



The Political Ecology of Design and Technology Education: An Inquiry into Methods

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ABSTRACT: At the beginning of this new century, design and technology educators face a serious dilemma: Practice conventional modes of design and technology, which have consumed proponents in Canada, England, Germany, and the US, *or* model design for sustainable lifestyles. Our conventional design, problem solving and technological methods embody a liberal, political ecology and in effect, these methods – our practices – are not sustainable. Using the political ecology of Nike shoes as an example, I describe ecological footprints, resource streams, and wakes as effective metaphors for sustainable practice. In contradistinction to technocentric methods, I argue for modelling ecocentric processes rooted in political ecology and cultural studies. Attending to the political ecology of design and technology means nothing less than remodelling the design of lifestyles and reducing production *and* consumption in our practice.

Keywords: cultural studies, design, design and technology education, ecodesign, ecopedagogy, Nike, political ecology, problem solving

Forget the methods until you get the atmosphere right, then choose a method that fits that.

(Jones quoted in Mitchell, 1993, p. 57)

The design, problem solving, or technological ‘process’ or ‘method’ is among the most deeply entrenched practices in design and technology education. While the shift of attention from skills to processes has helped to deflate preoccupations with industrial education, these processes were in themselves a foundation for industrial education. Design and technological methods are supposedly applicable across culture, geography, and time. Certainly, there are good reasons to question the predominance of ‘universal’ metaphors over local, content-specific processes. Today, design, problem solving, and technological method(s) simply amount to bad pedagogy, psychology, and sociology. As researchers in education, design, cultural psychology, and sociology have shown, design and technological methods are neither conducive to student work nor ontologically sound. These methods are rooted in a psychology of the private, Euro-centric intellect rather than in the everyday, sociopolitical mediation of culture and nature. I argue here that these methods are also inadequate for modelling good practice in the face of cultural change and environmental degradation at dawn of the twenty-first century.

The trouble with the methods conventionally modelled is that they are woefully inadequate in accounting for the political ecology of design and

technological practice. Conventional methods – ‘Identify and Represent a Problem’, ‘Generate Solutions’, ‘Choose, Model, and Test the Best Solutions’, and ‘Implement and Evaluate the Design’ – are technocentric and overly simplified representations of extremely complex processes. The challenge for practitioners and teachers of design and technology is to remodel their practice with cultural and natural life cycles. Products, whether they are basketball shoes, barges, bridges, or burgers have a *resource stream* and a *wake* – they’re interrelated with culture and nature in some small or large way. Some ecologists prefer to think of resource stream as ‘material life cycle’ and wake as ‘product life cycle’ or ‘product ecology’. Both streams and wakes are interrelated with the life cycles of living organisms and micro-organisms. To state this another way, our cultural ecologies are part and parcel of our natural ecologies. When we design and teach design and technological problem solving however, we invariably neglect the interconnectedness of products, streams, and wakes. Built within our design, problem solving, and technological methods are values of efficient consumption and production, or a liberal, political ecology and in effect, our conventional models – our practices – are not sustainable.

DESIGN, PROBLEM SOLVING, AND TECHNOLOGICAL METHODS

With John Dewey’s (1910, 1929, 1933) work in the last century, descriptive issues of ‘how we solve problems’ became a normative issue of ‘how we should think’. For Dewey, analytical processes for scientific inquiry were processes for everyday and technological inquiry as well. By 1933, when Dewey revised his seminal work *How We Think*, his earlier notions of reflective experience had become somewhat formulaic. In the revised *How We Think*, his model for everyday problem solving and education looks much like a model of scientific inquiry (1933, pp. 96–117). Along with much of psychology in the 1920s and 1930s, Dewey cast cognition as a private, intellectual endeavour. About a decade later, in an era when science and technology were questioned as inherently progressive, Dewey’s model for problem solving was given a new life in education. Like Dewey, Polya (1945/1957) placed problem solving method at the centre of cognitive processes. Revising and simplifying Dewey’s work, Polya’s model had four discrete, familiar stages: 1) Find, Understand, and Represent a Problem; 2) Devise a Plan; 3) Execute the Plan; 4) Check the Solution and Reflect to Consolidate Learning. Like Dewey, Polya turned to a description of problem solving and provided a normative method for mathematical activity (Lewis, Petrina & Hill 1998).

At generally the same time that Dewey was working through cognitive processes of scientific activity from the 1910s through the 1950s, Kotarbinski was concerned with praxiology and practical activity. Dewey was basically working within an epistemological tradition of Descartes where the problem was ‘how to know the world’. Kotarbinski was working

within a Marxist tradition where the problem was 'how to change or create the world' (Tsing 1993, p. 246). Kotarbinski (1960, 1965, 1938/1983) shaped praxiology as a science of rational action, and focused his efforts on work in what he called the practical sciences (administration, design, engineering, medicine), where design was the factor of distinction. This would involve describing, classifying and appraising, or establishing norms for and evaluating efficiency of, practical action (Gasparski 1983a, 1993; Skolimowski 1965). Given that praxiology is generally a search for methods appropriate for action of a practical kind, it is methodology. With an emphasis on the praxiological virtue of methods, the primary value of interest was efficiency, or rationality between means and ends. Concerns with ethics were relegated to moral philosophy; praxiology would guide design methods and ethics would be an evaluation of design ends (Kotarbinski 1938/1983, pp. 26–29; Skolimowski 1965, pp. 358–361).

It was Kotarbinski's student, Gasparski (1983b, 1984, 1989, 1993) who applied these praxiological principles most extensively to the study of design. For Gasparski (1989), the design process or method is a special instance of practical problem solving, concerning the 'formulating of a design problem and its solution' (p. 161). This includes three steps: '*generating*, or envisioning future states of affairs; *modelling*, or providing descriptions of these states; and *testing*, or analysing their feasibility' (p. 157). In this 'methodological reconstruction', *generating*, *modelling*, and *testing* were the 'invariants of design-making' or the essence; the rest was just ethics and politics (1983, p. 282). Gasparski argued that this method was universal, applying to all design problems regardless of form or content (Gasparski & Doroszewski 1993). His analyses of design were reinforced in the influential text of Simon (1969/1996), *The Sciences of the Artificial*, a study of efficient action *par excellence*. The good praxiologists that they were, Gasparski and Simon argued that there is *no* fundamental difference between designing a welfare policy, designing a sales plan and designing a shoe. These forms of design would merely differ on degrees of efficiency or the degree to which agents exercised rationality in relating means to ends. For the praxiologist, whether a pernicious sales plan and shoe or a noble plan and shoe are designed is dependent on the designers' rational action (assuming an efficient method). In its internal logic, Gasparski's design method elevates the value of efficiency and its praxiological evaluation to primary positions. No amount of heuristics or input of other values into this given design process can change this (de Vries, Cross & Grant 1992).

Yet while praxiological models of design and problem solving were being critiqued in the 1980s, technology educators were reinforcing these models for their design, problem solving, and technological processes. In 1989, 'the technological method' was fabricated to cover some of the weaknesses in a disciplinary approach to technology education in the United States (Barnes 1988; Petrina 1998; Romiszowski 1981, pp. 1–16; Savage & Sterry 1990, p. 12). The technological method was offered by Savage and Sterry (1990)

as a universal complementary to the universal technology systems and disciplines fabricated by DeVore, Lux, Ray and others in the 1960s (Petrina 1998). As the story is told, DeVore's student, Halfin (1973), took a praxiological approach to distil universal, intellectual processes for work in technology. These process were further distilled by Savage and Sterry, and this process of rationalisation continues today (DeVore 1998). The technological method is and was a conventionally praxiological model of Kotarbinski's adaptive action: 1) Perceive a human need or want; 2) Search for ways to fulfil that need or want; 3) Satisfy the need or want (Walentyńowicz & Wasiutyński 1983, pp. 377–381). Based on an input-output-feedback system, the technological method essentially models a capitalist market, where needs and wants, mobilised through resources such as capital, are rationally exchanged for products and services (Savage & Sterry 1990, pp. 12–16). There is an allowance for certain kinds of feedback, but these are secondary to markets, needs, problems, and wants. This model reflects an assumption of the rational agent, who in the process of designing will necessarily choose to maximise the utility of things such as values or resources for an end that is beyond question.

