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Engineering for the Human Environment

Frank E. Moss

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ENGINEERING FOR THE HUMAN ENVIRONMENT

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ENGINEERS' WEEK

In 1951 the National Society of Professional Engineers instituted Engineers' Week to be observed during the month of February. February was selected because it is the month we commemorate the birth of George Washington who is recognized as one of our earliest prominent engineers. The objectives of Engineers' Week are to create a greater public understanding of engineers and the profession of engineering, and to create an interest in the high school student to pursue the study of engineering.

Each year a theme is chosen and a week of activities is planned and centered around the theme. The 1967 theme was "Engineering for the Human Environment." The activities are planned and carried out in cooperation with the National Society of Professional Engineers, and through the cooperative efforts of professional engineering societies and student engineering organizations.

The activities conducted at Utah State University are coordinated through the USU Student Engineering Council which consists of representatives from the various engineering fields.

The highlights of Engineers' Week take place at an annual banquet. At this time, recognition is given to the outstanding students from each department and one is selected as the outstanding student engineer from the College of Engineering. Also during the banquet the Engineering Queen is selected for the coming year.

The banquet is highlighted each year by a guest speaker. Thanks to the help of Dean D. F. Peterson, the Engineering Council arranged to have Senator Frank E. Moss as the guest speaker. Senator Moss used the 1967 Engineers' Week theme "Engineering for the Human Environment" as the theme of his remarks.

Lloyd H. Austin
Chairman
USU Student Engineering Council

PRESIDENT'S INTRODUCTION

The environment of man has been the subject of intensive studies in recent years as the dangers of pollution become increasingly evident. The atmosphere we breathe, the water we drink, the food we eat, all are endangered by defilement. The resolution of the conflict can come only through a systematic reordering of the national way of life so that man himself will not fall victim to the wastes of his civilization.

For forty years Utah State University has been vitally concerned with the problems of pollution. Utah State surveys and studies have revealed the effects of pollutants on man, animals, and plants, and the search continues in USU laboratories for a solution to the problem.

The recent Utah legislature commended the University for its past efforts while noting that much remains to be done to finally resolve the dilemma. In recognizing the "urgent need to reduce air and water pollution in Utah to protect the health and welfare" of Utah's citizens, the Resolution applauded USU for its "able staff which has for many years studied water quality, the effects of air contaminants, solid waste disposal, and related matters," and urged a continuation of research designed to reduce the pollution of the environment.

The speech of Senator Frank E. Moss at the Engineering Week banquet is a penetrating analysis of the problems America faces in the area of pollution. It should be required reading for those who hope to effect a change in the processes of pollution.

DARYL CHASE
President

Senator Moss is a valiant fighter for the development and conservation of western resources. He is actively interested in the interregional transfer of water and is chairman of the Senate ad-hoc task force on the North American Water Plan. He has supported the development of a number of National Parks and Monuments and recently presented a plan to develop an integrated Department of National Resources in the Federal Government. Senator Moss has a strong interest in and understanding of international affairs, and has been firm and unswerving in his support of Utah State University.

ENGINEERING FOR THE HUMAN ENVIRONMENT

by Senator Frank E. Moss

I am pleased to be here tonight before this distinguished group of engineers. I am most interested in the theme of this conference: "Engineering for the Human Environment." The importance of a man's environment might be illustrated by this story that the late Senator Barkley of Kentucky used to tell. Barkley once asked a 90-year old friend the reason for his good health and longevity.

"Before my wife and I were married," his aging friend answered, "We entered into an agreement. Any time I nagged her or fussed with her, she would take her knitting, go out into the kitchen, and knit until it was all over. On the other hand, any time she would pick a fuss with me, I would put on my hat, go outdoors and stay there until the atmosphere became peaceful again."

"But," asked Barkley, "what has that got to do with your health and longevity?"

"Why," the nonagenarian replied, "that's obvious, I've spent most of my life in the open air."

The danger that faces us now is whether the old gentleman wouldn't be better off inside if he lived in some of our polluted cities.

The challenges we face with respect to our environment stem from our unique place in history. We are living in a time of great scientific and technological revolution. We have invented more things in the past five generations than in all the previous years of humanity. We are creating a new technological world. But we are now confronted with the realization that pervasive challenges to the well-being of man are inherent in this technology. The hazards which man has created in his environment demand solution if life is to be richer as well as more productive.

