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Source: *Journal of Business Ethics*, Vol. 89, Supplement 1: 5th Annual Ethical Dimensions in Business: Reflections from the Business Academic Community (2009), pp. 19-28
Published by: Springer
Stable URL: https://www.jstor.org/stable/40295074
Accessed: 01-06-2020 11:54 UTC

Journal of Business Ethics (2009) 89:19–28
DOI 10.1007/s10551-008-9907-9

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Joseph Guiltinan

ABSTRACT. Three decades ago, planned obsolescence was a widely discussed ethical issue in marketing classrooms. Planned obsolescence is topical again today because an increasing emphasis on continuous product development promotes shorter durables replacement and disposal cycles with troublesome environmental consequences. This paper offers explanations of why product obsolescence is practiced and why it works. It then examines the ethical responsibilities of product developers and corporate strategists and their differing responses to this problem. Pro-environment product design and marketing practices and innovative government policies may alleviate the problem over time. However, given the current lack of understanding about consumer replacement and disposal behavior, it is questionable as to whether these practices and policies will be sufficiently informed to be effective. Thus, marketing scholars have a significant opportunity to contribute to sustainable durables product development.

KEY WORDS: planned obsolescence, durable goods, environment, product development

When I first started teaching marketing, Vance Packard's (1960) criticisms of planned obsolescence were widely discussed by students and faculty. The prevailing view was that it was unethical to design products that would wear out "prematurely" (i.e., have useful lives that were well below customer expectations), particularly if they were costly to replace. Today, the mounting numbers of functioning durable goods ending up in landfills have led to renewed criticism of product obsolescence. Sources indicate that in North America over 100 million cell phones and 300 million personal computers are discarded each year, and only 20,000 televisions are refurbished each year while 20 million are sold, resulting in tremendous environmental damage from lead, mercury, and toxic glass (cf. Boland, 2001; Slade, 2006). Additionally, when electronics are recycled, 50%–80% are shipped to third world nations where workers use dangerous, primitive processes for extracting recyclable materials, often exposing themselves to toxic gases in the process (Associated Press, 2007). So, while advances in technology and increasingly skillful industrial design have enabled firms to develop innovative products in virtually every durable goods category, the nature of the materials that are often required and the rapid pace of product upgrading have resulted in negative environmental consequences for consumers and society (cf. Calcott and Walls, 2005).

Per Figure 1, two aspects of new product development strategy drive these environmental problems. First, frequent introductions of replacement products increase the opportunities and motivation to replace functioning durables. Mindful of Schumpeter's theory that established firms are often replaced by innovators (through a "creative destruction" process), today's strategists focus on rapid new product development to defend their competitive space. Industrial designers and engineers also drive replacement frequency by incorporating desirable benefits or styles into new products (abetted by marketers who promote the incremental value of these upgrades). Second, the recyclability of new products is influenced by choices of components or materials made by designers and engineers. Thus, environmental problems are exacerbated to the extent that corporate strategies emphasizing continuous improvement and those actually involved in creating and marketing new

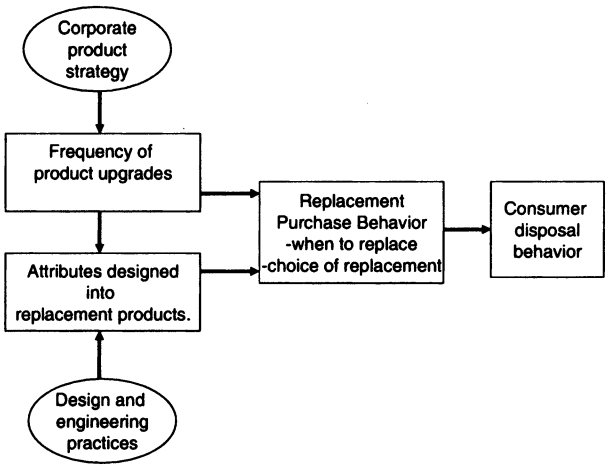

Figure 1. Product obsolescence and the environment: decisions and influences.

