TECHNOLOGICAL TRENDS AND NATIONAL POLICY[1]

ANTICIPATION of the future is the key to adequate planning for the best use of our national resources. It is, however, more difficult to look forward without the aid of precise instruments than it is to look backward with the aid of memory and records. Though this report attempts to deal with the future, it is fully realized that the future grows out of the past and hence that past trends must be studied to determine future trends.

Planning is usually carried on in relation to a specific task, for a definite time, in a limited territory; but changes coming from without these limits may upset the best-laid programs. Thus the chemical inventions making substitutes of wool and cotton from cellulose, gasoline from coal and rubber from coal and chalk may affect cotton, coal and timber production, and no doubt policies in regard to other natural resources. So closely interrelated is the mechanism of modern civilization that a change occurring in one part, say in industry, will produce an effect in a quite different and unexpected part, as for instance, in the schools or the use of natural resources. Hence we need a view of the general causes, types and trends over a broad front, since any specific program may be affected by forces originating elsewhere.

Invention is a great disturber and it is fair to say that the greatest general cause of change in our modern civilization is invention; although it is recognized that social forces in turn encourage or discourage inventions. Certainly developments in technology cause a vast number of changes in a great variety of fields. A banker once defined invention as that which makes his securities insecure. Hence a study of the trends of inventions furnishes a broad perspective of many great movements of change and basic general information for any planning body, however general or specific their plans may be.

THE NATURE OF THE REPORT

The report presents a survey of most of the great fields of technology and applied science, namely, agriculture, mining, transportation, communication, the construction industries, power production, the metallurgical and chemical industries and the electrical manufactures. Chapters on these subjects comprise part III of the report. The purpose is to cover a wide range; for the specialization so necessary for progress needs to be accompanied by broader vision. It was possible to obtain this wider perspective by dealing only with the more significant inventions. Since inventions were selected for this report on the basis of their social significance, omissions are important as truly as inclusions, especially as the surveys were conducted by competent authorities in the different fields.

It has been thought best to focus on the near future, which is defined as the next 20 years; but any blinders that cut off sharply the present, the more distant future or even the recent past would mean an inadequate investigation, since change is a process.

Most planning is not concerned with invention as such, but with the effects of inventions. These social effects come only after widespread use, which may follow long after the patent has been granted. Thus, telephoning for considerable distances has been possible for some time; but it is only in the future that the volume of long distance telephoning will be sufficiently large to have much effect on the relationship of location of residence to location of business or upon the growth of suburb and village. Some inventions that are already highly developed to-day are reported in the pages that follow, since the influences they precipitate will be occurring in the near future. Still more recent inventions will also have influences in the immediate future. The air-conditioning developments which lower inside temperatures during hot weather may or may not within the next generation affect southern cities and stimulate the growth of factories in warmer regions. Or again, tray agriculture, which produces a high yield per plant when the roots are suspended in a tray of liquid chemicals instead of in the soil, may or may not be used sufficiently to be of much social significance within the reader's lifetime. The particular social influences which the inventions here surveyed may have are indicated in many cases by the authors of the chapters in the third part of the report.

Part I of the report is devoted to the social aspects of technology and its relationship to planning in a series of selected topics of special importance, such as technological change and unemployment or resistances to the adoption of inventions. Throughout the report, then, there will be found discussions of the effects of inventions on society, although the many different effects are difficult to foresee. In the case of the airplane, for example, few persons even at the time of the world war foresaw the present influences of the bomber or international relations. There is as yet no science capable of predicting the social effects of inventions,

[1] Foreword to the report of the Sub-committee on Technology of the Science Committee of the National Resources Committee, consisting of Dr. W. F. Ogburn, *chairman;* Dr. John C. Merriam and Dr. E. C. Elliott. The Science Committee consists of Dr. Frank R. Lillie, Dr. E. B. Wilson and Dr. John C. Merriam, appointed by the National Research Council; Dr. E. C. Elliott, Dr. Charles H. Judd and Dr. W. D. Cocking, appointed by the National Council on Education, and Dr. W. F. Ogburn, Dr. H. A. Millis and Dr. Carter Goodrich, appointed by the Social Science Research Council.

and decades will be required for such a development. Until that time each planning unit of government or industry will try to predict the future by drawing its own conclusions as to possible influences of inventions, known and foreseeable.

