A Course in

TECHNOLOGY ASSESSMENT

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TECHNOLOGY ASSESSMENT

IN RECENT YEARS nearly all of us have developed a heightened awareness of the fact that technological developments can have unanticipated and often profound side effects. Sometimes these side effects are highly desirable, as in the many "spin-offs" from the manned space program in the field of health. Just as often side effects can be undesirable, as in the uncontrolled urban sprawl made possible by the automobile, or as in the degradation of earth's air and water due to industrial growth.

Fortunately, a feeling has also been growing that it is often possible to forecast side effects of new technologies and to take action ahead of time to monitor, control or eliminate "bad" effects or to stimulate and enhance "good" ones. Efforts to accomplish this task are variously known as Technology Assessment, Social Impact Analysis, or Environmental Impact Assessment.

A COURSE IN TECHNOLOGY ASSESSMENT

For the past two years, we at Washington University have been experimenting with a first year graduate course entitled "Technology Assessment and Public Policy." In 1971 the course was taught by Rolf Buchdahl, Affiliate Professor of Materials Science and Engineering with assistance from Robert Boguslaw, Professor of Sociology. In 1972 (and again in 1973) the author (an Assistant Professor of Chemical Engineering) conducted the course. In this paper I will discuss primarily my own approach to the course.

Our course in "TA" is offered through our interdepartmental Program in Technology and Human Affairs (THA) and can be taken for graduate engineering credit by Chemical Engineers. Incidentally, the Chairman of the THA Program is Robert Morgan, an Associate Professor in the Chemical Engineering Department.

COURSE DESCRIPTION

Last year I conducted our course using a seminar format in spite of the relatively large attendance. (In an experimental course I had hoped for at best eight students—I got 24!) Following Buchdahl and Boguslaw's lead, we met once a week for 2½ hours on Tuesday evenings. Their experience suggested, and mine confirmed, that relatively long class sessions are necessary for the participants, who had a broad range of backgrounds and perspectives, to overcome their distrust and hostilities and to begin to grapple with some of the thorny issues which arise at the technology-society interface.

Class sessions were actually a mixture of lecture, discussion, and student presentations. In initial sessions we addressed a number of issues including:

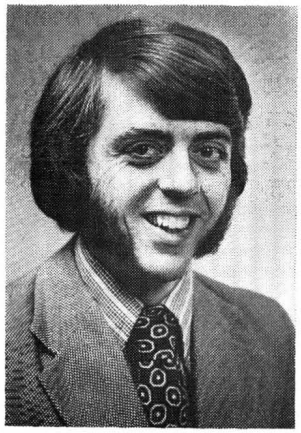
- **What is technology?**
- **How does technology develop, and what is its relation to science?**
- **To what extent is technology the cause and to what extent can it be the solution to current critical problems?**
- **Why is Technology Assessment an idea whose time has come?**
- **What is the role of the technologist in public policy formulation and decision making?**

As you might expect, discussions of these questions were often spirited. None of the students could be classed either as "anti-technologists" or as "technological optimists," but all had a genuine concern about the direction of technology along with a belief in man's ability to maintain at least a semblance of control. Perhaps students holding the extreme views are not motivated to explore TA.

In the second part of the course we began to deal with methodological points such as:

- **Technology Forecasting techniques**
- **Environmental Impact Statements**
- **"Hard" and "soft" science methodologies**
- **Brainstorming**
- **Futurism**
- **Analytical techniques for impact assessment.**

This part of the course was most exciting to the engineers and scientists in the group, perhaps because it dealt with problems in more quantitative terms. We reviewed the National Environmental



Christopher T. Hill earned his B.S. at Illinois Institute of Technology (1964) and his M.S. (1966) and Ph.D. (1969) at the University of Wisconsin, Madison, all in Chemical Engineering. Following two years at the Uniroyal Research Center in Wayne, N. J., he joined the Chemical Engineering Department at Washington University, where he is an Assistant Professor. He currently divides his teaching and research activities between polymer composite rheology and processing and assessment of materials and energy technologies.

Policy Act, the legislation which mandates preparation of Environmental Impact Statements, and discussed its relevance as a model for identifying a broader range of social, environmental, and political impacts of technology.

Technology Assessment as a process, along with all kinds of Futures Research, faces a very knotty problem of validation of results. A successful TA is ordinarily presumed to be one which provides a significant input to public decision making and it may therefore affect the lives of many people. Thus, one hopes that the results of a TA are reasonably "true." Scientist and engineers arrive at "truth" by an essentially social process: by replicating each other's results and by checking hypotheses against a sufficient number of experiments. In the case of TA, by the time the experiment (the technological development) has been run, the TA is no longer of interest. In addition, the results of the TA are designed to affect the experiment. The attempt to understand this dilemma, I believe, helped students gain a better grasp of how traditional science works.

The third portion of the course was devoted to presentations of Technology Assessments done by interdisciplinary groups of students during the course. Each student took part in two team efforts, not necessarily in the same group. The groups typically were made up of a natural scientist or engineer, a social scientist, an architect or designer, and a Technology and Human Affairs major.

For the most part, the Assessment groups tackled relatively small problems on a local scale. In a number of cases, they chose to assess existing technologies, rather than new or emerging ones. I now feel that this latter choice was a poor one, because it loses much of the futuristic or forecasting nature of TA. On the other hand, studying existing problems allowed the students an opportunity to make quantitative assessments, and to interact with individuals who had real responsibility for problems outside the classroom.

