lack of available water, or to be in a place where it is necessary to re-locate livestock to higher ground because of imminent flooding. Clearly it requires the invocation of science fiction to achieve this now. But, by using the power of our connected information pipelines it is possible to act vicariously and within the accepted laws of nature. So, although we cannot attain the objectives of the ideal world we can perhaps conceive of ways to beat the system.

Life, but not as we know it

Millions of people worldwide regularly pay money to Blizzard Entertainment to allow them the opportunity of having a parallel virtual life in Azeroth. Millions more fork out to be a citizen of Norrath or a colonist of Planet Calypso. These are computer games,[51] but not really games in the classical sense of the word. There are often no real objectives (other than survival, which is an idea stolen from real life). The whole point is to eke out an existence, gain experience, make friends, and occasionally kill a few baddies. There are hundreds of on-line virtual worlds[52] offering the chance for people to be someone other than the person they really are. Some of them are not even 'computer games;' the virtual world Second Life is a good example of a successful phenomenon whereby people ('residents') merely go somewhere to while away their time. In fact this is a gross simplification; Second Life is an extremely complex world in which some people work, some people play, and where services are bought and sold. It has an in-world currency that is exchangeable for real-world money (and vice versa) and there is the chance for fame and fortune (both in-world and out of it). Second Life, which is, of course, a purely commercial venture, currently faces many challenges. Although it has a pedigree stretching back to 2003, its developers have had to struggle to keep its customers happy alongside the rise of the likes of Facebook (launched, effectively, in late 2006) and Twitter (mid 2006). The phenomenal success of Facebook, with its ethos of using a browser-based interface (easily accessible via mobile devices) to convey the thoughts of its users, who post frequent (short) messages that are shared amongst their friends, has made a dent in the ambitions of those who thought that the global medium of choice for social networking would be virtual worlds. But, Facebook is an adjunct to real life. In contrast, virtual living is a quite different affair, involving a far greater commitment to an activity that, for some, can become an extremely important part of their existence; the best way to exemplify the difference is to note that some Facebook subscribers are, in fact, virtual personae.[53]

So, what is it about a rendered pseudo-3D image on a computer screen that has the power to keep people coming back for more, and to keep them investing many hours of their time as a pixelated avatar[54] existing in a world full of textured shapes constructed originally by someone pushing vertices about?[55] There are many academic studies that describe the psychological and social aspects of virtual worlds. Likewise, the relationship between an avatar and its owner is one that is more than just flesh/blood and electrons. At heart there is a social dimension. This is what distinguishes traditional 'console games'[56] with the relative anarchy of the virtual world. The former have intense story lines (analogous to the narrative of a book, or the screenplay of a film, i.e. something that is essentially the same each time you read it or watch it). The latter represent an immersive experience with all the unpredictability of real life. And although there are mash-ups between the two, each aspect remains as it is. As computer power improves (or rather, as the power becomes more affordable) the possibilities for *anyone*[57] to have a virtual life will become a reality. Having a successful and satisfying virtual life requires hard work. Hard, in the sense that it takes up time on a regular and routine basis.

The opportunities offered by a virtual world are manifold. It may be possible to assume the role of a super-human character living exclusively within a fantasy world. Or a ferret,[58] living on the equivalent of a virtual housing estate.[59] Some form of escapism is an essential ingredient. But, you can also be yourself.[60] You can also be at work[61] (in a place that looks like work), or somewhere that has blue skies, palm trees, a public house that never closes and some buildings without walls.[62] It is also possible to use a virtual world to simulate a real-life environment,[63] or an area of historical interest that is now effectively gone.[64]

Simulating the World

So what is the ultimate vision? To simulate the entire workings of the Earth, including the consciousness of its inhabitants, inside some kind of super-duper computer? In many ways this seems like a very grim view of the future, but one that undoubtedly forms the basis of many philosophical enquiries. Certainly if we can ultimately achieve this we will need to invent the 'Bostrom Test' as a measure of assessing whether we are in the real world or a virtual one.[65] For now we should concentrate on what may be within our grasp.

To address the more immediate requirements it is instructive to consider those elements of a virtual world environment that are relevant to our desire for producing a global educational enterprise. The principal component parts of the virtual experience are:

(1) It acts as a vehicle for connecting people, but in an immersive way rather than through flat-screen social networking.[66]
(2) There exists the possibility of creating a range of different environments.
(3) There is an opportunity for people to take on a range of personae or characteristics (in the extreme, this might mean being as much like the real world person as possible; this would dispel any concerns from those who would otherwise be uncomfortable with the concept of virtual life).[67]
(4) Enthusiasts will probably establish a strong emotional attachment with their avatar;[68] this is clearly a good thing in terms of developing a sense of existence (hopefully one that would have widespread reach).
(5) Avatars care about their virtual environment.[69]