In England during the 1990s, the design method, such as that distilled by Gasparski, was remodelled from its original adoption for craft, design, and technology education practices in the 1960s (Johnsey 1995). There were few changes between the early models of educators such as Richard Kimbell (1982) and John Eggleston (1976) and their current models (Eggleston 1996; Kimbell, Stables & Green 1996). Design and technology education reflects in form and function the praxiological methods that were used to effectively simplify the act of making the built world. Similarly, conventional methods of invention adopted by design and technology educators offer little more than a praxiological model of scientific inquiry. Here, variations on a model of 'Investigation', 'Invention', 'Implementation', and 'Evaluation' seemingly capture, in general terms, the workings of the curious, rational, innovative mind (Cross, Naughton & Walker 1986; Jeffery 1990a; Johnsey 1995, pp. 202–205). The emphasis is on praxiological or technocentric descriptions of cognition, design, and invention. These methods nevertheless frame and limit not only student work, but also the way we think about design and problems in teacher education (Barnett 1994; Custer 1995; Petrina 1994; McCormick, Murphy & Hennessy 1994). Over the past two decades, four areas of critique have been developed which render our technocentric design and technological problem solving methods inadequate.

Pedagogically, these models are reinforcing a distorted image of design and technological practice and are ineffective in assisting students in their work. Classroom studies suggest that students find design, problem solving, and technological methods cumbersome to utilise, and if held accountable, merely retrofit methods and their stages to their actual experience (Chidgey 1994; Cote 1984; Hennessy & McCormick 1994; Jeffery 1990a, 1990b; Johnsey 1995; Johnsey 1995; S. D. Johnson 1997; Jones 1997; McCormick 1993, 1997; McCormick, Hennessy & Murphy 1994;

McCormick, Hennessy, Murphy & Davidson 1997; Rowell, Guilbert & Gustafson 1997). The use of methods has become a 'ritual', some have suggested, having more to do with classroom culture than the actual solving of a problem (McCormick, Murphy, Hennessy & Davidson 1996, p. 10). Claims that these methods, among other process or cognitive skills, are universal and transferable are suspect and exaggerated (Howe 1996, p. 46; McCormick 1993; McCormick 1997, p. 146). In short, the value of current methods have been found to bear little resemblance to the way problems are solved in everyday life (Bloch 1998; Lave & Wenger 1991; Scribner 1985) or the way that designers, engineers, and scientists do their work (Buchanan 1992; McGee 1995; Cross, Naughton & Walker 1986; Latour 1987; Pea 1993, pp. 65–67).

Psychologically, design, problem solving, and technological methods are overly individualistic in their reliance on the rational intellect. Means cannot be judged separately from ends, as praxiologists would have us believe. Nor are choices and judgements made individually. In current theories of 'situated cognition', cognition is inherently social rather than rational and individualistic. Cognition is situated in local, collaborative action and mediated through culture and nature (Cole 1990; Cole & Engestrom 1993; Howe 1996; Lave 1990; Lave & Wenger 1991; Pea 1993; Scribner 1985; Seely Brown, Collins & Duguid 1989; Shweder 1995). Problems, be they technological or discursive – of means and ends – are not solved in the rational mind. If cognition is understood to be thoroughly situated and distributed across human and non-human actors, then 'boundaries' between individual and culture dissolve (Pea, pp. 65–71). In enactivist accounts of cultural practice, cognition is ecological and co-emerges with 'complex webs of experience' (Davis & Sumara 1997, p. 115). Collective knowledge and individual understandings co-emerge and interact. The culture and the individual change through the process. In situated cognition and enactivism are theories of the seamless interconnections between culture, nature, and psyche. These theories begin to address an ecology of 'thinking through others' (Shweder 1995, p. 77) and thinking through things. Cognition is neither fully personal nor social, but situated in activity of individuals and their natural and social ecologies.

Sociologically, design, problem solving, and technological methods fail to acknowledge the complex social nature through which culture is produced and consumed. These methods are inadequate in light of the new sociology which argues that technology is socially constructed through differentials of capital and power. Some individuals and cultures are served by the ill-distributed profits of design while others are disenfranchised. This is the point that appropriate technologists working in developing countries have been making for three decades (e.g., Duckworth 1995; Rea 1995). Rather than ignore the conditions and effects of capitalism, the new sociology makes these explicit in accounts of design, science, and technology. Empirical and theoretical work underscores the new cognitivists' idea that practice does not develop in a social vacuum, but rather is situated within

material and sociocultural contexts, or complex ecological webs of meanings and relationships. Artefacts are embedded in a web of culture, space, time, and the local, tacit rules of conduct through which they get constructed. The net result of the new sociology has been that those parts of design and technological methods that were once made invisible and accepted as given are now visible and in question (Bijker 1993; Buckley 1986; Latour 1987).

Ecologically, our methods, by implicating students and teachers in a continual cycle of generally blind production, and by making consumption and other processes invisible, are no longer sustainable. It is not only our products that have become ecologically unsound – it is our entire process of capitalistic design along with our lifestyles. Arguments that the issue is one of degree and not one of style miss the point that ecologists make. Additional amounts of information prior to the act of design will make little difference in the outcome. Nor is the issue one of applying principles of ‘green’ design or ecodesign to our methods. The issue is that western cultures are overproducing and over-consuming at the rest of the world’s and the future’s expense, and the resources necessary to maintain current levels of consumption and production are rapidly depleting. Design, problem solving, and technological methods have been about giving form to private objects rather than about shaping one’s public life for simplicity and the immaterial (Madge 1993, 1998; Margolin 1997; Wackernagel & Rees 1996; Wann 1996). These methods are atomistic and fail to account for the interconnectedness between product flows, streams, and wakes. They fail to problematise the interrelations between conspicuous consumption and ecological death. Within these models are values of consumption and production rather than seeds for reduction and ecopolitical literacy. Judging from a standpoint of political ecology and human justice, our current methods have been extremely unsuccessful.

Any one of these critiques can be mobilised for an argument to abandon our current models of design, problem solving, and technological practice. Taken together, it seems clear that nothing less than a reconceptualisation of our technocentric methods is necessary. If design is about lifestyles, as our most prescient critics have noted, then our methods are inadequate. To be sure, at the new millennium, design and technology educators face a serious curricular dilemma: Practice conventional styles of design and technology, which have consumed proponents in Canada, England, Germany, and the US, or model design for sustainable lifestyles.

POLITICAL ECOLOGY, ECOPEDAGOGY AND THE CURRICULUM

Political ecology has been constructed as a set of related practices and theories that underwrite radical changes in the structure and political organisation of western lifestyles (Atkinson 1991; Gare 1994; Gorz 1993). Political ecology represents a change in ethics and the way we in the west understand the meaning of life. In North America, it is a fundamental attack

on the 'American Dream' and its attendant capitalist economics and globalisation. There are serious problems, political ecologists argue, with an economic practice that commodifies life by exploiting individuals and cultures through competition with each other and by exploiting nature as a boundless resource. Political ecology includes shades of green perspectives on decentralised, co-operative and community based economics, a revolution in ecological consciousness, and a redistribution of profits toward conservation and egalitarianism. Ecological consciousness generally means acting sensibly toward the interconnectedness of culture, nature, and sustainability. Sustainability refers to the 'limitations imposed by the ability of the biosphere to absorb the effects of human activities' (Madge 1997, p. 51). Sustainable living means that we meet our present need without compromising our future generations' abilities to meet their needs.

