Productivism and the Product Paradigm in Technological Education

Leo Elshof

"To keep every cog and wheel is the first precaution of intelligent tinkering"
–American ecologist Aldo Leopold (1993)

Aldo Leopold was a pioneer in United States' wildlife management and his axiom is certainly familiar to anyone who has tried to repair a complex technological system, it applies equally whether one is rebuilding a small block V8 engine or repairing a computer. "Keep all the pieces" is good advice because in all likelihood they will all be necessary to restore the proper functioning of the system. Before we begin tinkering it's a good idea to figure out the purpose of the components so even if we initially forget where the pieces go, we will (if we're competent) eventually figure out where they fit. The metaphor is appropriate in light of the impact our technological systems of production and consumption are having on the biosphere. We are effectively tinkering on a dangerous planetary scale, damaging, even destroying critical pieces of the biosphere, often without even comprehending the role of the systems we have lost in maintaining a thriving and healthy planet. There is a serious disjunction between our science-informed environmental knowing and our technological-economic actions.

This paper will explore the nature of the modern product with respect to its relationship to technological education. The term *"product paradigm"* refers to a number of interrelated, implicit and explicit beliefs and assumptions regarding the nature of postmodern technological product culture that are increasingly problematic for technological education. It will also offer ideas to move technological education away from the *product paradigm*. In general the *product paradigm* consists of four distinct assertions. We will explore each of these nonexclusive dimensions in turn, but first we need to examine the critical role design has to play in perpetuating the *product paradigm*.

The Nature of the Problem

The ability to design, develop, manufacture, use, choose, and maintain technological products are an important part of technological education

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Leo Elshof (leo.elshof@acadiau.ca) is Assistant Professor in the School of Education at Acadia University, Wolfville, Nova Scotia.

(International Technology Education Association, 2000). It is also important that students develop the confidence and familiarity that will prepare them to "deal intelligently with current and future technological products" on their own (ITEA, 2000, p.6). Life as we know it would be virtually inconceivable without the plethora of products which define our built environment. Consumer-citizens situated within this context find it increasingly difficult to imagine ecological alternatives to the current product-inspired reality, thus making it more difficult to unravel the ecologically problematic dimensions of it. Technology fundamentally involves applying knowledge, materials, resources, tools, and information in designing and producing products or artifacts, structures and systems (Stein, Docherty, Hannam, 2003). Technological design activities should engage students in moral and ethical judgments that reach beyond the question of whether a product can be manufactured, to ask if it ought to be (Conway, 2000, p.250). As Flowers (1998) points out few products are designed to meet actual needs, instead human wants are engineered to meet product availability, thus reinforcing the message of materialism: "They are taught that creatively designing products is a good thing, regardless of the outcomes. The ultimate criterion for success is money" (p. 21). Because students come to technological design with preexisting notions and concepts about the design process (Jones, 1997), it is crucial that technological education provide opportunities for them to critically examine the implications of product materialism and more environmentally responsible alternatives.

Product design activities can provide opportunities for reshaping students' values and calling "new ones into play" (McLaren, 1997, p. 261). Thus product design should be closely connected with identifying and reconciling technical, economic, aesthetic, social, environmental, and moral values (Layton, 1993, p.21). The product design field has moved away from a preoccupation with isolated "things" and toward an understanding of how products operate in human, environmental, and cultural systems (Buchanan, 2001). De Vries (1997) identified a number of observable design factors relevant to the development of a particular product. These included scientific, technological, market, political, juridical and aesthetic factors. To this list a crucial missing factor needs to be added and that is an "ecological factor" that speaks to the environmental performance of a product. The problems identified by Petrina (2003) concerning CAD education in classrooms and in teacher education, that identified: "over-exaggerated technical content" and "attenuated and naïve" (p. 50) discourses concerning the ethical-personal and sociopolitical content of technological education, are problematic insofar as they are often ignored.

