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General Education and the Environment

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(Transcript of an extemporaneous talk, edited for publication by Joseph M. Condie.)

I imagine I was invited here because you can't hold a meeting these days without taking up the subject of the environment. Otherwise, you would be accused of being non-relevant and, you know, not with it. But, that is not why I came, I don’t think you need me for that. I came, and this may surprise you, because in my opinion these environmental issues are not merely the currently faddish educational topic, but rather a very interesting test of the entire purpose of education. I think the environmental issues will turn out to be a test of the competence of our educational system to continue to be of service to our society.

Now I don’t know how you feel about the situation of education, but I think it is in an historical crisis. I think it is in a mess. I have been, well let's see, I took my degree in 1941 so I have been in this thing 30 years. I have done all kinds of teaching from being a TA on up and I have a certain sense of history. I think the educational system from advance work in universities down to kindergarten, is at the point of an historical discontinuity. In other words, what's going to happen in the future, I am quite certain, will be drastically different from what
has happened in the past. To put it another way, everything that I learned to do a good deal of is going to turn out to be very wrong. We, all of us in the educational system, have been trained to do the wrong thing. Why do I say that? I say that out of experience with my own institution and with an ungodly number of other institutions that I have visited in the last two or three years talking about the environment.

Everywhere I go I find a very deep cleavage among the university faculty which splits it into two roughly equal parts. There are those people who are absolutely convinced that the present pattern of education, the division of faculties into departments by disciplines, with a chemistry department, a history department, and a biology department, etc., is not only appropriate and successful but somehow inherently built into the nature of knowledge. Handed down on golden tablets is the commandment: Thou Shalt Have a Biology Department. Something is built into the nature of the world which dictates that people must be concerned with biology, chemistry, history, physics, etc. These are the discipline-oriented members of the faculty and there are quite a few of them. Then there are the other people, those who think maybe, possibly, there is something wrong with this position. One of the reasons they feel it may be wrong is that it makes it difficult for the university or college to be concerned with real problems in the real world. In particular, they find it difficult to deal with those things that touch their students very deeply. So they feel there is something wrong and maybe something ought to be done about it. But they are not quite sure what. There is a very deep cleavage between these two groups. One group thinks everything is all right and the other group would like to think about the possibilities of change. The very idea of questioning the discipline-oriented approach turns out to be a very deep threat to the first group. This questioning has begun to have some very serious effects on the elan, the vitality, the drive of the educational process.

I remember very well when Sputnik went up, the Russian Sputnik. Everybody on campus got charged up. That was when we decided that Johnny had to learn how to read. We got the new math and the new this and the new that. Never mind what you think of what was done, the fact of the matter is that suddenly there was a very intense motivation about what had to be done. Now, however, my own experience is that this motivation seems to be lacking now. Even people who believe in the present organization of education have begun to lose interest in their own beliefs. I want to turn now to how I think the environment and the environmental issue relates to this loss of vitality in the educational system. We are in a very serious situation and I think that the environmental issue is going to tell us something about how to get out.
I want to do so by discussing a specific environmental issue. I thought I would take one that is in the news these days. Now you all know detergents are an environmental problem. Why? Because some people say that the use of detergents is degrading the environment. This claim has been taken sufficiently seriously that the manufacturers of detergents are spending a lot of money on big, full page ads to explain why the detergents are O.K. So you know it is a problem. Well what I would like to do is go back to the origin of the problem and see what we know about it and how this relates to the educational process. If there is something seriously wrong in the way in which we interact with the world in the case of detergents, it would at least suggest a hypothesis that the system that was designed to inform us about the world, namely, education, has somehow gone awry at least in this narrow instance. In other words, something has gone wrong in the way our society has been educated about the property of detergents, otherwise, I don't think we would be in this deep trouble. To put it the other way around, the fact that satellites did indeed orbit was a very good test of our educational system's ability to teach certain people arithmetic, higher mathematics, the laws of physics, engineering, etc. That things work is a really good test and when things don't work, somebody hasn't learned what they're supposed to learn. So I want to simply take detergents as a case history.