So far, so good. It is possible to imagine that youngsters could engage with such a medium, and that this could be used for educational purposes. And, more importantly, they could be used in a global context. Simulating the look and feel of a place is relatively straightforward. It

is just a question of modelling the topography and adding buildings.[70] In addition roads, trees, street furniture, ponds, fountains, etc. can all be constructed and placed, scaled and moved as appropriate. In order to get around one can walk (boring), run (better) or fly (the best). Long distances can be covered in various (fantastical) vehicles or, ideally, by teleportation (clearly if one wants to produce a globally relevant virtual world where people can experience a raft of different environments, there is not much point in simulating the boredom of an eight-hour airline flight if the required destination can be reached in five seconds). The problem though with using virtual worlds is that, as they stand, they might seem not to offer much more than could be achieved by just using the Internet for blogging, video diaries, e-mail, etc.[71] But, this may just be because of a limitation with our vision or ambitions. An aspect of virtual worlds that go beyond the two-dimensional realm of the status update is the fact that, in addition to offering opportunities for networking/communication, they can also be used to simulate reality. And, intriguingly, this power of simulation presents an opportunity for the virtual inhabitants to experience the affects of Nature and the effects of Science.

Laws of (Virtual) Nature

If one looks under the skin of a virtual world there is a piece of computer code that simulates the physics of the environment.[72] So, for instance, virtual worlds have gravity and components of weather, such as wind. Additionally a virtual world can be programmed to have a day/night cycle.[73] Clearly as far as 'physics' is concerned, virtual worlds are quite advanced and there are many possibilities to improve the degree of reality.[74] But, for a commercial product aimed at, say, the gaming market, the question would be: how much reality do you actually want or need? Effectively the sky might be the limit, but as it stands, virtual physics appears entirely adequate.

Next we consider virtual 'biology.' Now, this is all a bit crude; as an avatar you are essentially either alive or dead.[75] There are a few tricks for simulating age, but these are all reversible. So, again, it all comes down to a question of the degree of reality that is required. One would not want to log in to a favourite virtual world only to discover that one's avatar was either asleep or had a headache (and otherwise did not want to come out to play).[76] Thinking about the biology beyond avatars, virtual worlds can contain wild animals; these, often the source of much wilful slaughtering, tend magically to appear fully formed.[77] Plants are generally there all the time, in some cases gently swaying in the breeze. Gerontology is not something that impinges upon virtual plants, nor do they seem to exhibit any phototropic effects. But of course they could do if this was a requirement of the simulation. As far as virtual world 'chemistry' is concerned this is a little more abstruse. But there is a sort of chemistry involved;[78] this is often manifested by a sense of having to make things[79] out of various items that have been collected (say, by searching, mining, trading, or doing the inevitable killing).[80]

The bottom line is that in addition to the social and psychological aspects of life in a virtual world, there are also laws of nature ('physics,' 'chemistry,' 'biology,' etc.).[81] Within the boundaries of an individual virtual world these laws of nature are inviolable (i.e. they are the same day after day).[82]

So, what about the limitations? There are things that act independently of the virtual world simulation itself that conspire to affect an individual's perception of the experience. Speed and quality of a broadband Internet connection is an obvious variable, for instance. But there may be phenomena attributable to the specifications of the particular computer that is being used to host the simulation; these could include limitations on the so-called draw distance,[83] or on the

implementation of specific graphical features.[84] In a way this has parallels with the real world; some people have better eyesight than others, some chimpanzees have access to bigger sticks than others, etc. (the point is: life in a virtual world is sometimes as unfair as it is in the real one).

There is one more virtual law that is relevant, although this one is more theological in character,[85] and may be seen to have parallels with ideas about the origin (and purpose) of the universe in the real one. Long-suffering inhabitants of any particular virtual world often refer to the operators as 'Gods.' The Gods created the world and ultimately have the power to destroy it.[86] But there are more subtle aspects of behaviour that have the capacity to cause huge tension between the Gods and their Subjects. Take the issue of land ownership,[87] for instance. Earthlings have, for the last few hundred years, known what the planet looks like and where the major land areas are sited.[88] The current world geopolitical situation is a result of humans working within the confines of a known and ultimately finite landmass. Not so in any virtual world. Buying and selling land is an aspect of some virtual world economies. This is fine where a free market can appear and respond to the nuances of supply and demand. But if the Gods can generate more revenue for themselves by creating new land[89] it clearly has the potential to affect the dynamics of the market in a way that is fundamentally not like real life (if you want more land in the real world you have either to reclaim it from the sea, or try to appropriate it off some other land owner through means generally foul).

Back to Reality

Or, rather, the reality of virtuality. Is it possible to have a virtual world environment that is connected, engaging and potentially educational? For all its apparent faults, Second Life has a great reputation for educational applications. Clearly it would be possible, at least in principle, to use something like this as part of a worldwide campaign to educate youngsters about the real world effects of glocalization. The limitations become apparent when one starts to consider how the environmental aspects of the venture would work. For instance, there ideally needs to be a way of connecting the individual components of the virtual world in such a way that changing things in one environment has the capacity to change things (in a relevant way) in another. A really simple example here would be sea level (changing the level of this in a virtual world is conceptually an easy thing to achieve). Sea level in a virtual world could rise or fall, either inundating peoples' virtual properties (otherwise nicely situated on the waterfront) or retreating to expose new areas of land for development.[90]

So, it may be possible to devise a simulator that can be used to produce a virtual world that includes the effects of climate (and, by extension, climate change). And perhaps this could all be stitched together in some kind of advanced version of Google Earth, potentially providing the basis for a vast educational experience. But this highly sophisticated approach might be a decade away from realisation. Besides, an experience that is close to reality, but not quite, is one that may suffer from its own kind of uncanny valley.[92] Perhaps the objectives can be achieved by merely cobbling together a few entities that already exist.