The notion of a *product paradigm* stems from the fact that the conventional manner in which we have considered the role of products in the cultural life of rich, developed nations needs to be reassessed in light of scientific realities and in the paradigms that inform their production. The *product paradigm* draws our attention to these underrepresented considerations, it brings to the fore the need to question and reassess the manner in which we teach young people about product design, development, manufacture, use, and disposal. It is more accurate to think of products today in terms of interdependent *systems* of consumption

and production. Products are marketed in terms of lifestyle systems of consumption and lifestyle image. The term *"production-consumption"* system or cycle more accurately reflects the fact that designers, engineers, producers, suppliers, distributors, advertisers, salespersons, consumers, users, waste managers, applied scientists, researchers, and regulatory agencies are involved in an ongoing process of technological autopoeisis[1] (Krippendorff, 1996, p. 173). The cycle is autopoetic insofar as all the participants in this process have a stake in maintaining and expanding it.

Human technological systems have impacted planetary carbon and nitrogen cycles (Smil, 1997), changed the pH and distribution of rainfall, and are now fundamentally altering climate across the globe (Intergovernmental Panel on Climate Change, 2001). In essence, our economies have become degenerative not regenerative with respect to our "natural capital" (Hawken et al., 1999) and the long-term health and sustainability of the ecosystems upon which we all ultimately depend. Hundreds if not thousands of peer-reviewed science studies have indicated that the health of the planet's natural systems are in precipitous decline (World Resources Institute, 2005). The rapid decline in biodiversity over the last 50 years due to human activity has been more rapid than at any time in human history. Scientists estimate that 12 percent of birds; 23 percent of mammals; 25 percent of conifers and 32 percent of amphibians are threatened with extinction, and the world's fish stocks have been reduced by 90 percent since the start of industrial fishing (World Resources Institute, 2005). The critical insight emerging from geophysical, biochemical, and biophysical Earth systems science is that no "one" solution will remedy the crisis. It's not as simple as pointing to a product or system here or there and saying that if we fix this, then things will be O.K. The global sustainability crisis is nothing less than an indictment of our technological systems in toto. Technologies that may make sense when constrained by ethics, regulation and genuine wisdom, become self destructive when through the *product paradigm* they are driven solely by "bottom-line" considerations.

The inescapable conclusion is that our systems of technological production and consumption and the economy they support are dangerously out of step with the assimilative and regenerative capacities of Earth's ecosystems. In order to make a successful transition toward environmental sustainability, the U.S. National Academy of Sciences is emphatic:

> This transition could be achieved without miraculous technologies or drastic transformation of human societies…What will be required, however, are significant advances in basic knowledge, in the social capacity and technological capabilities to utilize it, and in the political will to turn this knowledge to action (National Research Council, 1999, p. 160).

[1] Autopoesis is the term applied to "self-producing" and self organizing systems after Maturana & Varela (1987). The term "industrial-metabolism" and the insights of biological autopoeitic systems are being used to design industrial ecologies. This is an important and neglected area within technological education.

Technological education has the potential to foster the eco-technological and social ingenuity to make this transition a reality, but first it must confront the *product paradigm*.

Factors within the Product Paradigm

The first of the four factors in the *product paradigm* states that technologies have only instrumental purposes and only instrumental meanings can be inscribed in them. Within the *product paradigm*, the symbolic dimensions of products are ignored, students are seldom asked *why* a particular technological product comes to hold the meanings it does. Without a critical cultural perspective towards technology, more products mean more cultural improvement… ad infinitum. In the *product paradigm*, products are understood to be progress embodied and construed as the driving force of cultural "progress." The nature of the *quality* of the relationships we have with our various technologies and how technologies change human relationships is for the most part left unexplored. Products are simply assumed to benefit all cultures and all groups within a given community more or less equally. The notion of technological benefits being distributed differentially is foreign. The iconic products of cultural progress in one region, large gas guzzling SUV's and enormous homes in North America for example, become harbingers of an oncoming dystopian world for people in coastal Bangladesh, the island of Tuvalu, and the Inuit in Canada's arctic. If global warming continues as the best scientific models tell us it will, these technologies will be in part responsible for rising sea levels and melting permafrost. The peoples least able to benefit from runaway product consumption, will be among the first to be hardest hit by climate change (Monbiot, 2005).

