

**KYLE:** Ladies and gentlemen, I would like to call this meeting to order. And first, I would like to welcome all of you to this MIT Sea Grant Convocation, and to our first annual Sea Grant lecture. May I introduce myself. I'm Alfred Kyle, director of the MIT Sea Grant program, and the Dean of Engineering. This day, today, to me, is certainly a proud and a very happy one. I, personally, have looked forward to the time when we could have this convocation, and I've been looking forward to this date since 1968 when MIT received the Sea Grant project, grant GH1, the first Sea Grant project made, grant made by the, then newly established, National Sea Grant program. That was just over four years ago. In retrospect, we have proceeded deliberately into this new program here at MIT. It was only after careful consideration that MIT decided to commit itself to a formal, Institute wide Sea Grant program.

And then we applied for, and received, our first coherent area project in 1970. We have moved forward rapidly since that time. We have broadened interests and the participation at the Institute. We have gathered momentum, strength, and stature in each project year.

We have made this progress because we had an enthusiastic participation from many faculty members and students, we had generous support and encouragement from the MIT administration, and we had a small but exceptionally effective MIT Sea Grant Program Office, which is led by Mr. Dean Horn.

I would like to use this opportunity today to express my sincere appreciation to everyone who contributed to this successful growth and evolution of our program. You'll find an overview of our present program in the program which you have in your hand, and I will not take time to repeat the information printed there. But I want to take special notice at this convocation

which marks our programs advanced institutional grant status. And that is, that it is the third step, and the key step, toward an ultimate objective of ours to become a Sea Grant college.

Now let's turn to the National Sea Grant Program. That program has grown dramatically since it was established in 1968, though not as rapidly as the original legislation had envisioned. Despite this financial difficulty, and despite the myriad of problems associated with organizing a completely new program where nothing existed before, and then also having added to those problems, which were created by changing from one parent organization, the National Science Foundation, to the newly established National Oceanic and Atmospheric Administration, and the Department of Commerce. Despite all these problems, the Sea Grant Program has become extremely well established.

It has expanded, at least, four fold by any measurement standards. In many respects, faster. In terms of participating schools, budget allocations, projects, and accomplishments. And that indeed is a dramatic progress. The man who made that progress possible in the Washington maelstrom is Dr. Robert Abel, the director of the National Sea Grant Program.

This election of Bob Abel as the first director of Sea Grant was most fortunate, because he brought with him many years of experience in ocean research and in program administration. He started as a chemical oceanographer at the Woods Hole Oceanographic Institution in 1947.

He next served as chief scientist aboard the USS San Pablo and [? republic ?] for the Navy Hydrographic Office from '51 to '55. Then he became assistant to the director of the hydrographic office until 1960. Then he moved to the Office of Naval Research, where he served as assistant research coordinator, and the executive secretary of the interagency committee on oceanography from '61 to '67. And this is exactly the period of the great coordination and upswing of the [INAUDIBLE] program in Oceanography.

Since '67 he has been director of the National Sea Grant Program. Added to this broad experience, Dr. Abel has also earned strong endorsement throughout the marine community, including a specific nomination by Dr. Spilhaus, our speaker today, to become the first director of the Sea Grant Program.

It is now my pleasure to present Dr. Robert Abel, the director of the National Sea Grant Program.

**ABEL:** Thank you very much, Al. Doctor Rosenblith, Dr. Spilhaus, distinguished guests, ladies and gentleman. If there are any historians here, let me state for the record that Al didn't leave out a thing. For those who are about to be introduced, I wonder if you have ever noticed the feast famine cycle we all have to stay on top of.

For instance, it's precisely one year ago today that I had the privilege of addressing one of the largest conservation foundations in the United States. Of course, as you know, to be a conservationist it is first necessary to be extremely passionate, devoted, dedicated.

The gentleman who had the problem, or shall we say, the assignment of the introduction, was the founder of the organization. And, therefore, a man by nature most passionate, most devoted, most dedicated. The gentleman, approximately 135 years of age, lumbered to his feet, and started off on his task. 22 minutes later, he sat down. And he had discussed conservation from beginning to end. He had obviously forgotten what he had come to do. This is normally no problem. After all, we're all big boys. You stand up, introduce yourself, and say what you're going to do.

Unfortunately, for the remainder of the evening the master of ceremonies, or the chairman for the evening, was sitting next to me with, what he forgot, was an open microphone. And forgetting his com completely, he said in a stage whisper that was heard from one end of the auditorium to the other, oh my god. The stupid idiot forgot to introduce the speaker.

Now at this point, you might think that the pressure is on the speaker. Actually, it would be entirely possible for me to have sung the first three stanzas of God Bless America at that point. Nobody would have known the difference. Such is not the situation today, of course.

It's been, and will be, a very exhilarating month for Sea Grant. Yesterday, I had the honor to be an observer when Dr. Spilhaus key noted a historic event, in which the governors of Alabama and Mississippi signed what must be considered a sort of a Sea Grant treaty, a bi-state treaty, uniting 10 schools. Public, private, black and white, coastal and inland, in one, what we in a biased manner, consider to be a rather magnificent enterprise.

It was historic. In a week the meeting will be held of a newly formed Sea Grant Association, paralleling that of the land grant colleges in Houston, Texas. In a week hence the Secretary of Commerce will officiate its ceremonies in Wisconsin and Hawaii, commemorating their accession to a status which we call Sea Grant College.