Consumption of products and services increased in profoundly unsustainable amounts in the twentieth century, quadrupling since 1950 alone. This unprecedented increase created huge inequities between industrial and developing countries. It is common knowledge that 20% of the world's richest populations are using 80% of the world's resources. For example, while at least three-quarters of all Americans and Canadians live a life of comfort, one-quarter of the world's population do not have basic necessities such as food, shelter and clean water. In commodities and services, industrial countries out-consume developing countries by a factor of sixteen to one. American consumers outpace their industrialised counterparts by equally staggering amounts of consumption and the generation of waste (Wackernagel & Rees 1996; Westra & Werhane 1998). Along with consuming 120 pounds per day in resources, each American throws four pounds of garbage away each day. Of course, most of those who design and produce products and services are implicated in political ecology in detrimental ways. As Papanek said of designers' complicity in 1972: 'By designing criminally unsafe automobiles that kill or maim nearly one million people around the world each year, by creating whole new species to clutter up the landscape, and by choosing materials and processes that pollute the air we breath, designers have become a dangerous breed' (p. ix). Our ecological crisis, in a fundamental way, is directly tied to mass production and hyper-consumption of commodities 'abetted by the seductive activity [i.e., setting fashions] of the designer' (Katz 1997, p. 465).

The political ecology of design has witnessed a gradual shift in ideology and practice over the past two decades. The focus has been shifting from a 'green design' approach, where clean technologies are developed to replace technocentric procedures, to lifestyle, cycle, and human problems approaches (Madge 1997). Green design or ecodesign has been both a force for, and product of, increasing costs for waste disposal and liability insurance, public awareness of occupational health and safety, and knowledge of the scarcity and vulnerability of energies and materials. Ecodesign remains an important strategy, but designers have begun to realise that no amount of new technologies can move us toward sustainable lifestyles.

Designers who opt for green approaches to product design are faced with the implication of merely designing different products to sustain an economy marked by dangerous levels of consumption and production. Good design has been recast as sustainable design to embody social principles of conservation: Clean, sustainable production; Simple, repairable, safe technologies; Egalitarian and just distribution of profit and waste; Simplification of material 'needs'; and the change in consumer preference toward a reduction in consumption. To be sure, good design has come to be a restatement of Schumacher's (1973) principles for appropriate technology: Simple, small scale, low-cost, non-violent technologies; and an economics of egalitarian distribution of power and profits. Designers are now faced with the eco-centric challenge of getting people in over-consuming countries to choose not to over-consume and over-value possessions. The political ecology of design currently extends from an agitation for voluntary simplicity to campaigns for regulatory control over corporate liberty (Buckley 1986; Campbell 1998; Manzini 1992; Madge 1993, 1997; Margolin 1998; Van Der Ryn & Cowan 1996).

Within this political ecology, design methods are in the process of dematerialization (Mitchell 1993). No longer can design be simplified as the intuitive creation of individuals working rationally through technocentric methods. As in situated cognition, enactivism, ecology, and the new sociology, sustainable approaches to design are requiring a new conception of the self. In political ecology, the self is resituated on Earth in relation to life. While technological practice is a web of natural and social relations, one of its failures has been a lack of sensitivity toward the complexity of life within this web. This insensitivity has been reinforced through a nearly total reliance on conventional methods. On the reduction of complex processes to design methods, an early scholar of this simplification, John Chris Jones (1991, pp. 174, 182) reflected:

In the case of design methods my intention was to find ways to make the design process more sensitive to life, but what happened was the imposition of methods that were of a larger scale than those we had before but which are less sensitive. Rationality, originally seen as the means to open up the intuition to aspects of life outside the designer's experience, became, almost overnight, a toolkit of rigid methods that obliged designers and planners to act like machines, deaf to every human cry and incapable of laughter . . . our world of design, seems to have driven design method out of its right place as a practical way of enlivening design and into the sterile function of being a vehicle for some pretty useless and fruitless academic nonsense.

Political ecology offers a key critique and alternative to what has become in design and technology education, a slavish adherence to unsustainable methods.

Ecopedagogy – political ecology of education – is intended to reorient curriculum and schooling toward a sustainable centre. This entails the 'working out of a pedagogy that is ecocentric and sustainable, deeply linked to the Earth's "limits of necessity and mystery"' (Jardine 1993, p. 53; 1994). Ecopedagogy, in a spirit of political ecology, suggests that however much

we are committed to the education of young people, we run the real risk of preparing them to live lives that work against the Earthly conditions necessary to sustain their lifestyles. In other words, we teach in full knowledge of an insane contradiction. Given that humane values are often not so humane, ecopedagogy represents the urgent task of making all pedagogy 'ecologically sane' (Jardine 1993, p. 53). One strategy in ecopedagogy aims to undermine the entrenched practices resulting in the disintegration of knowledge (Gough 1989; Jardine 1993; Leggett & Robertson 1996; Norman 1995). Recognising deep interconnections between culture, nature and spirit, ecopedagogy challenges educators to come to grips with the post-modern condition that 'everything is related to everything'. Without a political content of sustainability, interdisciplinarity and integration in the curriculum appear as superficial manifestations of the new ecology. A second strategy involves rewriting political ecology into literacy (Petrina, in press). The issue is not the amount of information necessary to be literate in today's world, but rather the kind of knowledge necessary to act for clean technologies, revival of local, ecological community, regulations on corporate liberty, and reductions in rates of consumption.

In design and technology education, there have been few sustained commitments toward a program of ecopedagogy. For McLaughlin (1994, 1996, 1997), ecology, global education, and technology education are fused as a single practice. He suggests technology educators practice with a critical wariness toward globalisation and approach classrooms with an 'undistorted international view' of ecology, economics, and global change (1996, p. 16). O'Riley (1995, 1996, 1999) questions design and technology education on grounds of an alignment with capitalist practices that exploit cultures, natures, races, and women. She argues for technology educators to confront their practices and attend to a political ecology design. Lawler & Goggin (1998) emphasize the promise of ecodesign and offer innovative strategies for moving toward green design practices. These are the minority of educators who have been vocal about ecopedagogy. From an ecocentric standpoint, our current design, problem solving and technological methods are part of the problem – not part of the solution (see also Barnett 1994; Elshoff 1998; Gradwell 1999).

It is troubling that even those who attempt to bring an ecocentric mindset to design, problem solving, and technological practices revert to conventional, technocentric methods. A good example of this can be found in *Integrating Technology, People and the Environment* (Gilberti 1992). While Horton (1992) offers an impassioned case for ecodesign, his 'Design Education Approach' is little more than the praxiological design method rooted in the private intellect. Practice within this approach may produce some green products, but political ecology does not govern the practice. Consumption and production, and their streams and wakes, escape the method. Savage's and his colleagues' work with bio-related technologies has potential to move some technology educators toward a more life-oriented and ecodesign practice. But this work does not contain in itself seeds for

bioethical, systemic change, relying as it does on a technocentric method and various biotechnological assumptions (Savage & Brown 1998; Savage, Rossner & Finke 1993).