Use of a Virtual World to Educate a Global Population about Water

So let us return to the key things that I believe are required to produce a virtual experience that could be used to address the issue of glocalization:

(1) The objective is to inculcate a sense of global citizenship.

(2) The target audience is youngsters, with the hope that they will take their experiences with them into adulthood.
(3) Water is an ideal (nay, obvious) candidate as a universally understood commodity that provides a point of reference across all cultures of the real world, or all server breaks in the virtual one.
(4) The youngsters engaged with the activity should feel a certain ownership of the virtual world as a whole; at least some part of the overall experience should be educational (but it should also be fun).
(5) There should be a connected world of separate environments that are in individual ways affected by the availability of virtual water.

I am not advocating that the virtual experience should be a game per se. But elements of what makes an engaging computer game should surely be included.[93] And quite apart from the various environmental simulations that are used to recreate aspects of the real world, there needs to be communal facilities that are neutral or fantastic in character, and which offer places for social interaction. Overall, a successful venture would probably need to involve interplay of flat-screen social networking, video conferencing and all kinds of asynchronous e-activities. There is also no reason why the virtual world aspect of the jigsaw puzzle should not exploit the possibilities offered by mixed-world events (i.e. where real and virtual come together).

Although water provides an obvious reference, and the objective is to use the availability of water as a means of understanding ecological and environmental issues, there are of course many other aspects of the global connection that present themselves as educational possibilities. From my own perspective I would like to use it as a vehicle for teaching youngsters about science. In this regard, virtual water tells us one thing, but experiments with real water, in the real world, have the capacity to teach other things. Not everyone wants to be a scientist, or to have a career that demands scientific credentials at the highest levels. We should celebrate that. But everyone should have a grasp of scientific methods and principles, and understand both the power and limitations of science.[94] The ideal is a future in which the leaders of the nations (of the real world) have a well-developed scientific literacy in the same sense as they are already likely to have an appreciation of music, arts, culture, etc.[95]

Looking to the (not too distant) future, parameters that describe an individual avatar need to be made easy to export so that a virtual identity can easily be moved between different worlds. In this way, an avatar from one particular place (*Hack-'em and Slash-'em Empire*) becomes transportable to the more sober virtual classroom of another (*Mr. Smith's Virtual Maths Class*). In this way, hard-earned virtual chattels, attributes, clothes, assets, etc. remain connected to one's virtual identity and help to strengthen the bond between avatar and owner. Who knows how far this relationship may extend. Our survival as a species in the real world may ultimately require us to change radically our approach to activities we currently take for granted. It seems almost incongruent to suggest it, but just maybe the era of air travel for the masses will end.[96] And if it does we would surely lament the passing of the opportunity to experience different cultures from around the world. Entering a virtual world may ultimately become the only way for most people to travel the globe[97] (or, alternatively, if we are to be subjected to any more humiliation at airports, maybe it will become the means of choice in any case).

But these are just short-term challenges. My personal belief is that the imperative of a technological civilisation (i.e. the type that has been created by Homo sapiens as opposed to that of Delphinus delphis) is to extend outwards from its point of conception. Looked at another way, the prospect requires the global cooperation of billions of individual animals. It is interesting that limitations in the global distribution of water, one of the most abundant

resources on Earth (or indeed, the Solar System) may act either to constrain the ambitions of our genes, or ultimately to propel us along the journey that destiny has prescribed for us.

Acknowledgements

My day job involves looking for water beyond Earth. This could be seen either as a purely academic pursuit, or one that is ultimately essential for the development of the human race. Either way, I was extremely fortunate to have the time and space to think about this during an extended stay at the University of Durham as a Fellow of the Institute of Advanced Study (during the Epiphany Term, 2010). I am indebted to the Directors of the IAS for making this possible as well as Professor Martin Ward (Department of Physics) for the original invitation, and Professor Philip Gilmartin (Principal of St Mary's) for the hospitality extended by the College. During my time at the IAS I had many fascinating discussions with various people, unfortunately far too numerous to mention by name. But the almost daily dialogue with the other IAS Fellows is something I will cherish forever, not least of all because of the way this activity has helped to lift my eyelids. As with any experience there can only really be one highlight; with due deference to all the wonderful scholars in Durham I am afraid, for me, this accolade goes to a visit I made, along with Monica Grady, to a local school (organised for us by Stephen Spencer, a Tutor in St Mary's). We were privileged to spend time in the company of about 20 young and gifted children as part of a science club activity. The future of the human race is assured (although, like many others before me, I worry about all of that raw creative energy being beaten out of these proto-adults as they progress through the educational system).

