Section III
WORK IN PROGRESS

OTA's work is structured along three broad divisional lines: energy, materials, and international security; health and life sciences; and science, information, and transportation. Within those broad divisions, OTA conducts studies in energy, international security and commerce, materials, food and renewable resources, genetics and population, health, telecommunication and information systems, oceans, R&D priorities and policies, space technology, and transportation.

More than 57 projects were in progress during the year, including 22 new studies.

In this section, the broad concerns and current work of each OTA program are described.

Section III
WORK IN PROGRESS

ENERGY, MATERIALS, AND INTERNATIONAL SECURITY DIVISION

Energy Program

During 1979, the Nation experienced painful reminders that the energy crisis remains as threatening as ever. The gasoline shortages, a rapid rise in petroleum prices, and new questions about the safety of nuclear power were severe jolts to the Nation's well-being. Even though our energy demand growth had slowed considerably since the 1973 oil embargo, we were still dangerously dependent on imported petroleum, and the experience of the last half of 1979 showed just how foolhardy this dependence is. To deal with this problem, Congress and the President initiated several strong measures centering around two approaches. The first involved production of synthetic fuels with proposed targets ranging from several hundred thousand to over 2 million barrels of oil equivalent per day by 1990. The second was an expanded conservation effort, particularly for residential and commercial buildings. There was general agreement about the need for these measures, but considerable debate developed about their nature and the balance between the two approaches. In addition, other issues concerning the future of nuclear power, the potential contribution of solar energy, and the availability and price of conventional petroleum resources absorbed considerable congressional attention.

OTA was able to provide substantial assistance to Congress as it addressed these issues. The OTA report on residential energy conservation and subsequent analysis provided the basis for many of the conservation initiatives before Congress, and for efforts to determine a rational balance between conservation and production approaches. In addition, OTA's work on coal and biomass, particularly gasohol, aided congressional consideration of the issues surrounding these fuel sources. These studies form part of the effort the Energy Program initiated in 1975 to build a sound understanding of the major energy supply and demand technologies and their implications for society. OTA has been able to draw on this basic groundwork to meet immediate congressional needs through testimony and other short-term responses to critical energy policy questions.

Currently, the Energy Program is shifting the emphasis of its work from individual supply and demand technologies to more comprehensive energy issues. Foremost among these new efforts is the alternative energy futures study which is exploring the various energy paths the Nation might take. In the coming year, the Energy Program will examine issues concerning energy and the cities, energy policy perspectives, global trends in energy supply and demand, decentralized electric energy systems, and industrial energy use as part of the energy futures study. In addition, the Program will continue work on specific technologies by examining synthetic fuels for transportation and solar power satellite systems. Finally, reports will be completed this year on assessments of energy from biological processes and liquefied natural gas policy.

Alternative Energy Futures

The debate over America's energy policy increasingly revolves around the nature of American society in the future. Advocates of varying policy choices argue that their choices will provide the best economic situation, the maximum amount of individual freedom and choice, the most desirable environment, and the strongest national security position. Although Congress does not explicitly act to "choose" a future, the series of incremental actions taken on various bills and proposals do, in the aggregate, move the country closer to, or farther from, different alternative futures.

OTA was asked to evaluate different combinations of energy supply and demand which are often proposed as possible and desirable. The re-

quest (signed by 54 Members of the House and Senate) asked that the Office analyze various levels of energy consumption and fuel mixes (high-demand high-coal, low-demand high-solar, etc.) and identify the likely impacts of those combinations on the country.

After initial work on the comprehensive approach, a decision was made, reinforced by budgetary and related constraints, to begin the work through a set of closely related projects. Each study will be complete in itself, but will form part of a base for an overall analysis to be completed in fiscal year 1981 or later. Those studies are as follows:

1. Industrial Energy Conservation—A new look at the macroeconomic relationships between industrial production, energy consumption, and gross national product. Industry has actually cut gross energy consumption over the past 5 years, while increasing product output. How has this been possible, and can this trend be expected to continue? One or two of the most energy-intensive industries will be examined in detail.
2. Energy in the *City* —This study will focus on the various options for providing energy in the city in the future: improved conservation, transition to renewable, differing forms of decisionmaking and management. The impacts of the energy choices, and of the financing mechanisms selected to implement them, will be analyzed for their likely impact on the shape of cities, as compared to suburban and rural systems. Substantial emphasis will be placed on social and institutional barriers to implementation.
3. Energy *Policy Forum* —A careful analysis of the major differences and agreements characterizing the energy debate at this time, and the evolution of these views over the decade of the 1970's. Principal areas of difference over fact and impact will be identified, thus suggesting research priorities and helping to determine which portions of the debate hinge on philosophical differences that are not likely to be resolved. This project will be completed by a series of workshops, interviews, and in-house analyses.

Energy From Biological Processes

In the search for domestic, renewable sources of energy, many experts see a potential for obtaining energy from plants and from plant and animal wastes. Commonly referred to as biomass, these biological processes represent a renewable source of solid, liquid, and gaseous fuels as well as of chemical feedstocks. On balance, biomass may be less polluting than domestic fossil fuels. In addition, biomass has the potential for contributing to energy self-sufficiency in agriculture and in the forest products industries, and appears to be especially appropriate for developing countries.

Although the resource base for biomass is theoretically very large, there are many established nonenergy demands for those resources. The resource base can be expanded by altering forest and agricultural management, by exploiting marginal lands with specially adapted plants, and by cultivating aquatic plants. There are, however, many practical problems associated with such an expansion of the resource base.

At the request of the Senate Committee on Commerce, Science, and Transportation, OTA is analyzing the potential for and impacts of biomass energy. This project will describe in detail the conversion processes that could become commercial in the near term, analyze policies for accelerating commercialization and their implications, and examine R&D needs for longer term conversion processes. The economics and net energy balances of selected conversion processes will be investigated, particularly for the production of liquid fuels. OTA also is examining the end uses of biomass-derived fuels and chemicals. The possible uses of liquids and the technical, economic, environmental, and systems tradeoffs between possible uses will be emphasized.

In connection with this investigation of liquid fuels from biomass, OTA has carried out an extensive analysis of alcohol fuels from agricultural products and processing wastes. The results of this analysis are presented in a technical memorandum on gasohol in response to congressional interest in synthetic fuels.

Finally, because little is known about the environmental and social impacts of developing bio-

mass energy sources, OTA will summarize the state-of-the-art knowledge and lay the groundwork for anyone planning to assess these impacts. This assessment is scheduled for completion early in 1980.

