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BEHAVIORAL ECONOMICS OF INDUSTRIAL WASTE REDUCTION

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Behavioral Economics of Industrial Waste Reduction

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Behavioral Economics of Industrial Waste Reduction

INTRODUCTION

Industrial waste reduction provides an opportunity to improve environmental quality while reducing industrial costs. Significant evidence exists that firms can realize economic benefits while practicing waste reduction techniques, yet opportunities are being missed by firms due to internal conflict and entropy. By studying the behavior of individuals within firms, firms and government agencies are more likely to affect a change toward increased waste reduction.

Traditional microeconomic theory asserts that costs are minimized by firms. Yet as much evidence as there exists that waste reduction is cost effective, large scale waste reduction has not occurred within the private sector. One of the assertions of behavioral economics, and particularly Leibenstein's (1979) general x-efficiency theory, is that firms do not maximize profits and minimize costs because of intrafirm activities that affect the firm's performance relative to its potential. That is, the relationships between various individuals and decision makers within the firm lead to non-maximizing behaviors because various sub-objectives of the firm's members may be inconsistent. Because of this potential conflict, Leibenstein emphasizes that

we must analyze individuals within the firm rather than the firm as a whole. He terms this analysis as micro-microeconomics.

The application of behavioral economics also involves a departure from the assumption of perfect costless rationality. Firms are not viewed as rational actors because of organizational problems such as multiple goals, standard operating procedures, resistance to change, and other factors. Individuals and decision makers are faced with uncertainty and information problems which often prevent them from being rational actors and utility maximizers.

Leibenstein and others demonstrate that the mix of decision processes and the behavior of individuals within a firm have important economic implications in the success of waste reduction. This paper formulates a number of hypotheses to explain why firms do not practice all of the profitable waste reduction alternatives available to them and describes how public policy may encourage firms to place waste reduction on their agendas.

ENTROPY, IRRATIONALITY AND AROUSAL THEORY

Leibenstein describes the ideas developed by Simon and others at Carnegie-Mellon University in which firms depart from the perfect rationality assumption. Although the theory is not completely developed, the firm itself is described as a coalition which resolves conflict, and organizational slack exists to stabilize

the coalition. Different members of the coalition, which is made up of those who run the firm, have different goals, and bargaining takes place between them in order to resolve their differences. Organizational slack is likely to enter as a means of conflict resolution.

Leibenstein expands on the theory of x-efficiency focusing on several elements. Under selective rationality, individuals determine to what extent they deviate from maximizing behavior based on pressures from peers and authorities within the firm as well as external pressures. Effort discretion exists when an individual is told what payment he is to receive but not how much effort he has to put forth. Because employment contracts are incomplete, effort discretion exists for every firm member. Every member determines output, therefore every member helps determine the costs of production. Inert areas exist when one does not move to a higher position of output because the inertial cost, or the cost of moving to that point, is greater than or equal to the utility gain. These inert areas help to resolve potential conflicts between firm members.

Organizational entropy, or slack describes a tendency towards disorganization, which is a potential cost increase within the firm. It is a result of the above factors and the various positions individuals assume within these factors. The choice of effort positions by individuals essentially determines the cost attributed to each individual. These individuals are the basic

decision-makers within firms and through their effort discretion choices, they determine cost of production.

Frank (1988) describes irrational behavior. Irrational behavior with regret include those behaviors people seem motivated to change once their irrationality is made evident. This may explain why many firms do not participate in waste reduction practices. Firms' agendas are always limited relative to the various opportunities that compete for their attention, and there are opportunity costs associated with giving up one behavior for another.

This notion also relates to Berlyne's (Lea, 1987) arousal theory in which there is an optimum arousal level for individuals to participate in an activity. Individuals within firms may require different signals or levels of arousal for different activities. Firms will be most likely to seize opportunities for waste reduction when these practices will both save them money and protect the environment, and probably less likely when only the latter is achieved.

The federal Superfund Amendments and Reauthorization Act (SARA) of 1986 may have served to arouse the attention of many firms. This regulation requires certain businesses to submit reports each year on the amounts of chemicals their facilities release into the environment, either routinely as permitted, or as a result of accidents. The purpose of this requirement is to

inform government officials and the public about releases of toxic chemicals into the environment and to promote and encourage waste minimization (waste reduction, recycling, treatment) efforts.

