THE FUTURE OF

ANOTHER IN A SERIES OF DISCUSSIONS OF ALTERNATIVE FUTURES PRESENTED BY THE WORLD FUTURE SOCIETY

Good evening, I'm Hollis Vail and this evening we are going to get into the area of technological innovation and some of the ways that the government affects or could affect and relate to it. To discuss the subject tonight we have with us Dr. Jorden D. Lewis. Dr. Lewis is the Director of the Experimental Technology Incentives Program at the National Bureau Of Standards. Dr. Lewis received a PHD in Thermaneuclear Physics and an MSE in Information Control Systems and an MSE in Neuclear Engineering, a BSE in Mathematics and a BSE in Physics all from the University of Michigan. In addition to this first academic program, or background, Dr. Lewis also has studied corporation finances, accounting and law at the Ohio State University. Besides being the Director of the Experimental Technology Incentives Program, Dr. Lewis serves as the Chairman of the Federal Task Force on energy intensive products, he is the U.S. delegate for industrial innovation policies in the organization for Economic Cooperation And Development located in Paris, he is advisor to the White House on regulatory reform policies and he is Chairman on the Interagency Panel On Civilian Research And Development Management. In addition, Dr. Lewis has published and spoken widely on R&D management, marketing and new products and new business development. So we have with us tonight a person who is giving a great deal of attention to the basic question of how is the government, and how might the government relate to technological innovation. I think it is very important

Dr. Lewis, that we start first on the subject of what are we really talking about when we are talking about technological innovation.

Thank you Hollis, I am happy to be with you this evening. technological innovation is a process in which ideas of a technological nature, of course, are converted simply from ideas into practical, marketable realities. I might add that technology is a very important resource in our economy. Most economists who have studied the structure of our economy find that, of course, the basic resources being capital, labor, land and technology find that technology is the single most important contributory to the growth of our economy and therefore to our general social and economic well being.

Hollis: Would I understand you then Dr. Lewis, that essentially if we are going to talk about the growth, the addressing of issues, the development of our nation in a changing kind of way, that what we do in terms of innovation in technology is probably the most influential aspect of the changes that our society will have. Is that correct?

Lewis: I would say that it is if not <u>the</u> most influential a major aspect of our general growth and vitality.

Hollis: Now are we limiting technology to machinery?

Lewis: I think of it generally <u>much</u> broader than that Hollis, technology is being anything that is derived from scientific

research, either in the social sciences or physical or life sciences and that produces useful knowledge that's generally what economists regard as technology.

Hollis: So that it isn't just a matter of whether or not that somebody is working on a new machine they may very well be working on a new concept for dealing with health care or something of that sort. Would that be correct?

Lewis: Even a new shape for a handle for a shoemaker's hammer that allows him to turn out shoes more rapidly or with better quality is technology.

Hollis: Now what's the situation with respect to the government. I'd like to start first Dr. Lewis, with a little bit of an overview of kind of where the government is <u>in</u> all of this technology innovation picture?

Lewis: That's a heck of a good question and a heck of a difficult one. What we're talking about of course is the nature, structure and the extent of the relationship between the public and private sectors in this country, which is something that certainly I don't understand and I suspect nobody really does understand. Let me, however, tell you what we <u>do</u> think we understand about it, specifically as it relates to technology, but I think from this you'll get a flavor of the more generic nature of the relationship. The process of developing and deploying new or improved technology can be described as consisting of three stages. Research and development which I

think most people appreciate what it is. It produces new knowledge about things, the way things work, what makes them tick. Then, after research and development what we might call the capital formation phase, in which this new knowledge is incorporated in new products new goods.

Hollis: An example of this would I say Dr. Lewis, might be a case of let's say that somebody develops an electric automobile in the research and development phase. Now there's a long ways between talking about 20 test models of an electric automobile and 2 million models of the electric automobiles scattered around the country.

Lewis: Precisely. And that latter stage is what we call the capital formation stage. Following that stage the new products or the new or improved processes then enter the marketplace to provide the benefits that are ultimately expected. So we have R&D, capital formation and market use as being the three stages of technological change.

Hollis: Let's take a moment on that last one. Would I understand you correctly if you were talking about market use to essentially say that what happens in the marketplace in <u>self</u> is a part of the innovative process. The illustration that occurs to me would be the shift from soap to detergents for example and in the impact that had on a whole series of things including the service systems and what not.