LIFE CYCLES, STREAMS, WAKES, AND A POLITICAL ECOLOGY OF NIKE SHOES

As indicated earlier, one promising aspect of political ecology is the realignment of design with an ecocentric politics of prevention, reduction, replenishment, and reuse. For about the past fifteen years, models of life cycles and product ecologies have been helping to make political ecology manifest in design practices (Farrell 1996; Jonas 1993; Manzini 1992; Pantzar 1993; Young & Vanderburg 1992). Product life cycle, or life cycle assessment (LCA) began as an engineering design model for analysing products over the course of expected and actual lifetimes – from ‘cradle to grave’. Early design issues focused on stages of product introduction, growth, maturity, and decline, much as conventional analyses dealt with stages of invention, development, innovation, and diffusion (Farrell 1996; Pugh 1991, Schaltegger 1996; Wilson 1996). Decisions on engineering feasibility at early transformative stages were to be fully tempered with knowledge of parts and product affordability, availability, usability, reparability, reliability, and disposability. In life cycle models, product design, production, use, and disposal are the same issue: design for life. Within a few years, life cycle design was explained in terms of sustainability, and became a way of accounting for material flows or streams from ‘cradle to grave’ (Farrell 1996; Van der Ryn & Cowan 1976; Young & Vanderburg 1992; Wilson 1996). In political ecology, the life cycle of products came to be seen as intricately interrelated with life cycles of living organisms.

The premise of life cycle design is that by thinking in terms of material or resource streams we can avoid malignant production practices and reduce our net consumption. The emphasis is on awareness and prevention in order to break our current cycle of production–consumption–pollution. *Resource stream* is an ecocentric metaphor that traces the flow of materials from their *extraction* through their use in part and product *production* and their ultimate *disposal*. Resource streams make visible the fact that ‘materials’ are extracted and refined, and manufactured into parts and products, which are consumed, used and maintained. Products and materials with no remaining ‘value’ are discarded with percentages of the waste being either disposed, dispersed, or recycled. A resource stream suggests that within any act of design, through capital and labour some material was extracted from some(one’s) place and harnessed for some use over time with some waste along the way and in the end. Accountability and sustainability mean that all ‘costs’– ecological, cultural, social – and not merely economic costs are figured into design decisions. Establishing a clear, visible account for resource streams is central to the life cycle process of political ecology.

Wackernagel & Rees (1996, p. 3) developed the 'ecological footprint' to account for resource streams. The ecological footprint 'accounts for the flows of energy and matter to and from any defined economy and converts these into the corresponding land/water area required from nature to support these flows'. Wackernagel & Rees argue that we account for our resource consumption and waste assimilation requirements in terms of land area, or footprint. The footprint represents the 'appropriated carrying capacity' of terrestrial ecosystems necessary to support a given person, society, country, or product (p. 11). This appropriated area necessary to support the habits of affluent countries has gradually increased throughout this century. The current ecological footprint of a typical North American is 'three times his/her fair share of the Earth's bounty. Indeed, if everyone on Earth lived like the average Canadian or American, we would need at least three such planets to live sustainably' (p. 13). A planet where everyone imposes an over-sized footprint is not sustainable. The ecological footprint puts our accounting of resource streams into local and global perspectives.

While the ecological footprint is a way of accounting for the sum of demands on nature from given lifestyles, material throughput is made visible in a resource stream. When we trace the resource stream of commodities, the interconnections between consumption, production, and waste are made evident. This is an essential, albeit difficult, task for life cycle design, ecopedagogy, and political ecology in general. For example, the average pair of sneakers, 'cross-trainers', makes quite an ecological footprint! These shoes are labelled, or 'branded', and designed by a multinational corporation in the US, engineered in Taiwan and South Korea, manufactured in China, South Korea, or Southeast Asia, and mostly purchased, worn, and disposed of in North America (Katz 1994, pp. 160–204; Ross 1997; Ryan & Durning 1997, pp. 26–32; Vanderbilt 1998, pp. 76–113). The leather upper of the shoes, consisting of about twenty parts, is typically from cows raised and slaughtered in Texas. The hides are shipped to Asia and treated through a chemical-intensive chrome tanning process, with a by-product of toxins dumped into an Asian river. The synthetic parts of the shoes are made from petroleum-based chemicals from Saudi Arabia, and distilled and cracked in a Korean refinery, with wastes again making their way into rivers. The midsole is Ethylene Vinyl Acetate foam which requires a number of processes to synthesise. The sole is made from styrene-butadiene rubber, synthesised from Saudi petroleum in a Taiwanese factory. In the factory, the sole is moulded and cut, generating the largest amount of solid waste in the shoe production process. The shoes are assembled in a Tangerang factory or similar Asian factories. Most of the assembly is done through the labour of children and women cutting, gluing, and sewing under sweatshop conditions of high temperatures (100 degrees F) and toxic fumes from solvent-based toluene glues and paint. Their average wage is about 15 cents per hour over their 65 hour work week (Klein 1999, pp. 365–379; Sage 1999). The finished shoes are hand packed with light-weight tissue from Sumatran rain forest trees and placed in a box. The unbleached,

corrugated cardboard for the shoe box was made in a closed-loop paper mill in New Mexico. The shoe box itself is folded in a mill in Los Angeles and shipped to Asia. The boxed shoes are shipped as cargo back to the west coast of the US, transported to local outlets, purchased for about \$60.00 to \$150.000 (USD) per pair, and worn for occasions having nothing to do with sports or training. The average pair of cross-trainers lasts less than a year and usually ends up in a landfill. This particular resource stream flowing into and through the production and consumption of these shoes is an example of current practices of globalisation.

Understanding this flow of resources is a necessary, but inadequate, condition to life cycle thinking about the shoes. We can begin to see how in any given stream, extractors, converters, labourers, producers, products, shippers, consumers, collectors, and recyclers act in tandem, but material life cycles or resource streams are in themselves inadequate to fully account for a product's political ecology.

The political ecology of design takes resources into account and helps us take the additional step in accounting for wakes of commodities. A *product's wake* – the rippling together of production, consumption, and waste – extends outside of resource streams. When we design, build, purchase, use, or dispose of a product, our actions have biophysical, psychosocial, and political consequences. Ecological values such as care, complexity, disequilibrium, interconnectedness, interrelationship, and limitation hold us responsible to product life cycles (Krippendorff 1989; Manzini 1992; Pantzar 1997). But, these values work in tandem with political values such as control, distribution, equity, interests, justice, liberty, and power. What is at question when accounting for wakes are the interrelations among nature, people, and things – the political ecologies of products. Rather than drawing distinctions between ecology, society, and technology, questions of relationships are intended to erase distinctions and emphasise the dynamic yet fragile web sustaining everyday life (Latour 1991). Within this web, individual choices have become increasingly dictated by 'situational factors, routines, and social norms, and less and less by individual preferences' (Pantzar 1997, p. 55). Clearly, when designers make choices, they operate with some understanding of how people interrelate with technologies. The trouble is, in conventional design and technological practice, these understandings have represented little more than a simple economics and praxiology of products, services, needs, and wants. Products do not merely mediate between actors, needs and wants, or between actions and motives; rather, actions motives and products interrelate in complex ways (Campbell 1998; Durning 1992, pp. 117–135; Margolin 1995). These interrelations are nested in a web of social practices and a plurality of relations between human and non-human actors (Latour 1991). Political ecologies of products presuppose intrinsically complex life cycles, demanding increased attention, care and participation in design and technological practice. The challenge is in framing this political ecology of culture, nature, and motivated actors.

The 'circuit of culture' is one fruitful entry into this political ecology

of design. In this model, representation, identity, production, consumption, and regulation are framed as cultural processes working in tandem. Du Gay, Hall, Janes, Mackay & Negus (1997) used this model to demonstrate how these five cultural processes are inscribed into the material design and social uses of the Sony Walkman. When the process of waste, or refuse, is added to this, the circuit is an entry into a complex political ecology of design (Feng & Petrina 2000). This circuit of culture makes it crucial to pay close attention to even the most mundane of products and services.