The requirement is a response to continuing community concern regarding hazardous waste and the chemical release tragedy that occurred in Bhopal, India. The database that will be developed, with information from the reports is intended to help increase the public's knowledge and access to information on the presence of hazardous chemicals in their communities and releases of these chemicals into the environment.

In addition to the increased public attention focused on chemical releases as a result of this requirement, there has probably also been an enhanced awareness on the part of firm management as to the amount of chemicals released to the environment. That is, whether or not businesses were consciously aware of the amount of releases from their facilities, the reporting requirements have served to bring this information to the forefront of their attention and to put the issue on the decision makers' agenda.

WASTE REDUCTION DEFINED

In the past, the use and exploitation of our natural resources contributed to a growing economy. The larger the volume of materials we processed, the richer and more secure we became. We

provided for the needs of the present with little regard for the future. Pollution and other environmental costs were relatively small and localized, and could be easily ignored due to the appearance that our resources were limitless. In the last decade environmental cleanup costs have soared, with both industry and government paying for these cleanups.

Then and now, U.S. environmental protection efforts have emphasized control and cleanup of pollution by hazardous substances after they are generated. Virtually all industries generate hazardous waste and the cost of controlling that waste totals many billions of dollars annually. (Office of Technology Assessment, 1986) Waste management in the form of treatment and disposal is merely a reactive approach to environmental protection. The result is that pollution control methods often do little more than move waste around from one environmental medium to another. Air and water pollution control devices generate solid, hazardous waste that goes to landfills and often leaches from there into groundwater. Many hazardous wastes, such as most toxic air emissions, are not yet regulated, and regulatory standards for permissible emissions legally sanction the generation of some wastes. Waste reduction, however, prevents pollution instead of controlling how much hazardous substance is released into the environment. Waste reduction has been defined differently by different agencies. In this paper it is defined strictly as reduction of waste at the source. That is, in-plant practices that reduce, avoid, or eliminate the

generation of hazardous waste. Waste recycling off-site or treatment of wastes after they are generated, are not considered waste reduction, rather waste minimization by most parties.

Waste reduction provides an opportunity to improve environmental quality while reducing industrial costs. A leading chemical company established a program in 1987 that reduced waste generated at the company's facilities by more than 100,000 tons. (Office of Solid Waste and Emergency Response, 1987, p. 2) This has saved the company an estimated \$250 million through savings on reformulated products, conserved materials and energy, and the ability to delay or completely eliminate the purchase of pollution control equipment.

BENEFITS OF AND INCENTIVES FOR WASTE REDUCTION

There are several circumstances under which waste reduction may become attractive to firms. The first is when firms actually save money by changing process inputs, cutting disposal and treatment costs, or by selling wastes as products to other firms. There is a great deal of opportunity for this type of direct savings and these opportunities are the ones most frequently targeted by state technical assistance programs.

At an Oregon firm, used solvent and paint thinner is now distilled on site, using a Canadian-made still which is expected to pay for itself in a little over one year. Paint thinner

expenses have been reduced from \$3.16/gallon to \$0.28/gallon. Solvent degreaser costs are down from \$4.91/gallon to \$0.22/gallon, a 90-95 per cent cost savings. Operating costs of the unit still average only \$3 each month. On-site recycling is more convenient, the entire distilling process takes three to five hours, and the liability of transporting 30-40 gallons of thinners and solvents to be recycled each month has been eliminated.

The second circumstance is when profits may initially decrease, but firm managers find it acceptable because their preference for environmental improvements is realized. Their net income may fall, but they have incorporated environmental benefits into their accounting and are willing to trade them for profit.

The third factor which has already motivated firms to practice sound environmental management, including waste reduction, is the fact that there is less chance for opportunism, given today's resource ownership. The public is well aware of environmental regulations and past illegal practices of some firms and thus serves as a policing force alongside environmental enforcement by the government. Firms are therefore less likely to take advantage of opportunities for illegal disposal of wastes or emission exceedances.

A fear of a change in future rights may also encourage firms to implement waste reduction. If firms do not make voluntary

efforts to decrease their waste generation now, it may be likely that the government will pass a law which requires them to in the future. The anticipation of yet another environmental regulation to comply with may be enough of an incentive to encourage the practice now.