But with all, it is quite doubtful that there can be a more stimulating kind of honor than to participate in a Sea Grant event of any kind at the Massachusetts Institute of Technology.

About 5 and 1/2 years ago, our office opened. All we knew was that we had a Sea Grant office, a secretary, and a file cabinet. And a small budget. At that point we share the problem in common with any new business, which opens its doors, and wonders if and when a client will make an appearance.

Naturally, we weren't too worried, because we did have money. And, of course, the appetite of a university, or any organization, for funds is well known and, of course, voracious. But, of course, the question is, if you are a new granting organization do you want to be known in history as a supporter of West Cupcake college? Or a first class kind of consortium? And that is why, my friends, we were so exhilarated when, almost the first university, to demonstrate its interest in our program was MIT.

Specifically, Al Kyle. I say this mostly to convey to you a sense of our elite feelings, because we had been told, you see, that MIT does enjoy one of the better reputations around the country. And we found this quite true. The University pursued its application, and shortly received the first Sea Grant Award.

What was interesting from, again, historians viewpoint, was that Dr. Spilhaus served on the National Science Board at that time, when they had the deliberating authority to decide if, and when, and why, we would make our initial awards.

In a sense, we were as proud to make this award to MIT, certainly, as the university may have been to receive it. And in the two year period following, during which the project was being prosecuted, this was an educational program involving design and production of, what are proving now to be classical texts in ocean engineering.

We certainly never had occasion to be ashamed of this grant. In fact, quite the contrary. We were all the more receptive, therefore, when the University decided to elaborate on its Sea Grant affiliation. And the Institute designed a system of projects and programs which were aimed at alleviation of urban problems, and thus, were focused on our essential goals, the aims of the Sea Grant program.

These have been no less successful in their prosecution. We have now come to the present when the Institute has, apparently, made a decision to apply many of its resources to the Sea Grant program. And, in fact, conduct a major effort under the Sea Grant banner.

I don't believe that I'm telling any tales out of school when I mentioned that our panel's reaction to this MIT's proposal was quite positive. And it thus makes it easy for me to say that we are now, not only happy to make this first institutional status award to MIT, but that we already consider it one of our very best programs.

This is a program which, parenthetically, includes 125 universities around the country, 98 industries, and about 35 state agencies. In this category now, MIT joins universities such as Michigan, Wisconsin, California, Miami, and Southern Cal. Miami and Southern Cal, incidentally, are the only other private schools in the country to be thus affiliated.

As many of you know, MIT was one of the first land grant colleges. It's perhaps not well known as a land grant college, because this Appalachian has been obscured by the institute's fame and so many other directions. But it may be, however, as one of the reasons why the Institute has made the decision to mount a strong program aimed at the Sea Grant college status.

Under the normal terms of the Sea Grant process, MIT must be in this status for two or three years to be considered for Sea Grant college status. Thus far, four universities in the United States have qualified, and have received their plaques designated them as Sea Grant colleges. So at that time, there will be another kind of ceremony in which I would be replaced by the Secretary of Commerce.

I don't say this as a matter of sour grapes, because you see, I have a disk problem and those brass plaques weigh 43 pounds apiece. But it is my hope that this will happen here in a minimal period of time, because I cannot conceive of a wall anywhere in the country which would better grace the Sea Grant plaque than the facade of this building in which I speak today.

Now, in theory, at this point I suppose I ought to be signing some sort of a document. But Washington bureaucracy being what it is, and the Office of Management and Budget being what they are, the document has encountered another type of history, and it's all sealed, signed, and delivered.

Of course, the cynics among you might say, well it's nothing stopping him from taking a piece of paper and signing on it for the presence of a photographer's. I tried this just once. It happened about five months ago. Sometime before the unfortunate demise of Senator Ellendor of Louisiana. Senator Ellendor, as an old shrimp farmer, was very greatly interested in our program. And hearing that his university was about to attain institutional status, invited me up so we could have a joint signing ceremony with all the appropriate side effects.

We check through with, what we call the shoe clerk factory. That is, where all these pieces of paper are physically stapled together, the right words legally are substituted for the right words, technically, et cetera, and they make a nice little package out of it.

What we do, naturally, to avoid any embarrassment, is to make sure the lawyer sees it first. That way, it is a perfect document when it goes up the line for signatures and finally comes to my desk. And so, knowing, in this particular case, that the document had already been cleared by people who had to worry about these monumental trivialities, we, of course, concurred. I went up to sign, the document hadn't quite come across. They said it will be here at three o'clock this afternoon, but the good senator has to do his TV bit at 10 o'clock in the morning, so we signed a piece of paper. And the cameras whirred away, took the document, then sent to tape, the TV tape back down to Louisiana by mail that noon. Nothing slow about Senator Ellendor. Then, 3 o'clock that afternoon, we got an intriguing phone call.

It seemed that the lawyer who had cleared the document a week previous had just resigned to go into private industry. And so the document, winding its weary way back through the paths of bureaucracy, had to have another signature from him. Since he wasn't there, they gave it to his replacement, who was a young lady type lawyer, would had just been recruited from HEW. She took one look at the document, and said, Louisiana State University, they don't ascribe to the Civil Rights Act of 1966 the way I see it. I am canceling out, and I'm sending the whole thing over to HEW for an investigation.