For an adequate political ecology of the example given earlier, it's necessary to follow the steps of the shoes, cross-trainers, through a circuit of culture. We have to interrogate their wakes and ask 'what do the shoes mean and how do we make sense of this?' Let us imagine that our pair of trainers was branded by Nike. Established in 1972, Nike had its best year in 1998 when sales topped \$9.6 billion. The company has produced 900 different types of shoes, most of which have been sport related and marketed, figuratively or literally, by athletes. Nike endorses more than 3,000 athletes through its advertising fold, including 72% of the National Basketball Association players, 60% of the Major League Baseball players, and 50% of the players in the National Football League. Over 200 universities fly the Nike banner for their sports teams. Nike sells about 160 million pairs of trainers each year, and nearly one of every two are purchased in the US (Egan 1998; Katz 1993, 1994; Reiland 1998; Vanderbilt 1998). The average American teenager buys between three and ten pairs of athletic shoes (specialty sports and fashion) each year at prices ranging from \$50.00 to \$150.00 per pair (Lane 1996, p. 45; Vanderbilt 1998, p. 116). Nike's brand logo is recognised by about 97% of all Americans, but the 'swooshification' of culture is global. And it has little to do with shoe sales and sports. Nike produces consumer demand, images, and brands of blackness and whiteness. With distribution increasing in Asia, distinct brands of being Chinese, Japanese, or Korean are also represented in advertisements and shoes (Clifford 1993; Media Foundation 1999).

Nike executives speak of creating an 'emotional tie' between affluent customer and branded shoe (Clifford 1993, p. 46). As Nike analyst Timothy Egan (1998, p. 69) said, 'the idea is simply to create a connection between consumer and product, a link often having nothing to do with what is actually being sold'. This connection is what's often referred to as 'brand consciousness'. The company has worked to construct the meaning of their shoes as well as the social practices with which a pair of Nike shoes is associated. To do this, Nike has used hyper marketing, sports, and urban street attitude in a unique, potent, strategic mix that adds up to exposure and endorsement. Nike spends between \$300-\$500 million each year, excluding athlete royalties, to create brand consciousness and desire. A pair of Nikes represents a competitive edge, glamour, rebellion, status, and the intricacies of coolness. Nike walks as a marketing giant, profiting each step through swoosh loyalty, in a culture where both conformity and egomania rule the day.

Nike produced, with their consumer loyalists, an identity and representation for their shoes in the mid 1980s. In 1984, the Georgetown Hoyas played to a national championship in college basketball with Nikes on their feet. In a gymnasium where white sneakers were everywhere, the Hoyas stood out as hard-playing rebels with their multicoloured grey and blue trainers. Later that year, Michael Jordan turned up on the professional basketball court in his Chicago Bulls uniform and Nike shoes laced and designed especially for him. And in the spring of his rookie year in 1985, he and his 'Air Jordans' starred in a thirty second commercial that defined Nike's representation of blackness and sport. The ad showed Jordan, arm extended with ball, legs splayed wide, feet fitted with red, white, and black shoes, jumping toward a jet aeroplane and all the while hanging in the air for a third of the ad. Here was Jordan's genius, grace, and shoes, and Nike's strategy, shown over and over on a global television network (Strasser & Becklund 1991). Rather than pitching a product, Nike produced an attitude with which their shoes could be associated. Adding to the mystique and rebellion, the National Basketball Association proceeded to temporarily ban the Air Jordans. Jordan, the Bulls, and Nike were transformed into icons in black and white neighbourhoods, and at about \$100.00 (USD) per pair, Air Jordan's accounted for \$130 million in sales that year. For the hearts, minds, and feet of many young men in inner city 'hoods', Nike made it possible to emulate Jordan's moves on the court and out of poverty.

More than any hoop dreams of class mobility, young men's identities were linked to the coolness and rebellion that the Nikes represented. An image had been produced, and by the late 1980s, some young men saw Air Jordans as representing an identity worth killing for. In 1989, a young man was found strangled in Baltimore, which later had been confirmed as a crime committed for the two-week old Nikes he was wearing. This and succeeding crimes underscored the meaning which with shoes had been ascribed in an aggressive, inner-city, street culture. Baggy jeans, pork-pie hats, and Nikes or similar shoes (e.g., Reeboks) stood for black, hip-hop and 'gangsta' identity. As they projected an identity of power and aggression, professional athletes and rappers came to be role models for young, black and white men. The shoes the basketball stars and rappers wore, and those desired by the young men, conferred a special blackness and identity. Since the mid 1980s, Nike reproduced this representation in their off-the-wall and in-your-face commercials. In 1991, Spike Lee and Jordan co-starred in a number of print and television ads, most of which captured Jordan in his patented 'Jumpman' leap toward the hoop and Lee bespectacled, bug-eyed and mouthy. Here was Air Jordan and 'Mars Blackmon' with popular appeal across racial lines – the shoes providing the edge – potently representing aggression, hipness, style of play, and distinction for black youth culture. In the ads, the camera invariably turned to Lee, who in his Blackmon character, exclaimed: 'It's gotta be the shoes'.

In producing an inspired Air Jordan, Nike produced a brand conscious-

ness where athlete, colours, logo, masculinity, performance, race, status, style, and shoes were represented and regulated as one. As Nike's vice president of research, design and development said, 'for us, design and emotion are symbiotic . . . [people] respond to the swoosh because our products deliver emotion' (quoted in Gragg 1997, pp. 63–64). To regulate desire for both identity and shoes, Nike releases new models on regular bases, while keeping supplies deliberately short. From the release of Air Jordan I to Air Jordan XIII, desire for symbol, status, and shoes have been regulated. The technical aspects of the shoes' designs are part of Nike's overall strategy in regulating the loyalty of 'Nike guys' the world over. Nike has of course expanded to a clothing line, and to nearly all sports, producing a new colour or style of shoe and identity almost every day. Doubling its shoe design team since 1995 to about 300 currently, Nike draws on a range of technoscientific areas such as biomechanics and material science. Nike has managed to cross the gender line along with other companies, and in 1994 women's total athletic shoe sales passed men's (\$5.4 billion versus \$5.2 billion). Like most large companies, Nike builds 'fashion ranges' through 'new design modifications, colour combinations and logos', all of which have little to do with improved design (McDowell 1989, p. 103). But Nike does *not* merely design, produce, and regulate identities and shoes that are consumed, as in a uni-directional exchange between active producer and inactive consumer.

Nike, shoes, and identities are co-produced within a political ecology where lines between producer and consumer are blurred. Nike and its shoes are appropriated by consumers who have their own representations of what it means to be athletic, black or white, cool, and street-wise. Nike's success in sales is partially due to the fact that the company has realised that it is not sufficient to rely on their designers or athlete-consultants for design advice. There is a huge reliance on trend-tracking and focus group firms that are aimed at teen-age markets. Nike also allocates 'cool hunters' to urban neighbourhoods and their NikeTown outlets to tune into what is 'fresh' – what turns young people on. Nike sends out hip representatives who go 'bro-ing' in cities like New York and Philadelphia to get brand reactions from young ghetto kids. Pairs of newly designed basketball shoes are given to some of the lucky kids for reactions on coolness and performance in return. The reactions are delivered back to the company's headquarters in Portland, Oregon where colours, styles and materials are redesigned. This may amount to simply altering shoes' soles, tongues or weight, or completely redesigning the shoes from the sole up. Nike's 'Air Jack' shoes were renamed 'Air Raid' in the late 1980s when Nike discovered that 'jack' denoted killing or robbing in street lingo. Air 'Jacks' would have represented a segment of culture that in the end, was uncool. And in spite of a fair bit of control, the frequency of Nike's ads continues to be regulated by the mass media's scheduling of sporting events. In this complex political ecology, it's difficult to tell who is producing and regulating what or who.