Notes

[1] As a professional scientist who has had a research career that, in addition to doing the odd experiment, or making an occasional analysis, has involved writing grant proposals, running a laboratory infrastructure, daily supervision of PhD students, and trying to get conventional papers published in so-called *high-impact journals*, the idea of writing an essay is a somewhat alien concept (the last time I wrote an essay was probably when I was at school). Fortunately, my advancing years have allowed me to attain a state in life dominated by activities that Boyer (1997) would describe as the Scholarship of Application, or the Scholarship of Integration. As such, it is entirely appropriate for me to confront the essay demon. Having done so, it seems inevitable that what I have written will be somewhat naïve, and I apologise for that. But, somewhere in here I am sure there is a germ of an idea that has some merit.

[2] UUID stands for Universally Unique Identifier: it is an identifier standard used in software construction, standardised by the Open Software Foundation (OSF) as part of the Distributed Computing Environment (DCE). In the context here it refers to the UUID of a water texture used in the virtual world simulator Second Life (http://secondlife.com).

[3] By 'virtual water' I mean that which exists within a computer generated 3D immersive/ virtual world and not 'embedded water,' which is a term used to refer to the total volume of water that is needed to produce a single item (a classic example being a litre of milk, which requires 1000 litres of embedded water to produce it).

[4] CAS stands for Chemical Abstracts Services. 7732-18-5 is the number for water, 7789-20-0 for purified water.

[5] Fuel cells work by converting a source fuel into an electric current. In the case of the hydrogen fuel cell the source is hydrogen gas; this is oxidised in an electrochemical cell

through a catalytic combination with oxygen (from air). The by-product is 'harmless' water vapour. Harmless, except that water is a major greenhouse gas (albeit the one that has ensured temperatures on Earth have stayed clement enough for life to evolve and prosper).

[6] See, for instance: http://www.evian.com/ (last accessed June 2010). Others would turn to good old tap water whilst the super rich would drink Bling H_2O, http://www.blingh2o.com/ (last accessed June 2010). The point of this digression is that putting water in bottles is unnecessary and contributes to environmental problems; this is another reason to try and instil some global understanding of the downsides of modern life. See, for example, the issue of Fiji water: http://www.geoffreyrobertson.com/obama water.htm (last accessed June 2010) and 'The Story of Bottled Water,' which was released on 22 March 2010 (World Water Day) http://storyofstuff.org/bottledwater/ (last accessed June 2010).

[7] Unless it transpires that we are in fact all living in a giant computer simulation. See Bostrom, 2003: http://www.simulation-argument.com/simulation.html (last accessed June 2010).

[8] See: http://www.dur.ac.uk/ias/ (last accessed June 2010).

[9] The calculation goes like this: assuming the human body is about 65% 'water' and the average person weighs 65 kg, then with a global population of about seven billion we can calculate the global mass of water constituted by humanity. Another way of looking at this is that for each human on the planet there are 200,000,000 litres of water.

[10] See, for instance, a NASA press release from 2006 that argues for the presence of liquid water at the surface of Mars, on the basis of changes observed in images of the same place taken seven years apart: http://www.nasa.gov/mission_pages/mars/news/mgs-20061206.html (last accessed June 2010).

[11] Indeed, bodies like Europa and Enceladus (satellites of Jupiter and Saturn respectively) are thought to contain subsurface oceans of liquid water. These objects are undoubtedly going to be the subject of future astrobiological space investigations since they have all the characteristics of places where we might expect to find life.

[12] To be clear, Uranus and Neptune are known as 'ice giants,' the ice being composed of water, ammonia and methane; the exact proportions are open to a certain amount of speculation, but water is likely to be significant. Pluto is an example of a class of Solar System bodies that populate a flattened disc that exists beyond the orbit of Neptune. There are likely to be tens of thousands of these objects and we can assume that they are each about 30% water ice.

[13] A delightfully apt term coined by the late cometary scientist Fred Whipple. Interestingly the surfaces of comets are actually some of the blackest in the Solar System, being covered in organic compounds that would actually have the appearance of something like coal.

[14] Well, it used to be. Those with a dry sense of humour now describe it as being 'damp.'

[15] The quotations were from the accompanying NASA press conference, as covered by many media outlets worldwide. In this essay I am going to try and argue the case for a globally facilitated campaign of education. In this sense I am struck by the dichotomy of the global reach of NASA, which seems to have a truly universal presence, and the cultural limitations

of our own individual colloquialisms, as in 'a dozen two-gallon buckets' to describe the amounts of water detected.

[16] As of 2010 there is a NASA spacecraft called *Messenger* in orbit around Mercury. See: http://messenger.jhuapl.edu/ (last accessed June 2010). In 2014 an ESA spacecraft called *BepiColombo* will be sent en route to the planet. See: http://sci.esa.int/science-e/www/area/index.cfm?fareaid=30 (last accessed June 2010). Note: it takes 6 years for a spacecraft to get to Mercury so *BepiColombo* will not arrive until 2020.

