

Transcending the Age of Stupid: Learning to Imagine Ourselves Differently

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Responses

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Our challenge is to learn how to recognize what we have trained ourselves not to see. We must remove the imaginative and historical veils that we have used to obscure this reality (Saul, 2008, p.35).

Introduction

The narrator of the satirical movie *'The Age of Stupid'* looks back from an ecologically ruined Earth in 2055 by reviewing news clips and documentary footage captured 50 years earlier searching for clues as to what went wrong (Barnett, 2009). North America in 2005 was accumulating evidence that a proverbial economic and environmental train wreck was oncoming; the gas guzzling sport utility vehicle (SUV) craze has peaked and the beginning of the economic collapse of the formerly 'Big Three' automakers has begun; the peak in growth of enormous inefficient homes or 'McMansions' that sprang up in sprawling suburbs around every major city in North America; the outsourcing and loss of hundreds of thousands of middle class manufacturing jobs continues unabated; the growth in zero equity mortgages and unsustainable levels of household debt growing to the highest in the world at nearly twice disposable income; and finally the impacts resulting from an enormous increase in greenhouse gases that have continued unabated over the previous decades have just begun to gather serious public attention.

This paper will explore the importance of 'disclosing' poor curricula, political ecologies and junkscience as they relate to technological and science education. Education attempts in part to engage young people in learning from some of the hard won lessons of the past, lessons that span all areas of human endeavour, from the arts and humanities to engineering and the sciences. Considered from an educational standpoint then, transcending the 'Age of Stupid' will require innovative and critical approaches to teaching and learning to understand the significance of how human beings have:

- Come to understand that climate change presents one of the most profound existential threats the human race has ever faced. We know this and yet remain in deep denial continuing to allow the richest among us to *accelerate* their rate of greenhouse gas emissions.
- Come to realize that although carbon-based sources of energy are a finite limited resource, and that we may have already or will soon arrive at a 'peak oil' situation, we continue to squander ever more amounts of economically cheap fossil fuels.
- Produced more ephemeral 'things'—products, gadgets and gizmos than at any time in human history. Although we manufacture-consume-dispose of more material than any humans in history, we remain willfully ignorant of the 'life-cycle costs' involved. The real cost is found in destroyed habitats, persistent toxins which make their way into humans and animals alike, overflowing landfills and poisoning the oceans.

- Come to realize that although we depend on the planet's free 'ecosystem services' for our very survival, we continue to degrade them systematically across all continents, often in pursuit of short-term economic gain.
- Come to realize that we now live in the '*Anthropocene*' a new geologic epoch in which humankind has emerged as the "potentially intelligent" globally dominant species, capable of virtually reshaping the face of the planet and its ecosystems through both intention and accident (Schellnhuber et al., 2004:1).
- Homo sapiens are now the top predator on the planet and directly responsible for causing the sixth great extinction event of life from this planet. The Global Living Planet Index (LPI) is a measure derived from long term studies of nearly 5000 populations of 1686 species, it shows an almost 30 per cent decline over the 35 years 1970-2005. Our global footprint now exceeds the world's capacity to regenerate by about 30 per cent (World Wildlife Fund, 2008).

One could argue that the points above are all indicators of '*systemic stupidity*' and evidence that significant aspects of our rich western worldviews have become dysfunctional and dangerous, insofar as they foster a cognitive disconnect from an understanding and appreciation of how the biosphere functions to maintain healthy human life on this planet. The fracture lines of an old out-dated and unsustainable worldview are still evident everywhere as our ways of thinking about our relationship to the natural world and each other are increasingly understood to be ecologically dysfunctional and counterproductive to a broader human and planetary 'common good'. It is time to learn to imagine a different world from the industrial age bubble from which we are emerging.

Disclosing and Defiance

Our job [as teachers] is to help people become truly conscious, understand the different worlds we live in, and develop a morality in the face of the evident amorality of our universe. It is to help people how to make up their own minds, and how to take control of the moment. It is to teach choice. It is to help ourselves and others break free from our pasts, plan for the futures we want and resist the futures we do not want. Our job is to teach defiance (Newman, 2006, p.10).