What do we know about the origin of detergents? Detergents were invented in the 30's and actually came on the market in this country in significant amounts only around 1946. Just to orient you, since 1946 something like 70 to 80 percent of the soap market has been taken over by detergents. It is a very big change and one worth thinking about. What are they? Well, in the first place they are intended to clean things. That raises an interesting question. Does that mean everything was dirty before detergents? No. There was another way we had of cleaning things and it largely involved the use of soap. So detergents represent a new way of cleaning things as compared with soap. So really I want to go back to soap and say what soap does and what cleaning is about, and then we will see why detergents have displaced soap.

What is soap? Soap is something which makes bits of grease more or less transportable in water. Now you know most dirt is greasy and it is hard to get rid of because what we have available to get rid of things is mostly water and water doesn't mix well with grease. Soap is an interesting kind of substance. You can think of it as a sort of long, bar-shaped molecule which has two different properties at either end. One end of the molecule tends to dissolve in fat and the other end of the molecule dissolves in water. That is the way soap works. The fatty end of the molecule dissolves in little droplets of grease, surrounding the grease with a skin of soap molecules with their watery
ends sticking out. In effect, you have wrapped up the ball of grease in a skin which likes to mix with water. Along comes the water and you wash the whole thing away. So it's a very nice kind of thing.

All right, where do you get these bar-shaped molecules? Well, they are made of fat and alkali in a very simple chemical reaction. Well, where do we get alkali? Alkali can be gotten from ores, or as in the old days, from the ash of burned plant materials. That's simple enough. Where do we get the fat? Fat is a product of living things. That's a very important point. In other words, living things produce various kinds of material, particularly organic compounds, i.e., complex networks of carbon atoms. Fat is an organic compound that has a chain of carbon atoms surrounded mostly by hydrogens and a few oxygens. Those are the elements in fat. It is put together by living things. Fat is a natural organic substance. O.K.? So this is material which is derived from living things. For example, it may be derived from coconuts by pressing the oil out of the coconuts, or from cotton seeds, or you can render it out of the fat laid down under the skin of animals. This last is the way fat was obtained for soap. Then it was boiled up with alkali and used in the way that I described. You notice that the way you use soap is that you flush water over the junk and it disappears.

Well it doesn't quite disappear. The water has to go somewhere. Where does it go and what happens? What happens to soap after it is used? Well it goes down the drain. One of the laws of ecology that I would like to promulgate is that everything has to go somewhere. It is a good parlor or cocktail party maneuver to simply ask the question where does it go. You can make a very intelligent ecological conversation with another person simply by repeating the question where does it go. That's all you have to do. And if you get any kind of reasonable answers, there will be a rather interesting ecological discourse.

So here we are and I say we have used the soap and you ask—well, where does it go? That's a very good question. I'm glad you asked that. Well, it goes down the drain. O.K. Then where? I mean, drains don't end nowhere. Well, it goes down the drain into the sewage system in an urban area. Then where? Well, if you would traipe along the sewage system, you will find it ends up at a sewage treatment plant. So what's that? Well, in a sewage treatment plant you first find a large tank where solid materials settle out. But the soap is not solid. The soap with a little grease in it sort of floats around, dissolves and then it goes into another tank which is really a kind of domesticated bacterial pasture if you like. (The way we domesticate cattle, for example, is to put them in a place where it is convenient for us to have them—pasture with a fence around it—and we let them do their thing.

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I mean that’s it. They just do what they usually do but they do it in a place where we would like to have it done.

Well that’s exactly what we do with sewage treatment plants. There are bacteria in nature which break down organic compounds—like fat, like sugar, like protein, like urea—break them down by oxidizing them, usually. That means that a certain amount of oxygen is required. They combine the oxygen with the organic matter and the products are inorganic materials, for example, nitrate, from the nitration part, phosphate, carbon dioxide which has carbon in it but is usually considered inorganic because it is so simple. So you have fat coming in with these bacteria, doing their thing and they are being supplied with oxygen to allow them to go ahead. Then the carbon is converted to carbon dioxide and the hydrogen and the oxygen appear simply as water and that’s it. You’ve now broken the fat down to inorganic materials.