Products, apart from their functional and instrumental purposes, also serve as carriers of a worldview, a way of relating to not only our human social world, but the natural world as well. For many people the relationships they establish with or through their technologies are more immediate and "real" than any "always distant" concerns about the environmental consequences associated with their consumption. A significant cultural lag exists when it comes to understanding the ecological impacts of our production-consumption systems and acting upon that knowledge on a personal and political level. However, when it comes to adopting some technologies and practices, the term "lag" is hardly an appropriate description, Doucet asks:

> How long will this cultural lag between our methods of production and humanity's biological sustainability endure? How can we develop the same speed and success in adapting our economies to biological imperatives as we have with machines like the BlackBerry and the Ipod? (Doucet, 2005, p.3).

Technological education has an important role to play in reducing the cultural lag to the widespread adoption of renewable energy technologies, product service systems, and other more ecologically "smart" technologies. Reducing this lag will entail helping young people explore and understand how corporations have created the symbolic meanings we attach to our SUV's, our enormous homes, and the ever-shortening cycles of product consumption.

Our relationship with products is not simply utilitarian; people can develop strong and even passionate emotional ties to their products, their belongings (Norman, 2004). We increasingly use products of various forms to construct, define, and project our identities and to mediate our social relationships. In schools adolescents use a variety of technological products to identify and signal style consciousness, group membership, status, and wealth. Schools have been transformed into not only sites of consumption, but also places where consumer behavior, consumer identity, and consciousness are constructed (Schor, 2004).

How Products Work

Furby (1991) suggested that material possessions have a number of meanings that may be categorically distinguished by their instrumental or symbolic functions. We are continuously involved in the act of interpretation and meaning making involving both dimensions. As "categorical symbols," products signify positional status as well as the smaller and broader social groups to which we belong. They also serve a self-expressive function in that they are deemed to project an individual's unique attitudes, goals, and personal qualities (Furby, 1991, p. 167). In Western culture, power, wealth, and status are some of the most common symbolic attributes expressed through product technologies. Advertising today is focused on "branding" consumers that entails developing a form of brand relationship and loyalty between consumers and whatever product is being sold. In essence, the product being "manufactured" in this symbolic product relationship is the consumer (Quart, 2004).

The language of corporate business or what Lankshear terms "Fast Capitalist" (Lankshear et al.,1996) discourses derive their power from the fact that: "how we think and write about the world has a great deal to do with how we act in and, thus, what it becomes in reality" (Lankshear et al., 1997, p. 25). These discourses that are found in the business press and mainstream media use metaphors like the "friction-less economy," "brand management," "outsourcing," and "tween" markets. In the hands of managers and politicians they become the background upon which decisions are enacted in the workplace and society. Fast-capitalist discourses, in combination with cultural, economic, and political forces (and worldviews), have shaped the technological education curriculum and the subjectivities of teachers and students alike. These powerful cultural discourses are transforming the nature of what we consider a technological "product" to be and at the same time shaping a general discourse concerning the attributes of the people who are needed to create and consume these products. It is crucial to appreciate the interdependent nature of these discourses as a prerequisite to developing an alternative and critical perspective toward technological education, one which situates technology and the meanings inscribed in it as a cultural enterprise (Petrina, 1998; 2000). In order to disentangle the meanings inscribed in product forms it is important that technology is understood as object and technique situated *within* culture, and not external to us.