So, after taking a few hundred [? ampugels ?] I called her and said, well, number one, you honestly can't expect a university to turn around 180 degrees between 5 o'clock one night, and noon the next day, which is when they're going to receive that cotton picking TV tape.

Number two. The time to negotiate, to insure that civil rights are carried out, is during the year when the activity is taking place, not while somebody's signing a grant.

And number three. Young lady, for God's sakes, when you've got to fight pick on somebody your own size. Not the chairman of the Senate Appropriations Committee.

But, with apologies to about half the audience. This is, after all, the age of you-know-what lib. And she said, I'm sticking to my guns. And the head of the legal counsel for the Commerce Department, the general counsel said, he had to back her up, because she could bring a federal suit under the act.

So, there we were, and I said, well that's all right. You've got one hour. At 5 o'clock tonight, I have to call a senator and tell him we're calling off the whole grant. You just take your pick. And, how long does it take to clear through HEW? He said, well, these investigations can take six months or more. I'll give them credit. They did expedite. Instead of six months, it took them 35 minutes to have the investigation completely cleared up.

Well now, having rambled, let me tell you why I'm really glad to be here.

You know, I will be followed by the speaker who will be your first annual Sea Grant speaker. He is the father of the Sea Grant program, and I'm certainly not going to steal the thunder of the gentleman who'll introduce him. This is Doctor Spilhaus. Alma mater as well. He is well known, however, as the inventor of the bathythermograph. This had been mentioned earlier. It is, for the uninitiate, the most widely used instrument in the history of oceanography. Therefore, it does become obvious, does it not, that an important mission of the Sea Grant program is to contest with this bathythermograph as the chief perpetuator of the name of Spilhaus. And, with all due respect to you all, you're crazy if you think that we are going to be beat out by a hunk of brass. Thank you very much.

**KYLE:** Thank you very much, Bob Abel. I would like to call on the provost, Dr. Rosenblith to respond to Bob Abel.

**ROSENBLITH:** Thank you Kyle, Dr. Spilhaus, Dr. Abel. When I was asked to say a few words of acknowledgement, I thought that all I had to do was to acknowledge the status as an institution. I didn't know that I had to argue with a lesson in affirmative action, this footnotes to brass history, and all kinds of other things.

So, with all apologies to you, Doctor Abel. I shall just deal with one point. Let me say, it is the most pleasant occasion. It is a privilege and a pleasure, on behalf of Doctor Wiesner to acknowledge our designation as a Sea Grant Institution. I'm glad, by the way, that this is institution, not institute. Because to be a Sea Grant Institute squared wouldn't do. Let me also say that, apparently, we live in an age in which learning results in degrees. Not only for people, but also for institutions. And as I see it, we are climbing up that ladder. And if I should just draw the moral from what you have said, I can only hope that the two or three years of purgatory will seem very short.

Now, this is seriously a responsibility that Dean Kyle and his colleagues who have worked so successfully on this program for the last half dozen years, and all the rest of us, take very seriously. You, Dr. Abel, made a remark with respect to land grant colleges. I've always been impressed with the fact that the University of Wisconsin, whom you have otherwise also mentioned, declared officially when it became a land grant college, that the frontiers of the university are the frontiers of the state.

And, in a sense, this seems to be a very interesting, statesmanlike statement. Now, in recent years, the frontiers of the universities have gotten not only the frontiers of the state, but also they are the frontiers in space, and now the frontiers in the sea. And each physical agent, each of the astronomies, optical, radio astronomy, x-rated astronomy. Each of them give us a new kind of frontier, in some sense.

In a way, we are trying to put together a model, an image of the cosmos that makes all these frontiers be coherent. And I think that, in a way, what the Sea Grant program does, is, in a way, it forces us to integrate knowledge in a different way. In a useful way for man.

It's important to realize that this question of cooperation, which is brought about by problems that a society has, by problems that the real world poses, is not the natural way in which faculties live. It's important to realize that this kind of corporation comes about in a very different manner in different areas. Ever since Brian Flowers made his speech, in which he talked about the extrinsic and intrinsic forces that shape the university as an institution. Ever since that speech, I think people have tried to find new examples of what is extrinsic, and what is intrinsic, and how do they interact?

And in a very real sense, the disciplines are of the most intrinsic forces of them all. And without that balance between extrinsic and intrinsic forces, the integrity of the different disciplines, and integrity of fields of knowledge, might be in great trouble. But it is because of this fact that we have this balance between the demands of a society, the ways in which the real world is not organized, as my old teacher Phillip Frank used to say, according to departmental labels.

And I would add that when you talk about problems in nature and society, and society is perhaps nothing else but a special form nature. When you talk about these kinds of problems, then clearly, they do not come by departmental labels. This interaction that a program such as the Sea Grant program presents at MIT. The mobilization of resources from the outside, together with a willing to reconsider the way in which we do things the normal way.

This seems to me, brings about the kind of healthy metabolism for intellectual institutions. Disciplines, a friend of mine says, differentiate. Programs integrate. And in a way, what the Sea Grant program is doing is giving on once a most healthy integrations. And so, I shall all be due to come after that purgatorial period is over, and look not only at the plaque, but at the things that Alfred Kyle, and Ira Dyer, and Dean Horn, and all of their colleagues in the departments and their students would have brought. Thank you very much.