Now here is a very important point. You might say why don’t we dump soap and other organic material, like sewage, right into the water. Well that turns out not to be a good idea. If you do that you put so much organic matter into the water that the bacteria burn up, use up all of the oxygen dissolved in the water. The oxygen level then goes to zero. Now the bacteria need oxygen to work on organic matter and they also need it to live. So they die. When that happens, there’s no way to break down the organic matter and it piles up. In other words, organic matter can so overwhelm the microbial system that it breaks down. Besides, the organic matter smells, in contrast to carbon dioxide, nitrate, and phosphate which are rather innocuous. In other words, it is not a good idea to put too much organic matter in an aquatic system. So what we do in the sewage treatment system is to confine this process in a tank or pond and give the bacteria extra oxygen so that they can accommodate a large mass of organic matter. Then out one end comes the carbon dioxide and nitrates and phosphates that are the result of all this breakdown. That’s what happens with fat. The end product of this system is carbon dioxide. Really, it is the only product besides water, a great deal of water. Carbon dioxide is very plentiful and so the entry of fat (that is, the end product of fat, carbon dioxide) into the river and lake system has very little effect on the overall behavior of that system.

Now let me point out what can happen if other things go in. Before doing so, however, let me back off a minute and say that in nature, in rivers and lakes and so on, there is an ecological system which has the following general features. Let’s start with a fish, which is swimming in the water. That fish is made up of organic compounds of water and some inorganic materials. And when it excretes waste or when it dies, organic matter enters the water. The organic matter then is acted on by the bacteria, that I have discussed. From it is produced carbon
dioxide, nitrate, and phosphate. Then what happens to that? Well that is nutrient for another class of organisms in the water, the algae, a green plant. These take up the nitrate and phosphates and carbon dioxide and, being illuminated, they carry out photosynthesis which builds back from the inorganic materials the organic constituents of the algae itself, sugars, fats, proteins, nucleic acids, and so on. Now you have organic matter in the form of algae. Along comes a minnow and eats that. It converts to minnow organic matter. Then the big fish eats the minnow and converts it to big fish organic matter. The cycle is now complete. This cycle is what is responsible for maintaining the quality of the water. It accommodates the organic waste produced by members of the cycle such as the fish, it allows algae to grow and the whole thing keeps going. That’s the basic cycle in the water in nature.

What we’ve done in the sewage plant is to domesticate one segment of this cycle. We’ve domesticated the bacterial segment. The sewage plant, then, is sort of a loop in the cycle. It puts out a lot of inorganic material, and of course, that’s going to make the algae grow. So one of the things the sewage treatment plant, where our soap has gone, does is to stimulate the growth of algae. You will find that downstream from every sewage treatment plant there are an awful lot of algae growing. Now one of the things that happens when algae grow is that the layers they make in the water get thicker. Light however, is coming from above, which is the arrangement we have on earth. The result is, the amount of light which the cells at the bottom of the layer get is reduced. The ones above are shading them, taking up the light. There is a very sharp exponential reduction in the amount of light which gets through below.

Now a very interesting situation arises. Algae need oxygen like any other living or most any other living organism. They produce it during the day and use it during the day and at night. At night they obviously use more than they produce. If you don’t have a good balance between the number of algae and the rate of oxygen production, they consume more oxygen than they produce. That begins to happen as you thicken the layer because the cells down below are using a lot of oxygen but not producing much since they aren’t getting much light through the shadow of their fellow cells above. As you get thicker and thicker layers of algae, you get to the point where the algae can’t sustain themselves. The thick overgrowth of algae which we call an algal-bloom, dies very quickly. When it dies, it releases organic matter because that’s what is in the cells. The organic matter is now acted on by the bacteria, which uses up the oxygen and you’re back where you started from.

You might say this is sort of an idiotic way to take care of sewage. All the sewage treatment plant does is to remove the stress from the part of the cycle where too much organic matter is going in and put
stress on another part of the cycle where too much inorganic matter is going in. And that is precisely what the modern sewage treatment system is accomplishing. In Lake Erie, for example, our trouble now is not due to the dumping of raw sewage into Lake Erie. A very large portion of the sewage entering Lake Erie is treated. The trouble comes from the end products of the treatment plant—nitrate, phosphate. Entering the lake they cause overgrowth of algae which then die and consume all the oxygen and break down the ecological cycle. In all but the eastern part of Lake Erie now the oxygen has gone to zero for a good part of the year. That’s what the trouble with Lake Erie is.