products are insensitive to the need for sustainable innovation and promote excessive consumerism.[1]

In this paper, I specify the set of product development practices that are included under the umbrella of planned obsolescence, and I explain why planned obsolescence is so ubiquitous among durable goods manufacturers. I then examine the ecological responsibilities and responses of technical and managerial product development professionals. I show that design practices (prodded by regulatory initiatives) can be developed for assuring that "creations for consumers" will be less destructive to the environment in the future, but that cultural changes at the product design level are likely to be somewhat constrained by corporate and marketing realities and perceptions. I conclude that the lack of understanding of consumer behavior with respect to replacement and disposal of durable goods is an impediment to marketers and public policy makers seeking this goal, creating an important opportunity for scholars in the field of marketing.

Planned obsolescence practices

The objective of planned obsolescence is to stimulate replacement buying by consumers. The most direct way to speed replacement demand is to shorten the usable life of a product through one or more of the following *physical* obsolescence mechanisms.

- *Limited functional life design (or "death dating").* In a recent book, Slade (2006) notes that in the 1950s and 1960s death dating was standard practice for many appliances. (At one point portable radios were designed to last for only 3 years).
- *Design for limited repair.* Disposable single-use cameras were designed to be non-repairable, although a small recycling industry emerged for a time until Fuji and Kodak took these firms to court for copyright violations (Adolphson, 2004). McCollough (2007). It suggests that the price of repair for consumer electronics encourages disposal, and household income correlates positively with the propensity to dispose of and replace appliances rather than repair them.[2]
- *Design aesthetics that lead to reduced satisfaction.* Cooper (2005) shows how aesthetic characteristics can influence premature disposal. One example is the design of "faultless forms and surfaces" on products like small appliances which leave a pristine and polished appearance which, with everyday quickly becomes damaged, engendering user dissatisfaction and premature disposal.

Faster replacement can also be achieved through new product replacement strategies designed to foster *technological* obsolescence. Packard (1960) termed this form of obsolescence "voluntary" because there was no reason that consumers could not continue to be satisfied with their existing products.

- *Design for fashion.* Although comic detective Dick Tracy kept his two-way wrist radio from 1946 until he retired in 1977, today fashion influences many durables replacement decisions. Increasingly designers have applied fashion thinking to watches, mp3 players, cell phones, and even laptop computers. Slade (2006) suggests that the rise of General Motors and its displacement of industry leader Ford was the first victory of fashion positioning over durability positioning among "hard" goods.
- *Design for functional enhancement through adding or upgrading product features.* Technological development frequently allows firms to expand the number of uses or benefits of a

product (e.g., adding a camera feature to a cell phone) or to improve the level of performance on existing benefits (as when a laptop maker increases memory and speed or reduces weight). Note that if there are clearly stratified benefit segments in a market, the early generation product may not have a high demand cross-elasticity with the new one because the new level of performance may not be (at least initially) desired or needed by all customers. In such cases older platforms may be retained as long as there is significant demand for them (cf. Saunders and Jobber, 1994) and the obsolescence effect will be minimal. The obsolescence effect is stronger when many consumers perceive the old products to be "unfashionable" (cf. Mason, 1985) or when the incremental features of the new products are universally perceived as beneficial and desirable.

Drivers of obsolescence and fast replacement

Durable goods producers face a specific challenge in maintaining a high rate of sales growth. This "durables problem" – the core driving force behind planned obsolescence in any market structure (from monopoly to intensive competition) – occurs when successful sellers quickly saturate their markets. The more reliable and long-lasting the product, the longer the repeat purchase cycle and the slower the rate of sales growth. If a firm chooses to rent its goods, it would receive a consistent flow of revenue for several years, but once a firm sells its durable goods output it no longer has a vested interest in the value of those goods. Instead its interests lie in the next generation of goods. (To economists this is known as the "time inconsistency" problem). The existence of a market for used versions of the durable further complicates the problem, because the more durable the product is the greater is the competition between new and used versions and the lower is the price of replacement products (Bulow, 1986). Thus, durability becomes a drag on replacement sales volume and, when a used market exists, on the prices of replacement goods. To mitigate competition from the used market, firms increase the frequency of the revision (upgrade) cycle (Iizuka, 2007). Thus, increasing the rate of replacement through obsolescence will enable firms to: (1) stimulate revenues through faster replacement; (2) reduce competition from any used good markets; (3) by virtue of making used or owned goods less competitive, increase prices for the replacement product.