Decentralized Electric Energy Generation Systems

The possibility of using solar energy in all its direct and indirect forms and the rapidly escalating economic and environmental costs of large energy facilities have stimulated considerable interest in small, decentralized energy systems. In particular, problems faced by the electric utility industry, such as rapidly rising capital costs, long leadtimes for construction, and difficulty in finding suitable sites, make the introduction of decentralized electric energy systems appear attractive. Last year, Congress provided for the establishment of rules encouraging decentralized electric energy systems in the Public Utility Regulatory Policies Act.

This study, requested by the House Committee on Banking, Finance, and Urban Affairs, will examine the role that small energy conversion equipment could play in meeting the country's needs for electric energy. It will review the economic, environmental, social, and institutional consequences of decentralized electric systems, and their effect on the electric utility industry. Finally, it will analyze policy options that Congress may wish to consider.

The assessment will begin by examining the technical features of decentralized systems using a variety of small electric-generating equipment. Then, employing models developed for the earlier OTA study on onsite solar systems, the assessment will analyze the economic and technical effects of such systems on utilities. Concurrently, changes in utility structure will be evaluated on the basis of planning and decision models. Finally, a series of issues about the effects on society (e.g., employment, risks, etc.) of decentralized systems will be examined, including public perception of small-scale, onsite energy facilities. The study is scheduled for completion in the late summer of 1980.

Global Energy Trends

Energy shortages and high prices will create serious economic and political difficulties during the next three decades. As a result, the Senate Foreign Relations Committee requested that OTA perform an assessment of the future energy situation to determine the effects of these possible shortages and high prices and the foreign policy options that are available to the United States to mitigate these negative effects.

This study is proceeding in two stages. The first stage assesses future global energy supplies and the construction of credible scenarios governing future energy supplies and demands. Because of its central importance, future world petroleum availability is being assessed first. The preliminary results of this study have been used as a basis for OTA testimony before the House Select Committee on Intelligence. The second stage of this study, to be carried out primarily by the International Security and Commerce Program, will examine the implications of these scenarios on the United States and the world. This analysis will cover the economic, political, and national security impacts of these scenarios. U.S. foreign policy responses, including U.S. assistance in energy technologies to other nations, will be analyzed.

An analysis of world oil-production prospects will be completed in the spring of 1980.

Liquefied Natural Gas

Public debate has focused on both safety and economic aspects of liquefied natural gas (LNG) imports. An OTA report, *Transportation of Liquefied Natural Gas*, published in September 1977, describes the technology, reviews critically the physical and institutional components of the LNG import system, and explores public awareness and concerns.

Partly in response to questions raised in that study, the Senate Committee on Finance requested OTA to examine LNG import policy in the context of other energy alternatives, with emphasis on economic costs and benefits. The request arrived after President Carter, through the National Energy Plan, had relaxed a policy of the

previous administration to limit LNG imports, and after the General Accounting Office (GAO) had suggested in a report to Congress that this new policy required reevaluation and further improvement, essentially because insufficient rationale appeared in the plan.

In response to the Senate Finance Committee's inquiry, this assessment mainly looks at the economic and energy supply implications of the technology. Safety of LNG facilities has been excluded from the study, in order not to duplicate the recent effort of GAO.

The purpose of the project is to aid Congress and Federal and State regulatory bodies in establishing or reevaluating the circumstances under which LNG imports are in the public interest. Seven separate but related analytical tasks contribute to meeting the objective:

1. a compilation of the history of Government LNG import policy;
2. a review of U.S. gas demand projections under alternative price and policy assumptions;
3. a survey of North American gas and oil resource estimates;
4. an investigation into the availability and cost of LNG in world markets;
5. a description of the cost and structure of LNG import projects, including financing and the distribution of risk among the public and other participants;
6. an analysis of the distribution of costs and benefits of imported LNG in domestic gas markets; and,
7. a brief discussion of the broader social and environmental impacts of LNG imports.

The report is scheduled for completion in early 1980.

Solar Power Satellites

Solar power satellites are viewed as the most promising solar source of baseload electricity by proponents, while opponents believe that their development would be a huge waste of Federal R&D money. While expenditures on the concept have thus far totaled less than $25 million, several estimates place development and demonstration costs in the $40 billion to $80 billion range. The potential impacts of these satellite systems on the environment and on society are the object of considerable debate as is the ultimate cost of the energy produced. There is considerable congressional support for a more aggressive approach to investigation and development of the concept (the House passed **a** bill last year to initiate a 5-year program expected to cost $275 million).

A number of very different concepts for solar power satellites have been proposed. The most familiar would place giant arrays of photovoltaic cells in orbit to convert sunlight to electricity and transmit it to Earth by a microwave beam. Other concepts include the use of giant orbiting reflectors to create solar farms on Earth where sunlight would be available around the clock, or the use of sunlight to directly excite a laser that would beam energy to Earth. The concepts are technically diverse and may have significantly different economic prospects. Perhaps equally important, their environmental and institutional impacts, which are likely to influence public acceptability, would be substantially different.

This study will address key uncertainties in a balanced treatment of both positive and negative impacts of proposed satellite power systems. Major topic areas will include: 1) the feasibility and cost of alternative satellite systems; 2) factors affecting public and institutional acceptance of these systems; and 3) the energy systems context within which development and implementation of satellite power systems must be viewed. Within these categories, particular attention will be devoted to the health effects of microwave radiation, the implications of highly centralized electric-generation systems, the expanded role of the Federal Government in energy production that may be required, and the implications for national security and international relations. Strengths, weaknesses, and uncertainties associated with solar satellite concepts will be contrasted with those of other future energy sources such as nuclear fusion and terrestrial photovoltaics.

The study was requested by the Chairman and ranking minority members of the House Committee on Science and Technology and its Subcom-

mittee on Space Science and Applications. Completion is scheduled for the fall of 1980.

Synthetic Fuels for Transportation

The U.S. automotive transportation system is becoming increasingly dependent on imported petroleum. The rapidly escalating cost of imported oil and the apparent willingness of some oil producers to use oil as a political weapon have created a strong concern both for the U.S. economy and for our continued freedom from outside coercion. The manufacture of synthetic fuels and the improved efficiency of the automobile are two major pathways for reducing U.S. oil dependence and its effects.

The Energy Program is cooperating with the Transportation Program in **a** study of synthetic fuel production, automotive fuel-efficiency improvements, and the tradeoffs between them. The Energy Program will be responsible for the portion of the study dealing with synfuels. A major purpose of the study will be to examine the total costs and benefits of synfuels, including the costs and benefits of moving synfuels into the marketplace (refining and distributing them as well as adapting the automobile to use them, if necessary). OTA will also carefully examine the time necessary to develop a synfuels industry under different deployment conditions, and will attempt to determine what additional costs would have to be borne if an emergency deployment schedule were adopted. This analysis should establish the possibilities for using a synfuels commercialization capability as an emergency "escape valve" to combat the effects of an externally imposed oil shortage. Finally, OTA will attempt to identify those critical issues that must be resolved before the next major steps towards commercialization are made, and to identify instances where the current Federal program may fail to resolve these issues in time.