The changes occurring in our society are the most significant since Neolithic times when man first started growing his food rather than hunting for it. Once agriculture assured a constant food supply, people in-

creased so rapidly that they never could return to a life of hunting. Thereafter, most of mankind was bound to earn his living by the hard work of sowing, cultivating and reaping. Today, through our technological revolution, we have changed farming from a harsh and demanding labor to an industry which only requires a small percentage of our citizens to produce a bounteous harvest for all of us.

The great impact of this technological revolution has only been felt since about the time of our Civil War. Thus it is only for a little more than a century out of the total span of our western civilization that the forces generating the profound changes in our society have been at work.

The effects of this continuing technological revolution might be viewed as a mixed blessing.

First, there are the beneficial consequences. Man has vastly extended his ability to alter nature to his advantage, yielding goods, reducing toil, accelerating communication, and providing recreation and leisure.

Second, there are the deleterious effects. Our society is now face to face with the consequences of our technology, blighted and polluted landscapes, dangerous environmental contaminations, economic conflicts, and dreary cities for most of our citizens.

It was a favored notion a century ago, when our technological revolution began, that man had mastered his environment. The train, the telegraph, the steamplant — all gave him dominance over the traditional barriers of space and time. It now may be more accurate to say that for the last century we have been ignoring man's dependence upon his environment, with increasingly disastrous consequences.

As our ability to change our environment grows, we must now turn our efforts to directing this development toward the highest humanitarian goals. Opportunistic economic and industrial considerations, which have dominated our environmental development, cannot be allowed to continue to the detriment of natural surroundings.

Thus, the challenge to our society is two-fold:

We must diminish the injurious effects that derive from our technological revolution. This is urgent be-

cause the prospective health hazards associated with the advance of technology are growing more complex, more far-reaching, and more difficult to reverse.

And, we must assure that the extension of this technology enhances the quality of life. We have an enormous potential to shape the conditions of our life and the quality of our environment. These challenges call for the wisest exercise of our governmental processes in influencing the course of future technological development.

There is widespread awareness that almost any excessive level of pollution of air, water, and soil will have deleterious effects on man because his evolutionary past has not prepared him to cope with modern pollutants. But the adverse effects do not end there. Man also has certain psychological needs that have as much force as physiological requirements.

It has been suggested that the pell-mell exodus to the countryside every weekend and whenever conditions permit means more than a mere search for comfort and quiet. It is an expression of man's biological need to maintain contact with the kind of environment in which he evolved.

The ancient Greeks symbolized this truth in the legend of Anteus who lost all his strength as soon as his two feet were simultaneously off the ground.

Some economists say there is no need for environmental management because conservation of resources is not necessary. If we run out of iron by allowing half of our production to rust away, for example, we invent substitute materials like plastics to take its place.

I agree that science and technology can invent almost anything for man's needs. But the one thing that we cannot re-invent once we have ruined it is the diversity of our natural surroundings.

Loren Eisely, the biologist, tells a pertinent story about one of our great atomic physicists. This man, one of the chief architects of the atomic bomb, so the story runs, was out wandering in the woods one day with a friend when he came upon a small tortoise. Overcome with pleasurable excitement, he took up the tortoise and started home, thinking to surprise his children with

it. After a few steps he paused and surveyed the tortoise doubtfully.

"What's the matter?" asked his friend.

Without responding, the great scientist slowly retraced his steps as precisely as possible, and gently set the turtle down upon the exact spot from which he had taken him up. Then he turned solemnly to his friend.

"It just struck me," he said, "that perhaps, for one man, I have tampered enough with the universe." He turned and left the turtle to wander on its way.

This sense of collective guilt comes largely from an awareness that the immense and exciting grandeur of this hemisphere is rapidly giving way to an immense ugliness. Brush or erosion is overcoming mountain slopes that once were majestic forests, industrial sewers are sterilizing streams that used to teem with game fish, air pollutants generate opaque and irritating smogs that dull even the most brilliant skies.

The most immediate threat to our environment has come in the form of polluted air and water. To sketch the magnitude of the threat to our environment, I would like to discuss the problems of polluted air and water in more detail.

Water

Perhaps it is significant that one of our main environmental problems, water pollution, is not a serious technical problem at all. We have the technology now to clean up our water and keep it clean, but that is not the whole story. The expense of cleaning up the water, public lethargy, and the active opposition by some unenlightened business leaders, combine to make the task an almost insurmountable one. Perhaps we have not conveyed a sense of urgency about our pollution problems and should heed the example of the firm that was considering adopting some new policies on insurance.