Competitive pressure for technological obsolescence

While the "durables problem" exists even in monopoly settings, as Sonntag (2000) notes competitive considerations create additional pressures for obsolescence. Pointing out that a consensus has emerged that cost, quality, time-to-market and performance based on distinctive product features are hallmarks of competitive businesses today (see also Hua and Wemmerlov, 2006), Sonntag argues that advances in manufacturing practice that yield faster product cycles are now a defining force in business strategy. Through the use of flexible, modular, and faster design software and production equipment, concurrent product development processes, and information technology, firms have reduced both the length of the production process and the time required to adapt production to demand and competitive actions. The result is rapid execution of orders and delivery, faster implementation of new product concepts, and reduced capital, inventory, and unit costs. Perversely, such systems demand growth in output because the technologies amplify economies of scale and scope which can only be realized through faster product replacement and increasing consumption of products designed for particular needs. The competitive success of such technologies and processes has led to emulation by other firms. Thus, the incentives for obsolescence in the traditional "durables problem" are compounded in industries in which rapid new product development is embedded in the competitive environment.

Gillette's strategy of regularly replacing its market-leading razors is often cited as an exemplar of the competitive necessity of a self-cannibalizing product replacement strategy. That firm saw the wisdom of this strategy after its experience in 1962 when a small British cutlery and garden tool maker, Wilkinson Sword, created a stainless steel blade that lasted three times as long as Gillette's offering and took away 20% of Gillette's share. Gillette had resisted

introducing a stainless steel blade itself due to concern for cannibalization of its existing market leading brands and because of the negative demand impact of the longer lasting feature of the blades (Tellis and Golder, 2001). Thus, the managerial dilemma regarding "willingness to cannibalize" is that if a firm will not cannibalize its own product's sales its competitors will.

Additionally, an idea that has gained currency among marketing managers and strategic planners is that brand loyalty is a route to high profitability because of the higher "lifetime value" of customers who can be retained for multiple repeat purchases. Firms want to facilitate migration of their customers to their own version of the next technological advance rather than risk losing them to competitors because it is generally much less expensive to retain customers than to acquire new ones. Notably, durable goods upgrades may provide avenues to customer retention even in non-durable industries. Witness the cellular phone service competition in which free phone upgrades are offered every 2 years as incentives to consumers to renew cellular service contracts.

Thus, the existence of a highly competitive environment, combined with the fundamental economic motives for obsolescence discussed earlier have created a sort of path-dependence for product development strategies geared toward faster replacement of durables.

The impact of consumer decision-making processes

The success and consequences of technological obsolescence ultimately depend on consumer behavior in the marketplace. Consumers decide whether and when to replace functioning durables with new versions. In at least some cases, consumers also have choices among replacement products that differ in their durability or in their environmental benefits and liabilities.

In general, little is know about consumers' durable goods replacement decision-making processes. However, technical product obsolescence is clearly a more significant driver of replacement timing than physical obsolescence. Grewal et al. (2004) compared "unforced" replacement decisions driven by technological (including fashion) obsolescence with replacement decisions that were "forced" by poor product performance. They found that durable product replacement intervals were shorter for unforced decisions, explaining the result with the argument that, in the case of voluntary replacement, consumers are more excited about and interested in the decision to replace and thus more motivated to act. (The major exception to the finding that technological obsolescence is more of a driver of replacement purchasing than physical obsolescence is that unexciting, out-of-view durable – the washing machine (Box, 1983)). The Grewal et al. study also identified various attitudinal functions served by durable goods, including social approval, utilitarian, and "value-expressive" functions. It is difficult to speculate on the relative impact of fashion changes versus functional enhancements in replacement buying. However, if "fashion" is defined to include industrial design aesthetics, then it is likely to be a factor in the purchase of luxury utilitarian goods and value-expressive goods as well as goods where replacement is motivated by the desire for social approval.