It is useful here to explore Csikszentmihalyi's distinction between "instrumental" and "terminal" materialism. In terminal materialism the end is

valued as final, not as itself a means to further ends and therefore not subject to "cultivation." This entails ignoring the outcomes of transactions which conflict with the terminal goal – here "the end justifies the means" because the object is valued exclusively as an end in and of itself (Csikszentmihalyi et al.,1995, p. 231). The fast capitalist instrumental version of technological education fosters terminal materialism, through an emphasis on the development of objects of immediate and ephemeral iconic-marketable value, objects geared to terminal consumption. Consideration of a product's "meaning" is reduced to consideration of transient market satisfaction and creative consumer manipulation. The idea of terminal materialism is consistent with a worldview that seeks to maximize every individual's drive to consume products. Global spending on advertising will reach $604 billion in 2006 (Sanders, 2005), more than half of which is spent in U.S. markets. Overall this represents an almost nine-fold increase over 1950 (Worldwatch, 2004).

Instrumental materialism on the other hand is defined as the possession of things which serve goals that are independent of greed itself and that have a specific limited scope within a context of purposes. (Csikszentmihalyi et al.,1995, p. 231). Through instrumental materialism we cultivate the development and use of objects as instruments that are an essential means for discovering and furthering other goals. The larger context in which both processes work is the "fuller unfolding of human life" (Csikszentmihalyi et al.,1995, p. 231). Examples here might include musical instruments, books, and hiking equipment.

Likewise, productivism is a discourse that embodies a wide variety of beliefs, practices, concepts, and "sedimented structures" which include, in part, an expansionistic, growth-oriented ethic and a socio-economic orientation to life (Smith, 1998, p. 10). The discourse of productivism is part of a complex hegemonic system within which we believe: "the everyday material actuality of industrialization and the concomitant metaphysical faith in its ability to improve the quality of human life" (Smith, 1998, p. 5). Productivism as an encompassing belief system offers an uncritical valorization of industry, economic growth, and the consumption of technological products and is a theme within many parts of technological education. As Smith explains:

> Productivist discourse is a story in which scientific and technological knowledge promise a happy ending to the problems of poverty, disease, and tyranny. The affluent West holds up itself and its history as both the example and the way (Smith, 1998, p. 34).

The focus of productivism is based on the normative assumptions that technological education should exist to promote economic growth by producing the skilled "human resources" required to increase productivity and profit and to produce "skills for work" and so enhance the employability of students (Anderson, 2004; ITEA, 2000). In light of the environmental consequences described earlier, these assumptions need to be scrutinized much more critically to assess whether they do form a rational and legitimate basis for technological education.

The corporations and systems that sustain and expand hedonic consumption have become so ubiquitous that to even question this paradigm is almost akin to aligning one's self against basic "human nature." The process of "adaptation" plays an important role in human psychology and our relationship to products; we tend to get used to things and then we take them for granted (Schwartz, 2004, p. 184). Our ever-expanding list of perceived "needs" is often derived from the new "wants" we create when we compare our personal material situation to our neighbors or to those we see in the media. After we finally acquire something we have longed for, or even dreamed about, it just doesn't excite us quite as much. With time our once "precious" product may grow to be a disappointment, then it becomes trash. Schwartz terms this "hedonic adaptation" and explains in part why in 1973, 13 percent of Americans considered air-conditioning in their cars as a necessity, but today 41 percent do (Schwartz, 2004, p. 169). This rapid "fad" change in the cultural meanings of a technological product can have profound ripple effects on the natural world. History is replete with examples of animals hunted and fished to extinction to meet the ephemeral demands of the product market for their fur, flesh, and feathers.

Increasingly today, the marketing of products and lifestyle construction form a seamless cultural web. Postmodern integrated product marketing strategies weave a "seamless web" of technologies, entertainment, and consumption. Jeep "Liberty" sport utility vehicles(SUV's) are cross marketed with Columbia outdoor clothing and gear, the Disney film "Madagascar" is used to sell Dodge "Caravan" minivans, or hockey legend Wayne Gretzky becomes a spokesman to sell Ford sport-utility vehicles and McDonald's products. A typical advertisement for the Ford Explorer SUV features a man using a snow blower to blow snow *onto* his driveway. The man then opens his garage and proceeds to drive his SUV over the pile while a voiceover intones: "Whoever says you don't need a four wheel drive in Toronto, isn't having enough fun" (CBC, 2005). This ad epitomizes the hedonistic relationship we have with some of our most environmentally damaging products. While citizens of the developed world over consume, the world's poorest people will need to *increase* their consumption levels if they are to lead lives of "dignity and opportunity" (Gardner et al.,2004). Appeals to "do the right thing" based on guilt, fear, or other external pressures only have limited success. In fact, they often cause people to withdraw and ignore the issue at hand altogether. The better approach is to help young people discuss and debate the meanings that products hold for them.