**KYLE:** Thank you. Thank you very much, Walter. Before I introduce the next speaker, I would like to take a few minutes to present the background and objectives of the MIT Sea Grant lecture series. The Lectureship has been in our long range plans since the start of the MIT Sea Grant program. And we believe that this convocation here is the ideal time to inaugurate that lecture series. That series is intended to provide an annual review and the coalition of perspectives for major opportunities in the marine field. And to serve as a national focus for a person's interested in working in the field. We want to address, in particular, issues of conflict in multiple usage of the sea, while striving at the same time equanimity and balance among economic needs, quality of life, and the environment.

We seek to reach new horizons in the effective use of the seas and their vast marine resources. And finally, we envisioned this lecture as a vehicle to highlight marine activities for us at MIT, and for the Sea Grant program in general.

The MIT faculty Sea Grant council, which President Weizer has appointed, has decided to sponsor this annual lecture, and is participating in the planning for the resources required to continue it.

Each year, under this program, MIT will select an authority in the marine field to present the annual Sea Grant lecture. The selection of the first Sea Grant lecturer was obvious to us. Who could possibly be better qualified to inaugurate that series than the man who originated the concept of Sea Grant during his famous address to an American Fishery Society meeting in 1963. Dr. Athelstan Spilhaus. I will not attempt to recite Dr. Spilhaus long list of achievement, his honors, his career highlights, because that would delay too long in bringing him to the podium, and have him present the information he will deliver to us.

Suffice then to say that in addition to being the, quote, "front father of Sea Grant" unquote. He is proudly claimed as one of MIT's illustrious Alumni. It is a deep personal pleasure for me to present the noted meteorologist and oceanographer, scientist and engineer, Dr. Athelstan Spilhaus to deliver the first annual Sea Grant lecture.

**DR. SPILHAUS:** Doctor Rosenblith, Dr. Kyle, Dr. Abel, distinguished members of the faculty, and those ladies and gentlemen in the audience. Its' a great pleasure for me to be back here, on this occasion. It was 40 years ago, almost to the day, when I entered MIT as a graduate student. 1932. I came from Liverpool direct to Boston. And with my bags in hand, walked from Atlantic Pier to MIT.

The dean of admissions had not heard of the University of Cape Town where I'd done my undergraduate work. However, as I'd come so far, they did admit me on probation to course 16. Which Dr. Hunsaker was in charge of at that time. And they allowed me, somehow, to stay. So my whole career in the United States started at MIT.

My interest in the oceans had started earlier when, as a student, I went in my vacations on trips from Cape Town around Africa to Burma and India, and worked at sea as an engineer. But after taking a degree in aeronautical engineering here, I went upstairs, where a brand new meteorology department had been started by Carl Rossby. And it was there I was introduced to the science of oceans and atmosphere. And then another, both teacher, and room mate, and friend, Doc Draper interested me in instruments. And with Rossby's interest in ocean dynamics, this led me to combine the two. And I suppose my little start in ocean engineering, the bathythermograph resulted. And it was first built in a bootleg fashion in 1936 in the small shop in the basement of aeronautical engineering. Tested it, would so.

At the same time, I recall I was supposed to, officially, to be working on the dynamics of jet streams in a model rotating basin. Which was so large that the only space for it was a seldom used men's room in the basement of mechanical engineering.

It was in 1963 when I had the idea of the Sea Grant colleges, and '66 when the act was signed by President Johnson. And I like to think, as it's been said today, that the fact that MIT received the very first Sea Grant award under the new program, the fact that I happened to be on the science board at the time, and the fact that I'd brainstormed the Sea Grant program we're not entirely unrelated.

MIT's well deserved institutional status in the national Sea Grant program, to my mind, strengthens the whole program. It implies that the tremendous intellectual and practical resources of our great institution will be committed, even more fully, to better uses of the sea. And that MIT should be a leader in ocean engineering is, of course, to us quite natural. It rests on the great foundation of its distinguished department of Naval architecture and marine engineering. And relates to all the strengths of the areas of the institution.

MIT also has a magnificent dedication. Not only to good science, but also to the use of good science and engineering for people's needs. And that is just what the Sea Grant program is about. This is also the right time for MIT to turn more to the sea. We're seeing, at this time, it's the right time, because we are seeing a burgeoning of aspiration and concern of people with regard to the quality of the environment. And such aspirations and concerns are excellent.

But what is not excellent is some of these peoples over simple attacks on industry and technology. Attacks, often, without alternative positive proposals. What is not excellent is the uninformed concerned leading to unrealistically stringent controls, often with impossibly short time scales of accomplishment.

These, I believe, can inhibit the very industry, technology, and productivity that we need to use to give us the quality environment to which we aspire. What is bad, is that this has resulted in a body of uninformed vocal opinion, which one might characterize as supporting non engineering, or even anti engineering.

Engineering's job is to apply not only our scientific knowledge, but also our arts. To supply people with the things they need. Non engineering takes place when protests and action, sometimes in the name of conservation and environment, stop us providing for people's needs. What is bad is controls without incentives. Attacks without proposals. Actions that result in non action, that leads to profound social consequences. Social consequences that lack adequate positive, social, and engineering planning.

Doom forecasts are mostly based on what will happen if we don't do some things differently. By differently, hopefully better. But what's new about such forecasts? We always do something differently. We see the problem, and as engineers we try to tackle it. We do indeed need to do some things differently on a very large scale, in regard to our environmental problems. And I'm sure we will do so. An engineer's analysis of the future should, I suppose, start from where we are and find out what must be done in business and industry to arrive where we would like to be to achieve desirable results.

