ENGINEERING FOR A BETTER ENVIRONMENT

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Good afternoon. I appreciate this opportunity to participate in your National Waste Processing Conference. While I am pleased to be your luncheon speaker, I sometimes suspect that the luncheon speech is a subtle form of punishment that we inflict upon ourselves because of our puritanical background. I will strive hard to keep my subtle punishment from rambling on too long, although I cannot guarantee that everything I have to say will be an aid to digestion.

When we take a close look at the environmental dilemmas that we face as we celebrate our nation's 200th anniversary, it is apparent that many people have been working too hard for too long on the wrong things. At the least, many of our past technological efforts have been too narrowly conceived. Hard and valuable work aimed at economic progress too often has led to environmental degradation, heedless destruction of natural resources, and the pollution of air, water, and land. Of course, environmental mismanagement was not our intent; it was not the product but the by-product of our efforts.

Our forefathers welcomed innovation and produced a social climate in which the fruits of burgeoning scientific endeavor could be translated rapidly into the concrete realities of applied technology. Engineers, without doubt, have played a key role in this extraordinary historical process; for engineering is the prime profession for ensuring that technical knowledge is translated into practical activities. Taking advantage of our abundant resources, we have achieved benefits for human life of which our ancestors could not have dreamed. We have stamped out most of the contagious diseases. We have achieved an unparalleled abundance of food and consumer goods for an evergrowing population. People now live longer, are healthier, better nourished, better housed, and better off by almost every measure of ease, comfort and convenience than ever before.

At the dawn of this decade, however, rising public awareness and concern about air and water pollution reached a crescendo and forced our attention to the fact that all of us "experts" as engineers, lawyers, doctors, politicians, or whatever, had evidently failed to notice that society was paying some very bitter costs for the age of affluence. We were forced to admit that the pollution, the crowding, the noise, the impersonality of modern life, the estrangement from the natural world, were not consistent with the "better life" that we had bargained for.

We have come to see that the decisions that have shaped the world of the present were not the result of any deliberate weighing of alternatives, not the result of any careful study of environmental or economic impact, nor did they involve thoughtful consideration of what was best for society as a whole. Engineers were not acting within the framework of a comprehensive societal consensus when they helped to develop the motor vehicle or the highways on which they travel, or when they developed processes for extracting natural resources and converting them into consumer services and products. Anything
resembling a rational consensus would have dictated that we give commensurate attention to the by-product environmental problems which accompanied these accomplishments.

There is no question that the public admires your profession, as indicated by the tendency to apply the term “engineering” to many activities in a way that connotes purposeful, orderly initiation and implementation of desirable changes. Consider for example, such terms as “human engineering” and “social engineering,” and talk of the need to “engineer” changes in public attitudes or expectations.

While the compliment may be deserved, the application to people of techniques meant to be applied to objects often does more mischief than good. Traditionally, engineers have been specialists in the techniques of manipulating things, dealing with facts, concrete objects, quantities, and physical structures. Applying these techniques to dealings with people, who generally refuse to behave as predictably as do these other objective phenomena, is certainly one of the reasons for the creation, and inability to solve, some of the environmental dilemmas which confront us today.

Not that engineers are to blame. The public in our country has traditionally demanded technology solutions to problems and has generally assumed that people will somehow adapt themselves to all the efficiencies, all the labor-saving wonders, and the “obvious advantages” of technology. By the beginning of this decade, we increasingly found ourselves on the sidelines as enthralled and charmed observers, who began to wonder where we fit into the world of high technology.

The environmental awakening marked the end of an era when the public was content to stand on the sidelines and let scientists, engineers, lawyers, politicians, and other “experts” tell them what was good for them. It was this drastic change in the public’s perception which brought about passage of the National Environmental Policy Act six years ago, a unique law which symbolized the end of the frontier philosophy and accepted the truism that man and nature must exist in productive harmony. Engineering, law, business, politics have never been the same since, and never will be again.