One of the biggest incentives for generators to reduce their hazardous waste volume is the high and escalating cost of other forms of hazardous waste management. Land disposal of hazardous wastes once cost as little as \$10 per ton of waste and has risen to \$240 per ton in some locations. (Office of Solid Waste and Emergency Response, 1987, p. 3) Disposal sites are in short supply, so prices keep rising. Reducing the amount of waste generated, or switching from generating a hazardous to a nonhazardous waste will mean lower disposal costs.

Rising cleanup costs from past practices provide another incentive for industries to turn to waste reduction. Long-term liability is one of the best reasons to avoid hazardous waste generation. This liability is a much feared problem, but often it is not adequately factored into corporate cost accounting since it is difficult to predict future cleanup costs.

Other incentives for waste reduction include reduced costs of raw materials through the reuse of these materials within the plant, improved process efficiency, and improved safety conditions for

workers by replacing hazardous materials with less hazardous or nonhazardous materials.

The application of behavioral economics, the study of individuals within the firm, can assist government agencies and private firms in achieving higher participation in waste reduction.

APPLICATIONS OF BEHAVIORAL ECONOMICS USED TO STIMULATE INDUSTRIAL WASTE REDUCTION

Change in Preferences

One approach to produce a large scale waste reduction effort is to in effect induce a cultural change throughout society. That is, a change in consumer preferences away from products that produce wasteful by-products to those that do not. Hirschman (1982) demonstrates how preferences change as a result of disappointing experiences. He describes how ideology reinforces a certain lifestyle and preference pattern which may later be changed by these disappointing experiences or some radical occurrence. An example of this type of behavioral change was exhibited during the energy crisis of the 1970's. Energy demand leveled off in the face of that crisis, probably due to both an increase in prices and a change in preference, as a result of mass appeals at the time, toward a lifestyle less dependent on energy usage.

Hirschman describes two phases which contribute to the formation of new preferences. The first is the actual formation of the new preference. He uses smoking as an example and describes how a smoker would first develop a new preference for not smoking over the current preference for smoking. The second phase is to actually impose the preference. This two phase sequence that results in a behavioral change goes beyond the traditional change in tastes of consumption theory. The tension between what is actually done and what is felt ought to be done is an important aspect of this theory.

With regard to waste reduction, the first phase of forming the new preference has in most instances been met by both industry, government and the general public. That is, these groups all hold the same preference for improvements in human health protection and environmental quality. Although most people agree that we need to improve the quality of our environment, and many know how it can be done, few have been willing to change their habitual lifestyles. There are however, several ways in which this preference may be imposed on society.

EPA issued a proposed policy in January 1989 which appeals to individuals and industry to "practice source reduction and recycling through changing their consumption or disposal habits, their driving patterns and their on-the-job practices." This is really an appeal to change their lifestyles, and involves the formation of new preferences towards less wasteful habits. By

making these types of appeals, the public is more likely to change their own individual habits as well as apply pressure to industry and individuals within industry to reduce the amount of waste generated.

Moral Commitments and Noninstrumental Behavior

Etzioni (1988) suggests that when the goal of a policy is to change a behavior, both normative and economic factors should be considered. Etzioni recalls President Carter's appeal to consumers in 1980 to use less credit on patriotic grounds. There was a positive response - attributed both to his appeal and increased interest rates at the time. Public leaders can help set society's moral climate in favor of saving, buying American, or reducing the generation of waste. Whatever effect is gained is achieved at a much less cost than through a complete reliance on price factors.

Moral factors can play a role both in public policy and within the firm, and government agencies may draw on moral commitments to further policies like waste reduction. Etzioni's policy point is that "one needs to work not merely on the cost-benefit, deterrence, incentive, and police side but also on the formation of preferences side via moral education, peer culture, community values and the mobilization of appropriate public opinion."
(Etzioni, 1988, p. 242)

Roberts (1975) describes how changing social attitudes will result in some changes in an organization's behavior. This occurs because individuals within the organization prefer to be identified with socially acceptable organizations. In researching the behavior of several firms, Roberts found that more rapid personnel turnover resulted in changes in an organization's behavior toward currently acceptable directions. He attributed this to the more "modern" views of newer and younger members. He also found that for top management to change a widely held organizational strategy, it may be necessary to advance these new individuals to key positions. In almost every company some members, especially the younger ones, were even willing to criticize their superiors for not doing more to prevent air and water pollution.