The 'swooshification' of culture is intricately tied to the 'sportsification' of the world. As Nike officials wrote: 'We will mature in tandem with the inexorable penetration of sports into the global psyche' (quoted in Egan 1998, p. 67). Within a complex of global capital, mass media, and sports, Nike's particular representation of culture has become accepted as normal and universal. Through these agencies and processes of regulation, aggressive play, coolness, and rebellion conferred through branded commodities such as hats, shirts, and shoes have come to be the fashion norm in countries like Canada and the US. Nike is prospering within a larger revolution against formality as 'ath-leisure' fashion has been a hot trend for the past few decades (McDowell 1989, p. 104). We are what we wear, and more than ever who we are is branded and regulated by some multinational corporation. Nike dominates British athletic shoe markets and since the early 1990s has been penetrating Asian markets where teens appear all too anxious to adopt Nike's representation of culture on their own terms of rebellion. According to Dyson (1993, p. 72), 'the sneaker symbolises the ingenious manner in which black cultural nuances of cool, hip, and chic have influenced' an increasingly Americanised global landscape. Yet this regulation of what Hoberman (1997, p. 4) calls the 'black athletic aesthetic' stimulates 'wildly unrealistic ambitions in black children – an improbable number of black boys expect to become pro athletes – and imitate fashion trends and hairstyles'. Racial norms are regulated and where social conditions act against minorities, at least in sports there has come to be the acceptance of black bodies and minds (Dyson 1993).

For many young people, Nike represents athletic fame and marginalised culture. For young blacks, Nike celebrates the success of blacks in a media world devoid of colour outside of music and sports. Nike reaffirms a popular form of blackness. Most teens understand that Nike sells identities and since the mid 1980s have produced Nike as much more than a shoe company. Nike's response to teens' media insights has been to drop any pretence that the company is marketing anything less than identities, accounting for much of the success. Nike plays on the fact that most youths have a marked distrust of moral leadership, and if given the choice, would rather be represented by Nike's athletes than by others such as politicians. Yet for all the media literacy and active consumption and production of American teen-agers, they buy between three and ten pairs of athletic shoes each year, as noted earlier. Resistance evidently may or may not be cool. Skateboarders are anti-Nike, but with feverish loyalties consume other brands.

Detractors who in the end realise that what Nike produces and markets are consumers, posture the swoosh as everything that is wrong with global capital. In 1990, Reverend Jesse Jackson led a boycott of Nike to demand that the company award contracts to black businesses in proportion to the sales made in inner city neighbourhoods. Despite a disproportionate amount of money coming from blacks, Nike was a white company with a white board of directors. For Jackson, Nike represented a typical American

company-the establishment-in spite of the representation of rebellion the company projected. Currently for human rights activists, Nike's swoosh is more a 'swooshtika' as the company has made little attempt to alter its labour practices in Asia (Egan 1998, p. 67). Nike has been criticised for not ensuring fair wages, labour rights, and safety standards among its subcontractors. The 'Nike ethic' has come to be defined simply as: 'Extract from the many to benefit the few' (Brissell, quoted in editor, 1999, p. 25). And the advocates for social change have subverted the Nike slogan from 'Just do it!' to 'Justice do it!'. Nike represents the effects of the globalisation and regulation of American culture. Nike workers are paid \$1.75 a day in China, \$2.46 a day in Indonesia, and \$1.60 a day in Vietnam (Johnson, G. 1998, p. 57; Sage 1999). If a pair of trainers sells for \$100.00, \$50.00 will go directly to the store, \$33.00 will go to Nike (Plus store profit if sold in a Nike Town store), \$11.60 goes to the factory where 40 cents will be distributed for wages, and \$5.00 will go toward shipping and taxes. As described earlier, Nike's factories chatter with the deafening noise of sewing machines and average temperatures are 100 degrees. These workers, most are under 24 and 75 to 80% are women, are jammed on assembly lines to turn out about 7,000 pairs of trainers through their 10–13 hour work day. In all, there are between 350,000 and 530,000 workers in Nike's Asian plants. The low US tariffs on most of Nike's shoes (8.5% on finished shoe) and the leather and synthetic upper materials, combined with the labour-intensive designs explain some of the incentives behind the political geography of Nike's global production practices (Barff & Austen 1993; Klein 1999, pp. 365–379; Sage 1999). The US government has not been willing to increase tariffs and regulations on globalisation. But, activists and workers were successful in 1999, through political protest, to bring Nike to reconsider some of its labour and resource practices. At this moment in the political ecology of Nike shoes, we are directed from the wake back into Nike's resource stream.

Through this political ecology of Nike's cross-trainers, we are not suggesting that the shoes caused a footprint, resource stream, and wake. Footprints, streams, and wakes are useful, ecocentric metaphors that help us move beyond deterministic, technocentric metaphors such as impacts (Petrina, in press). To follow in the footprint or stream of the shoe means attending to the conditions and processes surrounding the ecology of the shoes. To follow in the wake of the shoe means attending to biophysical and psychosocial conditions and political processes surrounding the culture of the shoes. Footprints, streams, and wakes are the material of political ecology. With this example, I am suggesting that the shoes, or any artefact or service (occupations in Dewey's rhetoric), are useful foci for understanding interrelations among, or boundaries between, nature, people, and things-the political ecology of design and technology.

SUSTAINABLE PRACTICE AT THE MILLENNIUM

Using a political ecology of Nike shoes as an example, I argued that conventional design, and technological problem solving methods are inadequate for understanding contemporary design practises. I argued that these methods are unsustainable as they fail to account for life cycles, streams and wakes. And whether in school or in the workplace, this is an issue of accountability. Conventional methods – ‘Generate Solutions’, ‘Choose, Model, and Test the Best Solutions’, and ‘Implement and Evaluate the Design’ – embody values that are unsustainable in terms of political ecology. These methods assume a separation of means from ends, and in this praxiological sense, the means-ends distinction is left unquestioned. As was indicated in the case of something as mundane as a pair of shoes, the process of designing or technological problem solving is implicated in complex political ecologies where means are inseparable from ends. As a step away from technocentric models that make streams and wakes invisible, I argue for current notions of life cycles and cultural circuits, or models that make political ecology visible.

Figure 1 is a humble attempt to capture critical, dynamic processes in

Political Ecology of Design and Technology: Designing Conditions and Processes

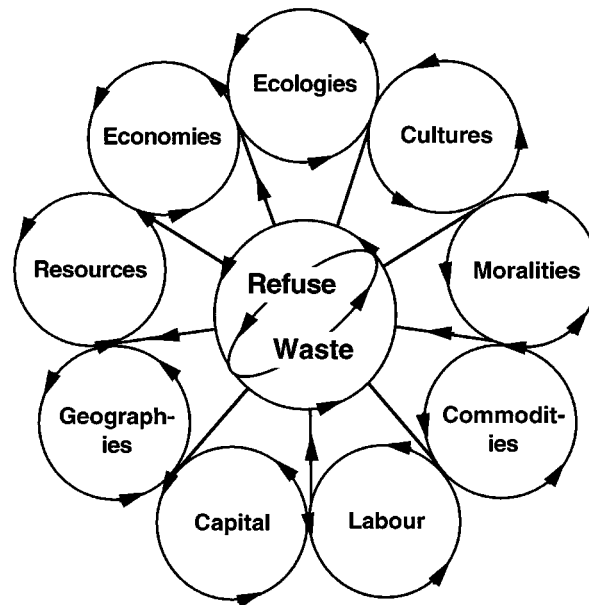


Figure 1. The emphases in the political ecology of design and technology are on conditions and processes. Resource streams flow through each of the ten cycles and the larger, encompassing product cycle.

product life cycles to attend to in designing for sustainability. Rather than any static inputs and outputs or means and ends, the focus is on conditions and processes in the political ecology of design and technology. The model is intended to be ecocentric, and indeed, the process of waste is the pivotal centre around which the other cycles revolve. Each of the ten cycles combine to create, and are integral to holding together, a larger product life cycle. Of course, these cycles are inseparable in political ecology but are separated here for clarity. For example, one does not ‘use’ resources without disrupting someone’s cultures, ecologies, and geographies. It is not important which cycle you start with, as long as all the cycles are attended to their interrelations within any given design or technological problem. In contradistinction to simple methodological ‘how to’ models proliferating in design and technology education, this model is helpful in accounting for resource streams.