[17] Venus is a really interesting case study for planetary scientists. It is often referred to as Earth's sister planet on account of a number of similarities between the two bodies. Not least of all, Venus and Earth are about the same size as each other and we can be fairly sure that they will have both started off with similar overall chemical compositions. So, Venus used to have water on it and now it effectively has none (one of the reasons we think this is true is because of isotopic enrichments observed in water 30+ years ago by the Russian spacecraft *Pioneer* as it descended through the Venusian atmosphere). The bottom line is that Venus, for whatever reasons, suffered from the effects of a runaway greenhouse (all of the carbon once present at the surface of the planet is now in the atmosphere as CO_2). The surface became very hot, the water was evaporated, and through atmospheric interactions with the solar wind, hydrogen was lost irrevocably. Note to Earthlings: beware the consequences of a runaway greenhouse effect.

[18] 'Water' here is taken to mean water as a liquid, solid (or gas).

[19] I am acutely aware of the issue of water distribution on Earth. However, as a scientist one cannot fail to be struck by the fact that there is an abundance of water close by. It should not be considered science fiction to imagine a future where the human-water relationship is continued in environments beyond Earth.

[20] I am indebted to those colleagues who were also Fellows of the IAS at the same time as myself for pointing out that most of the water on Earth is seawater (and therefore undrinkable). Of course, the sea is teeming with life, all of which thrive in its salty environment.

[21] 'Space is big. Really big. You just won't believe how vastly hugely mind-bogglingly big it is. I mean, you may think it's a long way down the road to the chemist, but that's just peanuts to space' (Adams, 1979).

[22] Interestingly, as I read through this essay for the final time, I note that a raft of articles have appeared in the press recently that seem to suggest the world is now in the grip of 'climate realism.' So, perhaps governments will soon be telling us that there is nothing to worry about. See, for instance: http://www.newsweek.com/2010/07/12/a-green-retreat.html (last accessed July 2010).

[23] The term 'Homo sapiens' describes the species of hominid that left Africa about 200,000 years ago, from which both ourselves (Homo sapiens sapiens) and, for instance, so-called Neanderthals (Homo sapiens neanderthalis) are descended.

[24] See, for instance, the book by the current Astronomer Royal, Martin Rees, entitled *Our Final Century: Will the Human Race Survive the Twenty-First Century?*). For more information see: http://news.bbc.co.uk/1/hi/in_depth/uk/2000/newsmakers/2976279.stm (last accessed June 2010).

[25] The term was coined a long time before this; see, for instance, Wolfe (1987) *Bonfire of the Vanities*.

[26] See, for instance, Kurzweil (2006) *The Singularity Is Near: When Humans Transcend Biology*. See also: http://www.singularity.com/ (last accessed June 2010).

[27] The Universe is thought to be about 13.7 billion years old, whilst the Earth was formed about 4.6 billion years ago. Evidence for anatomically modern Homo sapiens is found up to about 100,000 years ago.

[28] See, for instance, http://bible.com/ (last accessed June 2010).

[29] One thing we can be sure of is that when these visitors arrive on Earth they will be knee deep in life, and probably plagued by midges. Life is a fundamental property of the natural world; it emerged on Earth a very long time ago and will still be here a long time after humans have disappeared.

[30] Vanity aside, one is amused by the thought of someone reading this in 50 years' time and wondering what on Earth a mobile phone was (something then that will seem as quaint as the meat safe or mangle does today).

[31] I am indebted to Anthony Charles Lynton Blair for this title (the Prime Minister of the United Kingdom from 2 May 1997 to 27 June 2007).

[32] I take some of my cues here from the thoughts of Sir Ken Robinson. See, for instance, http://www.ted.com/talks/ken_robinson_says_schools_kill_creativity.html (last accessed July 2010).

[33] What is meant by 'a child'? Is there some kind of universal definition? Is the state of childhood a biological phenomenon? Or is it cultural? What I mean by 'children' are those people that are not yet cynical enough to be adults.

[34] I realise that this apparently trivial example is in fact very complex. Petulant teenagers want new phones because of peer pressure and an incessant campaign of advertising through any/all of the media channels they are exposed to. But, in detail, the global economy (as it is currently constructed) relies on people changing their mobile phones even though there is actually nothing wrong with them. It is unlikely that children can understand global economics (indeed, the author – a professional academic – struggles with this subject).

[35] Interestingly this would not be the case for those members of the human race in orbit, aboard something like the International Space Station. But, capturing this very fact is part of the education process; it begins to tell us something about gravity (i.e. without recourse to complex mathematics, which may otherwise not be understood by everyone).

[36] Adding salt to naturally occurring ice (i.e. the unwanted sort that is found deposited on footpaths in winter) causes it to melt, which is ultimately a consequence of its becoming impure.

[37] It will boil at about 70°C atop Mount Everest.

[38] pH means 'potential hydrogen,' a rather curious scale that measures the acidity or alkalinity of a liquid. Pure water has a pH of 7; drinking water varies from about 6 (slightly acid) to 8.5 (slightly alkaline).

[39] The Uniform Resource Locator in question is: www.wikipedia.com (last accessed June 2010.

[40] Hydrogen bonding in water arises where the hydrogen atoms of one molecule interact with the oxygen atom of another – this is integrated throughout a body of liquid water. This intermolecular attraction is a relatively strong form of the effect compared to, say, van der Waal's forces. Although one can go through life without having to understand hydrogen bonding it is nonetheless the phenomenon that gives rise to 'surface tension' and explains why water forms droplets.