Is science and technology education actually producing a scientifically and ecologically literate population? One metric of improvement might be our societal response to two of the most serious challenges facing humanity as a whole, climate change and the biodiversity crisis. In this paper we ask in a general way, how effective has technological education been in terms of '*disclosing sites of injustice and unsustainability*' and '*mobilizing people to make a difference*'? And even more importantly, what changes to science and technology education are necessary to ensure that it does fulfill this democratic disclosing and mobilizing function?

Education that dampens genuine rebelliousness and defiance cannot effectively disclose and mobilize people to act. If '*disclosing*' is to mean anything genuine, it entails bringing young people into critical contact with the zones of friction and conflict that exist between those who work on behalf of maintaining the status quo and its associated privileges and power, and those who are working to transform society in order to make it more equitable, just and sustainable. This is not a simple project involving personal introspection, 'perspective transformation' and subjectivity, but rather an apprenticeship in realpolitik, an understanding of how ideology, economic power and worldviews co-evolve to shape public policy and consciousness.

Most educational systems have no mechanism to foster within the privileged the self-defeating notion that they enjoy the benefit of their lives by impoverishing and oppressing others. Injustice is either obscured in the immediate or highlighted in the remote and distant (van Gorder, 2007, p.13).

We might reflect on how our education systems often end up distracting and disengaging young people from the very real 'jugalur' questions of our time. As van Gorder asserts:

In contexts of privilege and third-world inequality, education promotes silence for the sake of order (van Gorder, 2007, p.13).

Education often becomes complicit in reinforcing social bromides that support the continued propping up of the status quo, while masking systems of inequity and maintaining sites of privilege for a select minority. There is probably no better example of the argument to maintain privilege and power than that being put forward by the proponents of climate change inaction. This group of inactivists includes some of the largest and influential corporate organizations and will be addressed further on.

Defiance follows from disclosing, when we learn how vested interests work to conceal power and intent, “we may be rebellious by nature, culture or inclination, but we have to choose to be defiant” (Newman, 2006, p.61). As Newman points out:

If we are to engage in learning in order to act on and change our social or political world, then we need to examine who is trying to lay out our futures for us, who is telling us what we should and should not do, who is holding us back, and who is preventing us from acting effectively in our own and other’s interests. We need to do our learning by identifying and naming the wielders of power, analyzing the kinds of power they hold and, where we deem that power to be malign, examining the ways they use it (Newman, 2006, p.10).

Education is of course not about telling people *what* to think, but rather how to think critically and deeply about the world. Nor is education about telling young people *what* to be defiant about, but rather to enculture them into the idea that acts of defiance are essential to the democratic process. Both defiance and protest have had a profound impact on the history of human progress, righting injustices, changing policies, practices and laws. It is through this participatory democratic process that worldviews supporting historical inequities, socially and environmentally unjust practices and indefensible forms of power and authority, are transformed.

A time of Upheaval and Opportunity

Trillions of dollars of wealth have evaporated from the world’s economies over the last year bringing national economies to their knees. This collapse had little to do with the relative competitiveness of global workforces, the performance level of students or employees on standardized tests and exams, or for that matter the science and technological skills and knowledge of ordinary working class people. The implosion was made possible, even inevitable by the rapacious greed and enormous sense of entitlement held by many of world’s financial elites, those ‘trained’ in our finest schools and universities. Technology is of course an enabler of laissez faire predatory capitalism and the ‘casino economy’ (Canterbery, 2001), in which trillions of dollars sloshes through the world’s economic systems everyday in perpetual search for a profit margin. The system was ‘gamed’ by its manipulators because it lacked oversight and could be, and the thinking that made it possible is central to this dysfunctional worldview that still lingers. This thinking is encapsulated in the cultural meme peddled to citizens that *‘the unregulated invisible hand of the market fixes all’*, in effect a form of neoliberal corporate rule, whose accompanying narrative attempts to marginalize participatory democratic politics is as an effective force for the common good. The notion of *‘consumer sovereignty’* has been a rallying theme for neoliberals who resist any and all forms of democratic intervention on behalf of the public common good, into this hallowed realm. Consumer sovereignty is used by groups like the ‘Fraser Institute’, the ‘Competitive Enterprise Institute’ and the ‘National Association of Manufacturers’ to work on elected officials and publics alike to reject any and all attempts to regulate and enforce ‘polluter-pays’ legislation, to reduce greenhouse gases or to ameliorate unjust and/or unhealthy labour practices.