Lewis: That's a perceptive and I think a critically important observation. The ability of the marketplace to receive new technology provides very strong incentives for those who are considering investing in technology. If the market for structural or other reasons cannot receive the technology it's not likely that anybody, at least any intelligent organization or party, is going to make an investment. So that's very important.

Hollis: So what we have is we have the kind of interesting situation where that the innovator, at the research and development end, is a long ways away from really in experiencing what's going to happen on all his research and development.

Lewis: Well, we know for example, in industrial technology, and I think it's generally regarded that this holds true across the board, research and development represents about 15% of the total cost of technological change. Capital formation perhaps 30-40-50% depending on the economic sector we're talking about and then the marketing cost is the rest of it. So R&D is the "small tail wagging the dog here but the dog won't move because the rest of the system isn't prepared".

Hollis: But on conversely your not going to move the other part of the system if you don't have the R&D.

Lewis: Correct.

Hollis: So we're really talking about a fundamental that the dollar distribution or the manpower distribution or the resource distribution whatever you take which ever one you're talking about, divides sort of equal, on this proportionate very small amount of resources and manpower money goes into the first part. A substantially large amount of resource is manpower and money goes into the formation but then when it finally hits the marketplace you have enormous resource usage and manpower.

Lewis: That's right. And its preceptions regarding what is likely to happen in the marketplace that key everything else.

Hollis: Alright, now can you give us a little overview Dr. Lewis, on what happens in the federal part of the this. Where does the federal fit into this?

Lewis: Well it fits everywhere. As we like to say today the government is everywhere and at least in the case of technological change it certainly seems to be true. Let's take the R&D stage, the first of our three stages of technological change. Government supports roughly half of the 30, 32 billion dollars of research and development in this country. If we look at this more closely we find that, not including space and defense R&D, only 8% of industrial R&D is federally funded. So if we're talking about industrial technological change outside of the space and defense arenas, government R&D is not very important.

Hollis: In other words, would I be correct then that is there some degree in much research done on the farm technology it's not going to be done by the government's support R&D?

Lewis: If we are talking about farm equipment or fertilizers or pesticides or any other farm technology aside from basic crop research, you're correct. That is virtually all derived from private investment. Moving on, the government is a large sponsor of R&D in the so called public areas such as mass transit health, police equipment, fire and energy. But most of this R&D is conducted in federal laboratories and universities and, at least in our country, we have a very poor history of translating the results of this R&D into useful and used technology.

Hollis: I'm sort of getting the wind a little bit as I listen to this comment that one of the things that we may get into and I don't push the discussion too quickly into this, but one of the things that we maybe getting into is that there isn't a very good linkage between what they do in academia and what they do in the marketplace.

Lewis: There are a number of different linkages. Certainly our maintenance of the academic communities through grants and outright support of universities provides a direct link in that the students who metriculate through the system go into the labor marketplace, but the technology that is generated by R&D in universities is the knowledge that comes out of this R&D defuses very slowly into the marketplace. Now, I do not

mean to be criticizing universities, their first priority certainly is to produce knowledgeable, educated and useful citizens, however, if one is concerned about the efficiency of our R&D system, then one has to look at the rate at which knowledge flows efficiently into use.

Hollis: What's the overview with respect to the government's role in capital formation?

Lewis: A tough question, this is to a large extent a hidden question, even from public policy makers although I think it's really a "sleeping giant". Capital formation in this country runs to something over 100 billion dollars per year in the private sector and it's generally not known that federal subsidies for capital formation amount to approximately 25 billion so that the government is a very large source of capital formation in our nation. This runs from anything from mass transit to pollution abatement equipment to airports to various environmental services for cities and so on. It's in the form of grants, loans, loan guarantees, tax subsidies and so forth. We find in our work today that capital sudsidies and others have found these are very inefficient economically. Subsidy programs that are intended to benefit the poor end or benefiting the wealthy are economically extremely inefficient they just place other economic functions that have been need and are no longer functional.

Hollis: Would it be here that we may be talking somewhat about a function of the government in capital formation in which that

the capital formation is not necessarily innovative with respect to the market sector? Would that be a possibility?

Lewis: Yes, you're really on target. If we look again at the three stages of technological change R&D capital formation and market use if capital formation isn't tied in to both ends of that process then the whole process is inefficient and we find that often in capital subsidy programs, either technology is incorporated that's ahead of the state of the art or way behind the state of the art so that the capital thus formed is very inefficient. We find that subsidies are provided for capital acquisition but not for operating costs, as a result the operating cost goes sky high because nobody has really considered them or we find capital subsidies planned without any real consideration as to the extent of the market need so that we make over or under investments in capital formation. The whole thing appears to be out of kilter.