[41] The word 'glocalization' was coined to describe the phenomenon of people considering their local actions in the broader sense of global ramifications; the word has been popularised in the English-speaking world by Roland Robertson, see: http://www.abdn.ac.uk/socsci/staff/details.php?id=r.robertson

[42] 'The continuous presentation of scary stories about global warming in the popular media makes us unnecessarily frightened. Even worse, it terrifies our kids' – Bjorn Lomberg (2009). See:http://www.guardian.co.uk/commentisfree/cif-green/2009/jun/15/climate-change-children (last accessed June 2010).

[43] The sort of anxiety that greeted the arrival of the printing press.

[44] See, for instance: 'Internet access is a fundamental right' – http://news.bbc.co.uk/1/hi/8548190.stm and 'Finland makes broadband a legal right' – http://www.bbc.co.uk/news/10461048?utm_source=twitterfeed&utm_medium=twitter

[45] Actually, it is, of course, a fascinating subject. See, for instance, the following (which is from the Unknown History of the Internet): The beginnings of packet switching (RAND Corporation), Paul Baran, http://wiwiw.org/entrevista_ej.pdf (last accessed June 2010).

[46] The title of this section is concocted from the names of a few of the more popular social networking tools that were available in 2010 (± a few years). In some ways they represent an old person's view of the world; a more trendy collection might include, say, *BlackPlanet*, *Foursquare*, *Muxlim*, *Plurk* (but sadly not *MySpace*, which is already considered passé).

[47] The phenomenon that is Facebook: http://www.facebook.com (last accessed June 2010). As of 2010 it appears that at least 5% of the world's population have Facebook accounts.

[48] Twitter is a social networking tool that allows status updates that are limited to a total of 140 characters. For illustration, the previous sentence is 110 characters in length. Interestingly, Twitter is now being used by people attending academic conferences to keep colleagues and lurkers alike up to speed on what is being said (effectively in real time). This allows facts and figures to be checked and queried, and ideas to be discussed (silently), all before question time. See: http://www.twitter.com (last accessed June 2010).

[49] Bebo, a sort of Facebook for juniors that is currently on life-support, see: http://www.guardian.co.uk/media/2010/apr/07/bebo-facebook (last accessed June 2010). Register for an account here: http://www.bebo.com (last accessed June 2010).

[50] In any case, the illuminati widely predict the demise of blogging, with personal efforts becoming supplanted by professionally scripted ones. See, for instance: http://www.wired.com/entertainment/theweb/magazine/16-11/st_essay (last accessed June 2010).

[51] The games in question being, respectively, World of Warcraft, EverQuest and Entropia Universe.

[52] The website http://www.mmorpg.com/ (last accessed June 2010) lists about 400. They are segregated into categories such as sci-fi, fantasy, sports, real life, historical, and so on.

[53] In principle this is against the Terms of Service for Facebook. A further social networking tool, *Avatars United*, provides a facility that is exclusively intended for virtual life-forms. See: http://www.avatarsunited.com/ (last accessed June 2010).

[54] It seems appropriate to record that the notion of a virtual world inhabited by virtual characters was first popularised by William Gibson in his 1986 novel *Count Zero*. The words 'metaverse' and 'avatar' were used to denote such phenomena by Neal Stephenson in his 1992 novel *Snow Crash*.

[55] The 3D shapes that populate a virtual world are constructed in a number of different ways, but industry standard gaming techniques use a virtual mesh comprising a number of faces (generally either 'squares,' i.e. any shape with four edges, or triangles with three) joined together. The points that define the ends of the edges are the vertices. Making shapes is all about moving vertices around on a computer screen.

[56] A style of gaming made popular by consoles such as Sony's *Playstation* or Microsoft's *Xbox*, in which a real-life person plays against the logic of a computer.

[57] Qua everyone.

[58] The default avatars in Second Life are either male or female human characters. However, it is possible to 'wear' items that transform an avatar into something like a robot, or an animal. A high proportion of the avatars in Second Life are animals of one kind or another (known as furries).

[59] 'The original goal of Second Life was for most/all of the content to be created by its users. However, as Linden Labs wrestled with a static take-up in the numbers of new users they began to provide their own content. This culminated in the appearance of islands packed full of identical looking virtual houses (one for each 'premium user'). There are lessons here for people who aspire to harness the creativity of users.

[60] Even now it is possible to put a 'photorealistic' skin onto an avatar. If you want to be yourself you just have to take a few appropriate digital images and stitch them together in a graphics program of some sort (this is still something that takes a certain amount of skill). One can only imagine that in the near future it will be something that is offered as a kind of entry-level possibility.

[61] Sun Microsystems used to run its own corporate virtual world, *Project Wonderland*, to keep its employees connected and engaged (the rationale was that at any one time, with about half of its workforce 'out of the office,' the technology would allow people to get together for meetings, socialising, etc.). After Sun was taken over in 2010 the virtual world has carried on as an Open Source collaboration called, inventively enough, *Open Wonderland*. See: http://www.openwonderland.org/ (last accessed June 2010).