The only way this could be accomplished was for all twelve of its employees to agree on the new program. Eleven of the twelve agreed; the twelfth was adamant in his opposition. Finally his boss, in desperation, told the hold-out to report to his office after work. When they were alone, he said to the employee, "Either you accept the new policy, or you're fired."

The next day the man in question voted for the new program. His friend asked him why he changed his vote. "Well," he said, "before the boss called me in, I had never had it explained to me."

A greater awareness of urgency by the public, technical breakthroughs by the engineers, and a recognition of the great costs involved would all help in solving the problem.

It is now clear that almost every American river or lake of any consequence is infested with pollution from one source or another. Municipal sewage turns the Potomac brown, wastes from steel mills pour red rust into the Cuyahoga, mine salts and chlorides contaminate the Grand river. The Columbia's pollution from paper mills poses more threat to the Salmon than the river's dams.

Canning wastes pollute the San Joaquin and the Sacramento. Oil refinery wastes taint the lower reaches of the Yellowstone. About one-fourth of Lake Erie is all but dead from pollution. And I do not need to tell this group about the pollution which for many years made Great Salt Lake little more than a cesspool, about the sugar beet factory wastes on the Bear river, and the uranium mill wastes in the Colorado.

The pollution becomes cumulative with water carrying an increased burden as it moves downstream, despite attempts at pollution control on a riverway. While the adverse effects of water pollution may be seen along the waterway, the most serious effects are seen in the estuarine zone. Here the pollutants which have been carried long distances down rivers, end in an estuary and become trapped as the result of river deposition and washings from the sea.

Why is it that all of a sudden the drive for clean water has become a national crusade? We have been using our lakes and streams as municipal sewers and industrial garbage pails for years. But the technological revolution produced three events by mid-twentieth century that foreshadowed our present water pollution

crisis: a population explosion brought about by improved medical care and higher birth rates, the metropolitan migration as mechanization and improved methods reduced the number of people needed in farming, and the development of synthetics, especially detergents.

Between 1940 and 1960, the population of the United States increased by 50 million people. During this period our water supplies remained constant, but the amount of municipal and industrial sewage being poured into them practically doubled. Sometime during this era, complacent communities began smelling their rivers before they could see them.

During the same twenty-year period, the great exodus from the farm began. Almost 70 percent of all Americans became urban citizens. They not only used more water, but they contributed to greater concentrations of pollution.

Finally, the new scientific and industrial community was bringing about the widespread changes in American economic life. This resulted in not only more pollution, but in new physical and chemical pollutants with which to deal.

Now that the crisis is upon us, we must decide upon a course of action. The responsibility to restore our waters belongs to each of us. To every citizen who must make the ultimate decision to pay the cost of clean water; to technicians who must devote their talents to the job of cleaning and rehabilitating, and the elected representatives who must define the role that government is to play.

The federal government exerted only a minimal effort to arrest water pollution until Congress passed the water quality act of 1965. This act will undoubtedly go down in history as a milestone in the protection of the health and environment of the American people. As this bill moved through Congress, we hammered out a new philosophy on water pollution. We discarded the idea that the purpose of pollution control is only to remedy past damage to our water, and moved on to the broader concept of enhancing the quality and value of our water resources.

The Federal Water Pollution Control administration in the Department of the Interior was given broad authority in the fields of pollution treatment and abatement. All 50 states have agreed to set clean water standards. Now the states must decide on the standards for potable water and the means of enforcement. The federal government will pay 30 percent in matching grants to aid in the construction of waste treatment plants. A continuing program of research is being conducted to find better methods of pollution abatement.

Surveying our efforts in the water pollution field reminds me of a story about Mark Twain.

Mark Twain was en route to a friend's farm in New Hampshire and stopped to ask directions. "How far is it to Henderson's place?" he inquired.

"About a mile and a half," said the farmer. Mark Twain continued along the road until he met another farmer and again he asked the distance to the Henderson farm.

"About a mile and a half," replied the second farmer.

Still further along the road he asked another passing farmer the distance and was again told, "About a mile and a half."

"Thank God," said Mark Twain. "I'm holding my own!"

Despite all our efforts in the water pollution field, that is about where we are—holding our own. It will take all of our efforts to draw closer to our ultimate goal of clean water.