The second *product paradigm* factor occurs when product production-consumption is not directly connected to resource depletion and the pollution caused by the extraction, processing, transportation, and disposal of materials in other parts of the world.

Globalization has exacerbated the product paradigm. In the rich North, we take it for granted that we can walk into a food store in nearly any month of the year and purchase fresh strawberries, mangoes, and bananas that have been air freighted in from all over the globe. The average size of North American

grocery stores has "mushroomed" from 31,500 square feet in 1991 to 44,000 square feet in 2001 and stocks an amazing 30,580 items (Paquet, 2003). All of these products are transported using oil in some form and in the age of "peak oil" (Deffeyes, 2005) we are entering, will become even more unsustainable. The infrastructure to support these global product supply chains consist of massive logistical and technical networks of people, computers, and multi-modal transportation systems. Beneath the surface of these systems is often an ecological and human "wake" of pollution, degraded water, soils, and exploited workers – all effectively, and in many cases deliberately, hidden from the consciousness of the product-consumer.

If design connotes "consciousness, intention, in making, using, or acting" (Mitcham, 2001, p. 31), then it is a deficient design consciousness that is responsible in part for the proliferation of our mass produced culture of consumption. Products designed with little or no consideration given to the energy consumed and wastes produced in their manufacture and use, or the eventual fate of the constituent components and materials at the end-of-useful life are on a planetary scale, life-threatening. Bringing a new product to "life" entails a responsibility which extends beyond point of purchase and the immediate now.

The "hedonic adaptation" effect described earlier also contributes to the problem of the "rebound effect." The rebound effect occurs when, through redesign, mass production, energy, and/or material efficiency savings, the cost of a product decreases to a point where aggregate consumption of it increases, effectively neutralizing or diminishing any eco-efficiency gains. For example, the gains achieved through more fuel efficient cars will be lost if people simply drive more because they can afford to. This environmentally counter-productive process raises important questions concerning the simple commonplace notion that greater consumption of "green products" will resolve all of our environmental problems. Unless eco-efficiency gains are coupled to genuine reductions in aggregate material and energy throughput in our economy, little environmental benefit is gained, and as Guber asserted: "the Earth does not benefit from symbolic gestures" (Guber, 2003).

Compounding the problem are simplistic and inadequate design processes that encode values that lead to increased consumption and waste, not eco-product literacy. From a political ecology and human justice standpoint, our design education processes are unsuccessful to the degree that waste has becomes a "natural" outcome of production processes and the terminal state of the constituent materials at the end of a product's life (Petrina, 2000, p. 212). Considerations of pollution prevention, if they occur at all, happen at the "end of the pipe" so to speak, after the product and manufacturing processes have been designed. This is too late, and not as effective as integrating design for the environment (DfE) in the initial design process. Design processes that lead to dematerialization, energy efficiency, and even elimination of the need for the product via product service systems (PSS) are crucial.