As indicated earlier, the emphasis is on awareness and prevention in order to break our current cycle of production–consumption–waste. To be certain, this model leaves an option for producers and consumers, students included, to say ‘no’ to, or refuse, the ends of production and consumption. In distinction, our conventional design and technological problem solving methods necessarily do not – or cannot – end in a reduction of consumption and production. Their very nature is the production of consumers, producers, and things. These ends, given that they are separated from means, are unquestioned. It is crucial that we leave open the option that, in school, a design or technological problem may be halted for lack of accountability to an ecologically sustainable resource stream. Another option is that thirty student problems or projects may be consolidated into two small-scale problems. There are difficult questions to address: If we know little about the stream in which our materials arrive, ought we produce anything at all? If we slow down or halt production and consumption in design and technology education, can we legitimise the subject area? To what degree are we implicated in the current cycle of production–consumption–waste? What is our comparative ‘ecological footprint’?

Students ought to be encouraged to do nothing less than ask and answer some difficult footprint, stream and wake questions of our school practices (Petrina 1998, pp. 128–130).

- Where do our materials come from – from whose backyard and at what ecological cost?
- How did the materials get here – through whose backyard and at what ecological cost?
- How sustainable is our material practice?
- Where does the waste of our production and consumption go – to whose backyard and at what ecological cost?
- Whose identity is appropriated and represented in our design practices (or in this artefact, sign, text, etc.)?
- Whose identity and what is regulated through our practices (or in this artefact, sign, text, etc.)?

- What are the mechanisms through which representations and regulations are occurring?
- How can this identity, representation, production, consumption, regulation, or waste be re/appropriated for collective justice?
- How do I change my lifestyle to produce and consume less?

Figure 2 is an ecocentric model of the 'circuit of culture' (Feng & Petrina 2000). Like the first model, the focus is on conditions and processes in the political ecology of design and technology. The model is intended to be ecocentric, and indeed, the moment of refuse or waste is the pivotal centre through which other moments are interconnected. Of course, these moments are inseparable in political ecology but are separated here for clarity. In the Nike example, it is clear that the company is producing and regulating consumers, identities, representations, and waste. It doesn't much matter where you begin as long as all six moments are attended to in any given design or technological problem. In contradistinction to simple impact

Political Ecology of Design and Technology: Circuit of Culture

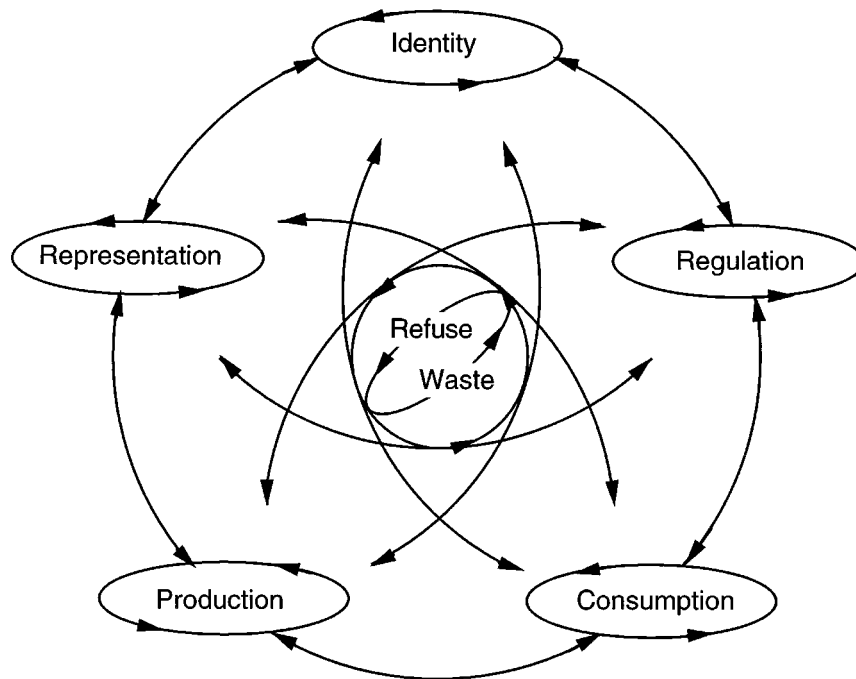


Figure 2. The Circuit of Culture takes on a complex political ecology when the ecocentric moment of waste is introduced. This model maps directly onto the Political Ecology of Design and Technology model in Figure 1. Adapted from DuGay, Hall, Janes, Mackay & Negus (1997) and Feng & Petrina (2000).

models in design and technology education, this circuit is helpful for us in accounting for wakes.

This model is meant to be literally superimposed on the first model. With these models superimposed on each other, we are reminded of the intricate interrelations between streams and wakes, or between culture, ecology, economics, and politics. These models are meant to help some difficult questions surface from the streams and wakes of design and technological problem solving. Understanding that at some point after a complex problem posing process something is going to be produced in laboratories and workshops, I have not left production processes to default to conventional methods. In Figure 3, I have added a dimension of familiarity. Embedded in the political ecology of design and technology is a pedagogical approach whereby students critically interrogate conditions and processes to pose problems, concretise some form (artefact, sign, technique, text), critically interpret the form, and situate the form for public critique.

Figure 4 takes another step in refamiliarising our model of political ecology. In this figure, familiar life cycle moments are mapped around the circumference of the larger of the cycles. In a way, these familiar moments distort the model by suggesting a counter clockwise cycle that begins at eleven o'clock. This has the danger of reducing the model to a

Political Ecology of Design and Technology: Designing Critical Processes

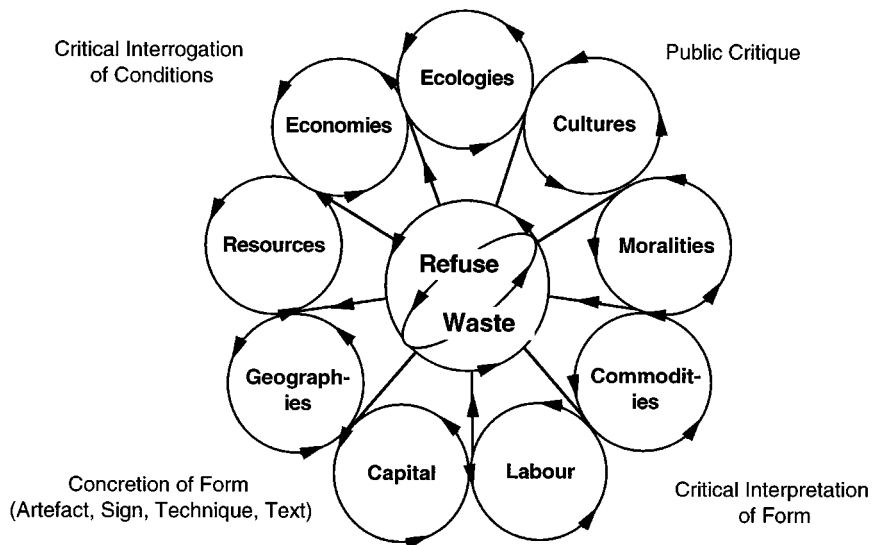


Figure 3. Four critical processes are spaced around the circumference of our model of the political ecology of design and technology. These are normative processes in sustainable design.