Often the seeming apolitical language of *‘the market’* is used to promote policies whose means belie the ends. According to Galbraith, the effective re-branding of capitalism in terms of a more publicly acceptable ‘market system’ contends, renders the latter “without meaning, erroneous, bland, benign” (Galbraith, 2004, p.8). Furthermore, he observes:

No individual firm, no individual capitalist, is now thought to have power; that the market is subject to skilled and comprehensive management is unmentioned even in most economic teaching. Here the fraud (Galbraith, 2004, p.8).

And as Galbraith explains:

Another name for the system does come persuasively to the eye and ear: “the Corporate System”. None can doubt that the modern corporation is a dominant force in the present day economy, and certainly so in the United States. Nonetheless, allusions to it are used with caution or not at all. Sensitive friends and beneficiaries of the system do not wish to assign definitive authority to the corporation. Better the benign reference to the market (Galbraith, 2004, p.8-9).

In October of last year when the world financial crisis was starting to unravel in earnest, the chair of the U.S. House Oversight and Government Reform Committee challenged Alan Greenspan the former chairman of the U.S. Federal Reserve with: “You found that your view of the world, your ideology was not right, it was not working?” Greenspan responded with: “Absolutely, precisely... You know, that’s precisely the reason I was shocked, because I have been going for 40 years or more with very considerable evidence that it was working exceptionally well”(Irwin & Paley, 2008). Under Greenspan’s tenure at the federal reserve banking regulations put in place by U.S. president Roosevelt to lift the country out of the Great Depression, were rolled back or eliminated entirely. In their place so-called ‘sub-prime mortgages’ as well as new complex and risky mechanisms for manipulating and concentrating ephemeral virtual capital emerged such as derivatives trading and credit default swaps. The ultimate economic and human fallout from this ideological worldview gap with reality will continue to unfold for years to come.

Disclosing the Curriculum

We can’t possibly flourish in a future filled with sharp nonlinearities and threshold effects—and, somewhat paradoxically, we can’t hope to preserve at least some of what we hold dear—unless we’re comfortable with change, surprise, and the essential transience of things, and unless we’re open to radically new ways of thinking about our world and about the way we should lead our lives. We need to exercise our imaginations so that we can challenge the unchallengeable and conceive the unconceivable. Hunkering down, denying what’s happening around us, and refusing to countenance anything more than incremental adjustments to our course are just about the worst things we can do (Homer-Dixon, 2006, p. 282).

Often scant opportunities exist for young people to talk about public policies as they relate to science and technology or how these relate to the larger notion of *‘the common good’*. Teacher and their professional associations still rigidly police disciplinary and curriculum boundaries, so people involved in writing technology education curricula are rarely involved in doing the same in science, and vice versa. Schools of education often reinforce these disciplinary and curriculum schisms in terms of professional preparation, all of this working against genuine interdisciplinary understanding and curriculum cooperation.

Elshof (2009) examined the extent to which the concepts, ideas, and processes that are associated with the sustainable development concept are present in technology education curriculum documents from five developed, wealthy, English-speaking countries. The G8 countries account for about 65% of the world economy and have some of the largest ecological and carbon footprints on the planet (Wackernagel, 2006; Figdor & Cassaday, 2006). For this discussion we will just concern ourselves with the 857 total pages of secondary technological education curriculum documents from two of the richest provinces in Canada, and the national curriculum of England, and the United States. The sustainability related concepts in **table 1** were either completely absent as stated or nearly absent (# of occurrences in combined total of 857 pages).

Table 1 Selected concepts completely absent or nearly absent (#occurrences) from three combined G8 countries secondary Technology Education curricula.