Roberts found the impact of changing social attitudes to be evident in the views and policies of older executives as well. The typical position of these executives changed from whether or not to spend on environmental protection measures to how much to spend.

Events of recent years, including the New York garbage barge, medical wastes washing ashore on ocean and Great Lakes beaches, and reports of contamination from landfills, have heightened public awareness of the need for improved waste management. The environmental ethic is growing again and people are becoming more and more committed to protecting the environment. Nationwide

support for waste reduction and pollution prevention must be built. This can be done through community education efforts and pressure from the public to demand products from industry that produce less waste.

In order to make people and firms feel as if they are making a difference and affecting a change, our institutions must be structured in a way that they encourage more participation and give firms and consumers incentives to participate. The more people are involved in decision making and the larger the voice they have in the process, the more informed they will be and the more likely their outlook and behaviors will change. This large participation in policy and program development will also result in programs that are more easily administered.

It may not even be necessary for people or firms to feel as if they are making a difference. Hirschman (1984) believes that people often participate in activities because it enhances feelings of belonging to a group. He considers this action, in economic terms, as an "investment in individual and group identity" (page 92) and believes it explains why people will participate in noninstrumental behavior. (This conclusion is opposite to the free rider argument with respect to collective action.) If individuals do realize results and affect a change this may be an added bonus to the person that is satisfied merely from striving to obtain a goal. Organizations should note that this may occur and attempt to draw on both types of commitment.

Holt (1988) suggests that the way to motivate large groups of people and influence public policy is by conducting a communications program that parallels a modern political campaign. This program includes mobilizing large numbers of supporters, planning events that attract media coverage, focusing on key points important to the supporters and using television and other media as much as possible. By allowing interest groups to play a constructive role in shaping policy, a more implementable project can be produced, increasing its success. Credibility is also gained by the sponsors.

The State of Michigan has formed three committees to develop waste reduction strategies. Instituted by legislation, these committees include members of government, industry, the general public, members of environmental organizations and others. They are designed to reach consensus decisions on types of technical assistance to be made available to industries, how state funds should be allocated for waste reduction research and how policy should be shaped to achieve a higher rate of waste reduction. By including people from all sectors, efficient solutions are more likely to be formulated, and most importantly, implementation will be easier to achieve because these groups reached agreement from the very start of the planning process.

Within firms, Roberts (1975) found that, in certain instances, strategies that lack group advocates are seldom adopted. He found that group perspectives within an organization have the

most influence on its choices when the available policy options are more numerous, uncertain and difficult to evaluate. An example he gives involves two different firms trying to implement a new technology. The firm that included members from various divisions was more successful than the one that involved an outside agency rather than their own staff in the key decision making.

Corporate Behavior and Decision Making

Roberts (1975) provides an explanation of the variations both within and among three public and three private electric utilities in their impact on environmental quality. He refers to Simon and others' theories in which organizational decision making is a result of intendedly rational, but imperfect, choices of individual members of the firm. That is, choices of individual members result in a pattern of collective action or corporate behavior, and the gains of perfect over imperfect decisions are typically not worth the added costs.

In this model, there are control and incentive variables for each member of the firm which determine how they achieve the multiple objectives of the firm. These variables include regulatory constraints, social and political pressures, delegation of authority within the firm, compensation practices, personal and professional beliefs held by members and peers, the plans and approaches to business problems chosen by top management and other variables as well. As a result, corporate behavior is a

function of a complicated set of these variables which change over time in response to internal and external pressures. Roberts believes an organization's response to these pressures reflect the past history and development of the organization. He suggests that the internal features of an organization will have the greatest impact on decisions that are uncertain, complex and long term.

Since 1971, IBM has been committed to a corporate policy which minimizes energy and materials consumption. (Center for Environmental Management, 1986) Since that time, their policy has developed into one that, as a first priority, reduces the generation of hazardous waste at the source. IBM's program involves waste reduction at every location and its success is dependent on concerted efforts at the plant level, the level closest to the manufacturing process. Plants are responsible for achievements in waste reduction, while corporate offices provide support, guidance and incentives. As described by Roberts, this strong control system provides top management with the opportunity to have a greater impact on the organization's choices.