Air

The problem of air pollution is developing much faster than the gradual pollution of our waters. In Los Angeles county, 9,000 tons of carbon monoxide, 1,100 tons of hydrocarbons, 400 tons of oxides of nitrogen as well as sulphur compounds and acids are discharged into the atmosphere every day. Much of the time they are trapped by a temperature inversion—producing an irritating smog. As recently as four years ago such

inversions were considered extremely rare in the East. Yet today, pollution on the East coast is often worse than in Los Angeles.

At the recent conference on air pollution in Washington, Secretary of Health, Education and Welfare John Gardner said, "The truth is that we are actually losing ground in the fight against pollution. The smog continues to grow more dense even as we talk about it."

Ordinary air in urban areas is filled with tons of pollutants. These pollutants cause asthma, bronchitis, lung cancer and emphysema. The air erodes machinery and buildings and damages trees and farms. In our cities, human life itself is threatened.

The quality of air is determined by the uses for which it is needed and by the pollutants injected into it by man. A differing amount of air is consumed in the process of burning various fuels: 1 pound of gasoline requires 158 cubic feet of air, 1 pound of oil requires 166 cubic feet of air, 1 pound of coal requires 136 cubic feet of air, and 1 pound of natural gas requires 248 cubic feet of air.

It has been estimated that fossil fuels used throughout the nation during one year require 3,000 cubic miles of air each year, of which motor vehicles use 640 cubic miles, or about 21 percent.

The federal government has already set up a national standard for motor vehicles and also established 120 local air pollution programs. It is working in areas where pollution is an inter-state problem. But this is not enough. The President has just proposed the air quality act of 1967. If enacted, several significant steps would be taken.

First, emmission control levels would be set for those industries that contribute heavily to air pollution that crosses state boundaries.

Second, each state would be given the chance to adopt equivalent levels or stricter ones. If no state standards were adopted, then the federal ones would prevail.

Third, regional Air Quality Commissions would be established to enforce pollution control measures in

"regional airsheds" which cut across state and local boundaries.

Fourth, matching grants to the states would help establish programs for inspecting motor vehicle pollution control devices.

Fifth, an accelerated program of research and development would be started to provide alternative sources of power and new devices for pollution abatement.

In the long run it will be the research and development grants that are the most important factor in air pollution control. In this field, much more than in water pollution control, important engineering breakthroughs are needed. Perhaps the best example is our failure so far to find a means to significantly modify emissions from motor vehicles.

I think the President's message on air pollution summarized the task before us. He said:

"America's air pollution problem emerges from our success as a modern nation. Sources of pollution may be environmental villains, but they are also social and economic necessities. Our task is to determine how to abate the poison they pour upon the air, without seriously diminishing the benefits they provide. Surely this is not beyond the capacity of a great nation's productive and scientific genius. Clearly, it is an absolute necessity for the health of the American people."

For better or worse, the American people look to the scientist and engineer to find a way out of the environmental problems that have been created by our own cleverness. Most of the nation's environmental needs are subject to technical solutions or approaches that are not now commonly employed. The engineer must assume an enlarged role in public programs that are directed toward meeting these needs. In many respects, this is the traditional role of the engineer—the problem solver who brings technology to bear on both public and private problems.

At the present time engineers all too rarely are involved in political policy issues or goal setting. They are too often called upon for solution to housekeeping problems within a well-established policy. This is not

the classical idea of the engineer. The engineer historically has been the modifier of his total environment and concerned with the overall results of his efforts.

It is true that engineers are not trained in the social and political barriers which often are governing on technical solutions. But the real need is for the engineer to make his knowledge available to those charged with the political decision-making and to pose alternatives which technology can offer.

The engineering schools should take a more active role in developing curricula, which would go beyond those now available; to equip men to deal with our massive social problems. The state and local engineering societies should work more closely with all levels of government. Policy can only be made intelligently if the expertise is available throughout the policy development.

The universities of this country have been our principal source of knowledge and information, particularly that growing out of basic research. But the Land Grant colleges established under the Morrill Act went beyond this. In the field of agriculture, these universities have an admirable record in not only generating knowledge, but in applying it to a major public need.

Just as the problems of agriculture and food supply were paramount to a growing nation 100 years ago, the social and political needs of an affluent urban society are of great importance today. We must again look to the universities to contribute to the solution of these major public problems. Engineering for the human environment is needed, nay **demanded** in our time.