[62] The Open University runs a number of islands in Second Life. These are used for tutorials, lectures, discussion meetings, building projects, development of human resources, research projects and the occasional party. The SLURL for the site of the village community, *OUtopia*, is: http://slurl.com/secondlife/OUtopia/85/56/30, or the map is at http://maps.secondlife.com/secondlife/OUtopia/128/128/28 (last accessed June 2010). Once in-world, other facilities can be found nearby.

[63] There are many examples, such as the *NewcastleGateshead in SL* area, see: http://maps.secondlife.com/secondlife/Newcastle%20Gateshead/128/128/25 (last accessed June 2010). Kate Boardman at the University of Teesside is currently building a virtual Durham Cathedral, see: http://photos-h.ak.fbcdn.net/hphotos-ak-snc1/hs027.snc1/2361_619484721103_61208650_39874015_9206_n.jpg (last accessed June 2010).

[64] Although we often think of history as something that takes place on historical timescales, it is sobering to think that there is a generation of Germans growing up in Berlin who know little about what life was like during the era of the Wall. A virtual reality project aims to capture some sense of this, see: http://www.virtuelle-mauer-berlin.de/index.htm (last accessed June 2010).

[65] I suggest the name 'Bostrom Test' in honour of the 'Turing Test' proposed by Alan Turing in his 1950 paper 'Computing machinery and intelligence,' in which he considers how it would be possible to decide whether a machine was intelligent (see: http://mind.oxfordjournals.org/cgi/reprint/LIX/236/433, last accessed June 2010). The Bostrom Test is an analogous concept for deciding whether or not one is actually in a real world or in a simulation (see footnote 7). As I write this I can hear the words of Samuel Johnson ringing in my ears – 'I refute it *thus*!' – after 'striking his foot with mighty force against a large stone.'

[66] I would also contend that life in a virtual world is a real-time phenomenon that works by virtue of experiences and interactions that take place in an instant of time. They are not necessarily then completely gone; they may, for instance, be video recorded just like in real life, or a text chat may be logged for posterity. Actually I think these are downsides; I rue the coming of the day when every real-life encounter is recorded in some way (the beauty about being human, as opposed to being a machine, is that one is still able to speak one's mind, and that mind might change on all kinds of whims, one makes mistakes, people remember the same event in different ways, and so on).

[67] Disability presents an interesting challenge for life in a virtual world. At one level people who are disabled in reality might feel the need to portray this when in-world. But at another, the playing field is levelled when entering a virtual world and so they can engage with an experience in the same way as everyone else. In fact, disability in a virtual context extends to people who are not actually disabled in reality, but nonetheless find it impossible to move an avatar around the screen without creating virtual mayhem.

[68] There needs to be a better word to describe the real world owner of a virtual world avatar. I suggest, by analogy with the etymology of 'avatar,' which comes from the Sanskrit word *avatara* (meaning incarnation, appearance, or manifestation), use of the word *dalang* (the Sanskrit word for puppet master). In order to let the word roll more easily off a western tongue this perhaps be modified to 'dalanger.'

[69] I realise this sounds like sophistry. What I mean by this is that the owner of an avatar cares about the environment in which it is presented. There are nice virtual environments and unpleasant ones. Communities of avatars (or rather, the owners of avatars) work together to make virtual living an enjoyable experience. Poor building design is deprecated; bad behaviour is not tolerated; people do not like living next to virtual burlesque clubs and they do not want advertising hoardings blocking their view. And so on.

[70] If required, buildings can have exact dimensions (i.e. to replicate an edifice from reality) and be covered with a 'skin' of digital images acquired from real-world entities. They can also be filled with furniture of tasteful or inappropriate qualities. Trying out architectural concepts in a virtual environment is clearly something that can have real-world significance. But, in addition, virtual buildings do not need to be replicas of things from real life. Here the notion of (virtual) space is far more important.

[71] In other words, are virtual worlds merely a different form of social networking (indeed, ones that currently require hardware of pretty advanced specifications and which use far more resources to operate than something less sophisticated)?

[72] This is the so-called 'gaming engine,' or 'physics engine.' The action of the code enables things that are dropped to fall to the ground, or dead bodies to slide down the sides of mountains writhing in agony (the latter effect being known as 'ragdoll physics').

[73] These are generally set to operate on a timescale of much less than 24 hours. This is because, oddly enough, people do not want to spend long periods of their virtual life in the dark.

[74] Flight simulators have been used for some considerable time to train aircraft pilots. And the military uses various battlefield simulators for combat training. Formula 1 racing drivers and teams were able to experience the new (2010) Silverstone circuit a long time before they got to see it for real, see: http://www.formula1.com/news/features/2010/7/10986.html (last accessed July 2010).

[75] Or, just not in-world (the real world equivalent of nowhere to be found). When you die in a virtual world you get reborn; the penalty associated with this is that you are generally sent back to some place where progress in whatever you are attempting to achieve is subjected to some element of starting again. Of course, the owners of avatars die (in reality) and this poses a number of interesting issues (for instance over ownership of virtual assets). There are places in virtual worlds like Second Life where there are memorials to the dead, as well as memorials to avatars who, for whatever reason, have simply decided never to log in again.