Management has established clear waste reduction policy, guidance to help plants in their waste reduction programs, reporting requirements for achievements by each facility, communication networks to facilitate technology transfer between plants, and long-term planning efforts for waste reduction. At the same

time, each plant is given the flexibility to design a unique program which reflects plant management preference. Plants are also instructed to utilize an employee suggestion program to motivate individuals within each part of the firm. IBM plants have aggressive waste reduction programs in place and have been successful in steadily and significantly reducing the volume of waste generated.

By understanding the internal workings of an organization, management may be able to better affect a change in decision making toward waste reduction practices. Government agencies may also learn how best to identify and influence decision makers within an organization in order to better conceptualize their behavior. At a minimum, government agencies may be able to realize their limitations in affecting firm behavior, given that internal features may have the greatest impact on uncertain, complex and long term decisions. Their best efforts may be in the direction of providing more information and certainty to the decision making process so it is not as complex as originally perceived by the organization. Further research into the structure and organization of firms that have successful waste reduction programs, such as IBM, could provide some useful information for other firms as well as government agencies.

Framing

Framing the consequences of a public policy in positive or negative terms can greatly alter the appeal of a particular

policy. Although current regulations may be seen as both incentives in some cases and disincentives to waste reduction in others, their intention is to control pollution after the waste is generated. Only recently have states begun to address waste reduction directly. Thus far most government programs addressing source reduction (before the waste is generated) have been from more of an educational, technical assistance angle, rather than through prescriptive, penalty-oriented regulations. That is, programs have concentrated on educating firms on the benefits of waste reduction without prescribing specific regulations with associated penalties.

If waste reduction measures can be presented to companies as cost savings rather than through threats of penalties and fines, then perhaps they will be more willing to participate in waste reduction efforts. Some combination of the two may produce even greater results. If companies can be shown specific information that they can save money and reduce environmental liability costs, this may provide an incentive which would improve the quality of their decisions toward waste reduction.

One of the current obstacles to waste reduction is the many environmental regulations that companies must already meet. While some people may view these regulations as incentives to reduce wastes so as not to have to comply with treatment and disposal regulations, in fact this has not been the case. Only a small percentage of companies have moved toward waste reduction,

and we would expect to see more if the regulations themselves did provide an incentive. Company efforts are currently directed towards compliance with these regulations and little time or energy remains to explore other options. Habits and standard operating procedures are barriers which are not easily changed. Only when the problem is well defined will consideration be given to alternatives.

The more straight forward a new program is presented to a company and the easier it is to comply with, the more likely companies will be to participate in it. Many states now offer technical assistance to companies which include the dissemination of information via clearinghouses, on-site technical assistance, workshops and training seminars, and analysis of waste reduction potentials and accomplishments in various industrial sectors.

The State of Michigan Department of Natural Resources and Department of Commerce have combined their statutory authority and created the Office of Waste Reduction Services. The Office employs two people from the Department of Commerce and three people from the Department of Natural Resources and has a first year operating budget of about \$350,000.

The program responsibilities are designed to further waste reduction efforts by Michigan businesses. Mandated activities include (1) operation of an information clearinghouse; (2) sponsorship of educational activities; (3) provision of on-site

technical assistance; (4) analysis of waste reduction potentials and accomplishments in various industry sectors; (5) identification of regulatory barriers to waste reduction and means by which such barriers might be overcome; (6) identification of ways in which waste reduction might be better encouraged through existing regulatory and permit programs; (7) and identification of whether and how the state might better support waste reduction research efforts. (DeBacker, 1989)

The Office's management plan for the waste reduction program has been greatly influenced by a belief that the input of potential clients must be sought as the program is developed if it is to be relevant to their needs. The plan also recognizes the important role trade associations play in communicating with members of industry and of the value of seeking their assistance and partnership in publicizing the merits of waste reduction to their members.

Valuable information may be gained by conducting evaluations of some of the state programs to measure their effectiveness. In general, states have been unable to do this themselves because of lack of staff time and money. It may be difficult, however, to separate waste reduction efforts initiated as a result of state assistance programs and those which should be attributed to firms themselves.