Technological educators need to encourage students to critically examine the "technological wake" (Durning, 1997) of product manufacture and use and

to explore the political ecology of products and product systems (Petrina et al., 2000). Although social and environmental justice issues are almost completely severed from our product consciousness, educators have a moral and ethical responsibility to help young people reconnect these issues to product design, manufacture, and use. This entails following the global wake of the product with respect to materials, energy, and waste over its entire lifetime. It is also on these global "frontiers" where the raw materials fueling global production-consumption systems are harvested and where safeguards with respect to workers' safety, human rights, social justice, and environmental harm are most precarious. As Sachs pointed out:

> Ever since the age of Pizarro, the 'New World' has been combed for valuable raw materials. But today the exploration and exploitation of new sources stretches into the remotest parts of the world's sea and land masses. Oil is extracted from deep inside the tropical forest and deep beneath the ocean waves; timber is carried from faraway Patagonia and Siberia; and floating fish factories plough the seas from the Arctic to the Antarctic. The opening of frontiers to foreign corporations has intensified the pressure to move forward the front line of exploitation. (Sachs, 2003, p. 13)

Globalized information systems provide the logistical control to interconnect far flung raw material suppliers, transportation systems, sub-assembly manufacturers, and point of sale inventory systems. These same information technologies are used by advertisers to create demand, to continually resignify the product, and to build emotional attachment and brand-logo loyalty (Schor, 2004). Where does ethical product design enter the picture when a huge proportion of the materials that enter the consumer-material cycle end up in landfills? In 1970 the average new home was 140 m^2, today the new "McMansions" in North America average 215 m^2, with much of the expanded area required to house accumulated products (McLaughlin, 2005).

The third *product paradigm* factor addresses non-consumptive dimensions of technology use, such as technological education for Repair, Reduce, Reuse and Remanufacture are marginalized or ignored. This is on one level counterintuitive, considering that many if not most technicians, technologists, and tradespeople are engaged in some form of these activities. This is not to suggest that these pedagogical activities should supplant the importance of new product design in the curriculum, but their absence in curricula signals that these are not important or valued technological activities.

These activities may be considered parochial since they have not yet been resignified as new, trendy, and worthwhile "high-tech" and "cutting-edge" skills. Product reuse and repair tend to carry a negative stigma in our materially rich culture. People who can afford to buy new products seldom think of repair and reuse as an option, after all, why repair something when you can buy a new one, often cheaper? The fact that many products are designed for quick obsolescence, with no replaceable parts and no system in place for their rehabilitation, is more of an indication that the manufacturer has externalized the costs in terms of disposal, pollution, and lost materials onto the public and the environment at large.

Despite this stereotype, the activities of remanufacture, reuse and repair are forms of product stewardship, keeping products out of landfills and incinerators prematurely and promoting eco-efficiency. They also provide important contexts and opportunities for students to reflect upon new design and the worthwhile task of reengineering existing products to make them more cost efficient, lighter, stronger, more durable, and more ecologically benign. The closing of the material cycle in product manufacture-use-reuse also reinforces the message that these activities make sense from an ethical and energetics-ecological perspective. Recycling and reusing materials save a considerable amount of energy and reduce the bioaccumulation of toxins which leach from landfills or drift out of incinerators. All of these activities are part of an important sustainable and expanding economic and social activity.

The fourth *product paradigm* factor is revealed when products are framed as only expanding human possibilities, never restricting them. In this perspective products only solve problems, they don't create them. The ubiquity of advertising supports our almost religious belief in technological-material progress, and suggests that there is a product to solve each of life's problems:

> By implication, material solutions can supplant social, psychological and spiritual ones, and the cumulative output of multinational corporations represent the pinnacle of all human achievement (Kanner & Gomes, 1995, p. 84).

The notion that human capabilities are *only* enhanced through technologies is one with deep historical roots. After all, we don't initially consider that the design and manufacture of a product will restrict the variety of choices available to users.

Borgmann's (1984) "device paradigm" also suggests that technology can form a constraining pattern (Higgs, 2003) to our lives. According to the device paradigm, the technological *device* serves to separate means from end, thereby producing a commodity for our convenient enjoyment while also simultaneously removing the machinery of its production into our conscious background. When we fail to reflect on the implications of this separation, or to even acknowledge it's reality, we further disengage ourselves from our bioregion, our community, and our lived history. The promise and the power of technological devices according to Borgmann emanate from their promise of liberation and enrichment. Technological devices *promise* to liberate us from drudgery. Our time thus freed is available for personal enrichment, but as Higgs (2003) points out, this time is often used for intensified work and more consumption. Reestablishing sustained "focal practices" into our lives is, according to Borgmann, integral to generating meaning and connection and a sense of sufficiency.