So obviously something has gone wrong in the educational process which leads to the design and the construction of sewage treatment plants. That’s quite clear. I have made this assertion for quite a while. This assertion makes engineers and educators who are responsible for this quite uneasy, very uneasy.

Well anyway, I’ve digressed a little bit to talk about sewage treatment plants, but the point I’m making is that soap (I haven’t gotten to detergents yet) is a natural product which enters the ecological system. If you don’t pile too much soap in (the amount of soap is much less than the amount of sewage), then it is not going to have a very serious effect.

Back to detergents. In the forties, in the thirties and the twenties, chemists began to make synthetic imitations, sometimes replicas of natural organic products. In 1928 uria, which is very simple, was the first man-made organic substance to be synthesized. What that meant was that a chemist learned how to put together a molecule which hitherto had been made only by other living things. This was a very remarkable educational process. Now over the years it became possible to synthesize very complex organic compounds of various kinds. Eventually as the chemists began to learn how they could make sugar, let’s say, and learn various techniques for putting these complex molecules together, it naturally occurred to them that they need not be bound by the limits of natural substances. They could put together organic compounds which departed from the composition of those found in nature. And this is what we mean by synthetic organic compounds.

At first these were made out of the sheer joy of doing chemistry. I don’t know if you’ve ever known a synthetic organic chemist. They love to make complex things and get it in a little vial and put it away, and there it is. It’s like writing a poem. It’s a real accomplishment. But after a while people begin to realize that maybe some of these things would be good for something. For a long time an array of these things accumulated and they’d be taken off the shelf one at a time. Now obviously, some of them smelled in certain ways and had certain colors and could be used that way. That is how synthetic dyes and
perfumes were made. At first, you know, dyes were natural substances such as cochineal, and so on, but very quickly in the nineteenth century chemists learned how to make colored compounds which could stick to fiber and would dye.

This went on for quite a while. DDT, for example, was synthesized some fifty years ago. Then someone took it off the shelf and found it killed insects. These are unnatural substances, and as the chemists began to learn about them, they realized that they could begin to make things to order. They could figure out what it was that made a molecule stretchy, and therefore could synthesize a new form of rubber. Or what made a molecule capable of taking up fat in water, and they could synthesize a detergent, and so on.

Now let's talk about detergents. These are synthesized by taking a carbon chain molecule and putting a sulfur containing group at one end that made it water soluble. These at first were molecules that were gotten out of petroleum, by distillation. They found a chain-like, fatty kind of molecule that could be gotten out rather easily and cheaply. It happened to have a branch in it. The carbon chain instead of being straight was branched, one carbon sticking off on the side. When they put the sulfonic acid group on the end it worked quite nicely as a cleaner. It had one advantage over soap. Soap is sort of glummed up by calcium. This stuff doesn't glum up as badly. They found that problem could be taken care of anyway by putting a lot of phosphate in with it because phosphate tied up the calcium. They were able to make a mixture of this stuff, isolated from petroleum, and phosphate which really cleaned things rather nicely. And it was put on the market. Its one real advantage over soap was that it works well in hard water. That was the only advantage it had. Soap works very well in soft water and it also works very well in hard water which has been softened. There are various ways of doing that.

At any rate, detergents came on the market and, as I said, they displaced soap. Now this began in 1946. In the 1950's, about ten years later, people noticed that there was some trouble. The rivers began to foam. The Ohio River, for example, had huge banks of foam in various places. In Long Island, if you took a glass of water out of the tap, it had a head on it like beer. What was discovered, discovered belatedly, was that detergents were going right through the sewage treatment system unchanged. O.K.? Still later it was discovered that the bacteria did not break down those branch molecules.