Incentives and Rewards

Motivating individual employees can play a strong role in promoting waste reduction. Management can do this by involving all employees in the program, not just the pollution control personnel. An education and reward system for meeting waste reduction goals may be included in company policy and apply to all aspects of the organization. Rewards may include monetary bonuses, prizes, recognition awards, as well as promotional opportunities. Perhaps the most important ingredient in reinforcing behavior is Skinner's principle of contingent reinforcement. (Platt 1972) He demonstrated that behavior may be shaped by using positive reinforcement and that the size of the reinforcer is much less important than its immediacy and contingency upon the desired behavior. (This is related somewhat to the framing of policy in positive terms discussed earlier.)

Several years ago, GE Plastics of Ottawa, Illinois, made the decision, based on increasing disposal costs and observations of state and federal regulatory trends, to conduct extensive waste minimization and reduction activities. (Kraybill, 1989, p. 202) A waste minimization team was formed which included at least one person from each area of the plant. All team members were required to participate in training, not in waste minimization techniques, but in the concept of working and functioning as a team. They were provided with training in brainstorming, setting priorities, and teamwork in general.

Very little resistance was encountered during the implementation of the program. Waste generation was reduced from 58 lb / 1000 lb of production to 11 lb / 1000 lb of production, and resulted in savings of \$196,000 per year in disposal costs and \$1.1 million per year in additional production. (Kraybill, 1989, p. 204) Personnel attributed this success to the involvement of employees at all levels of the plant in developing the program and participating in the decision-making process.

Although there were no direct monetary or other rewards mentioned, the team members were among an elite group which were able to implement their ideas to an extent that positive results accrued to the company in the form of reduced waste generation and cost savings. The opportunity for participation in decision making served as a major motivational factor for employees. More than likely, the success of individual members contributed to high performance ratings by their supervisors and/or recommendations for promotions or bonuses. The waste reduction project is on-going at GE and ideas and suggestions from plant personnel are received and evaluated on a regular basis.

State and federal regulations may also set goals for industrial sectors to meet each year as well as provide rewards for various achievements. Wisconsin annually presents the Governor's Award for Excellence in Hazardous Waste Reduction to firms that have made significant achievements in the area. Five companies

received the award in 1988, including one that reduced hazardous waste disposal by 77% and solvent use by 74% between 1984 and 1988. (Midwest Waste Minimization Council, 1988)

The timeliness of these rewards and the public recognition they provide can go a long way in reinforcing these company efforts. Positive public relations can often work to shape a company's decision making since many of the hazardous waste generating firms are viewed in a negative manner by community and environmental groups. It would be interesting to analyze the different incentive and reward systems used by firms and government agencies to determine those that inspire individuals within the firm and the firm as a whole toward waste reduction practices.

Changing Property Rights

As much as a voluntary waste reduction program would be preferred by all, it may not produce results as expediently as mandated government requirements. A voluntary program leaves the distribution of rights unchanged and will put only those behaviors that are consistent with the firm's welfare, as they perceive and define it, on their agenda. While waiting for new preferences toward waste reduction to develop and for waste reduction as a profit enhancer to be placed on executives' agenda, it may be appropriate to change rights and apply short run incentives to improve performance. That is, to make firms pay for resources used, but not owned, under some new rules.

Converting long run consequences into more immediate ones may be successful in bringing the consequences to bear on behavior. That is, bringing the cost of environmental pollution to bear on firms so they will be more likely to reduce waste. This may be done in the form of effluent taxes and the incorporation of disposal costs into product price so that prices reflect environmental costs.

Social incentives or punishments to encourage waste reduction and discourage the use of virgin materials may be more effective. A raw material tax may be appropriate for industry in order to encourage them to recycle their wastes in-house. Packaging control and excess packaging taxes may be appropriate. Direct subsidies and fiscal incentives for using recycled materials as well as the elimination of subsidies for virgin material production may also encourage a greater participation in waste reduction. Financial incentives for technological developments may also be made available to firms. All these incentives may change the direction of decision making.

The findings of Tversky and Kahneman (1986) should be kept in mind when considering such incentives or disincentives as taxes and subsidies. They found that people seem to weigh gains and losses differently and attach considerably less importance to a gain (subsidy) than to a loss (tax). They found this to be true even to the extent that many people actually refuse to accept

pairs of events (gains and losses) that would increase their overall net gain. This is quite different from the rational choice model which says that people evaluate events in terms of their overall effect on total wealth. The implications of these findings demonstrate that a raw material tax may be more effective than a direct subsidy, even if the subsidy were equivalent to or greater than the proposed tax.