Hollis. In other words, to take in illustration I understand that some of the things that we did with respect to the Bart transportation system in San Francisco didn't yield to good capital formation issue here at that time.

Lewis: That's a very good example. In the bid area of rapid transit system technology, namely Computer Control Systems, was incorporated that was actually ahead of the state of the art at the time. The result was that this particular mass transit system performed very inefficiently. There is another example one can pull out of the so called Bart system and that

is that it was intended to be a full-time all day long mass transit system and the capital investment was made on that basis. However, it turned out to be useful only to commutors so it's used only during the rush hour. So here's a case where we made a huge over-investment in capital formation and consequently distorted the capital formation process in the country to some extent since there is only a certain amount of capital available in any given time.

Hollis: Where does the government fit into the markeplace?

Lewis: Everywhere, I think a businessman would say and certainly from the perspective of econimists as well. There are two or three basic functions of the government with respect to the marketplace, one is regulation. We regulate what can and cannot enter the marketplace with regard to our health, our saftey the environment, even with respect to transportation. If a trucker wants a new route, he has to get a permit, a license if you will, from the Interstate Commerce Commission. If a radio station wants to broadcast or if it hasn't broadcasted before, it needs a license from the FCC. New airline routes are approved by the Civil Aeronautics Board. Virtually every economic activity we engage in today in the marketplace is regulated in one way or another by government and not only federal government, state and local governments as well. Government procurement, the government purchases goods is also a major marketplace activity, although generally not recognized as an economically important activity.

Hollis. How much money does the government pump in the purchasing end?

Lewis. I would estimate that this year based on extrapalations from past years about 65 billion. It's huge. The government, it is generally not known, is the largest single buyer of most consumer, health care service and commercial products manufactured in this country. It is the largest single buyer. It has long been hypothesized, that is the government, were to be an early buyer of innovative products the market entry risks for these products would be reduced and these innovative products would enter the general marketplace much earlier.

Hollis. That takes us Dr. Lewis, I think into possibly the third aspect of what we want to talk about tonight and that is the matter of what might the government what in these areas we do certain things and all too often the government's role is like the dead hand rather than the innovative hand. What are some of the things that the goverment might do, let's say in the area of R&D, that would create an innovative linkage and link these things together?

Lewis. In research and development activities of the government it's at least my fealing, and I think that of others too, that there is a very strong need for what I would call a market planning in R&D agencies. Many agencies do not give consideration to the process of capital formation and market use that must follow their R&D activities and, therefore, do not set

their priorities against what is likely to happen or not happen once the R&D is completed.

Hollis. Could this in part be the reason why that in the space effort that we had were an enormous amount of research and development was formed that they're complaining about the problem of getting the research to the marketplace?

Lewis: I think that's really a different issue. The R&D conducted for the space effort, like military R&D was in support of a non-market activity, i.e. getting to the moon. It is not clear that the technology that derived from that R&D is broadly useful and economically valuable in the commercial sector that has yet to be proven. I'm talking more about programs and health, safety transportation and law enforcement where R&D is conducted, in essence to buy technological change in the marketplace and yet that hasn't happened very well.

Hollis. So if you honor what the space program did in terms of what it did then its R&D was an effective program.

Lewis: Very good, very effective.

Hollis: If, on the other hand, the argument for the R&D of Nasa was while you get so many market benefits from it then it was very good.

Lewis: That's right.

Hollis: But what we're really talking here more in the areas of what the government can do at R&D that is in the market area. What would you suggest is may be some of the key areas the government might initiate or do here?

Lewis: I think, as I mentioned previously, the need for a real market planning function in civilian R&D agencies that considers the existence of resources in the marketplace to take the R&D and use its incentives on the part of people who would employ those resources whether or not they want to do that.

Hollis: Well now, in the stratagems, I guess what I was really asking the question is=if we set up a unit like that in an organization, are there any stratagems that they might want to try out?

Lewis: I don't think it's that sophisticated an activity. I think it's just something that industry, a couple of decades ago, learned how to do and government agencies are still catching up. I don't think it's that sophisticated.

Hollis: In other words, we know that business has solved much of this problem the government has.