This assessment has been requested by the Senate Committee on Commerce, Science, and Transportation. The House Committees on Science and Technology and on Interstate and Foreign Commerce have also expressed strong interest. Completion is scheduled for the late fall of 1980.

International Security and Commerce Program

It is becoming increasingly evident that international interdependence is no longer just a slogan, but a reality. A wide range of the U.S. national goals can only be achieved with the cooperation of other nations, while other goals may involve conflicts of interest with foreign countries. In the international arena, U.S. technology has long represented a particular area of strength, and we have grown accustomed to relying on superior technology to help us in achieving both economic and military strength. Technology should remain a distinctive U.S. asset in the future as well, but only if it is used wisely in the pursuit of national objectives. The International Security and Commerce Program assists Congress in a variety of areas where the appropriate national policy is in doubt because of questions regarding the impact of either U.S. or foreign advances in technology.

One such area is the international competitiveness of U.S. industry. Is the United States moving into a period in which key industries depend on exports for their survival, while some key products are imported because U.S. manufacturers can no longer compete? If so, what consequences can be hoped for, or feared? Is a more explicit national strategy appropriate, or feasible? A closely related question is that of technology transfer. How is technology transferred from the United States to other countries? What factors determine whether imported technology is efficiently used? Under what circumstances is technology transfer good or bad for the United States? Answers to questions such as these do not emerge reliably from theoretical analysis; instead, it is necessary to look closely at the details of a variety of specific cases. In 1979, the Program completed an assessment of technology and East-West trade. An ongoing assessment addresses the international competitiveness of the U.S. electronics industry. Future efforts will include other cases of competitiveness (probably

the aircraft industry, and a comparison across industries) and of technology transfer (such as technology transfer to the oil-rich nations of the Middle East, and the effects of relocation of U.S. industries to areas overseas where labor is cheaper).

Another such area is the technology of national security, including both the effects of weapons technology and the technological considerations involved in arms limitation. In 1979 an assessment of the effects of nuclear war was completed, and we expect to initiate further projects during 1980.

The Program is conducting a joint effort with the Energy Program to assess the implications of global trends in energy supply and demand. Based on work done in the Energy Program on petroleum supply, an assessment is planned for 1980 on the range of ways in which energy issues can affect East-West relations, and on the policy problems and options to be expected as a result.

The International Competitiveness of the U.S. Electronics Industry

While there are many factors other than technology which affect the competitiveness of the U.S. electronics industry, it is assumed that the relative sophistication and appropriateness of the technologies employed (both in end products and in manufacturing processes) will have a major impact, and that there are significant U.S. Government policy choices which in turn will affect the level of technology. This assessment, undertaken at the request of the Senate Committee on Commerce, Science, and Transportation; the House Committee on Ways and Means; and the Joint Economic Committee, addresses the technology issues affecting competitiveness in an industry that has been marked by a very high rate of innovation and by extremely sophisticated technologies. It is of interest not only for its own sake, but because of the strategic role that electronics are expected to play in the future of other industries. A companion study on the competitiveness of the U.S. steel industry is being carried out by the Materials Program.

The assessment addresses three sectors of the electronics industry: consumer electronics, in which the U.S. industry producing color television receivers has lost much of its market to Japanese manufacturers; semiconductor devices (notably integrated circuits), in which U.S. industry holds a strong competitive position, but is under a fierce challenge; and computers, in which U.S. industry is presently leading the world, but where future challenges are to be expected. The assessment will focus on those determinants of technological competitiveness that appear to be susceptible to modification by governmental action, and involves comparison of U.S. and Japanese practices and considerable attention to some sectors of Western European industry. The assessment is scheduled for completion in mid-1980.

Taggants in Explosives

This assessment responds to a request from the Senate Governmental Affairs Committee to assess a proposal to add substances to commercial explosives that would permit detection of the explosives by suitable sensing machines (so-called detection taggants) or identification of the batch of explosives involved in a bombing through so-called identification taggants retrieved from the debris. When hearings were held on this prospect, the assertions about the technologies involved from executive branch sources (who favor it) and industry sources (who oppose it) were so completely in disagreement that no reliable conclusions could be drawn. The request is being met by the Program because experts and laboratories who normally work for the military provide a source of unbiased expertise regarding explosives. The assessment addresses the safety of taggants, their probable costs, and their probable utility to law enforcement. The assessment is scheduled for completion early in 1980.

Materials Program

The industrial base of a modern technological society requires a vast array of raw materials of many different types. The importance of materials to our society is suggested by the fact that annual consumption of minerals in the United States is about 40,000 lbs per person. Society uses materials through what is called the materials cycle. The cycle starts with extraction of minerals or harvesting of renewable resources such as wood, proceeds through processing and end-product manufacture to use of the product by the consumer, followed by disposal of the product, and, in some cases, by reuse or remanufacturing of the product or recycling of the material.

At every stage of this cycle, the ways in which materials are handled are affected in complex and interlocking ways by institutional, economic, environmental, and technical factors. For example, the exploration, development, and production of a significant fraction of our minerals and timber are governed by the Federal land management laws and regulations; the degree to which materials are recycled after use depends partly on the relative costs of virgin and recycled materials and these costs partly depend, in turn, on institutional and technical factors; environmental concerns are leading to more stringent and costly controls on operations at all stages of the materials cycle from extraction through waste disposal; and new technology has simultaneously opened up hitherto untouched areas for exploration, development, and production, and helped to mitigate at least some of the associated impacts on the environment.

The Program has two ongoing projects related to extraction (oil shale and Federal coal leasing) and one ongoing project related to processing (impact of technology on the competitiveness of the U.S. steel industry). The new projects started in 1980 will probably be concerned with technologies for efficient and environmentally sound processing and manufacture.

Oil Shale Technology

At the request of the Senate Committee on Energy and Natural Resources, OTA is studying the history, status, and possible futures of efforts to develop the oil shale of the Western United States. The Committee's letter of request called for a complete assessment of shale oil recovery technology in general and of the current Federal prototype oil shale leasing program in particular.

U.S. dependence on foreign sources of liquid fuel has increased significantly since the 1973-74 oil embargo and price increases. In 1978, the United States imported nearly 45 percent of its petroleum at prices five to six times higher than they were in 1972, and prices have risen dramatically since the end of 1978. Short-term reliability of imported-oil supplies is uncertain, as exemplified by the problems in Iran. Long-term reliability is also questionable, as worldwide oil production may peak within the next few decades. In the United States, oil reserves have been declining for several years.