Interestingly, rates of technological obsolescence influence the value that consumers attach to upgrades. Rapid product improvements can increase the household discount rate (or the "impatience" rate) so that consumers value purchases made in the near term more than the savings from delayed purchase (Winer, 1997). Moreover, even when improvements are not obvious, an empirical study by Boone et al. (2001) indicated that more frequent introductions of upgrades may be interpreted by consumers as cues to higher rates of intergenerational improvement, so a policy of "continuous upgrading" creates a heightened sense among consumers that their existing durable is outmoded. Thus, more rapid introductions appear to motivate faster replacement regardless of the actual level of quality enhancement. In sum, based on what we do know from the limited studies available, replacement buying behaviors are complex, heterogeneous, and perhaps based more on heuristics and extrinsic cues than on a calculative cost-benefit tradeoff process.

With respect to the process of choosing among alternative replacement durables, there is little evidence that durability is a key consumer buying motive. Economic theory generally assumes that warranties signal higher quality, and that firms that build in quality and signal it through warranties are

rewarded with higher prices (cf. Utaka, 2006). But a study in the UK (Cooper, 2004) indicates that consumers who buy premium appliances do not do so because they view high prices as signals of higher durability. Moreover, a recent retail study of TV purchasing concluded that warranty information trailed behind picture quality, brand name, price, and picture size in rated importance (Cervini, 2005). There is also substantial evidence that consumers ignore information on features that reflect product durability (cf. the discussion of the furniture industry consumer in George, 2000). Indeed Cooper's aforementioned study concluded that: consumers are equally divided on whether appliance life spans are adequate; often do not consider durability to be a critical attribute; and see product life span as a quality issue – not an environmental issue (Cooper, 2004).

Similarly, environmental attributes play a modest role at best in durable goods decision-making with green purchasing restricted to a small segment of the population. Right now, any expectation that consumers will suddenly become dramatically pro-environment in their purchasing behavior seems excessively optimistic. A Finnish study by Niva and Timonen (2001) on product purchasing points out why this is the case: (1) consumers lack knowledge about the environmental implications of their purchases – even in product categories where such impacts are widely discussed in the media; (2) consumers believe it is the responsibility of manufacturers to produce environmentally benign products and for distributors to screen for such qualities, and that consumers have little impact on those activities. Of course environment-related attributes will only influence purchase choices when there is some variance among the alternatives offered on the environmental dimension. If competitors do not create or promote such attributes one cannot expect "green" purchasing by consumers.

Ethical responsibilities and responses

While innovation and technological progress are good (*ceteris paribus*), the gains from some new products may not always be worth the consumer or societal cost. To the extent consumers and society at large incur the economic and environmental costs associated with disposal of durable goods, the more frequent the replacement and the less recyclable the durable, the greater the problem.

The responsibility for the negative consequences of planned obsolescence is a shared one. First, when technical professionals (engineers and industrial designers) involved in new product development design durables to foster premature physical obsolescence they create corporate (and possible personal) gains at the expense of consumer welfare and the environment. Second, managers responsible for product replacement strategies act in ethically questionable ways if they "psychologically condition" consumers to believe that the utility of a product is diminished simply because a new version becomes available. By extension, offering frequent product "upgrades" while touting minor or illusory benefit improvements might be considered a wasteful and potentially misleading practice (cf. Giaretta, 2005). Third, from the perspective of utilitarian theory, consumers may also act unethically when they add to the public burden with what some might consider frivolous, self-serving replacement behavior as well as when they knowingly use or dispose of products in ways that are environmentally harmful in order to save time or money. Even when new products yield significant increases in consumer benefits, mass replacement of the existing stock can still be a negative if improper disposal is a result. For example, one can anticipate mass replacement of analog television sets as HDTV set ownership diffuses through the market.