We can see the change already. The talents of the engineering profession, which have contributed inadvertently to the creation of environmental problems, are increasingly employed deliberately to curtail them. Engineers have played a key role in developing the sewage treatment plants and the other control procedures and mechanisms which promise one day to restore the quality of our streams and lakes. They have played a key role in developing the scrubbers, the precipitators, the catalytic converters, and the other control devices and processes, which promise one day to restore the quality of the air over our cities. Without such developments we could not have achieved in the last six years the improved air and water quality we are beginning to observe across the nation. Ironically, our limited successes in dealing with these media already are forcing us to give attention to the misuse of the third environmental medium, the land—illustrated by the indiscriminate dumping on land of industrial, municipal, agricultural, and mining wastes. More and more of the wastes that we once dumped freely into the air and water are being added to the immense quantities of wastes that we have always placed on the land in ways which too often allow them to find their way back into surface or ground waters or into the air.

We have just begun to realize that we are not properly handling the 260 million dry tons of solid waste generated each year by industry in the United States. Studies conducted in the last three years confirm that hazardous wastes, generated mainly by industry, have environmental impacts far greater than most people would have thought. It is estimated that from ten to fifteen percent of the approximately 260 million dry tons of solid waste that industry generates each year contains hazardous substances, such as toxic metals and organic solvents, in sufficient concentration to be potentially hazardous to public health when disposed of improperly. At present, only about 4 percent of such hazardous wastes are treated before disposal on the land. Another 4 percent is recycled.

Added to these waste problems are some seven million tons of sludge generated by our municipal sewage treatment plants each year. And that amount is growing, too, as more and more communities are building new wastewater treatment facilities.

Of particular concern to municipalities is the collection and disposal of residential and commercial solid wastes. This is currently carried out at a total annual cost of about $3.5 billion. The costs are expected to increase substantially over
the next five to ten years. In 1974, it cost an average of $26 to collect, process, and landfill a ton of municipal solid waste. It is expected that this cost will rise to $50 a ton by 1985. Per capita waste generation for 1973 was estimated at 3.5 pounds per day, compared with 3.3 pounds in 1971. Of these wastes, packaging accounts for 35 percent of the tonnage. Between 1958 and 1976, consumption of packaging, 90 percent of which is disposed of, has increased an estimated 63 percent. Projections to 1985 indicate that wastes disposed of will amount to some 30 million tons above the 1973 figure of 135 million—even if the tonnage of waste recovered and recycled is increased fourfold over 1975 levels.

Most of this municipal waste ends up on the land. There are some 18,500 known land disposal sites in the United States. Some masquerade as sanitary landfills, but fewer than 6,000 of them meet State regulations. And there are large but unknown numbers of open dumps.

Moreover, recent investigation gives us good reason to question whether the sanitary landfill which does comply with current standards of good practice is capable of adequately protecting our groundwater supplies from potential leachate damage in some areas.

Almost half of our cities estimate that they will run out of available municipal waste disposal sites within a few years. Our 48 largest cities now spend nearly half of their environmental budgets on solid waste collection and disposal.

Ironically, despite greatly increased environmental concern, we are currently recycling a lower percentage of our resources than ever before in history. The United States annually consumes over 200 million tons of major metals, paper, glass, rubber, and textiles. It has been estimated that about three-fourths of the total comes from virgin resources. The remaining quarter is obtained from resource recovery operations. Virtually all of the recovered materials are derived from discards of industrial processing and manufacturing activities rather than from postconsumer waste from the municipal solid waste stream.

The mixed municipal wastes from our larger urban areas now pose an environmental problem, but they could be made to generate 830 trillion Btu's of energy—the equivalent of 400 thousand barrels of oil per day, which is a third of the initial output of the trans-Alaskan pipeline. Seven percent of our iron, 8 percent of the aluminum, 5 percent of the copper, 3 percent of the lead, 19 percent of the tin, and 14 percent of the paper consumed each year could be supplied from what is now residential and commercial waste. EPA has identified over 60 major metropolitan areas where mechanical energy and materials recovery seems feasible. These areas account for about 180 thousand tons of solid waste a day, 66 million tons annually, or more than half of the municipal waste stream.

About 7 percent of the energy and materials available from municipal waste is being recovered today—almost all of this through separate collection, rather than high-technology approaches. Dry fuel production and steam recovery incinerators have been demonstrated and are actually being employed in a few cities. Energy recovery by wet shredded fuel production, as steam or electricity, and as pyrolytic gas and oil, should all become viable demonstrated options in the not too distant future. Mechanical materials-recovery systems are somewhere between the demonstration and operational phases.