There is a very interesting lesson here, but first I want to make a very important general point. Every organic compound made in nature by living things has somewhere in nature a catalyst, an enzyme which breaks it down. That's a very curious thing. That means that nothing is made unless provision for destroying it exists. But many unnatural things can't be broken down and that includes these early detergents.
So making them was obviously a mistake. If this sort of mistake occurs, there must be something wrong with our teaching. What was wrong? What was wrong was that the sanitary engineers, rather than the chemical engineers who made this, never asked the question: "where does it go?" We had a symposium in which the secretary of the soap and detergent industry was asked this question directly: During the research and development that led to the production of detergents was any study made of what happens to the detergent when it went down the drain? The answer was no. In other words, all they were concerned with was cleaning.

Now I raise the question, "why?" Is it inevitable that somebody should be concerned only with the cleansing properties of a substance and not with its fate in nature? Well then, obviously not. You have to ask the question, why was no one concerned with its fate in nature? Let's try to answer. Where was this research going on? It was going on in industry. What is industry? Industry is the operation that produces things for sale. Well, what were they selling? They were selling a cleaner. And they were getting paid for what? For its cleaning properties, not for what happens when it goes down the drain. And so what they were interested in—to put it very brutally—is the money-making aspects of detergents. You can't sell something by saying this is good for the bacteria in the sewage treatment system. You want the housewife to buy it because it cleans clothes. So the kind of scientific interest which the engineers showed in this substance was determined very largely by the economic interest of their employers. And the economic interest of their employers in turn derives from a very simple economic fact. The profit made per unit sales on detergents is nearly twice what it is on soap.

That's just a simple fact. It is very easy to get. The U.S. Census of manufacturers reports every five years or so various data on industries. There is an industrial category called soap and detergents. It reports the labor, materials, profit, etc. per thousand dollar sales. In 1946 when the industry made nothing but soap the return was about $30 per thousand dollars. That's before taxes, $30 returned per thousand dollar of sales. In 1967 when the industry was making 70% detergents roughly and 30% soap, the returns were $54 per thousand dollars of sales. If you remember your algebra it is possible, by taking the intervening years and making the plot, to extrapolate for the profit due to one hundred percent detergents. It turns out to be nearly twice that of soap.

Oh, you say, what a terrible, radical thing to say. Well, it isn't. What do you think the soap and detergent industry managers are in there for? What is their responsibility to the stockholders if not to make a profit and, in fact, to increase the profit? That's what makes
the stock value go up. They found a way of doing it by making detergents rather than soap.

You might say, why do they make more money on detergents. That's a very interesting question, too. It turns out that in our system the profit you make is largely determined by the degree to which you can exclude the need for human labor. That's a curious thing to say. (I've just given you the definition of productivity.) Productivity is the amount of wealth, the amount of goods produced per unit of human labor. As you know from Mr. Nixon, we are in grave trouble because our productivity has not been rising fast enough. It's been rising all the time but we're in trouble because it isn't rising as fast as it used to. What does that mean? It means that we are producing more and more goods per unit labor. Each good produced is now produced with less and less labor. A very interesting thing.

When you look at the labor required to make a unit of soap and the labor required to make a unit of detergents there is much less labor involved in detergents. The reason for this is that you can use a flow system. You've seen pictures of chemical plants where a man stands in front of a panel of meters and a lot of pipes go out from there. He sits there turning knobs and so on and that determines the flow of stuff. Out one end comes gasoline or soap or detergents or DDT or what have you. That's the way the chemical plants operate now and you need relatively few people. You don't have to have somebody around stirring and tasting it and so on.

So what's happening here is that a substance has been produced which is not natural and it's been produced for some of the reasons I've described. Nobody bothered to find out what happened when it went back into the ecological cycle because ecology didn't fit in with the economic motives. The upshot was real trouble. Trouble because the stuff wasn't breaking down. It began to mess up sewage treatment plants. Later these detergents were replaced by straight chain materials which broke down. These are the so-called biodegradable detergents. But I forgot to tell you a fantastically ironical thing. At one end of the detergent molecule is a benzene ring. Benzene in water is readily converted to phenol, which is carbolic acid, which is a toxic substance. Now, in the original detergents, since they didn't break down, the benzene unit was protected from chemical action and did not form phenol. But now that we have biodegradable detergents this benzene is converted to phenol. The fact of the matter is, you can kill fish much more readily with the new degradable detergents than with the non-degradable ones just because they are degradable. There is an interesting textbook on chemical engineering by Stevenson, a rather important one. In it he describes what I've just told you, and says it's going to be very interesting to see what happens when the public discovers this fact about degradable detergents. A very interesting thing.
He wrote it to the students but he wasn’t telling anybody else. He was sort of waiting to see what happened when people learned this.