What are the options available to firms for addressing the environmental concerns about planned obsolescence? This is a question that must be answered at two levels: (1) the designers and engineers responsible for choosing specific components, materials, architectures, and interfaces, and (2) marketing and business strategists.

Environmental ethics: responses from industrial design and engineering

With respect to product development practice, one could argue that significant progress is being made in building a sustainable design culture among industrial designers and engineers involved in new product development. Design trade groups have placed sustainable and ethical design practices high on their

educational agendas, and many firms that employ designers and design firms are buying in to such practices (Cooper, 2005). Design is one way of attempting to increase replacement intervals. For example, classic designs (such as the one used for years by Volvo) or local, cultural designs that communicate a community identity are sources of "timeless" designs that make a product's appeal long lasting (cf. Zafarmand et al., 2003). Typologies of strategies for sustainable design are available from several sources (cf. Charter and Tischner, 2001).

Similar kinds of strategies are being developed in engineering. For example, Sonntag (2000) suggests that firms could adapt the current technologies of lean and flexible manufacturing for producing value-added products that will be more intensively used by consumers (such as multi-function products). One option for coping with changing needs driven by culture, fashion, or function is "design for adaptability" (cf. Kasarda et al., 2007) – the development of new products that are amenable to adaptation by replacing subsystems or modules as an alternative to full product replacement.

Many new processes and technologies have also been developed for the cross-functional communication process in firms where sustainable new product development is a priority. These include important tools like "design for environment," "life cycle assessment," and "environmental effect analysis" (cf. Tingstrom and Karlsson, 2006). Pujari (2006) argues that the leading firms in developing eco-innovations are those that have fully integrated such tools into their new product development planning so that they think in a positive sustainability mode rather than a reactive mode of just eliminating environmentally problematic features. For example, King and Burgess (2005), recognizing the strength of the culture of fashion obsolescence, argue for applying platform strategy thinking in which key components and subassemblies can be remanufactured and integrated into new products.

These developments would seem to bode well for the evolution of environmentally friendly product development or, at least, for increased attention on creating products that consumers will keep longer. However, design decisions at the individual product level will have to be consistent with the firm's strategic priorities on positioning and growth objectives. (Per Figure 1, the specific attributes designed into new products will usually, in part, reflect strategic decisions regarding the frequency of product change).

Corporate responsibility and marketing/business strategy

As noted earlier, relentless product change has become the centerpiece of new product development strategy in many durable goods industries. But to some observers (cf. Giaretta, 2005) relentless product change is a one-sided strategy because it focuses on the needs of the firm at the risk of detriment to the environment and to consumer welfare. She argues that a firm should seek a market positioning that distinguishes it on the basis of true customer satisfaction, environmental friendliness, and reliable long-term usefulness of its products. Adolphson (2004) offers an insight on what is entailed in redefining a firm's agenda to implement such repositioning. Following Werhane's (2002) concept of "moral imagination" he argues that firms need to revise their mental schemas for new product development to include a "biophysical" perspective which places the economic system in the larger context of an ecological system. In this perspective, value cannot always be captured in monetary terms. For example, nature performs work that is valuable without any exchange of money. This occurs when farmers reuse seeds from produce to plant future crops. On the other hand, the single-use camera forces premature disposal and thus wastes energy resources. This constitutes a waste of "natural capital" that would normally be ignored in estimates of the consequences of a given decision.

Such thinking would mean that managers should consider the costs of product disposal to be real costs that someone must bear rather than as "externalities," so that the decision-making "script" (i.e., the protocol by which new product proposals move through the development process from concept to launch) for each new product development business case includes an ecological dimension. A Swedish example of revising the script is reported by Byggeth et al. (2007). They developed a specific set of "sustainability product assessment modules" for evaluating proposals that could be easily adapted to a variety of established protocols to pro-actively identify opportunities for improved sustainability (such as energy savings, use of

recyclable materials, and disposability). A similar initiative being applied in Ireland is reported in Maxwell and van de Horst (2003).

