A Course in

TECHNOLOGICAL FORECASTING

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THE FULL TITLE of the course is "Technological Forecasting: An Aid to Decision Making." It is a one trimester course (13 weeks) offered to graduate students in engineering and open to extension service students. The existence of this course reflects our view of the technological age for which we are training graduate engineers. That view accepts the role of the engineer in industry, business or in the public service, as an expert technologist, as a prime agent for technological innovation, for technology transfer from pilot to full production scale, and so on. It also recognizes that we live in an era of unprecedented concern for the husbanding of natural resources, for the protection of public and environmental safety and for the economic and societal consequences of technology and its spreading use. Further, it considers the engineering graduate and more particularly the holder of Masters or Doctoral degrees as a decision maker who will function in that capacity at a very early stage of a professional career. It is no longer reasonable however, to make decisions on technological matters without taking into account the possible economic, societal, environmental and political motivations for these decisions and in turn, the impact of the decisions on these interrelated factors. Our course is designed to introduce the graduate engineer to the complex interactions between technological and the non-technological factors noted above and to create in him an awareness of the complex crossimpacts which must be weighed in the decision-making process. In short, we hope to give him a balanced preparation for the complex roles which he will in all probability, be asked to perform in the course of a professional career.

The growing discipline of technological forecasting (TF) appears to offer a suitable vehicle for coping with the intellectual problems outlined above. In recent years TF has become a staple of planning groups in business and government. Such professional organizations as the Hudson Institute, the Stanford Research Institute, Boston Consulting Group, etc. have become widely recognized spokesmen for the importance of this planning aid. Though far from a precise discipline, TF has now taken on some aspects of analytic science (1-8) and has been the subject of training courses offered mainly to executives in industry and government. We believe there is a need in the graduate engineering curriculum for a view of this evolving discipline, in a version which stresses the analytic concepts of data analysis and trend extrapolation, and which particularly stresses application of TF methods to situations relevant to regional and national needs touching upon technology. We are not alone in this belief; to give a few examples, J. H. Hallomon, of M.I.T.'s Center for Policy Alternatives, has recently urged universities to act as focal points for the development of skills in technological planning, technology assessment and in evaluating the impact of technology on those who should use it (9). The widewing concern in Engineering faculties over the functions and power of Technology Assessment offices, has led to Symposia on this complex topic (10). To the best of our knowledge, however, our just-completed exposure (winter 1975) of the TF course makes the first formal appearance of this "soft" discipline in an approved curriculum.

COURSE CONTENT

The TF course is divided into three main sections and a complementary fourth part:

Background: In this first three-week segment, the philosophic basis for planning disciplines is laid down. Mathematical principles of data analysis, elements of probability functions and

games theory are introduced. Particular stress is laid on the character of linear and exponential growth. Examples of the latter mode were drawn from the Club of Rome Study on the Limits of Growth (11).

The Tools of TF: The second segment (four weeks) is devoted to a consideration of major practical approaches to the technological planning function. Intuitive, huristic and normative methods of forecasting are outlined. Major approaches considered in detail include:

- trend extrapolation
- Delphi interrogation
- structured interview
- relevance tree construction
- substitution theory
- input, output tabulation
- scenario writing

As a course guide here, we have used J. R. Bright's *A Brief Introduction to Technology Forecasting* (Pemaquid Press, Austin Texas, 1972), but emphasis was placed in case histories drawn from published reports of Institutes such as Stanford Research, Battelle, etc.

TF & Planning Workshop: The third and major portion of the course is 6 weeks long with additional consultation sessions arranged between instructors and students. The students were divided into working teams (5-6 individuals per team), each team selecting a topic on which they would develop a scenario depicting the future technological status (5-10 years away) of the industry relating to the topic. The scenario had to consider various non-technological options, such as a surprise-free future, major changes in political, environmental or social attitudes toward a given section of technology, the resource base from which the industries must operate, etc. A major need was to identify threats to opportunities for existing technology and innovative technology respectively, and to identify events in the forecast span which could be used as signals as to the validity (or non-validity) of the planning forecast. The completed scenario was used as the solo source for determining each student's standing in the course.

Supplementary Lectures: A group of lectures (four in the 1975 term) given by invited senior spokesmen from industries and governments, dealing with special aspects of technology planning, its management, transfer and assessment, complemented the formal content of the course. Though inevitably only loosely interconnected, the lectures served their purpose in providing insight into the role of technology and of the engineer in various occupational spheres and at various career stages.

INITIAL COURSE EVALUATION

WE ARE UNDER NO illusion as to the hazards involved in presenting a course of this type to engineering students, and as to the difficulty in deciding on the content and methods of presenting the material. We have much to learn, but are pleased with the response obtained in our first year of operation.

It was evident that the engineering students (about 2/3 of a total of 23—the remainder had backgrounds in economics and business administration) initially approached the subject with misgivings and were distinctly cool about the ultimate value of the course to their fund of knowledge. Matters began to change noticeably in the second portion of the course; the case examples involved here ranged from "classical" illustrations of substitution theory (steamship technology replacing sail, jet engines replacing piston plants, etc.) to analyses and extrapolations of the development of computer technology, and Delphi-based statements on the future competition between audio-visual communication methods and public transportation (both long and short distance). In each of these examples, further evidence was presented to support the thesis that technological growth patterns can be categorized, that to some degree the technology of the future can be planned for and controlled. Consequently, the students began to comprehend their role as future coordinators of the multidisciplinary pressures upon and arising from their activities in the technological sphere.

Our view of the technological age recognizes we live in an era of unprecedented concern for husbanding natural resources, for the protection of public and environmental safety and for the economic and societal consequences of technology and its spreading use.

The work-shop section was enthusiastically accomplished, notwithstanding the fact that the average time input far exceeded the formally

scheduled period of 18 hours. Scenarios were produced on:

- Evolution of steel-making technology (1975-2000)
- The competitive balance between the steel and plastics industry in 1985.
- Plastics recycle technology in 1985.

The final results lack the authority and balanced viewpoints of professional reports. They are by no means academic exercises, however, and have provided some interesting insights into the future stance of industries important to the regional and national economies. Beyond any doubt the authors have a truer view of the nature of these industries and of the environment in which they will probably be operating during the students' working careers. We believe that as a result of this training, this group may accommodate more quickly to the realities of the industrial and business worlds; and thus make their presence felt to their benefit and to the benefit of society in general. □

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