The richest oil shale deposits in the Western United States are those of the Green River formation in Colorado, Utah, and Wyoming. The Green River shales contain the largest single deposit of hydrocarbon materials in the world, but only a small portion of the total resource could be recovered by existing technologies. It has been estimated that about 190 billion barrels of shale oil could be recovered from the Green River deposits with existing technology, but the profitability of recovery is clouded by numerous technical, environmental, and economic uncertainties. These resources, if recovered, could supply a l-million-barrel-per-day oil shale industry for over 500 years.

In its assessment of oil shale technology, OTA will place emphasis on identifying the remaining technical, economic, and environmental uncertainties connected with commercial oil shale development and evaluating how these uncertainties could be resolved. OTA will formulate several scenarios for oil shale development, from "no additional Government involvement" to "Government-assisted accelerated massive development ." A range of financial and institutional incentives for each scenario will be analyzed for their effectiveness in achieving such aims as encouraging oil shale development, minimizing cost to the Treasury, and maximizing managerial efficiency. The likely environmental, socioeconomic, and water availability impacts for each scenario will be identified. Completion is scheduled for early 1980.

Impact of Technology on the Competitiveness of the U.S. Steel Industry

A growing number of people have become concerned that the U.S. steel industry has lost its ability to compete with foreign steel producers, both in domestic and world markets.

At the request of the House Committee on Ways and Means, OTA is analyzing the role played by technology in the fate of the U.S. steel industry and in steel manufacture around the world. This assessment will examine the kinds of technologies now available worldwide and attempt to anticipate those that may be available during the next few decades.

For the purposes of this study, the steel industry is not being treated as a single entity. Rather, three major elements of the industry are being treated separately: integrated carbon steelmaking, non-integrated carbon steelmaking (including "mini-mills"), and alloy/specialty companies. Each category presents unique opportunities and problems for study.

The study is examining ways in which research, development, and demonstration of new steelmaking techniques are now conducted in the United States and by our major competitors. It is also exploring the incentives and barriers to the introduction of new technologies. The impacts of a variety of Federal programs and regulations (including labor regulations, environmental controls, and health and safety regulations) are also being explored. A broad range of possible legislative solutions to problems identified will be presented and their impact assessed. Completion is scheduled for early 1980.

Federal Coal Development

The administration's National Energy Plan calls for expanded domestic coal production to offset the rising prices and uncertain availability of other fossil fuels. Over one-half of the Nation's coal reserves are found in the Western States. The Federal Government owns approximately two-thirds of these Western coal reserves. In 1974, an estimated 15 billion tons of Federal reserves were under lease, seemingly more than enough to meet future demand; yet less than 50 million tons of coal per year were produced from these leases. To meet the projected goal of 1.2 billion tons of coal in 1985, domestic coal production must increase nearly 80 percent over 1976 levels. Production goals for Federal leases call for a sixfold increase to approximately 300 million tons per year in 1985. Recent uncertainties about the role of nuclear power and increased interest in large synthetic fuel production may further increase the demand for coal.

The low-production figures for Federal coal leases raises uncertainties that some leases would not begin production in time to meet future coal demand. In 1973, in response to charges of speculation and mismanagement, the Department of the Interior imposed a moratorium on further leasing. The coal industry advocates increased Federal leasing to meet projected 1985 production goals.

The Federal Coal Leasing Amendments Act of 1975, Public Law 94-377, revised the leasing system and required that most existing leases begin production by 1986 under threat of cancellation.

Section 10 of Public Law 94-377 directed OTA to conduct an analysis of all outstanding Federal coal development rights, which include over 500 leases and 200 preference-right lease applications in effect in August 1976. This assessment will analyze all mining activities on Federal

leases, determine the present and potential value of the outstanding coal development rights, estimate revenues to the Federal Government, and examine the feasibility of using deep-mining technology in leased areas. Completion is scheduled for early 1981.

SCIENCE, INFORMATION, AND TRANSPORTATION DIVISION

Telecommunication and Information Systems Program

Telecommunication and information systems technologies are rapidly advancing and becoming more integrated. New facilities are being established, new services are being planned and offered, and new enterprises are emerging in the United States and abroad. Governments are taking increased interest in the social and institutional implications of the new technologies. Governmental and industrial reorganizations are occurring, new legislation is being proposed and adopted, and relevant international norms are being formulated in global and regional forums.

Because of the unprecedented growth in new telecommunication systems investment, and the expanding impacts on society of emerging national information systems, several committees of Congress consider it essential to assess the developing technologies and their broad societal impacts. The Telecommunication and Information Systems Program comprises two core projects, one on national information systems and the other on telecommunication systems. They are being conducted on a coordinated basis.

National Information Systems

The project on societal impacts of national information systems was initiated in fiscal year 1978 to explore the issues and impacts of three broadly representative information systems–the Federal Bureau of Investigation's National Crime Information Center and its Computerized Criminal History Program, the role of the U.S. Postal Service in electronic message systems, and the impacts of emerging electronic funds transfer systems. Using these case studies, issues and impacts generic to comparable national information systems will be assessed.

Previously available only at relatively high costs, computers are now available in drastically reduced sizes, at dramatically reduced prices, and with greatly enhanced speed and capability. In this "the information age," our greatly improved capacity for generation and dissemination of information should be for the benefit of all, but there is presently little understanding of how national information systems affect society. They could bring enhanced convenience and efficiency to many services and functions of society such as mail, criminal justice, research, education, and marketing, and to personal services such as banking and shopping. However, their use could result in the deprivation of individual rights and civil liberties and could have unanticipated impacts on areas such as: employment patterns; choices in the free market; national security; international data flow; and the infrastructures of providers, users, and regulators of information services.

The information systems study is designed to assess these impacts and to define policy options. Impacts and issues raised by the three in-depth case studies will be analyzed for any general conclusions that might help Congress in its efforts to shape a coherent national policy on information systems.

This assessment was requested by the House Committees on Post Office and Civil Service and on the Judiciary and the Senate Committee on the Judiciary. A report is expected in early 1980 on the implications of the National Crime Information Center and the Computerized Criminal Histories Program. Other aspects of the study are expected to be reported on in the spring of 1980.

Telecommunication Systems

The assessment of telecommunication systems, which was begun during early fiscal year

1979, will identify and analyze new technologies and emerging services, take into account the regulatory and institutional aspects of the Communications Act of 1934, project the rate and scope of system and service growth, and explore alternative national policy frameworks for the telecommunication sector.