'Future Generations' (2)	'Sustainable Development'	'Design for the Environment'	'Social justice'	'Stewardship'
'Limits'- Environmental or Natural	'Interdependence'	'Ecological' or 'Carbon Footprint'	'Developing World'	'Eco-efficiency'
'Ingenuity' (2)	'Embodied Energy' of materials	'Reuse' of materials (7)	'Indigenous technology'	'Photovoltaic' (1)
'Life Cycle Analysis' LCA	'Industrial Ecology'	'Precautionary Principle'	'Global warming' or 'Climate Change' (1)	'Geothermal Energy' (2)
'Life Cycle Management'	'Biomimicry'	'Consumerism'	'Dematerialization'	'Rebound Effect'
'Holistic'	'Democratic' (2)	'Recycle' (2)	'Fairness'	'Systems thinking' (10)

For an in-depth discussion see Elshof (2009).

It is important to point out that some progressive technological classroom teachers are incorporating of the ideas and concepts outlined in table 1 in their classroom practices (Hill & Elshof, 2007). The major point is that government curriculum departments in these jurisdictions have failed to provide timely and effective leadership in these key areas. They have been innovation laggards insofar as their curricula reflect an industrial age consensus of what technological education might and should be. There is little evidence these curricula that engaging youth in thinking about alternative sociotechnological futures is viewed as important, pedagogical strategies and tools like mapping alternative futures, system dynamics and scenario planning are largely absent. In a world quickly running out of easily obtained oil and natural gas, a rapidly warming planet and a population heading toward 9 billion in the next few decades, the ability to create and consider future scenarios and preferable technological futures is no longer a curriculum option, but an ingenuity necessity.

As our education systems rush toward more standardized testing and outcomes-based assessment, in effect becoming more rigidly aligned with a narrow prescriptive notion of what learning entails, it is increasingly at odds with the real world is pushing back. 'Ingenuity gaps' (Homer-Dixon, 2002), the gap which exists between society's ability to access ingenuity and it's demand for ingenuity, are emerging all over the planet. The consequences for human resilience are already emerging:

Capitalism's constant pressure on companies to maximize efficiency tightens links between producers and suppliers; reduces slack, buffering, and redundancy; and so makes cascading failures more likely and damaging. As well, capitalism's pressure on people to be more productive and efficient drives them to acquire hyperspecialized skills and knowledge, which means they become less autonomous, more dependent on other specialized people and technologies, and ultimately more vulnerable to shocks (Homer Dixon, 2009, p.15).

It would be difficult to identify a more important curriculum project for critical disclosing and mobilizing than that involving our culture of automobility, oil consumption and their connections to climate change.

Disclosing the Political Ecology of Oil, Climate Change and the Automobile

Too frequently, the injunction of ‘critical thinking’ in education has often become a domesticated ‘platitude’ reduced to being a “corporatist competency” in the service of ‘human resource’ development (Newman, 2006, p.10). But as Newman reminds us “like the critical theory from which it sprang, critical thinking was associated with the pursuit of social justice” (Newman, 2006, p.9). Reclaiming a critical technological literacy with a central concern about how technology relates to social and ecological justice is an imperative for this century. In order to begin this project we need to reflect on how much or how little critical sociotechnological explanatory power is embedded in the instrumental outcomes of our curricula? We could ask for example, whether science and technology education prepares young people with the analytical and critical thinking skills that would enable them to understand the complex dynamics of our transportation system? Does it provide students with opportunities to explore the sociopolitical dynamics and the causal factors that explain why we in North America seem to be locked into such an inefficient transportation system, one dominated by the personal automobile, and largely oblivious to the social and environmental costs that are heavily subsidized by all citizens? And importantly does transportation education assist young people in identifying social and political arenas in which they and their communities might act to effectively reduce automobile dependency, improve public transit and bicycle and pedestrian access?