An engineer should not merely sit back and predict the inevitable result of carrying on present practices, he should design the future. Our people, on the average, I believe, are living in the most bountiful age. Healthier, cleaner, better educated, better nourished, better than they've ever lived before. In fact, so good that they can now afford these newer aspirations. There's nothing wrong with these aspirations. They're great. But there's a real danger that political and public manipulation of them can destroy the very productivity needed to achieve them.

These aspirations deal on the one hand with an increasingly protective attitude to people, and on the other hand, with the concern or an overconcern, perhaps, of an over clean environment. In both of these worthwhile objectives, there lurks the danger of ignorant over emphasis to the extent of inhibiting national productiveness. On the other hand, if we plan properly and imaginatively to move towards these new aspirations, we can both stimulate productiveness and initiate new kinds of industries to supply the new commodities, if you like, of cleanliness and safety for people.

But we cannot do this with naively overstated goals of zero risk, which may stifle inventiveness, initiative, and the production of new things for people's health, mobility, improved shelter, and food. Some people are already inhibiting innovations by naive over statements of possible side effects and risks of these might present. No one argues that the proper assessment of side effects of new chemicals, new drugs, new materials, new modes of transportation, is an essential part of good engineering and the industry depending on it.

But few among the public recognize the danger to our overall national productivity if this protective assessment is overdone. As often it is today. Similarly, the naively overstated goal of zero effluents prevents our developing the productivity.

Especially the productivity we need to enhance our environment. Again, no one will argue that great planned practical efforts must be made to prevent the further pollution of our land, air, and water. But we must make realistic engineering plans, and stimulate our technology, business, and industry. To use their muscles in their waxing to achieve the cleanup we desire.

We need to move toward a better public understanding of what I've described elsewhere as an ecolibrium position. Balancing the desired ecology, which is the harmonious pattern between organisms and their environment, with the necessary economy, the management of affairs with a view to maintaining productiveness.

Zero risk? Nonsense. There must be more realistic awareness that in all activities, there is an acceptable risk, and that it is not zero. Zero effluence? Nonsense. There must be more awareness that in the use of the components of our environment, air, land, and water, there is an acceptable burden of man's waste of the proper kind that these components of our environment can carry, and this is not zero.

There must be more awareness of the fact that one proper use of air, land, and water, is to dirty it. Air and water, particularly, is to dirty it. Whether we use it in the organisms that are our bodies, or in the organisms we call industry, we should be aware that certainly both our own body organisms, and the organisms we call industry, would die under a policy of zero effluence.

There must be awareness that water and air are commodities, that we must use, clean, and reuse. Just as the commodity food is grown, used, and regrow. We must think of the culture of our air and water in the future. Atmosphere and hydroculture if you like, as we think of agriculture today.

We must realize that there's a cost for these new commodities, air and water. That cleaning up is not a one shot proposition, but a continual added cost to the commodities which we borrow from our environment. And under pricing of these, such as water, air, and energy, promotes the waste of them. And thus, promotes pollution.

Above all, there must be an awareness that to continue to give people the things they need to ease their lives, and at the same time preserve a clean environment, and a clean world, will take more energy per capita, not less.

Starting with a given population to achieve the intermediate steps, involving enough food, cleanliness, better indoor environmental quality which is housing, to reduce depletion of resources, we need to increase the basic currency of civilization for each individual. Namely the energy at his command. Yet there are many who are delaying and inhibiting the production of the energy we need. Nowhere is this more striking than in the present misguided notions which are voiced loudly in the controversy of oil production, tanker imports, nuclear power plants, and the like.

And that is where we come to the sea. I entitled this talk: Bountiful Grants of the Sea. Because Sea Grant programs purpose is to make available to people the grants of the sea.

A grant is a gift for a particular purpose. And in this way, the principal potential grant of the sea to man is the space it offers him to extend his living to the other 3/4 of the Earth. The problems of the smaller and more crowded areas of land can be alleviated by great ocean engineering. The most bountiful grant of the sea is space. Space to offer man for his activities. Space to the coasts where people crowd. Space close to the majority of the cities of the world that are on the coast. Space close to the principal terminals of world trade.

Coastlines, after all, are of constant length. They're lines. One dimensional. Yet man and his activities are three dimensional. Man is not one or two dimensional. He's not a square, he's a cube. So far, man has broadened his line of coastline by extending it inland. He has, so far, not broadened his coastline by extending it much out to sea. We come, inescapably, to the fact that any land use plan must also be a sea use plan.

The sea has space to offer us and, particularly, space near the shores where 70 percent of the world's people congregate. The land use battle that's going on all over the United States today, is probably most intensely fought in view of the current environmental concern. It is most intensely fought about the use of the coasts. And it is a perfectly proper concern to view one of the most important and unique uses of the immediate coast and beach, as being for people's recreation or re-creation.

Land use involves sea use. Yet, there are now coastal management bills pressing 30 states to develop land use plans for their 100,000 miles of irreplaceable coastline.

The coastal zone management bill extends seaward. But while it is concerned with the preservation of the coasts to protect them as natural resources, it does not seem to have the adequate balancing positive encouragement for renovating the coastline to benefit human uses of these resources. I endorse the validity of land use and environmental concerns, but should we not have also a vigorous national program of sea use, to move such activities as we can that are presently cluttering up the shoreline, out to sea.