The Technology Assessments prepared by the students are as follows:

- **Permanent vs. Disposable Utensils in University Food Service**
- **Control of Automobile Density and Storage in the Central Business District**
- **Nuclear Energy in Developing Countries**
- **World Modeling: An Evaluation and Assessment of the Technologies**
- **Checkless-Cashless Society**
- **Computer Voting**
- **The Electric Hand Dryer**
- **Technological Assessment of the Campus Police Department**
- **Mudd Hall (a new campus building).**

Each of these assessments was 30-50 pages in length, and all tried to come to grips with the environmental, social, economic, and political implications of the technologies under study. In two cases, public preference and opinion surveys were run to learn why people make the choices they do.

From the list of assessment titles, you can see that TA is not only concerned with hard, engineering-type technology, but also with new forms of social and political organization. Oftentimes these new organizational forms are themselves made possible by, or are a direct side effect of, other hardware/technology developments.

PLANS FOR FALL 1973

TA is a rapidly changing field, and as a result the course given in 1972 is not appropriate for 1973. This fall I plan to emphasize TA methodology quite heavily, both by examination of some of the assessments which are becoming available, and by carrying out in-depth assessments in the class.

After discussing some of the philosophical, historical, and social issues around TA, the class will choose a technology to assess based on the interests of the students involved. I expect that the end product will be a publishable study. A number of

classes will be devoted to working meetings in which we will conduct brainstorming sessions, evaluate suggested impacts, and share disciplinary backgrounds. The methodological framework will be one which I have developed in some detail and which is available to readers on request. It consists of the following basic steps:

1. Development of a shared background of basic information among the study team in the areas of the physical technology, its overall social milieu, and projections of both for the future.
2. Identification and description of the unintended good and bad side effects or high order impacts of the emerging technology.
3. Evaluation of the probability and magnitude of the side effects within different frames of time, geography, and affected publics.
4. Detailed consideration of those impacts of high probability or magnitude, or both.
5. Identification and assessment of alternatives and ameliorating or enhancing actions which will influence the development of the technology and its side effects.
6. Communication of the results of the Technology Assessment to policy and decision makers, special interest groups, and the general public.

No good TA textbook has yet been published, and we are forced to fall back on excerpts from research studies for methodology. Until recently, nearly all the written materials on TA were essentially philosophical in nature; pointing up the need for a TA function somewhere in the society. Among these are the NAE and NAS studies (1, 2), the book by Kasper (3), and various government documents (4). More recently, assessment reports (5) have been issued and methodological articles (6, 7) have begun to appear. A new journal, *Technology Assessment* (8) is now being published by the International Society for Technology Assessment, and it is shaping up as a good source of material for a course. Fortunately, there are several good books on Technology Forecasting (8) which is an essential part of TA.

ROLE OF CHE IN TA, AND IMPACT OF TA ON CHE

At this point you may be asking of what relevance is Technology Assessment to us as Chemical Engineers. I firmly believe that the connection is deep and that it will be longlasting. The interests of Chemical Engineers have traditionally been the most wide ranging among the engineering disciplines, and they are accustomed to thinking about systems, inputs and outputs, recycle and waste, and economics; perhaps more than are other engineers. Our training in chemistry also provides a firm basis for understanding many of the environmental problems addressed by a TA.

From a broader perspective I believe that TA or its descendants will be a permanent part of the engineer's world. Industry and government will be increasingly involved in systematically forecasting and assessing the second order consequences of proposed new technologies. The National Environmental Policy Act has already led to the preparation of thousands of Environmental Impact Statements, assessing the probable consequences of federal actions for the environment. Very recent revisions of rules for such statements by the Council on Environmental Quality has broadened their scope of concern beyond narrowly defined environmental issues, and a number of judicial decisions have done the same.

The National Science Foundation is, at this writing, soliciting proposals to perform TA's in nine areas:

- **Solar Energy**
- **Geothermal Energy**
- **Advanced Data Processing and Telecommunications in Criminal Justice Systems**
- **Cashless-Checkless Society**
- **Biological Substitutes for Chemical Pesticides**
- **Integrated Hog Farming**
- **Conversion From the English to Metric System in the U.S.**
- **Alternative Work Schedules**
- **Alternative Strategies and Methods for Conserving Energy**

Congress has established an Office of Technology Assessment (OTA) which will conduct or contract for major TA's for Congress. Much of their work will be contracted for by think-tanks and engineering consulting firms, and engineers will play key roles in these studies.

It has been pointed out that a large percentage of upper level federal, state, and local government employees are engineers, and we believe that this fact alone justifies a place for Technology Assessment in the engineering curriculum.

SUMMARY

I have described and given some of the rationale for our graduate course in Technology Assess-

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The leaders felt the Workshop group, though small, was enthusiastic and responsive. We learned a great deal in the process of trying to organize what we thought could be "teachable" to undergraduates and graduates. Hopefully this brief guide to some of the topics and the literature sources will help others to bring molecular concepts into greater emphasis in teaching.

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ment and Public Policy. The practice of Technology Assessment, while not a traditional engineering function, has attracted and involved many engineers and scientists and will continue to do so. Chemical Engineers, we believe, will play a key role in this new and exciting area. □

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