The issue of ‘carbon equity’ is one students need to consider. We cannot abandon basic concepts of equity, fairness and justice when it comes to how considering how much carbon dioxide each inhabitant of the planet should be allowed to produce, if we are to avoid run away climate change and the enormous hardships that this would entail. On what ethical/moral principles can people in rich developed countries base an argument in order to continue to enjoy gas-guzzling vehicles and continue with their profligate energy use in the products they buy and consume? In essence, the question young people need to examine is why should the richest continue to get all the ‘*environmental space*’ to continue polluting as usual? As Athanasiou states:

The bottom line is that each of us—Microsoft Chairman, Bosnian suburbanite, or Sudanese peasant—has the same inalienable claim to the limited atmospheric commons (Athanasiou, 2000).

These are the difficult yet vital questions we need young people to grapple with when they examine how many of our leisure activities involve burning hydrocarbons and releasing greenhouse emissions. Discussions of carbon equity and fairness implicate everything from internal combustion recreational pleasure boating, water skiing, jet skiing, snowmobiling to off road driving and motorcycling. If technological education is to be genuinely involved in ‘disclosing’ activities students need to be actively analyzing and critiquing the ‘business as usual’ practices that support the status quo in business, industry and politics.

Too often transportation technology education is an uncritical exercise in reinforcing car culture, celebrating speed and power through for example, imitation NASCAR, Indy Car and Formula One imitation racing activities. The following advertising promotion was sent out to technology educators in January 2009:

F1 IN SCHOOLS is a unique technology challenge that involves the construction of a 1/20th-scale CO₂ Formula One (F1) racing car out of balsa wood using Computer Aided Design, Manufacturing Technologies and a CNC router. This standards-based challenge seeks to raise the profile of engineering among young people and give them access to the latest technology in the engineering and manufacturing world. A team of students work together to design, analyze, make, test, and race their car. Just like the real world they must incorporate marketing and seek sponsors to compete regionally, nationally, and internationally (Team Work Canada, 2009).

The program described above is an example of what has been going wrong with technological education. A program developed by the manufacturers of CAD and CNC equipment to ostensibly teach young people skills in the guise of making disposable toys powered by disposable carbon dioxide cylinders and wrapped up with an emphasis on marketing car culture to other youth. An argument could be made that students gain valuable technological skills through this activity, however the fact that the skills are uncritically embedded in an unsustainable context reflects not only poor pedagogy, but also an insular attitude that has unfortunately characterized too much of technological education. Car racing, carbon dioxide, competition and marketing: *"Just like the real world"* is exactly the problem. We are on a path toward doubling the number of motor vehicles in the world from its current number of one billion to two billion in less than twenty years (Sperling & Gordon, 2009). If humans hope to maintain a livable climate, the cultural love affair between North Americans and their internal combustion cars needs to be reconsidered.

Critical science and technology would help young people understand how and why powerful corporate interests manipulate public opinion through their public relations campaigns to the effect of skewing public policy to be favourable to their interests. This story of 'thought control' dates back to the father of modern public relations Edward Bernays who called: "the engineering of consent, ... the very essence of the democratic process" (Chomsky, 2003, p.11). Critical technology literacy would help young people explore how 'greenwashing' and 'green-sloganeering' are the latest PR tactics to manipulate public opinion into believing that corporate actors are doing more to reduce their harmful impacts than they in fact are. The 'Ceres' organization is a national network of investors, environmental organizations and public interest groups working together to address climate change. They have put corporations like General Motors, ExxonMobil, Chevron, and Canadian Natural Resources on a 'Climate Watch List' as firms that are:

not adequately dealing with climate-related business impacts... lagging behind their industry peers and potentially undermining their long-term competitiveness in responding to the business challenges from global climate change (Ceres, 2009, p.1 Gardner, 2009).

So despite expensive media campaigns to sell the public on the contrary, investors themselves have put these corporations on notice for putting short-term profit ahead of long-term environmental responsibility and the common good.

Canadians, Climate Change and Denial

The ugly truth is that Canada has been an innovation laggard in terms of climate change, the Conservative government of the past few years has attempted to de-rail international climate change progress and has promoted a climate change policy that is based on meaningless *'intensity targets'* which allow aggregate greenhouse emissions to continue to increase as the tar sands projects expand. About one half of the 500,000 billion tonnes of carbon dioxide humans have pumped into the atmosphere over the past 150 years remains aloft, trapping heat and causing long-term changes to the climate and ecosystems upon which we all depend. As Campbell et. al. (2007, p.5) point out climate change is emerging as the human security issue of the 21st century:

We already live in an "age of consequences," one that will increasingly be defined by the intersection of climate change and the security of nations.