Telecommunication technology has been in a period of revolutionary change since the mid-1960's, and the end of new system and service innovations is not in sight. Computers, satellites, optical fibers, cable TV, and many other developments have been added to the repertoire of available electrical and radio technologies for communication at a distance (i. e., telecommunication). As new systems and services become economic, as new competing forces emerge in the marketplace, it is both timely and necessary to assess the technological changes and their impacts, including the underlying national policies which need review and assessment.

This study explores alternative choices of future national policies affecting industry structure, Government structure, and the role and consequences of competition in telecommunication services. It will also assess the underlying economic and social relationships. The focus will be on technologies and the effect of industrial institutions and Government regulation and policy on their development, introduction, manufacture, availability, cost, and use.

Requested by the Senate Committees on Commerce, Science, and Transportation and on the Judiciary, this assessment is scheduled for completion in the spring of 1980.

Applications of Technology in Space

An assessment of applications of technology in space was initiated at the request of the Senate Committee on Commerce, Science, and Transportation.

In order for OTA to properly advise Congress regarding the merits of a given application of space technology, it is necessary to compare the costs, benefits, and risks of the space approach with competing nonspace approaches. In the absence of such a comparative approach, it will become increasingly difficult for Congress to provide oversight of executive branch programs or to provide leadership in areas of perceived shortcomings or opportunities. Accordingly, assessments of applications of space technology are being addressed in the context of the specific application (e.g., energy, telecommunication, oceans). These specific applications will be explored within a broader national space policy options review and a consolidated study will be prepared.

A contract study on the institutional options for the national space program has been initiated which develops a range of scenarios for future space activities and the institutional options appropriate for them.

All the evolving space studies explore the adequacy of the space technology base and evaluate the possible needs for large space structures and for improvements in space transportation in the context of alternate applications and policy.

Transportation Program

Of major concern to Congress is the ability of the transportation system in the United States to provide fast, efficient, and inexpensive mobility for people and goods. Transportation industries have had to contend with increasing economic, operational, environmental, and safety problems in recent years. In addition, there are a number of factors, growing in importance, which may force a change of transportation policies in order to modify the system and the manner in which it is operated. These include:

- the almost complete dependence of the transportation system on petroleum in an era where dependence on imports must be reduced, and where supplies are dependent on the political stability of the Middle East;
- the rising percentage of the overall system

cost represented by the cost of petroleum fuel;
- the physical deterioration of roadbeds and equipment at a more rapid rate than that of investment in their replacement; and
- the increasing cost of operating transportation systems–both public and private, freight and passenger—because productivity has not kept pace with demand for transportation services.

Since transportation supplies society with mobility for people and the wide range of goods and services needed, a degradation in the transportation system could significantly effect the character and lifestyle of society in the future.

In 1980, congressional interest will probably continue to focus on the influence of the cost and availability of petroleum and its effect on the transportation system, the deterioration of roadbeds and equipment, and the inability of the existing system (based on yesterday's technology) to meet the economic, environmental, and social needs of the future.

The Program will center its efforts on the effects of technological development in the areas of:

- goods movement—rail and truck systems—to improve service and reduce costs;
- reduction of the dependence on petroleum through the development of electrical propulsion and energy distribution systems; and
- urban transportation—evaluation of alternatives to the automobile to reduce petroleum consumption, emissions, and congestion.

Automotive Fuel-Efficiency R&D and Alternative Energy Sources

The study will examine new or improved technologies for possible use in automobiles and trucks during the period 1985-2010 that would contribute to greater fuel economy. Included in this study will be an examination of the prospects for widespread introduction of electric and hybrid vehicles.

A second part, conducted in parallel by the Energy Program, will examine the potential for producing fuels from sources other than conventional petroleum obtained from primary and secondary recovery from domestic oilfields. The resource base for these alternate fuels and the technologies and time needed to produce them will be reviewed. In addition, the study will determine the economic and environmental costs of production and assess the fuels' potential contribution to the Nation's energy supply.

The results of these two lines of investigation will then be merged, to assess expected benefits and costs of each as near- and far-term solutions to the problems of dependency on imported petroleum. The cost and time needed to achieve increased automotive fuel economy will be compared with that of the development of alternative motor fuels.

One of the initial activities of this assessment was a 3-day workshop held in September 1979 to which automotive experts from industry and universities in the United States, West Germany, and Japan were invited to review the potential for fuel-efficiency improvements in engines and vehicle systems, materials, electronics, and electric and hybrid vehicles. A report on this workshop was published in the latter part of 1979.

Impact of Advanced Air Transport Technology

Acting on a request by the House Science and Technology Committee and the Senate Commerce, Science, and Transportation Committee, this study was initiated in late *1979.* The assessment examines the economic, energy, environmental, safety, and societal impacts of advances in the technology of transport aircraft of all types, both passenger and cargo. It also examines the potential impacts of the expected growth in air traffic for the next several decades and considers various options that may be appropriate for both managing and financing new aircraft which may satisfy the expected growth. An important portion of the assessment is the role of the Federal Government in R&D in aeronautics and civil aviation technology. The study is scheduled for completion in the spring of 1980.

Airport and Air Traffic Control System

One project under consideration for initiation in 1980 and completion in 1981 is an assessment to identify and analyze the airport and terminal area capacity problem for the Nation and the associated public investment decisions. This assessment will include an examination of the airport access problems and air traffic control and of alternative ways of alleviating these problems of future air travel.

Oceans Program

Recent years have brought an increased awareness of the impact of the oceans on the well-being of humankind—the oceans' potential as a source of food, fuel, and hard minerals; their use as avenues of world commerce and communications; and their role in man's search for knowledge about his resources and environment. At the same time, we are beginning to understand that, although the oceans are vast, they are not inviolate to the interventions of man. Much more needs to be understood about the effects of such occurrences as oilspills, overfishing, the discharge of toxic substances, and the role of the oceans in atmospheric carbon dioxide concentrations.

The United States, with a heavy marine interest, predicates its policies on facts derived from comprehensive ocean research. This effort is becoming increasingly more expensive as demands become more extensive. As a result, the job of Congress in determining the most effective allocation of Federal resources, both financial and institutional, has become more difficult and more critical.

To assist Congress in its deliberations in such matters, the Oceans Program focuses on a broad range of issues encompassing the uses and quality of the oceans and the systems deployed on or in the oceans or along their shores. The Program is particularly concerned with examining possible future uses of the oceans.