Well, on top of all this is the fact that the phosphate, added to soften the water, stimulates the growth of algae. I’ve already described the trouble that causes. This completes the picture of an environmental problem.

Now, I want to go back to the educational question. What went wrong? Something went wrong. That’s the first thing to realize. When a multi-billion dollar industry makes a mistake, there is something wrong. There is just something wrong. There is something wrong when the water foams. There is something wrong when the degradable material turns out to be toxic. There is something wrong when all this phosphate is being added that causes algae overgrowths and so on. It seems to me there really were two failures with the education of the people who were involved.

One is that the kind of information they were trained to get was not congruent with the processes that were happening in nature. So for example, the chemical engineers obviously did their job. Well, what was their job? The job of a chemical engineer is to study physics and chemistry so well that when his boss tells him to make a particular kind of substance to put on the market he knows how to do it. He knows how to design a plant that will produce it. That’s what a chemical engineer is supposed to do, as far as I know. Now the chemical engineers did that job very well. So there is nothing wrong with their training as chemical engineers. In fact, the trouble is that they did succeed so well. In the same sense, the trouble with nuclear bombs is that the engineers and physicists did their job so well, that the damn things went off. If they didn’t go off there wouldn’t be so much trouble. The trouble with cars is that the people who design them and manufacture them, succeed. It’s a beautiful job. All this stuff comes into the factory—rubber, steel, copper, glass and so on—then the thing is created and you sit in it and you turn the key on and it runs. And that is brilliant. But the minute you let it out of the factory, it kills people. Not simply on the road but also by producing smog and by releasing asbestos from the brake linings, which causes cancer when they get into the lungs. Everything has to go somewhere. The new cars, all the new cars since World War II are beautiful smog generators because they have high compression engines.

So what I’m saying is that the technologists do beautifully what they’ve been trained to do. Well, what’s wrong? Well obviously their training doesn’t match the behavior of nature. Because in nature stuff goes down the drain and gets into eco-systems. In nature it is a fact that synthetic substances are not readily accommodated by such things as bacteria. In nature it is a fact that a rapidly moving object hitting another one will cause damage. And the point I’m making is: there is
a sharp disparity between the structure of knowledge in our academic system and what's true out in nature.

Let me tell you a few more pointed stories. As I drove here, by some crazy coincidence, along side of me was a car marked "The Center for the Biology of Natural Systems." A good friend of mine, Professor Cole, who is a biologist, was waving out of it. He was off to Springfield. Sitting next to him was Professor Barr, who is an economist. Sitting in the back was an anthropologist. They were all off to do research. Research on what? The implications of the use of fertilizer in Illinois for water pollution. I won't bother you with the technical details. But let me tell you a little bit. As they say, isn't that great. The car is the epitome of interdisciplinary research. We've got them all in the same car. They're heading in the same direction. Well, let me tell you, getting Dr. Cole in that car was done over the intense opposition of his department. When Dr. Cole joined our program to do this study, a round robin letter was circulated in his department. It condemned him for departing from his previous study on photosynthesis, and engaging in something which was so far removed from the purposes of the university, namely, to study the plight of Illinois farmland and the people who are exposed to water pollution as the result of the use of fertilizer. He nearly got kicked out of the department. Fortunately, he had gotten tenure a few months earlier. But there was a real fight.