Canada's record on climate change has been nothing short of shameful (Demerse, 2008). Greenhouse gas emissions grew faster in Canada over the last eight years than in George Bush's America, in fact our emissions grew faster than in any other industrialized country (Simpson, 2009). The *'Climate Change Performance Index'* ranks 57 industrialized countries and emerging economies in terms of their performance to combat greenhouse gas emissions, Canada ranked near the bottom with the second *worst* climate change plan in the world, just above Saudi Arabia! (Germanwatch, & Climate Action Network Europe, 2008; De Souza, 2008). Canadians are no different from any other nation in terms of the national myths its citizens like to believe in. That myth that Canada is a progressive world leader in environmental public policy is

difficult to reconcile with the facts mentioned earlier. Other countries lead Canada by a wide margin in terms of investment in clean technology, the United States is investing over *six times* more per capita in renewable energy and energy efficiency than Canada (Pembina Institute, 2009).

The Alberta tar sands have been characterized as the ‘most destructive project on Earth’ making Canada the world’s dirty energy superpower (Hatch & Price, 2008). Every day in Alberta’s boreal forest another 82 Olympic-sized pools of toxic tailings are creating, further expanding the 130 square kilometer toxic lagoons (Dyer, 2009). Their scale is mindboggling:

If all the toxic waste ponds at Syncrude and other mines were dumped into Lake Erie, they would create a stinking pool 10 inches deep. By 2030, the waste would sit three feet deep (Nikiforuk, 2007, p.39).

Canadian government documents indicate that only a small percentage of the carbon dioxide released in tar sands mining and fuel production can be captured through carbon sequestration technology because the “emissions are not pure enough”. The lead author of the study, David Keith, a professor of petroleum and chemical engineering at the University of Calgary, stated: “Rational people shouldn’t focus on reducing emissions in the oil sands through carbon capture and storage” (CBC News, 2008). Despite the reality that technology will not fix the emissions problems from Canada’s largest emitter of greenhouse gases in the foreseeable future, Canada’s two major political leaders continue to take their cue from the oil patch. Butts characterizes the myopic position of Canada’s two largest political parties and their stated commitment to ‘silver bullet’ carbon capture technology that does not yet exist to ‘fix’ the tar sands as:

Keep smoking kids. We need the tax revenue. Trust us, we will cure cancer by the time you get it...We know this is bad for us but we have faith that a technological fix called carbon capture and storage will make everything better (Butts, 2009).

In a national public relations exercise Suncor one of the largest tar sands producers took out advertisements in major newspapers which included graphs indicating that the company had reduced greenhouse gas emission intensity in its Alberta oil sands development by 51 per cent between 1990 and 2006. As Littlemore points out, what the ad failed to point out was that “thanks to huge increases in production - the company's absolute emissions *increased* by 131 per cent over the same period” (Littlemore, 2008), and that oil production was expected to climb in three to five years a further ninety percent. This clever legerdemain is not unique to oil companies, the oxymoronic ‘clean coal’ promoters also employ every public relations greenwash tactic imaginable to try to convince the public and legislators that “coal is the energy of the future” (American Coalition for Clean Coal Electricity (ACCE), 2008).

The movie “Thank you for Smoking” parodied the public relations industry and the front groups they establish and manipulate to give the appearance of ‘arms-length’ independence and ‘sound science’. The anti-science climate change disinformation industry does exactly the same thing. So-called ‘astroturf’ groups pretend that they are really ‘grass roots’ initiatives of ordinary citizens seeking redress from some grievous wrong committed by governments, environmentalists or ‘big science’. These groups find and often fund sympathetic scientists, economists and business people to put their name forward as ‘experts’ and ‘insiders’ who purport to tell the public their ‘*real story*’ about science. In Canada examples of junk science ‘astroturf’ lobby groups include the ‘*Friends of Science*’, the ‘*Natural Resource Stewardship Project*’ and the ‘*International Climate Science Coalition*’. All of these promote climate science disinformation, and lobby governments for climate change *inaction*. All three of these groups involve more or less the same cast of climate denial polemicists and energy industry or libertarian think tank connected scientists. The ‘*International Climate Science Coalition*’ (2009) headed by a Canadian professor and an energy industry lobbyist even stoops to promote cartoon-filled climate junk science to children on its website.