Lewis: That's right. I might just add here that it's a much more difficult job for government business to invest in R&D and make profits on the products that result from it so it has a

very tight feedback on what its investments are doing. Governmetn agencies invest in R&D, somebody else does the R&D for them, a third party takes the R&D and puts into the capital and somebody else uses the results of that capital, so there's no tight flowback to the agency as to the benefits generated by their R&D. It's much more difficult for them.

Hollis: I would suspect also that in this whole thing there is a lot of it mixed in public policy.

Lewis: A great deal of public policy and political decision making.

Hollis: Whereabouts are we now in the capital formation. What are some of the things that we might do in the capital formation?

Lewis: Similarly, in capital formation we need market planning functions in our capital subsidy programs to consider the extent of capital formation that's <u>really</u> need to try to couple capital formation subsidies with operating subsidies and to make sure the technology that's incorporated in the capital is at the right state of the art it's <u>just</u> ready to be used and it's not way behind the times.

Hollis: In other words, well I'd like to just touch for a moment maybe for illustrating purposes on the state of the art. If you have a federal agency that is trying to push capital formation, like in the case of the Bart example that you used,

where their pushing the formation ahead of the state of the art then you're going to have a lot of problems and your're going to have a bad market framework. Is that right?

Lewis: Correct.

Hollis: On the other hand, if you're let's say putting money into buses and you don't some how or other in your policy formulation insist that the bus have any new characteristics, well then what may very well fill up our city streets would be buses that were designed about making 40 or something like that.

Lewis: That's right, and there's even a more complicated problem behind this. How do we know how much capital subsidy to put into buses and how much in the subways. It's a guess. We don't really know. So one of the things that I think needs to be done is to try what we call demand side subsidies in which, instead of giving the capital subsidy to a bus company or to a mass transit subway company, give some chits if you will to users and say you can use whichever of these you want in your city so that we can get some feeling for the patterns of demand. We need to innovate in this way.

Hollis: Let's step to the marketplace now and what can the government do beside buy a lot of stuff from the marketplace?

Lewis: Well, in its buying, the government can use things like performance specifications, which describe what a product is to do but not how it is to be made which give people opportunities

to innovate in their products. The government can emphasize the total cost of a product not only its purchase price but its operating costs in its consideration of how much he wants to pay so it'll get away from the cheapiest products and into the most economically efficient products. This is something that we believe can work and we have seen, in limited cases, actually work.

Hollis: So if one of the things it can do is to, instead of in other words I think the problem that we're dealing in the last case was that if you have a we'll only buy the lowest priced item you're not going to get a very innovative item.

Lewis: Precisely.

Hollis: If on the other hand, you take another strategy and you said performance, in say for instance in the transportation area, if you said "I don't care how you get from here to there but I'm going to fund you getting from here to there," then this would be innovative market.

Lewis: Very good, that's right.

Hollis: Now, what about such things as the influence that the government can have on a private enterprise initiating something. In other words, where there's big buying power I would assume that somehow or other that we can maybe provide a market that would enable a man to make a step that it would take on the regular market.

Lewis: This can happen and I think it will happen if inventors or potential inventors perceive that the government is consistently a first buyer of innovative products. We're trying to experiment with ways to put the government in this mode but I think it can be a very strong incentive for product innovation.

Hollis: One that occurs to me that might be an example of this I understand is in the field of micro-fish duplicating, in which that traditionally when you make a micro-fish you do it all at once or you don't do it at all and they have developed new technologies now which enable you to update a micro-fish. I would assume that if the government went into the manufactures here and said we'll buy, we want perforamnce of such-and-such kind and we'll buy it that might be important.

Lewis: I think that that could be a very powerful influence.

Hollis: So this kind of buying, this kind of stepping into the picture, could be a very powerful influence for getting businesses and others to take the initiatives.

Lewis: Yes it could.

Hollis: Well Dr. Lewis, the time comes all too quick and we have to call an end to this one and really the issue of government innovation and the steps I hope that I understand you are working on the business and I'm hoping your going to be able to promote some of these.

Lewis: Thank you very much. I enjoyed it.

Hollis: Dr. Lewis has been brought to you this envening by the World Future Society. The objectives of the society are to encourage the serious investigation and a reasoned awareness of the future and to explore and develop methods for the study of the future. If you would like to know more about this society you can write to me, Hollis Vail, c/o of this station or to the World Future Society, P.O. Box 30369, Bethesda Post Office, Washington, D.C. 20014. Thank you and good night.