These perspectives are consistent with the "stakeholder" model of corporate responsibility which would acknowledge the possibility that a responsible product replacement strategy may compromise profitability (cf. Godfrey and Hatch, 2006). They are also consistent with the American Marketing Association's statement of Norms and Values. That statement calls on marketing professionals to support specific ethical values including "Responsibility – to accept the consequences of our marketing decisions" and "Citizenship – to fulfill the economic, legal, philanthropic, and societal responsibilities that serve stakeholders ins a strategic manner." However, Sonntag (2000) indicates that the World Business Council for Sustainable Development (a CEO-led global association of 200 companies) purposely does not include extending product durability on their list of eco-efficient practices because of the belief that fast repeat purchase is healthy for their bottom lines as well as for the public goal of higher levels of employment. The latter point raises a challenging issue for public policy: when two public goals – employment and the environment in this case – are in potential conflict, how does one resolve this dilemma. It also reflects the reality that individual firms operate in a complex environment that includes investor norms and expectations.

Public policy initiatives

To corporate strategists, asking firms for voluntary reductions in the rate at which new product improvements are brought to market would be akin to a request for unilateral competitive disarmament. Moreover, absent a matching response from other firms, the net effect on the total volume of durables sold may not change – just the distribution of market shares. So, it would take industry agreements (anti-trust issues notwithstanding) to reduce such cycles or to assure that all sellers deliver to the market durables which are equally environmentally benign (at the likely cost of reducing some consumer benefits). Because this will lead to the return of the "durables problem" industry-wide economic sacrifices are the price of sustainability. Thus, we have a social dilemma.

Such dilemmas also exist at the consumer level. The cost and effort of recycling, trading off lower price or some other desirable benefit to buy a more environmentally friendly product, and denying one self (or delaying) the benefits of a prospective upgrade are examples of perceived sacrifice that impedes more "green" consumer behavior.

One solution for a social dilemma is public policy action. Many of the strides being made in sustainable design were initially motivated by public policy directives. For example, the EU is stipulating minimum reuse and recovery rates for end-of-life automotive vehicles (cf. Ferrao and Amaral, 2006), and another EU directive on waste electrical and electronic equipment makes manufacturers and importers responsible for the treatment and disposal of products discarded by consumers in those categories. Product "take-back" laws are "on the books" in many parts of Europe and East Asia, and efforts to enact such legislation have occurred in nearly all the 50 States of the United States (Toffel, 2004).[3] These efforts are based on the belief that such laws provide incentives to firms to implement design changes that will reduce the environmental burden created by future new products while shifting the cost from local government.[4]

Because product take-back laws increase the unit cost of new products (when disposal costs are factored in) they are an "upstream solution" – one that is intended to motivate the design and marketing of green products. Current environmental policy wisdom favors "upstream" solutions over "downstream" solutions (those that focus on recycling incentives and taxes) (cf. Thorgerson, 2000). As Calcott and Walls (2000) argue, downstream solutions such as disposal fees only influence upstream behavior when there is a fully functioning recycling market in which recyclers pay each household for each recycled item and the price varies with the value of recyclable components of the product. Because such systems appear infeasible, they argue that the next best approach is a deposit-refund system (producers pay a tax and recyclers receive the refund).

Thus, public policy initiatives have the potential to motivate business and marketing strategists to support environmentally friendly designs emerging from new product designers and engineers. But as Malcolm (2005) notes, the effectiveness of upstream solutions ultimately depend on whether "greener" products will be competitive in the mind of the

consumer with "less green" alternatives once the costs and benefits of green alternatives are weighed against the cost (tax included) and benefits of less green options. Additionally, the effectiveness of take back laws presumes compliance on the part of the consumer who must still bear the transaction costs of returning durables to manufacturers' recycling drop-off sites.