Radioactive Waste Management and Disposal

Although the United States is more than three decades into the nuclear age, nearly all of the high-level radioactive waste generated by weapons manufacture and by the operation of commercial nuclear powerplants is still in temporary storage. Continued delay in developing and implementing a radioactive waste disposal system might significantly limit the future use of nuclear power, whereas hasty action, if it were to lead to serious mistakes, might undermine public confidence in the Federal Government's ability to dispose safely of radioactive waste. While many technological solutions to the problem have been proposed, experience has shown that considerations focused solely on the technology are not enough.

A clear understanding of the problem of managing radioactive waste from its generation to final disposal requires comprehensive analysis of the interactive relationships among possible storage and disposal technologies, transportation systems, regulatory considerations, and Federal, State, and local jurisdictional prerogatives. The OTA study uses systems analysis techniques to evaluate a range of strategies for developing and deploying a commercial high-level radioactive waste disposal system. The study is intended to provide a framework not only for synthesizing existing information about proposed technological options for dealing with radioactive waste, but also for examining the interrelationships between technical and nontechnical considerations.

This study was requested by the House Committees on International Relations, on Merchant Marine and Fisheries, and on Science and Technology, and the Senate Committees on Commerce, Science, and Transportation and on Energy and Natural Resources, as well as the National Ocean Policy Study. The project is expected to be completed in the summer of 1980.

Ocean Research Assessment

This study examines future needs and capabilities of technologies used to conduct oceano-

graphic research supported by Federal funds. The request from the Senate Commerce Committee said it would like to know how the Federal Government is using the equipment it has and how it is preparing for future uses. The Committee also would like to know if our capabilities will meet the most urgent national needs; if there are opportunities for improvements in technology or management, or for savings in money; and if better, more efficient systems could be developed.

The study will evaluate the technologies used by the Federal Government in ocean research: ships, submersibles, aircraft, satellites, unmanned platforms such as buoys—and the equipment used to make scientific measurements. Eight Federal agencies have major activities in ocean research: the National Oceanic and Atmospheric Administration, the Navy, the National Science Foundation, the National Aeronautics and Space Administration, the Coast Guard, the Environmental Protection Agency, the Department of the Interior (U.S. Geological Survey and the Bureau of Land Management), and the Department of Energy. The total Federal ocean program costs over $1 billion a year and a large portion is spent on the technology to be addressed by this study.

A principal objective of this study will be to provide Congress with a comprehensive view and a coherent structure for evaluating the many new plans, proposed programs, and funding requests for ocean research. In addition, it is expected to present options for providing technical capabilities to conduct ocean research and more cost-effective methods for coordinating or consolidating Federal activities.

Several categories of ocean research efforts are directed towards addressing major national problems. These problems reflect the growing need not only for management of ocean activities and resources, but also for improved ocean research technology. Congress has recognized and responded to these problems through legislation establishing mandates for specific types of monitoring and research. Four research areas, which this study will examine to identify technological needs, are: weather and climate, marine pollution, ocean minerals and energy sources, and fisheries (and other living resources). The study is scheduled for completion in the summer of 1980.

Fresh water Resources Management, Planning, and Policy

The study, "Freshwater Resources Management, Planning, and Policy: An Assessment of Models and Predictive Methods, " will summarize the numerous current and proposed models and predictive methods in the water resources field and determine their effectiveness as decision-making tools. As the Nation's water problems become more complex, the often conflicting advice presented to Congress by the Federal agencies, advocacy groups, and expert witnesses is increasingly difficult to evaluate. Often this advice is based on the results of computer models and predictive methods of unknown quality or effectiveness. The critical need for an examination of the merits and disadvantages of the range of available techniques has been expressed in testimony before Congress by many distinguished panels of experts considering future water research priorities. OTA will advise Congress on the current and future capability of these tools to supply needed analyses to water resource managers, planners, and policy makers.

Specifically, the credibility and efficacy of major waste resource models will be examined in three broad subject areas: physical-ecological, socioeconomic, and integrative. Physical-ecological models are concerned with water supply prediction, the movement of materials through the environment, and effects on living systems. Topics in the socioeconomic category include future water use predictions, economic evaluation, and risk analysis of flood and drought. Integrative methods are a combination of the physical-ecological and socioeconomic approaches. For instance, integrative methods may be used to determine areawide development policies in watersport regions of the country. The assessment will also identify legal and institutional barriers to implementation, future research needs, and possible Federal Government roles.

This assessment was requested by the House Interior and Insular Affairs Committee, and was endorsed by the House Science and Technology Committee and the Senate Energy and Natural Resources Committee. The study is scheduled for completion in the late summer of 1980.

National R&D Priorities and Policies Program

The National R&D Priorities and Policies Program assists congressional deliberations addressing the use of science and technology to achieve national goals. More specifically, the Program provides analytical support to Congress in dealing with broad cross-cutting issues stemming from or common to several technologies as opposed to assessing an individual technology.

Technological Innovation and Health, Safety, and Environmental Regulation

This assessment was requested by the Senate Committee on Commerce, Science, and Transportation as part of the Committee's review of Federal policies affecting industrial innovation.

The issues addressed are:

1. whether regulation is effective or not in tapping the innovative resources of the private sector to reach health, safety, and environmental objectives, e.g., safer chemicals and nonpolluting industrial processes; and
2. whether, for a given level of protection, regulation creates unnecessary barriers for innovations to meet market demands.

The latter issue is important because innovation is a major source of economic growth, increased productivity, and exports.

This assessment will ascertain whether existing regulatory policies create problems, as defined here, and, if so, develop alternative policies for dealing with them.

To derive practical policy consequences from such a broad subject, the assessment has been organized around three sectoral studies:

1. effects of product regulation on innovation in pesticides and chemicals;
2. effects of emission, safety, and fuel economy regulations on innovation in the automotive industry; and
3. effects of regulation to control air and water pollution on innovation in industrial processes.

In addition, the effects of regulation on indicators of aggregate economic performance—gross national product, productivity, etc.—will be examined in order to formulate the issue of regulation's effect on future economic vitality through its effects on innovation. An analytic framework of alternative regulatory mechanisms will also be developed to delineate the role of innovation concerns in the broader range of concerns that determine the selection and implementation of regulatory programs. The study is scheduled for completion in the summer of 1980.

An Assessment of Technology for Local Development

The study was requested by the House Committee on Science and Technology and the House Select Committee on Population. It is concerned with those technologies that are designed to:

1. help meet tasks or needs as identified by the local community, and
2. utilize to the greatest degree possible renewable resources.

The study will assess the availability, feasibility, and impacts of several such technologies, the institutional supports necessary to develop and apply them. It will weigh the impacts, both positive and negative, of these technologies.