Political Ecology of Design and Technology: Designing Life Cycles

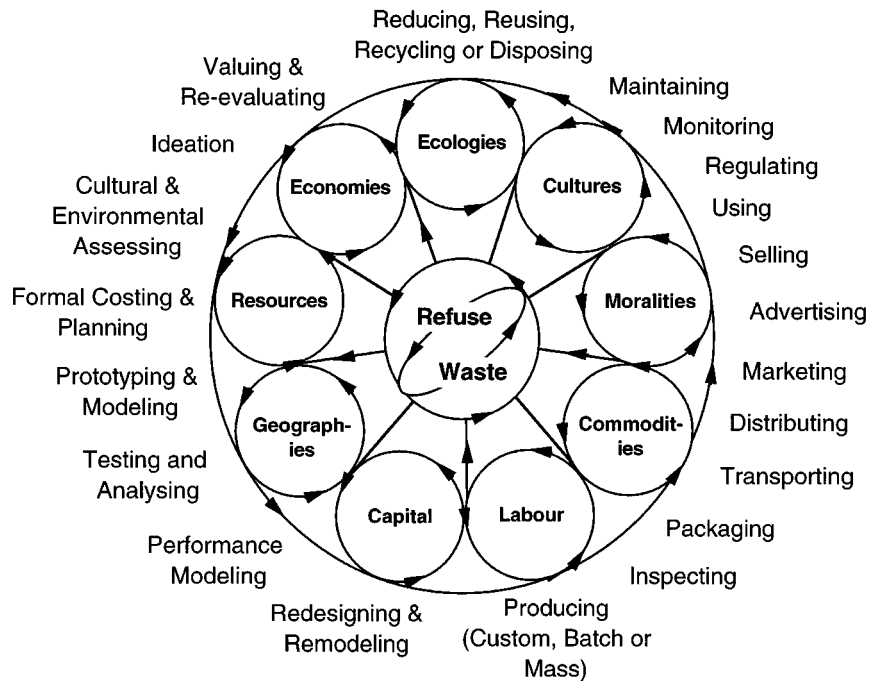


Figure 4. Moments familiar to design and technology educators are indicated around the circumference of the product life cycle. The difficulty of mapping directional moments onto a non-directional model is evident.

banal, technocentric method. Of course, in a world of designers who are more and more working in a model of concurrent design (Nike is an excellent example), there is no single order to design. But if we are accountable to political ecology, we necessarily have to slow down design and production. That is the value of the inner model. The moments around the circumference merely indicate another dimension of resource streams, life cycles, and wakes, and are meant to help us make a transition from the familiar to the unfamiliar.

Figure 4 adds a dimension of product life cycle thinking to our political ecology. Any one of the moments mapped around the circumference can be critically interrogated from an ecocentric standpoint. For example, we can ask some initial ecodesign questions of streams and life cycles (Fox & Murrell 1989; Van der Ryn & Cowan 1976):

- How much embodied energy does the product or process require over time? (Embodied energy refers to the amount of energy necessary for the production of materials in the product or process)

- Are renewable or sustainable resources used in the product or process?
- Are there less energy-intensive, longer lived alternatives to the resources used?
- Whose resources and labour was used in extraction and manufacturing?
- Are local resources for the product available?
- What hazardous, gaseous, aqueous, or solid wastes are created? What ecologies and people are exposed to this waste in extraction, construction or manufacturing?
- Can this waste be reduced through alternative materials and techniques?
- Does the product require special techniques, treatments or finishes that are health and safety hazards?
- How much energy is required for transporting the materials and product?
- How easy is it to maintain and recycle the product?
- How much maintenance does the product require over its life?
- How resource-intensive is the maintenance program?
- What wastes are produced in maintenance? Who will maintain the product or process?
- Can the product be recycled or reused at the end of its useful life?
- Do different materials offer better chances of resource recovery at the end of the product's life?

With familiar moments mapped onto our ecocentric model, we are reminded that our challenge is greater than engaging with design and technological problem solving in a way that merely results in 'making and doing'. Despite all the questions that we may ask in the name of greening our 'making and doing', current issues suggest that design is about lifestyles. No amount of ecodesign is going to add up to sustainability. We have to face the reduction issue inside and outside of school. Good design and technology education is about reduction in production and consumption. Rather than sustaining current levels of consumption and production, I am arguing to take time to attend to the footprints, streams, and wakes of our already built world. Built into the models offered above are the seeds for ecopolitical literacy. To be sure, sustainable design means adopting an outlook and the tools of political ecology. In design and technology education, where we want to provide a 'critical' literacy of the built world (Petrina, in press), we can afford to do no less.

THE POLITICAL ECOLOGY OF KNOWLEDGE AND SKILLS

Education for design has become a very complex task. We must train people capable of revolting against stereotyped ideas, but we must also equip them with the means to do this; otherwise the revolt is only declamatory. Moreover, in most cases the act of creation is not something beginning and ending in an individual. It is a social fact. To create is frequently to form the life of others, but in some cases it can contribute to deform and even to damage – or to destroy – the life of others. Thus education for design can be indifferent neither socially nor culturally, because design is not indifferent. Education for design is education for responsible creativity. (Maldonado 1965, p. 122)

scale in Figure 5. Those programs still emphasising production in automotive, metal, or wood shops, or committed to investing in new technologies such as vendored modules continue to reinforce over-consumption in their respective countries. Design and technology education is *the* most resource-intensive of all subject areas, and it would be healthy to frame the issue as one of accountability and sustainability. What is necessary is a fair and just commitment from educators in affluent countries, or those on the unsustainable side of the scale, to reduce their in-house consumption by a factor of ten. This would be attuned to the 'factor of ten' social movement for reducing consumption (Ryan & Durning 1997). In practising with an eye toward our larger global context, we will have to make some difficult decisions about what constitutes a fair share of resources. It is abundantly clear however that we ought to provide curriculum and lessons for encouraging lifestyle values such as frugality and simplicity.

Some practices are promising in light of the political ecology of design and technology education. At the British Columbia Institute of Technology for example, student teachers have been given a '2 × 4 challenge' over the past three years. The students are challenged to design and construct 'something' of aesthetic and utilitarian value with only a 2 inches × 4 inches × 8 feet board of Douglas Fir. They can use glue, but must construct their fasteners from the allotted wood. The weight of the final object is compared to the weight of the original board for a measure of conservation. Students have been known to salvage their saw dust to create filler, using nearly 100% of the original resource. Of course energy is expended, but there can feasibly be zero waste of the material resource. Yet this is an activity among many others that do *not* attend to sustainable practice and the net effect is an over-consuming teachers valuing a high consumption to skills ratio. For all our assembly line activities that end in the production of objects, we do not have a dis-assembly line activity where these objects are taken apart with very little resultant waste in the cycle.

Design and technology educators are a lot like Nike. Design and technology educators work hard to appeal to all kinds of people and practise as though we have a product that is 'all good'. We are extremely proficient in designing things but also know that we are involved in something larger than artefacts. We produce identities with our students and represent particular cultures through our practises. We are intricately tied to a complex political ecology of material resource streams and wakes, and produce consumers, albeit semi-skilled consumers. Like Nike, we seem to want little responsibility to this political ecology, preferring to neglect resource streams and increase production and consumption. Yet in this global market for capitalism, Nike is not, as educators ought to be, in the business of attending to collective justice and the common good. Like good design at the turn of this new century, good technology education is about lifestyle changes for ecological and social justice. What do we really want our children and students to know about the political ecology of design and technology? Do we 'want to be like' Nike?

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