The fact that the span of our perceptions, feelings, and awareness can be both broadened and narrowed or restricted through the use of technology is not given adequate attention in the *product paradigm*. Ihde has pointed out that: "tools amplify certain aspects of normal embodied experience while simultaneously reducing others"(Ihde, 1985). The dominant legitimized

discourses within technological education have essentially been situated in a mechanistic, modernist, and conservative worldview (Petrina, 2003;1998), and as such are complementary and congruent with the historically authoritative account of expansionistic neo-liberal economics. This worldview and the associated narrative of human beings as rightful dominators and plunderers of all living systems on a resource limitless planet, has been discredited as simplistic and dangerous.

Confronting "Crude" Products through Product Critique

Central to a reconceptualization of the *product paradigm* is the "interdiscipline" of technological criticism described by Petrina (1998) and "*critic competence"* (Layton, 1993). This form of critique confronts ecological, social, and ethical dimensions of technology as well as the precepts guiding design:

> The critic of technology asks fundamental questions about what a technology offers (perception and description), what it means with its embedded values (analysis and interpretation), and the technology's worth (judgment) (Petrina, 1998, p. 122).

It becomes increasingly indefensible for technological education to ignore fundamental ethical and moral issues and questions related to our perceived "right" to consume and pollute the planet in orders of magnitude greater than citizens of the developing world.

Engaging in product critique is a form of connoisseurship that helps young people appreciate the attributes of products that are durable, well designed, and ecologically responsible. It also helps them avoid the mediocre and/or irresponsible products of technology. Critique and connoisseurship enable young people to identify products that are not designed for long-term human and ecological health but which nevertheless meet *minimal* standards with respect to attractiveness, performance and longevity as "unintelligent and inelegant crude products" (McDonough et al., 2002, p. 37). Teachers have a responsibility to help young people characterize and identify for themselves the nature of the "crude products" that surround us and overflow from our shopping malls. Students thus empowered are less likely to accept or support substandard, short-term, environmentally destructive product culture. Until young people learn to understand crude product culture as being both inauthentic and contributors to the false consciousness of the *product paradigm*, their ability to re-create our built environment into a genuinely sustainable environment will be made that much more difficult. For example, transforming suburban sprawl into healthier, more diverse neighborhoods requires a fundamental reassessment of car culture and public transportation.

This paper has outlined the major problematic characteristics of the product paradigm. Educating teachers to critically assess and challenge the product paradigm is not straightforward or unproblematic. Confronting worldviews and value-systems that have uncritically incorporated and reproduced facets of the *product paradigm* make it all the more difficult to question its fundamental tenets. Gladwell (2000) suggested that ideas, products, messages, and behaviors

spread just like viruses do, and eventually the aggregate effect of small changes trigger a system "tipping point," leading to large scale change in the system. Technological education is still some distance from a tipping point with respect to a transition to sustainable product perspectives and practices. Advancing a sustainability paradigm will require that teachers take a critical look at the implications of the *product paradigm*.

Transforming the troubling socio-technological trends described here into a sustainable and hopeful future will require a positive but pragmatic vision and a concerted effort by the technological education community. Knowing these realities without acting in some form of common purpose effectively amounts to civic and global irresponsibility. One of the most important transformations involves a re-thinking of the nature of the product form and its culture in the manner in which we teach technology in secondary schools. Mitcham's observation that: "technology, or the making and using of artifacts, is a largely unthinking activity" that "emerges from unattended to ideas and motives" to produce "unreflected-upon objects" (Mitcham, 1994, p. 1), is increasingly indefensible when modern production systems scour the globe for the lowest priced materials and labor and leave a wake after their presence. Although Leopold's axiom may seem like "common sense," we as creators of the technosphere need to stop our tinkering lest it lead to global biosphere collapse.

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