EPA is helping to finance several projects to demonstrate new technology in the recovery of energy and materials from waste. One project uses shredded waste as a partial substitute for coal as fuel to generate electricity. Another project recovers metals, color-sorted glass, and paper fiber from municipal refuse and then incinerates the residues along with sludge from an adjacent sewage treatment plant. Another will use a process of pyrolysis to produce a marketable oil-like fuel and recover metals and glass from solid waste. Another project will produce aggregate for street paving and steam for heating and cooling from solid waste—also by means of pyrolysis. Another will extract metals and glass and then produce supplemental boiler fuel from municipal solid waste, industrial waste, and sewage sludge.

An example of private initiative in recovering energy from waste may be seen nearby on Boston’s North Shore. At Saugus a privately-financed firm is working with 16 independent

1) St. Louis (1970–1975); cost, $3.8M (Federal share, $2.6M).
2) Franklin, Ohio (1969–1976); cost, $3.1M (Federal share, $2.2M).
3) San Diego (1974–1977); cost, $13.6M (Federal share, $4.3M).
4) Baltimore (1973–1978); cost, $26.0M (Federal share, $7.0M).
5) Delaware (1977–1981); cost, $28.0M (Federal share, $9.0M).
communities of Greater Boston and with a large industrial steam user to solve the growing problems of environmentally-sound refuse disposal and the energy shortage. The plant, which is designed to produce steam by burning only refuse without auxiliary fuel, also has a subsystem to extract ferrous metal and aggregate from the post-combustion residue.

An increasing number of utilities and private fuel users are beginning to view solid waste as an attractive fuel. High materials and energy prices, along with demands for environmentally-sound disposal practices and escalating land prices, will require municipalities to place more attention on resource recovery as it becomes more economically competitive with disposal.

The high-technology systems are important and of interest to everyone. As I said earlier, the spectacle of machinery operating with minimum human intervention fits well into our traditional view of how the modern world ought to operate. Nevertheless, technology cannot succeed by itself nor take care of all the problems and exploit all the opportunities in solid waste management.

Projections to 1985 indicate that wastes disposed of will amount to some 30 million tons above the 1973 figure of 135 million, even if the tonnages of waste recovered for recycling or for use as fuel are increased almost fourfold over 1975 levels. Even a doubling of current projections for resource recovery plant installations by 1985 would still leave over 70 percent of the municipal waste stream unrecovered, or 145 million tons destined for disposal.

Source separation and waste-reduction alternatives and appropriate economic reforms must also receive support from the public and the engineering community.

What about the source separation collection approach? Separate collection systems potentially have much wider applications than mechanical systems, because they do not require intensive capital investments, are not dependent on economies of scale, and generally allow much more flexibility. With the help of EPA grants, two other nearby Massachusetts communities, Somerville and Marblehead, are now determining to what extent the public will cooperate and separate municipal solid wastes at the source, in their homes. If these tests are successful, and preliminary reports indicate they will be—this could represent a significant step forward. How appropriate it seems for New Englanders, who are so well known for their Yankee thrift—as well as for turning tea-parties into really serious affairs—to be demonstrating this method of resource conservation.

Separation at the source—whether commercial or domestic—could greatly improve the economics of recovering paper, glass, and metals in metropolitan areas. Moreover, for thousands of small communities, source separation may be the only feasible way to recover resources and lower disposal costs. As a Federal official, I find this very important because Federal programs often tend to overlook problems of small communities.

I realize that separate collection of certain components of the waste stream may not provoke the degree of fascination that the technological approaches do, but I submit that it is an approach which deserves some engineering thought. Right now our nation is understandably very much concerned about energy, but over the long term, the metals and other nonorganic resources which we now haphazardly bury in the ground as wastes—are likely to represent the more serious shortage.

I believe most of us would agree that one day we will—and must—learn how to enjoy a high standard of living with much less energy waste than today. In addition, we will learn how to derive significant quantities of energy from sources which today are largely or totally untapped. But with respect to the metals and other raw materials that our industries must have, there is less room for maneuvering. The steel, aluminum and other materials which we do not now return to the production stream were derived from finite iron, bauxite, and other resources which we may not be able to economically and feasibly extract as virgin ores forever.