You might say what a scandalous thing for Commoner to say in public. It's in print in the September 25th issue of the New Yorker and it's in my book The Closing Circle. You might say why do you say this? Well, I say it because Dan Cole's plight is repeated over and over and over again. John Wood, the chemist at the University of Illinois, who first discovered the mercury problem in 1967, had his paper describing it rejected by two reviewers from Science Magazine. Why? He had made a brilliant discovery that vitamin B-12 transfers a methyl group to mercury, making mercury into methy-mercury which is soluble. That's what gets in the fish and is poisoning. Brilliant discovery! But it happens that vitamin B-12 is part of something that bio-chemists teach their students. It has to do with metabolism and there is an enzyme involved. When you say vitamin B-12 to a bio-chemist he's ready to reach for the blackboard and say, oh yes, this is what we teach about vitamin B-12. This is what is in the textbooks. But, there is nothing in the bio-chemistry textbooks about mercury, in connection with vitamin B-12. But, clearly the relevance of vitamin B-12 in the real world is that it has this peculiar effect on mercury. Well, Wood had written all this up and, incidentally, it is a very brilliant piece of scientific work. It was rejected by the reviewers on the basis of a uniform complaint: It is not relevant to an understanding of the enzymatic, the mechanism of the enzyme that deals with vitamin B-12. In other words, it wouldn't form a footnote in the bio-chemistry text-
book. It was out of phase with bio-chemistry but was it out of phase with the world? No.

I can give you one instance after another of basic scientists like John Wood who have begun to become interested in practical problems, but find their academic careers threatened because they are departing from the kinds of publications that lead to tenure. There are two reasons for this.

One is: it is much harder to make publications when you deal with the real world. Everybody says well, one of the reasons for the experimental method is that it is so neat, you know, it's intellectually rigorous. We have a control group here and experimental group here and it's all in the laboratory and so on. That may be true, but don't kid yourself, there's a much more important reason for the experimental method. It's a quick way to publish a paper. Take it from me, it takes us five times longer to get anything sensible out of a field experiment as compared to one in the laboratory. We're working in Illinois. Last year was a rainy year, and we got a beautiful set of data having to do with the movement of nitrate from the soil into the water. This year it is dry. And everything is all mucked up and it is very difficult for us to understand what's happening. Well, I assure you if we were running a laboratory experiment we'd have it rain all the time. And so it is not easy to publish papers, scientific papers, if you're dealing with complex things in nature or in the ghetto, where it might take you nine months to get somebody else to talk to you. And so just the speed with which papers are published is held down.

Secondly, what you're likely to publish might not fit into any known journal. Now look at that carload I mentioned. Our Illinois project involved an anthropologist who is going around talking to the Amish farms as well as the English farms, about their fertilizer practices; an economist who is worrying about the economics of the use of fertilizer in farm management; a geologist who is worrying about the movement of water; various kinds of biologists concerned with what's happening to the soil in Lake Decatur, and so on.

The thing I want to tell you is that the biology that the biologists in our project are doing they never learned in class, because they have to start thinking about how it relates to something else. What I'm trying to tell you is that the real problems in environment do not match the curriculum. That's all there is to it. Not only do they fail to match the curriculum, which you might argue is artificial, they fail to match the intellectual structure of the discipline. That's why there is a threat. When someone in a discipline-oriented department goes out into the field, he is now going to talk about things that the other fellows weren't interested in or never heard of.

Now that's the point I'm making, the whole environment system is the problem. (I won't need to go into detail—read my book for the
rest of it.) What I mean is we’re in real trouble. The environment system that supports us is being degraded by the very method by which we extract wealth from it. We’re on a suicidal course; that is real trouble. What I’m really concerned with here is the origin of the trouble in the educational system. And the origin is simply this: that the disciplines have become separated from real life.

Now, you know, we all laugh when we read medieval works about medieval scholasticism. It’s an interesting word “scholasticism;” it doesn’t sound like a bad thing—to be a scholastic. You know, that is schooling. Great! But we know that scholasticism led to various foolish things, like people spending their time debating how many angels were on the head of a pin. Now I assure you that those debates led to tenure or whatever they had in those days. Those debates were carried out not because people thought it was relevant to the real world. These weren’t kooks! These were the run-of-the-mill academic types. And they were doing what they were supposed to do. What I’m saying is, here is historical evidence that it is possible, indeed likely, for intellectually-minded people to become concerned with what passes for intellectual activity when it is probably totally separated from the real world. And what I’m suggesting to you is that we are now in the same fix. That the disciplines represent a return to medieval scholasticism. Now I’m not going to tell you how this relates to your own interest in General Studies. All I want to tell you is don’t be afraid of those departments. Go get them. Thank you.