This conclusion is contradictory to the one reached previously in which the framing of a public policy in positive terms was deemed more effective than through threats of penalties and fines.

DiMento's (1989) research into noncompliance with environmental law found evidence on both sides of the issue. He found some authors who suggest that severity of punishment deters criminal behavior, and others who believe perceived severity has no deterrent effect. Peer behavior, moral beliefs and social disapproval were stronger deterrents than fear of formal sanctions. DiMento found that "criminal sanctions may chill a legitimate and useful challenging of environmental rules and counter a learning process about effective regulations" (page 114).

Perhaps the differences lie in whether the disincentives are perceived or actual, with the actual disincentives carrying more weight than if they are nearly threatened. Or perhaps the difference lies in how the individual as compared to the firm

evaluates the alternatives. In any case, as industry's opportunity sets change, so does their performance. (Schmid, 1987) Each change in their rights may have different implications in predicting the behavior of the firm. Perceptions of the future change as these various opportunity sets are presented or imposed, and different firms may react in different ways. To predict the consequences of these various sets of property rights, it would be necessary to understand the specific circumstances relevant to firms and their organizational structure which determine firm decisions. This is an area where additional research could provide some useful information in determining which of these incentives or disincentives are more likely to change behavior without resulting in resentment by firms.

Planning and Commitment

Both government agencies and industries must realize that long-run planning must become a priority if we are to improve our waste reduction efforts. Gazzaniga (1985) describes our modular brain in which the lower instinctive portion is usually in control. This instinctive brain guides us through our every day decision making without regard to long term effects. Our more evolved, higher rational brain, however, allows us to plan ahead and to insure that we have taken precautions against our short term behavior. This idea applies to our past methods of

environmental protection which had little regard for the future. By putting in place the aforementioned technical assistance programs, incentives and rewards, we are allowing our rational brain to override our instinctive brain and plan for the future. This is similar to Frank's concept of how a commitment device works to provide an incentive for a behavior people believe to be in their own best interest, yet they have difficulty carrying it out due to other temptations. He describes the example of Homer's Ulysses who had to sail past dangerous reefs where sirens lay. Ulysses knew when he heard the sirens' cries he would be drawn to them and sail to his death on the reefs. Having foreseen that this would happen, he had his crew tie him to the mast until they had sailed past the reefs. This resulted in an effective commitment device since Ulysses was able to avoid the temptation of the sirens.

3M Corporation's fiscal policy towards funding new waste reduction projects has evolved into a more long-term planning effort with specific goals (Center for Environmental Management, 1986, p. 9). Liability is taken into account in evaluating projects, and those that have a substantial environmental benefit are not required to have as high a return on investment as purely economic projects. They have also committed to long term waste reduction goals and set specific timeframes for achievement.

The 1984 Resource Conservation Recovery Act (RCRA) Waste

Minimization Amendment required that existing waste minimization plans be documented more formally and, in some instances, be reported annually to state regulators. This amendment did not prescribe specific methods or require companies to meet particular levels of waste reduction, but it did require them to plan ahead in terms of how they will attempt to reduce their waste and to make a commitment to begin practicing waste reduction. In many companies, the RCRA Amendment has precipitated a more formalized system for waste reduction efforts and for assessing plant performance.

FUTURE OF WASTE REDUCTION

Although waste reduction practices can have enormous benefits, both environmentally and economically, current waste reduction efforts barely scratch the surface of overall waste generation. While some hazardous waste generators have made significant strides in reducing their waste generation, many generators have not yet explored their options in this area. More must be done by government and industry to substantially reduce the volume and toxicity of waste being produced.

A social movement in the direction of increased waste reduction may be largely dependent upon a total change in values and expectations by individuals and firm managers. Because this is a long run learning process, perhaps we should only expect

incremental changes. Government agencies must be very sensitive to firm behavior and realize that they have many internal and external pressures which ultimately factor into their decision making. Further, government agencies can play a role in stimulating support for these measures by providing information and technical assistance to all interested parties.

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