Conclusion

The World Business Council on Sustainable Development includes the following as a major action point: "Encourage consumers to prefer eco-efficient, more sustainable products and services." (World Business Council for Sustainable Development, 2000). As noted, such products could include goods that pose fewer toxic threats that are more readily recyclable, or that consumers will keep longer. Prospects for achieving this goal are enhanced by the fact that sustainable product development is now a motivating force for many product development engineers and designers. Additionally, this action point is consistent with public policy initiatives focused on "upstream" solutions. However, two impediments exist: (1) the competitive pressure for and consumer expectations of frequent upgrades for durable goods; (2) the lack of consumer concern for environmental consequences when contemplating upgrades of durable goods. Thus, achieving the WBCSD's goal requires not only green design but also effective green marketing by firms and public policy initiatives that offer the right mix of consumer and manufacturer incentives.

Iyer (1999) makes the pessimistic argument that a sustainability paradigm based on encouraging "green" consumer behavior is inadequate. He notes that this "anthropocentric view" presumes that more pressure by green consumers will result in products that do not reduce human quality of life, yet there is little evidence that consumers exercise their market votes in a way that will achieve this outcome. It is not clear that we know why this is the case. However, as Moisander (2007) notes, a consumer's motivation to act partly depends on his/her perception of the degree of behavioral control they have in a given situation. Ecologically responsible purchase/consumption/disposal often requires practical skills and knowledge that are not readily available to consumers, so for consumers to have behavioral control they need meaningful choices and complete and relevant information about those choices. Managers and public policy makers need to know what constitutes a choice that is "meaningful" to consumers and how information about these choices can best be communicated. Specific questions of interest would include:

- What information content, framing, timing, and sources will be effective in educating and motivating consumers to consider and choose "greener" options or to make more "rational" or cost-effective evaluations of when to purchase upgrades?
- What would the consumer response be to new products that were more resistant to technological obsolescence (e.g., adaptable products per the discussion of sustainable design strategies from above) or to leasing of durables that might be modified or refurbished/remanufactured for next generation production? (Recall that rental of durables reduces the reliance of the manufacturer on repeat purchase demand for future revenue. It also assures that consumers will return the good to the manufacturer or its agent).
- What incentives (tax credits, rebates, trade-in discounts) or disincentives (deposits, taxes) will influence upgrade purchasing patterns or choices?
- What kind of information about disposal options or costs (personal and societal) of durables will be evaluated and used in the consumer's decision-making process?

Unfortunately, as noted earlier, the marketing literature offers very little insight on the drivers of upgrade behavior or on the decision-making processes involved. Our current theoretical understanding about how consumers perceive, understand, and use environmentally related goods product information has limited managerial utility because of the complexity and variety of the decision situations that might be studied (Leire and Thidell, 2005). Moreover, what we do know about why people are motivated to perform certain green behaviors (e.g., energy saving practices) is not readily translated to

other contexts such as durable purchasing behaviors (Cleveland et al., 2005). Thus, marketing scholars would seem to have a great opportunity to contribute to the understanding of how consumers interpret and respond to green marketing overtures and to government incentives for green behavior.

Notes

[1] Replacement products also may offer positive environmental benefits if they are more energy efficient, made from more eco-friendly materials, or create fewer undesirable side effects. van Nes and Cramer (2006) offer an approach to assessing the lifecycle impact (production, distribution, usage, and disposal) of a product on the environment that includes the calculation of both positive and negative benefits.

[2] The rationale given for the latter finding is that high income households have a higher opportunity cost of time, and time is required for most repair situations.

[3] That the EU is more advanced than the United States on take back laws can be attributed in part to the political strength of Green Parties (notable in Germany which pioneered such laws), in part to the division of regulatory powers between the states and the federal government in the US, and perhaps to a more communitarian political ethos in the EU.

[4] Some major firms are offering to take back electronic items. However, by the end of 2007 only Sony had agreed to take back all televisions, breaking from the Electronic Manufacturers Coalition for Responsible Recycling which (along with the Consumer Electronics Association) has opposed take back legislation on economic grounds (Gunther, 2007).

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