The project is based on case studies of specific technology areas and applications. It also includes a study of the history of Federal interest in appropriate technology to date; a study of relevant Federal, State, and local policies; and a study of the financing mechanisms which encourage or hinder the use of those technologies. The study is scheduled for completion in the spring of 1980.

The Impact of Inflation on the Federal R&D Investment

The United States will invest $31.2 billion in R&D activities in fiscal year 1980 to support the missions of various executive agencies, to ad-

vance our knowledge of basic science, and to stimulate innovation. In April 1979 the House Science and Technology Committee held hearings to review the Federal R&D budget. Their inquiry found little agreement on how inflation should be treated in the Federal R&D budget process and conflicting practices in accounting for inflation in budgeting for R&D among the executive agencies. The Committee's appraisal of the Federal R&D investment was hampered by a lack of understanding of how inflation affects the Nation's R&D efforts.

The OTA study will assist the House Science and Technology Committee in its appraisal of the Federal R&D investment by providing the Committee an understanding of:

- the response of the Federal R&D budget process to inflation, and
- the impact of inflation on the performers of federally funded R&D.

The project will be conducted in two parallel tasks. Task 1 will establish an understanding of the differences and similarities among the executive agencies in dealing with inflation in their R&D budget processes and Task 2 will address the question of the consequences of inflation for the performers of federally funded R&D. The study is scheduled for completion in early 1980.

HEALTH AND LIFE SCIENCES DIVISION

Food and Renewable Resources Program

As with energy and many other natural resources, until recently Americans took for granted that our supply of renewable resources—foods, soils, forests, water, and wildlife—was inexhaustible. But no resource is immune to the mounting pressures of our modern age; it is possible to stress even these self-renewing resources. With this in mind, and with growing congressional interest in renewable natural resources, OTA's Food Program broadened its scope and in April became the Food and Renewable Resources Program.

Food is a major concern. In today's world of 4 billion people, perhaps as many as 10 percent are suffering from malnutrition and, in some cases, starvation. And the global population will rise to 6 billion by the year 2000. Consequently, world food demands will continue to rise. How can technology contribute to the solution of food problems?

Economic and environmental pressures in the United States are affecting the nature of our agricultural base. We are losing some of our best soils to unacceptable rates of erosion. Competing uses tax our water resource, and affect its availability and quality. What are the new technologies that can help us sustain the land's natural productivity, and maintain water quality?

To provide Congress with information on these and other related problems, the Program identifies current and emerging technology issues that affect the U.S. and world food and renewable resources situation as well as issues affecting the renewable natural resource base.

The food studies are organized around three functional areas: 1) production including all resources required to produce agricultural products and get them to the farm gate; 2) marketing, consisting of processing, wholesaling, and retailing; and 3) consumption and nutrition, both in and out of the home.

Future renewable natural resource studies will fall into one or more of the following categories: land and soils; forests and other vegetation; ground and surface water; wildlife; and the interrelationships of these and how they might be maintained, restored, or improved through wise application of technology.

Impact of Technology on Productivity of the Land

This assessment is concerned with the sustainability of the primary productivity of our land.

Were it not for technological advances, world agriculture would never have been able to keep

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pace with world population growth thus far. Historically, U.S. technology, in particular, has had a pronounced positive impact on increasing the productivity of croplands and grasslands. Our dependence on a continuing supply of renewable natural resources and on maintaining stable ecological systems from which the resources are drawn is emerging as a key element in our country's future. Now, however, there is increasing evidence showing that parts of the natural biological and physical systems are being overburdened by human activities and that the land's productivity is in jeopardy.

The land productivity study will focus on the present use of technologies and their beneficial and adverse effects, and on emerging and new technologies that might be used to offset adverse effects derived from some present technologies. The assessment will include an evaluation of: 1) the adequacy of present data on our land's productivity and gaps in our knowledge base and 2) new or emerging technologies that may have potential for restoring, maintaining, and improving land productivity, especially croplands and rangelands. Selected case studies will be prepared that show how society is affected directly and indirectly as the land's ecological systems are altered through applications of technology.

This study **was** initiated in November 1979 and was requested by the Senate Committee on Environment and Public Works. Expressions of support were received from the House Committee on Agriculture, the Senate Committee on Appropriations, and the Subcommittee on Parks, Recreation, and Natural Resources of the Senate Committee on Energy and Natural Resources, and is scheduled for completion in late 1980.

U.S. Food *and Agricultural Research*

The success of U.S. food and agriculture industries has been based on an ever-increasing use of new technologies. However, the effectiveness of these technologies and/or their development seems to be decreasing at a time when areas requiring research are expanding and the intensity of some traditional problems, such as soil erosion, is increasing. The principal creators of new food and agriculture technologies in the United States are Agricultural Research, the U.S. Department of Agriculture (USDA); State agricultural experiment stations (SAES) of land-grant universities; and private food- and agriculture-oriented industries. Historically, USDA has been more concerned with problems of national and regional importance, and SAES with problems of a local and state nature. Yet often USDA and SAES work on problems that seem indistinguishable. In addition, the administration has attempted to reduce funding in certain areas in the hope that the private sector will provide the needed research.

Congress and others have shown concern over how research priorities are developed and how time and funds are allocated among various research activities, as well as over what appears to be a lack of overall research planning especially at the top levels of administration. These concerns have prompted numerous studies, but none has addressed specifically what needs are best addressed by what research branch. Which research problems should be dealt with at the national, regional, or local level has never been determined on a scientific basis. Moreover, the roles of the various actors—Federal agencies, State experiment stations, and private industry– are not well-defined.

This assessment will: 1) examine the scientific base for establishing national, regional, and local research problems; 2) identify the role of Federal, State, and private research institutions in developing technologies for solving national, regional, State, or local problems; 3) evaluate methods by which the expertise and interests of the Federal, State, and private research organizations can be used in a cooperative manner to identify priority research areas and the role of each actor in solving these priority problems; 4) update evaluations of the adequacy of present research efforts as related to research priorities for basic, applied, and developmental research; and 5) evaluate public policy options for Congress that will maximize our research potential.

The Senate Committees on Appropriations and on Agriculture, Nutrition, and Forestry have requested this assessment. In addition, the House Agriculture Subcommittee on Department Investigations, Oversight, and Research has endorsed this request. The assessment is scheduled for completion in the spring of 1981.

Genetics and Population Program

The Genetics and Population Program was created to accommodate the increasing interest in these subjects in recent years. Interest in genetics arises from greatly expanded understanding of, and emerging capability for, altering or affecting, the inherited characteristics of man, animals, and plants. The term "genetics" is used broadly and includes related biological technologies such as in *vitro* fertilization and artificial insemination. The importance of these emerging technologies is illustrated by the concern of the scientific community and the public over research with recombinant DNA which led to development of the National Institutes of Health guidelines, the increasing use of procedures to detect genetic defects, and the recent successful human in vitro fertilization.