[76] There is a sort of virtual equivalent to this phenomenon that arises when the servers running the virtual world are unavailable for some reason (either crashed, being maintained, or upgraded). In these circumstances people resort to a number of other social networking tools to discuss their virtual lives with those of others (often a good old moan about the service providers).

[77] One may question whether or not this would be appropriate in an educational context. The animals in question are, of course, by and large fantasy characters (and are easily substituted with aliens or robots, etc.). The point of killing animals is to gain skills, respect from one's peers, and to gain resources with which to trade. In this sense the relationship between avatar and foe is entirely rational.

[78] Albeit a bit more alchemical in nature.

[79] A process that involves developed skills (i.e. there usually *is* a learning element).

[80] Just like in real life, it is generally possible for people with cash to buy the things of interest without having to work up a sweat (i.e. hence the requirement for a virtual proletariat). Fundamentally it is activities of this nature that drive a virtual world economy.

[81] Discovering the laws of nature that operate in a virtual world is an educational experience that may be easily overlooked.

[82] Although I call these inviolable this is only true insofar as the operators of an individual world may decide to change them (this may be to make them more sophisticated, say, with a new release of software code). But they are inviolable in the sense that between software updates, the behaviour of the gaming engine does not change randomly for any apparent reason.

[83] Some of the best virtual experiences are ones in which spectacular vistas can be appreciated on-screen; lack of a decent graphics card may mean that these are instead replaced with a kind of murky-looking fog.

[84] Shadows, for instance. Hardly important you may say but it is surprising what subtle cues humans take from such things (shadows serving to accentuate an environment baked by a blistering sun, with misty diffuse light emphasising an atmosphere laden with moisture).

[85] Depending upon your viewpoint this makes a virtual world experience either more, or less, like the real world.

[86] Virtual worlds come and go. See, for instance, There, which closed down in 2010: http://www.there.com/info/members/download (last accessed June 2010), or Metaplace, which closed at the end of 2009: http://www.raphkoster.com/2009/12/21/metaplace-com-closing/ (last accessed June 2010). Note that Metaplace has reappeared as a Facebook game application, which may say something about supply and demand.

[87] For those not familiar with virtual worlds, the notion of land ownership is a concept that may be difficult to grasp. What is meant in reality is a rental of server space (which, of course, has to be paid for in some way).

[88] Of course there are many people that still believe in the existence of lost continents, and this is in the real world not a virtual one.

[89] Which they do by adding more servers to the grid. There are many resources on the Internet that investigate the land economies of virtual worlds. Many believe that the Gods play around in this way at their peril.

[90] One does not normally drown (and die) in a virtual world. Indeed, it is possible to live underwater. There may be some excellent educational possibilities here from an ecological point of view.

[91] See: http://earth.google.com/ (last accessed June 2010).

[92] The phenomenon of the 'uncanny valley' refers explicitly to the psychological issues associated with the appearance of a simulated human head/face, but would seem also to apply to the simulation of the real world in general. See a translation of the original paper by Masahiro Mori (1970) here: http://www.androidscience.com/theuncannyvalley/proceedings2005/uncannyvalley.html (last accessed June 2010). See also:http://spectrum.ieee.org/automaton/robotics/humanoids/040210-who-is-afraid-of-the-uncanny-valley (last accessed June 2010).

[93] A good example of how gaming technologies could be used for educational purposes is provided by the work done by Mindark under contract from the European Space Agency. The relevant video is here: http://www.youtube.com/watch?v=ITUSDHLIBNs (last accessed July 2010).

[94] Limitations in an educated sense, i.e. that 'science' is not necessarily a panacea for all kinds of the world's ills, or that 'science' cannot simply be applied to any old problem in order to provide an instant solution.

[95] What I am referring to here is 'physical science,' as opposed to social science, or political science, or whatever. I do not wish to take anything away from the humanities; I believe it is equally important for our illustrious leaders to have an appreciation of these things as well. I am talking about 'nuts and bolts' science, the kind of phenomena that remain true regardless of opinion.

[96] In terms of the present day panic over CO_2 emissions we can have all the windmills we like, but the reality is that travel by aeroplane contributes massively to the carbon footprint of Homo sapiens. See the excellent book by D. J. C. McKay (2008), *Sustainable Energy – Without the Hot Air*. The entire book is available for free download from: http://www.withouthotair.com/ (last accessed 2010). One sure fire way of reducing the amount of CO_2 being added to the atmosphere is to scrap air travel (as opposed to, say, getting rid of other CO_2 generating activities like heating our houses or producing food). Perhaps the question will ultimately be reduced to this: cars or planes?

[97] However, let us be clear, using a computer has a CO_2 overhead. And it is not just via the electricity that is used to power an individual's laptop. Although it is probably not widely understood by people, each Google search uses up energy (i.e. because the server farms that comprise the search engine have to be powered in some way; each search requires the activity from a pile of electronic components to interact with a vast array of memory devices etc.). In the extreme a Google search is estimated to use as much energy as boiling a kettle of water, although this is disputed. See: http://news.bbc.co.uk/1/hi/technology/7823387.stm (last accessed June 2010).

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Insights

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