All the area of land is constant. Less than 1/3 of the earth's surface. Land is not boundless, as man once thought it to be, when there were fewer of us. But an inventive, imaginative, daring, and adventurous ocean engineering program could multiply our living space by the proper use of the sea. The bounds of land, in other words, are only the bounds of men's minds, limiting their imagination. And man's use of land should not be bounded by sea shores.

Now, if what I say seem like dreams to some of you, I remind you that you and I have had dreams, and seeing them rapidly become reality. And if some of the things seem like stunts, I merely remind you that we have seen stunts that have become rapidly routine.

In fact, dreams are indeed the stuff that practical progress is made on. Non engineering, or status quo practices, are the material for nightmares. Dreams go beyond the state of the art, and challenge the state of the heart of innovators. Stout hearts that can take us beyond present art.

15 years ago, in a little pamphlet called Turn to the Sea, I dreamt about man's return to the sea, and I compiled dreams of the study, and use of the sea, into a little story. Which is called, as I said, Turn to the Sea. Almost all of the dreams in that little book have come to pass today, have become reality. It's not surprising. Man has indeed been turning to the sea, returning to the sea for thousands upon thousands of years. The first light that warned sailors of dangerous shoals and rocks, or guided them into protective harbor safe from storms was probably a fire on a Cape.

The first lighthouses were built on shores, but the lighthouse then tiptoed out to sea. First onto a shoal. But for their day, what daring and imaginative structures were those lighthouses far out on shoals.

But then the light stepped further out. On floating houses, the light ships.

Similarly with oil. Man found it first seeping out on land. And he sucked it up, also sucked up naphtha with sponges from the edge of the sea. He first drilled for oil on land, but then he built the Texas towers that strode out to sea on their long legs. Then man drilled oil from floating rigs in deeper water. And now we see oil production moving under the sea. Not only prospect drilling, but production and storage.

Harbors, too, have traditionally been at the meeting point of sea, air, and land. The worst possible point, where tides, waves, winds, and shoals combine to make the harbor, which should be a great refuge, a potentially dangerous entity as well. And as ships grow larger and larger, they cannot come in to these potentially dangerous harbors. And so, they discharge their cargos, often to smaller ships.

An uneconomical process. Now, we fill tankers from buoys out at sea. And in the North Sea, companies are building artificial islands as harbors for large vessels. Harbors too, you see, are striding out to sea. But now, they must stride more quickly, because they have the gun of environmental restrictions on land behind their backs. And they have the moral duty to satisfy, what we call the impending energy shortage, which is beckoning them to sea.

Yet, at the same time, people and government are banning refineries from coastlines of Delaware, Maine, New Jersey, Florida, and many other coastal states. And even if they don't ban them, the environmental restrictions they place on the refineries make it impossible for industry to go ahead with the urgent plans to supply the energy.

The East Coast needs eight new oil refineries by 1975. But the president of one large oil company says, no company will build them here, because the restrictions will force them to build overseas instead. The US need 78 new refineries, each costing \$150 million and requiring three years to build by 1980. None of these are even on the drawing boards.

Land use restrictions and the environmental concerns thus, if too extreme and too hasty in their implementation, will cause companies to export these plants, the refineries, and the jobs that go with them. And, in addition, this exporting will merely move the pollution associated to somebody else's backyard. Would it not be better, by good imaginative engineering, and the provision of a sufficient time scale, to retain these plants, refineries, and the jobs and wealth that go with them, and to contain the pollution associated with them.

Until we can do this by considering, imaginatively, the proper use of the sea for these kinds of activities. We must completely reverse the current popular attitude toward energy. Far from curtailing our energy production we must vigorously increase the amount of energy we produce. Even produce more than we need immediately, so that we may invest some of this energy in producing new energy sources for the future.

Nuclear power is one of the most important investments we can make. Yet, it too has a gun behind its back. People live on the coastline. Power plants are necessary where people are. Power plants choose sites on capes or sea shores, where they're close both to the people, and to the huge amounts of water required for their cooling.

Yet environmental pressures delay and prevent these plants from being built. By using the sea, can we have our cape and heat it, too.

Harbors are urgently needed and in connection with the same problem. Energy. The fundamental currency of civilization. Yet the kinds of harbors that we need for the ships of the future, the huge safe ships of the future, are ones, which, if we build them in the existing way on shorelines, will take the shoreline away from the use of people. The cheapest way of transporting oil, ways of transporting oil, are by tanker over the sea and by pipeline over the land.

The larger the tanker the more economical it is, and the more safe it should be made from spillage and from collision. But the larger the tanker the more feasible it is to spend the money to make it free from the possibility of oil spills and collisions.

We don't have a single harbor in the United States that can accept the half million ton tanker that the Japanese, for one, are building for use tomorrow. And we'll have to adopt the expedient of offloading these tankers into small barges, or some other way. This increases the possibility of spills and pollution. Can we not take these offloading harbors out to sea and contain the oil spills?

I believe that proper engineering can completely protect shore and adjacent waters from pollution and spills out away from the coast. A harbor out to sea would be a garage, if you like. A marina of highly sophisticated spill equipment. A harbor at sea would have this spill emergency equipment and environmental control brigade, just as a city on land has a fire brigade for emergencies.