Most of the current technological methods for recovering materials from the municipal waste stream are less attractive, in terms of quantity of materials recovered, than the relatively inexpensive and abundant recovery which could be achieved through simple, well-engineered source separation and separate collection programs. I do not think we should view the compactor truck as such an apex of technological supremacy, that we must follow wherever it leads. It leads, inevitably, to a disposal site, where wastes of all varieties are compressed and homogenized and therefore
present a formidable challenge to those who would reclaim the valuable resources which reside there.

While the recovery of energy and materials is vital, waste reduction also urgently demands the attention and serious thought of the engineering community. When we talk about waste reduction, we're talking about the actual means—mechanical, chemical, and other physical means—which engineers have provided for industry to convert raw materials into products and services for the public. Many of these means, traditionally, have been wasteful. Estimates on how much of the energy that industry uses today in producing products and services is actually wasted vary from high to extremely high. The same is true with regard to materials use. Traditionally we have given almost no thought—for we did not think it was necessary—to the materials waste, energy waste, or other adverse environmental consequences of our way of doing business.

Waste reduction inevitably involves the subject of packaging. Packaging activity in the United States has grown at a very rapid rate in recent decades. Shipments of containers and packaging were valued at $19.7 billion in 1971, an increase of 5 percent since 1970, and an increase of 82 percent since 1960.

The growth of packaging consumption has led to increased consumption of raw materials and energy and an increased rate of generation of solid waste. In 1971, the latest year for which comprehensive data are available, packaging accounted for approximately 47 percent of glass production, more than 8 percent of steel production, and approximately 29 percent of plastic production. At that time, energy used for production of packaging materials represented an estimated 5 percent of total U.S. industrial energy consumption.

Post-consumer waste resulting from the discard of packaging material was estimated at between 40 and 50 million tons in 1971. Packaging was thus estimated to be between 30 and 40 percent of municipal solid waste, based on the EPA estimate of 125 million tons of municipal solid waste in 1971.

I do not mean to imply that packaging per se is an evil. The packaging materials, techniques, and practices of yesterday could not possibly suffice in our society of today. Moreover, some of our current packaging practices significantly curtail other potential components of the municipal waste stream. What is needed is a clearer definition of what comprises undesirable packaging, agreement to curtail its use, and renewed efforts to employ packaging materials, whenever feasible, which avoid excessive energy and materials use. These measures should be coupled with vastly extended and improved resource recovery programs throughout the country.

The leading edge of the packaging controversy has been the returnable versus the nonreturnable beverage container issue. The furor surrounding the returnable beverage container relates to a fundamental question with disturbing implications for those who believe that high levels of energy and materials use and consumption are the hallmark of a technologically advanced society. Behind the returnable beverage container arguments lie serious issues concerning, for example, long-lived tires, more durable appliances, smaller cars, more renovation and less demolition, and could involve the redesign of many other products to make them require less energy, use less material, and last longer.

A primary focus of EPA's recent policy studies has been to identify barriers to resource recovery. One major barrier is the failure of product prices to include the costs of solid waste collection and disposal. This, in effect, is a subsidy for virgin material and imposes a financial burden at the local government level where solid waste is collected, treated and disposed of at the expense of the taxpayer. To address this problem, we have been studying the concept of a waste charge that would be levied on products which eventually enter the municipal waste stream. This would ensure that such costs are considered in market decisions.

I think we need a new approach by engineers to virtually everything our society does. As I said at the beginning of my remarks, we have in the past too often provided engineering solutions that would work if only people or economics were not involved. We must place increased emphasis on the social and economic, as well as the technical, aspects of the problem before us.

We must accept the fact that we cannot go on using the earth's finite resources as if they were infinite—and that we can no longer deal with environmental issues as if they were simple, isolated problems, susceptible to solution outside the broad social, political, and economic framework of which they are a part. Increasingly, engineering knowledge, when applied to the problems of the extraction of resources, their processing into
manufactured goods, their distribution, and marketing must also include serious thought about the environmental consequences of these actions. In solid waste management, upgrading of collection and disposal systems to environmentally acceptable levels, and maximizing the amounts of waste we recover are essential for air and water pollution control efforts, for the public health, and to contribute to proper land use. However important these steps are, they are only partial. The ultimate answer must include reduction of both the waste we generate and the amount of resources we consume. Absolutely essential to the ultimate achievement of this aim are the understanding, support, and creative energies of engineers.