The public relations tactic of having multiple names and websites for what is basically the same organization, is an established strategy aimed at creating maximum web exposure and to give the impression that the denial group is larger than the fringe association it is. These groups often use the bandwagon effect to self-referentially refer to their non-peer reviewed “papers” or press releases produced by the ‘other’ organizations as “evidence” that their message has wider credibility. This manipulation is often called the

‘echo chamber’ effect in which inactivists quote and promote each other’s junkscience, until the PR ‘echo’ sounds louder than it would otherwise. These groups form part of a larger network of American and Australian anti-science libertarian and industry ‘think tanks’ which have been working for over ten years to stall and derail public climate policy, discredit both climate change science and the Intergovernmental Panel on Climate Change, on behalf of their corporate backers.

The examples described draw attention to the importance of fostering a critical media literacy in science and technological education. It is equally important to draw students’ attention to those who advocate on the public’s behalf against narrow corporate interests.

Public Science & Technology and Public Scientists

Young people certainly need exposure to the work of citizen scientists, politicians and engineers who have stepped out into the public arena to speak directly to the public about issues significantly affecting the common good. Former U.S. vice president Al Gore and James Hansen, one of the world’s leading climatologists have supported civil disobedience to protest the development of more coal-fired electricity generating stations in the U.K. and the U.S. Canada’s preeminent climatologist Andrew Weaver and water scientist David Schindler are examples of scientists who have spoken out publicly about the politicization of science in this country. In October before the last federal election in an unprecedented press release, 120 of Canada’s leading climate scientists called on Canadians to consider the climate policies of the federal parties pointing out that:

In the last two years, Canada has obstructed international efforts designed to develop policies to deal with global warming. At the 2007 Commonwealth Heads of Government Meeting in Uganda, Canada scuttled attempts aimed at getting consensus on a strongly worded commitment to greenhouse gas reduction. At the United Nations meeting in Bali in December 2007, Canada was an international embarrassment, winning a record total of fourteen not-so-flattering Fossil of the Day awards given by the international organization Avaaz.org to the countries who did the most to block progress. Canada resisted all attempts to include specific reference to reduction targets by 2020 proposed by the European Union and others. Our country also blocked efforts to include language calling for global emissions to peak in ten to fifteen years (Canadian Climate Scientists, 2008).

Another open letter last fall from 85 scientists called for an end to the political “subverting” of science, including the closure of the office of the National Science Adviser, the misrepresentation of climate science, the firing of the head of the Canadian Nuclear Safety Commission and ‘political appointments’ to the board of Assisted Human Reproduction Canada (Jay, 2008). Specifically these Canadian scientists identified “blatant examples” of instances when:

- Systems developed to provide non-partisan scientific advice were undermined, interfered with, or dismantled for political reasons;
- Science was interrupted, suppressed and distorted for political reasons;
- Scientific uncertainty was manufactured in instances where none existed;
- Reputable scientists were attacked because the results of their work were unpopular or inconsistent with the views of political parties (Canadian Scientists Against the Politicization of Science, 2008).

Understanding how science and technological policy is often directed to serve political ends is an important disclosing activity. The politicization and censoring of science by governments is something a vigilant citizenry needs to be on guard against if genuine participatory democracies are to thrive.

Mobilizing for Change

A full discussion of how to mobilize for change in technological education is beyond the scope of this document. But in addition to the political ecology dimensions of curriculum discussed earlier young people

need more experience in working with scenario planning and development, understanding the basic concepts of risk analysis and the precautionary principle. 'Climate Futures' (Forum for the Future, 2008), a science scenario-based exploration of how climate change might impact the world under different sets of assumptions and public policy decisions is a good example. Developing an integrated and holistic understanding of the climate change conundrum is essential if young people are to plan, develop and implement effective technologies and public policies to combat climate change.