We must develop pipelines vigorously. Not only for transferring oil and slurries from offshore harbors to points inland, but also for transporting all kinds of other goods. Traveling bands, chains of hoppers, and other forms of pipe transportation are necessary. Of course, it's easy to transport fish conveniently in a slurry of water. Submarine tankers are an imaginative idea, but they've been ruled out in the past because of the complications of offloading them on the surface. If they can offload under water into submerged pipelines they may, someday, again become feasible.

Fishing for US fishing vessels has only one hope. To take a technological overleap in automation and sophistication. But to justify this cost, fishing vessels must spend more time at sea and less in port. They must be coupled to fish factories. One can imagine these fish factories and processing plants associated with the complex that you see building out to sea. And separating the seafood waste from the food parts and piping the food parts in to shore.

The waste of the fishers themselves could be treated and used as nutrients for beneath the sea portions of this growing complex which would be used for fish farming. And thus, aquaculture would grow around the sea city, just as agriculture surrounds our land cities.

Organic wastes from land could be piped out to waste treatment plants at sea. They're to be used, also, for aquaculture purposes. Here at MIT I have been fascinated to learn of the exciting project to irradiate sewage with electron beams, and destroy viruses, bacteria, deactivate detergents, so that sewage can either be returned to the land, or to the ocean, with fertilizing effects instead of polluting effects.

This is a very important project. I remember a year ago when I was in Seoul, Korea. I was talking to the Minister of Health of Korea. And he was moaning to me about the terrible problem he had in trying to educate the people there away from the great thousands of year old tradition of putting the night soil onto the land for the growing of their crops. And I said to him, I said, Mr. minister. I'm having a terrible problem in the United States convincing our people but it's the only proper thing to do.

Now if we can borrow their tradition, and we can supply the high technology, both countries will be better off. The high technology to put it on sterilely.

The low grade heat, so-called waste heat, could be used, also, in aquaculture to regulate the temperature of water to the conditions for fish farming. Extraction of minerals could also be done. Mine phosphate rock, production of magnesium, and so forth. One of the great costs in the extraction of things from the sea is that you have to pump an awful lot of water.

But if you pump this water for several purposes, you may be able to use the same pumping and use the water for extracting minerals, deriving fresh water, using cool water for air conditioning, and so forth.

Airports are somewhat in the same plight as power plants. They need to be near where the people are, yet they then occupy huge tracts of land near the cities that people constantly need for other purposes. Traffic congestion on the ground, to and from the center of the city, reduces the airports usefulness. Airports are also under fire for increasing noise and restrictions on the reduction of power coming in. Could not airports, perhaps, in the complex move out and join the complex at sea?

Well, here you come to a city. A city anywhere must start with a purpose. Then people come to work towards that purpose, and build houses to house the workers, and thus the city grows. This is a proper way for a city could grow. Otherwise, if one builds a city at sea, you'll have merely a bedroom city, or a city in search of a purpose.

But with the multiple uses that I've described here, these constitute the real purpose of a complex which we might call a sea city. With airports, harbors, hotels, travelers would be necessary. As would be housing for the workers.

Well, you think of hotels at airports on land, they have to be insulated from the aircraft noise. What better insulator could there be than the seawater, with hotel accommodations within the huge floats or pylons beneath the sea surface. And there, travelers would have a real ocean from below. Recreational facilities, marinas, submarines, underwater parks, things that are all in their embryo stage now, would, of course, join the complex.

Now you'll all recognize, those of you who are in the relating to the sea, you'll all recognize, I'm sure, that this complex I've described is just the putting together of many well known suggestions. In fact, many parts of this complex are being worked on already. Either in the Sea Grant program, or in related programs. Here at MIT and other institutions.

Here at MIT I've learned that work is going on the sea environment, on marine resources, aquaculture, the better uses of foods from the sea such as squid. The disposition of food wastes, offshore petroleum, ocean borne commerce, port design, commodity transport, liquefied natural gas, harbor traffic control, navigation, oil pollution and preventing its spread at sea, and the use of waste heat in aquaculture.

Also, some of your people have been making sophisticated analyses of complex ocean structures necessary to support various sea loads. Well, that's everything I've said. And most importantly, here at MIT you have people in public policy working on the development of public acceptance of the proper uses of the sea. Acceptance, not only naturally by the public, but also acceptance within what will have to be a new structure of national and international law.

Actual engineering works are going on in some of these directions. Last week, we read of the offshore nuclear power plant, which is to be floated three miles off the Jersey coast. Some of us know of John Craven's imaginative model of a floating city to be associated with the bicentennial celebrations in Hawaii.

And again, in Hawaii, Honolulu's airport is to be multiplied in capacity by extending a runway on a reef offshore. And others are planning a port offshore to serve Texas.

These things are going on in our country, they're the beginnings of parts of the complex. But other nations are ahead of us. The Japanese already have plans well along for a very large floating city. European nations around the North Sea are planning and even building a considerable number of offshore harbor and industrial islands in the North Sea.

All of these steps are good ones, and they can contribute the experience they represent to the complexes we'll put together in the future.

But the question is, how can we in the US take a step, jump, and put the whole system together, instead of whittling piecemeal and having to solve all the public policy questions, and the endless national and international debates over and over again for each step we take seaward.