FINDINGS

(1) The large number of inventions made every year shows no tendency to diminish. On the contrary, the trend is toward further increases. No cessation of social changes due to invention is to be expected. It is customary to speak of the present age as one of great change, as though it were a turbulent transition period between two plateaus of calm, but such a conclusion is illusory. Though the rate of change may vary in the future there is no evidence whatever of a changeless peace ahead.

(2) Although technological unemployment is one of the most tragic effects of the sudden adoption of many new inventions (which may be likened to an immigration of iron men), inventions create jobs as well as take them away. While some technological changes have resulted in the complete elimination of occupations and even entire industries, the same or other changes have called into being new occupations, services and industries.

(3) No satisfactory measures of the volume of technological unemployment have as yet been developed, but at least part of the price for this constant change in the employment requirements of industry is paid by labor since many of the new machines and techniques result in "occupational obsolescence." The growth and decay of industries and occupations caused by technological progress necessitate continuous and widespread —and not always successful—readjustments and adaptations on the part of workers whose jobs are affected by these changes.

(4) The question whether there will be a large amount of unemployment during the next period of business prosperity rests only in part on the introduction of new inventions and more efficient industrial techniques. The other important elements are changes in the composition of the country's production (such as appreciable changes in the proportion which service activities constitute of the total), the growth of population, changes in the demands for goods and services, shift in markets, migration of industry, hiring age policies of industries and other factors discussed in the body of the report.[2] For instance, even if industrial techniques remained the same, the volume of production would have to be greater in the future than in 1929 in order to absorb the increase in the working population and keep unemployment to the level of that date. If the productivity of 1935 (the latest year for which figures are available) continues the same in 1937, and the composition of the nation's total product remains unchanged, production would have to be increased 20 per cent. over that of 1929 to have as little unemployment as existed then. Failing this there will be more unemployment and if labor efficiency is increased by new inventions or otherwise, then the production of physical goods and services must be more than 120 per cent. of what it was in 1929.

(5) Aside from jobs, subtracted or added, new inventions affect all the great social institutions; family, church, local community, state and industry. The committee finds that in all the fields of technology and applied science which were investigated there are many new inventions that will have important influences upon society and hence upon all planning problems. Particularly impressive were new inventions in agriculture, communication, aviation, metallurgy, chemistry and electrical tools and appliances.

(6) A large and increasing part of industrial development and of the correlated technological advances arises out of science and research. Invention is commonly an intermediate step between science and technological application, but this does not make less important the point that the basic ideas upon which these programs are developed come out of scientific discovery or creative activity.

(7) Advance of many aspects of industry and the correlated technologies is dependent upon scientific research and discovery. This fact is made clear by the increasing importance of research laboratories in the great industries. The research conducted is not only well organized but it is carried forward with the cooperation of investigators having high rank in the field of science. If the contribution of research were to be reduced, the industries would tend to freeze in a particular pattern.

(8) Though the influence of invention may be so great as to be immeasurable, as in the case of gunpowder or the printing press, there is usually opportunity to anticipate its impact upon society *since it never comes instantaneously without signals.* For invention is a process and there are faint beginnings, development, diffusion and social influences, occurring in sequence, all of which require time. From the early origins of an invention to its social effects the time intervals average about 30 years.

(9) While a serious obstacle to considering invention in planning is lack of precise knowledge, this is not irremediable nor the most difficult fact to overcome. Other equally serious obstacles are inertia of peoples, prejudice, lack of unity of purpose and the difficulties of concerted action.

