

We could try to reach the point where we have an on-line computer predicting the degree of pollution going down over Niagara Falls as a function of inputs and knowledge of ecology already available. I think it would be desirable to set up some of these on-line operations in ecology that can be tested against available reality.

Dr. TUKEY. By and large and on the whole, as a direction in which to move, this might be very interesting and helpful. I would feel that one ought to look for a much simpler system than all the waters upstream from Niagara as the place to begin. The thought of moving toward on-line checking in some places is one that I would heartily support. But if it is to be profitable, we have got to begin with situations that are easy enough for us to learn from them how to do it well and then learn how to improve, and broaden and develop our techniques of on-line prediction.

Mr. VIVIAN. Do you feel that there is a proper relationship between research and development and equipment and plant on a cost-benefit basis? Right now, as you may be aware, the Congress is considering putting another half billion dollars a year into pollution abatement. As a committee of Congress which deals with science policy, we were wondering about the amount of money we ought to put into research. Let's arbitrarily say we put a half billion dollars a year into abatement. What amount should we put into research and development?

Dr. TUKEY. There was a question about this, wasn't there? I don't know, I may not have written down comments on that. I think that one can give a qualitative reaction to this pretty well. If we think of dealing with pollution as an industry and say we are putting money into operating cost and new capital on the one hand, we are putting money into research on the other, what is the right ratio? I think the right ratio is about what it would turn out to be in those industries that are in the state of high innovation rate at the moment. If you look at the industries who have tried to find an economic balance and the ones where innovation comes rapidly and ask what percentage do they put into research as against operation and capital improvement, then this is probably about what we should be doing in pollution, because pollution ought to be a highly innovating industry for the next decade.

Mr. VIVIAN. Do you have a number on that?

Dr. TUKEY. I don't have an offhand number, but one can look at some of the chemical industries, one can look at pharmaceuticals and so on, and ask what people, who are trying to make money, are putting into research and development and see what would that come out if you brought it over into pollution.

Mr. VIVIAN. I wonder if perhaps your colleague is informed on that subject. Do you have any idea what that percentage ought to be, Dr. Spilhaus?

Dr. SPILHAUS. I can only give a guess that it is in the nature of a high figure, perhaps 5 percent.

Mr. VIVIAN. Department of Defense currently invests approximately \$5 billion in research and development and has a total operating budget of about \$55 to \$60 billion. That's about 8 or 9 percent.

Dr. SPILHAUS. It might run as high as that in highly innovated industries.