It is, probably, not economical for an individual activity by itself, say oil refining, to move out to sea as a single activity and in the short time scale available. But if we join these uses in the systems concept that has a common kind of underpinning, then moving out to sea may be feasible. The total cost of such a sea complex would be less than the sum of the individual costs of the components. And the total system will add more in social value, environmental, and economic gains for society than the sum of the individual social goods of the components of the system. But how to do it?

First of all, public policy. That is, new policies and new thinkings in government, industry, and indeed in the university's. New, because we must recognize that the dimensions of the task for the proper use of the sea are very large indeed.

The dimensions are so great that governments initiation must be comparable to the initiation for former national goals, such as we've achieved in space and in atomic energy. Industries effort is probably larger than even the largest of our industries would undertake alone. We must recognize that the basic underpinning of science and technology that we will need is probably larger than any single university can supply.

The size of the engineering and management job to be done, I think, requires new crossings, new meetings, new agglomeration. Not only in government departments among industries, but among universities as well.

For government, we know that already there are positive discussions going on in Washington on interagency cooperation in the new uses of the sea. So the Maritime Administration with its harbor problem, AEC with its nuclear plants, the EPA with its waste disposal, NOAA with its experimental platforms, conjoined with FAA, and I'm sorry for all these acronyms, with it's airports to plan a synergistic sea system.

But I wonder whether interagency cooperation is sufficient. I've seen that before. We'll need to jump that barrier that defines a traditional missions of government departments. Government has jumped these barriers before by establishing for atomic energy, the Atomic Energy Agency, and for space, NASA. These were autonomous agencies that have the clout commensurate with the job to be done. We have a sea agency in the National Oceanographic and Atmospheric Agency. But if NOAA and its parent department Commerce are to embark, or be the government focus of this massive program, they too must have in large support, and a clout and muscle commensurate to do the job. This cannot be done unless the government sets up, as they did in atomic energy and in space, the sea use project as a national goal on a time scale that is both realistically long enough to achieve its aims, yet realistically short enough to meet the urgency.

To illustrate the kind of rearranges in government, I've taken a curious example. When we talk about complexes that our cities, we transcend the normal missions of government departments. Whether the city be floating on the sea or on land. And let us take an example from land. We have, in our government, a Department of Housing and Urban Development. HUD. Yet, urban development depends much less on simple housing, and much more on commerce, labor, and the people services for health, education, and transport, that lead to well being and reduce the need for welfare.

Now, you'll notice in that sentence I've described the function of HUD in words that are the lead words of five other departments of government.

Perhaps, in addition to the watchdog Environmental Protection Agency, we need an Environmental Promotion Agency. Now on the international side, if we are to move complexes out to sea, we get involved in the very knotty problems of the international law of the sea. Practical considerations are dictated by nature. How steeply does the sea bottom shelf into deep enough water, and will often be in conflict with the arbitrary man made limits of 312 or x miles. Where water is shallow, as in the Gulf of Mexico, we'll need to go very far out. Where water is deeper, not so far. It seems that these problems can be solved better by multi or bi-state agreements, by multilateral, or bilateral agreements between nations. Between those that are affected with due regard to the particular geographic situation and the particular activities. Rather than by any blanket global international agreement that would tend to presume a geographical sameness of all situations.

In industry, I've said the size of the effort necessary to accomplish this task is such that we'll need to abandon old or social assumptions of the badness of size, of monopolies, and of cartels. In industry, we'll need to see associations of a number of our very largest industrial concerns to achieve the building of these complexes.

Far from discouraging partnerships among our largest industries, we need to encourage new kinds of combinations, new kinds of consortiums of industries, perhaps in the manner of the space program. Universities which must supply the scientific and technological underpinning of enterprises in the sea will, likewise, need to integrate the separate pieces that are going on. Both under the Sea Grant program and in related programs in many institutions in the United States.

Here we need, perhaps through the Sea Grant program, to give a contract to some institution, perhaps MIT, to bring together, to correlate, and to aim all the developments in the sea use toward the synergism and economy that could be gained in a combined complex.

We don't need to invent how to do this. We have many examples right here at MIT. Where national, scientific, and technological talent is or has been coordinated for special tasks such as the radiation lab in World War II, such as in the Draper Lab for navigational guidance, and in the Lincoln Lab.

Now Jefferson in 1801, wrote this about the ocean. Nature has made it common to all purposes-- has made it common to all for the purposes to which it is fitted.

You have a Lincoln Lab. How about a Jefferson Lab dedicated to the development of the purposes to which the ocean is fitted? I think that this project, viewed in its holistic sense and not in fragmented components, is a challenge I see for you as, more and more, MIT turns to the sea.

**KYLE:** Thank you so much, Dr. Spilhaus, for that inspiring lecture. For providing these long range perspectives. For challenging everyone's imagination towards means for meaningful utilization of the ocean space. You have put before us a challenge for imaginative and creative thinking. The challenge to look not only at usual, but also, especially, potentially unusual solutions.

And these are challenges which we as individuals, and which we as institutions, must face. You have set, with this lecture, a pattern and a standard for the kind of Sea Grant lecture which we would like to continue in the years to come.

Now, in appreciation for your efforts on our behalf, and as an expression of our gratefulness for accepting to be the first Sea Grant speaker, I would like to present to you an MIT plaque. Which we have engraved 40 years after you came to MIT.

In appreciation to Athelstan Spilhaus, the first annual Sea Grant lecture. September 27, 1972.

Ladies and gentlemen, this concludes this convocation. Thank you all for joining us.