(10) Among the resistances to the adoption of new inventions and hence to the spread of the advantages

[2] See pt. I, sec. 5.

of technological progress there is specially noted those resistances arising in connection with scrapping equipment in order to install the new. Better accounting methods and greater appreciation of the rate of inventional development facilitates the spread of improved capital goods. The rate of capital obsolescence is especially a major problem under monopolistic conditions, which probably favor the adoption of technological improvements less than do conditions of keen competition.

(11) The time lag between the first development and the full use of an invention is often a period of grave social and economic maladjustment, as, for example, the delay in the adoption of workmen's compensation and the institution of "safety first" campaigns after the introduction of rapidly moving steel machines. This lag emphasized the necessity of planning in regard to inventions.

RECOMMENDATIONS

(1) The reports herewith presented reveal the imminence of a few very important inventions that may soon be widely used with resultant social influences of significance. Since these inventions may deeply affect planning it is recommended that a series of studies be undertaken by the planning agencies herein recommended or by existing planning boards, with the aid of such natural and social scientists as may be needed, on the following inventions: the mechanical cotton picker, air conditioning equipment, plastics, the photoelectric cell, artificial cotton and woolen-like fibers made from cellulose, synthetic rubber, prefabricated houses, television, facsimile transmission, the automobile trailer, gasoline produced from coal, steep-flight aircraft planes and tray agriculture.

(2) A special case of the influence of invention is technological unemployment. It is recommended that a joint committee be formed from the Department of Labor, the Department of Commerce, the Department of Agriculture, Bureau of Mines, Interstate Commerce Commission, Social Security Board and the Works Progress Administration with such other cooperation as may be needed, for the purposes of keeping abreast with technological developments and ascertaining and noting the occupations and industries which are likely to be affected by imminent technological changes and the extent to which these inventions are likely to result in unemployment. It is recommended that such information be made available through the appropriate departments to the industry and labor likely to be affected.

(3) In view of the findings regarding the importance of technology and applied science, it is recommended that the Federal government develop appropriate agencies for continuous study of them; and more specifically that there be set up in the respective departments science committees with the definite function of investigating and reporting at regular periods on the progress and trends of science and invention and the possible and economic effects flowing therefrom as they affect the work of the departments and of the agencies to whom they render service. Copies of such reports should be supplied to the National Resources Board and it is recommended that in so far as is feasible they be made available to the various city, county and state planning boards and to the public.

(4) Since the patent laws have considerable influence on the rate of technological progress, it is recommended that the whole system be reviewed by a group of social scientists and economists. This review, unlike others dealing with specific reforms, technical operations, scientific aspects or ethical implications should be concerned with the articulation of the patenting process with the fundamental processes of human progress and the types of economic systems. From such basic relationships the better adaptation of the system to changing conditions can be worked out in the necessary detail.

(5) It is recommended that the Science Committee of the National Resources Committee, with the cooperation of other scientists that may be needed, make an investigation of the adequacy of the reporting of inventions and of discoveries in applied science and advise on the feasibility (*a*) of more balanced coverage, (*b*) of selecting those more socially significant and (*c*) of the assembling of such data in some central location or locations.

(6) The most important general conclusion to be drawn from these studies is the continuing growth of the already high and rapidly developing technology in the social structure of the nation, and hence the hazard of any planning that does not take this fact into consideration. This pervasive interrelationship so clearly manifest throughout the pages of this report points to one great need, namely, a permanent over-all planning board. Such a board is needed to give breadth of consideration to the variety of factors which affect specific plans. This board would take its place in the governmental pattern as coordinator for the many special planning boards, of which there are now 47 state boards, 400 county boards and 1,100 city boards. The Technology Committee, therefore, makes to the National Resources Committee, as a major recommendation of this report, the creation of a National Resources Board, as recommended by the President's Committee on Administrative Management in their report of January 8, 1937.