Lessons can be drawn from the emerging field of 'distributed innovation' of which open source software (OSS) projects like Linux operating system is a recent example. OSS communities are characterized by:

decentralized problem solving, self-selected participation, self-organizing coordination and collaboration, "free" revealing of knowledge, and hybrid organizational models that blend community with commercial success (Lakhani, & Panetta, 2007, p.98).

Distributed innovation systems are developing in a number of industries as diverse as biotechnology, pharmaceuticals, and music and entertainment (Lakhani, & Panetta, 2007, p.98). Lakhani & Panetta suggest that people join these collaborative initiatives not for reasons based in purely self-interest and financial reward, but rather for enjoyment and the social benefits of community. We might consider ways in which communities of science and technological students could approach a regional sustainability issue, with each contributing a part of a larger solution. Teachers might task students in developing open-source green technologies, systems and tools to reduce energy and material use that are freely available for adaptation by individuals and communities.

Other models are Fair trade initiatives and co-ops are enterprises in which primary producers are given access to a higher percentage of profits than conventional 'pillage and plunder' forms of neoliberal colonial capitalism. How might a fair-trade technology co-op work, that traded in community-based renewable energy technologies and know how? We also need to encourage young people to investigate how technological innovation is being fostered through grassroots initiatives in other countries. There are valuable lessons to be learned from innovative approaches in combining green technology projects and community development in developing countries. For example, local-based ingenuity is creating new entrepreneurial markets for energy services like solar lighting and efficient cooking technologies for poor families and street vendors in India, or 'drip irrigation projects that reduce water use and salinization (Novy-Hildesley, 2006).

The examples of executive's rampant greed and criminal mismanagement that has come to light in the wake of the worldwide financial crisis provides a stark counterpoint to the work of Nobel laureate Muhammad Yunus and the Grameen Bank he set up to assist the poor in India. Yunus recognized how technology could be harnessed to help the poor help themselves through micro-credit, invention-led development and the creation of social businesses and eventually stock markets that trade shares in them (Yunus, 2006).

Moving beyond what Senge terms the 'Industrial Age Bubble' requires that technological education be guided by new beliefs and precepts rooted in an understanding of the biosphere, toward that end some include:

- Surf the flux: Live within our energy income by relying on renewable forms of energy.
- Zero to landfill: Everything from cars and iPods to office buildings and machine tools is 100% recyclable, remanufacturable, or compostable.
- We are borrowing the future from our children; we have to pay it back.
- We are only one of nature's wonders: we need to begin to understand our interdependence.
- Value the Earth's services, they come free of charge to those who value them: healthy ecosystems must be protected.
- Embrace variety, build community. Harmony amid diversity is a feature of healthy ecosystems.

- In the global village, there is only one boat, and a hole sinks us all: Our mutual security and well-being depend on respect and concern for all.

(Senge, 2008, p39-40).

Conclusions

The last ten years have seen the lofty and worthy goals of *'technology education for all'* slip back towards parochial skilled trades preparation for *some*. The trend toward re-vocationalizing technology education has been too concerned with 'equipping' young people with "industry standards" without also engaging them in critical thinking about the social, cultural and ethical dimensions of sustainability and our present built environment. The jobs emerging in the green economy require technical skills and an understanding of the broader environmental and sociocultural dimensions of technological and community development (Renner et al., 2008).

This is an opportune time for progressive teachers, researchers and curriculum administrators to re-imagine technological education and in the process green the technology education curriculum from top to bottom. Perhaps the best guidance for educators struggling to make sense of what to do in this period of upheaval comes from Buzz Holling, one of the first scientists to uncover and describe how complexity is embedded in all natural cycles and is an emergent property of all systems:

The only way to approach such a period, in which uncertainty is very large and one cannot predict what the future holds, is not to predict, but to experiment and act inventively and exuberantly via diverse adventures in living (Holling quoted in Homer Dixon, 2009, p.15).

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