Rapidly growing population is a major factor influencing the quality of life everywhere. World population did not reach 2 billion until 1930, but only 45 more years were required to double it. Such rapid growth has placed great stress on the Earth and its resources as well as on economic and political stability, especially in those developing countries where population growth rates are highest. Increasing recognition of the importance of the rights of individuals both to have children and to choose their number and spacing is illustrated by rising support for family-planning programs over the last 25 years. Prior to 1965 only a few third-world countries officially supported family planning whereas by 1979 all but a few third-world countries had developed such policies.

Two assessments are underway: one on the impacts of applied genetics; the other on technology and world population. Both subjects are of unusual interest because of the central importance of many of the issues they raise to individual and societal values, attitudes, and beliefs.

Impacts of Applied Genetics

This assessment is concerned with nonhuman applications of genetic technologies. It is expected that a subsequent study will be proposed to the Board for assessment of applications of genetic technologies to humans.

To date the Federal Government has been primarily concerned with one technology, recombinant DNA, and one issue, containment of new and possibly harmful organisms. Little attention has been given to other technologies, such as cell fusion, or to other issues, such as costs and benefits and social and ethical questions.

This assessment is concerned with a range of technologies and their application to animals, plants, and micro-organisms (single-cell preparations). Single-cell applications are an especially rapidly growing area and the study will look at the use of such preparations to produce chemicals, pharmaceuticals, and food products. Some examples of issues to be considered include:

- the potential of genetic technologies to produce plants resistant to environmental stress;
- the relationship between Government regulation of research, freedom of scientific inquiry, and public risk;
- ownership of new life forms with commercial value, incentives for R&D, and distribution of benefits; and
- the potential contribution of genetically engineered organisms to easing energy and resource shortages and, more generally, to developing a sustainable society.

For each application, the state of the art will be described and alternatives to genetic approaches will be identified and characterized. Factors likely to promote or impede further development of genetic technologies will be described. The environmental, political, and social impacts of the technologies will be analyzed and appropriate policy options discussed.

The assessment is of interest to Senate and House committees with responsibility for agriculture, commerce, health, science and technology, and judicial issues. Expressions of support for the study were received from the House Committee on Interstate and Foreign Commerce and the Senate Committee on Human Resources. Congressional interest in this subject as an OTA assessment area dates back to September 1976 when 36 House Members requested an assess-

ment of recombinant DNA technologies. The assessment is scheduled for completion in the autumn of 1980.

Technology and World Population

This study, initiated in June 1979, will examine the causes and consequences of world population growth, with special attention to planned-birth technologies, national governmental actions, and U.S. international assistance.

The status of scientific understanding of the physiology of human reproduction and the characteristics of technologies to alleviate infertility and to control the number and spacing of births will be described. Of particular concern are the cultural factors affecting acceptability and use of these technologies throughout the world during the period 1960-80. New technologies which could reach the market during the period 1980-2000 will be identified and characterized, and a comparison of the consequences of world population growth during 1980-2000 and beyond under different assumptions about population planning and growth will be prepared. Policy issues that national governments may face in dealing with population growth during this same time period will be identified, and a research agenda will be prepared.

This study is primarily concerned with the less developed countries where infertility is often frequent and where, at the same time, population problems associated with fertility are particularly acute. For this reason, and because of the wide interest in world population, special attention has been given to development of advisory mechanisms for this assessment. In addition to a 17-member advisory panel to provide general oversight and review of the project, two other groups have been organized. A world roster of approximately 100 experts, half from less developed countries, will review and critique project products before the same products are reviewed by the advisory panel. A liaison group with representatives from executive branch agencies and national and international organizations in the population field has also been formed. This group will help the OTA staff and the advisory panel keep abreast of the many activities underway in the population field.

Congressional interest in domestic and international population issues is shown by the large number of population-related bills and resolutions introduced each session and the number of committees having jurisdiction in population-related areas. Fifteen standing committees in the House and Senate have population policy responsibilities during the 96th Congress. Issues to be taken up in this assessment are of particular interest to two of the committees: House Foreign Affairs and Senate Foreign Relations, which have written letters of support for this study. Completion is scheduled for late 1980.

Health Program

The value placed on health by the American people is reflected in the large number of Federal policies designed to assure health. Many of these policies directly address issues of health-related technology; a great many others indirectly affect the development and use of such technology. As a result, the Federal Government has become deeply involved in every aspect of medical technology—from R&D to regulating its spread into widespread use, from assessing its effects to encouraging abandonment of unsafe or obsolescent technologies. In turn, medical technology and its effects exert considerable influence on the Federal Government in areas such as fiscal policy.

The Health Program assists Congress by: 1) examining the Federal role in anticipating and managing domestic and international impacts of health-related technology; 2) identifying and highlighting the social, political, economic, and ethical concerns surrounding the development and use of medical technology; 3) examining evidence of the benefits and risks of particular medical technologies; and 4) assessing the consequences of Federal policies involving the provision of and payment for particular medical technologies.

The work of the Health Program up to now has focused on two areas: 1) methods of eval-

uating clinical medical technologies and 2) evaluation of computers in health care. However, although health may be viewed as being determined by four factors (genetics, personal behavior, environment, and health care), those two issues related almost exclusively to only one of the four—health care. The area of genetics is the responsibility of another OTA program, but little work has been done by OTA in the other two areas. Because of this fact, in 1978 it was decided to initiate studies concerning health and the physical environment. The first study is examining cancer and the environment. In addition, the Health Program is working with other programs on aspects of their assessments where health effects may be an important factor. For example, the Program has taken responsibility for developing information on the health effects of synfuel programs as part of an assessment being carried out by the Materials Program.

Cost= Effectiveness of Medical Technologies

Increased use of medical technologies are a prime factor in rapidly rising health care costs and these costs consume an increasingly greater share of the country's resources. Answers need to be found to questions on the relative contribution or benefit of the various medical technologies, whether they are drugs, devices, surgical procedures, or systems technologies? Are the resources spent on health care being allocated in the most rational manner? Does the patient have any voice in the spending decision?

Cost-effectiveness analysis is often suggested as a way to help allocate health resources more rationally. Such analysis compares the costs of alternate ways of attaining specified goals or results. There is growing pressure to make cost-effectiveness a prime consideration in deciding whether to adopt particular medical technologies.

This assessment, requested by the Senate Committees on Labor and Human Resources and on Finance, is examining the social costs and benefits of potentially widespread use of cost-effectiveness analysis and cost-benefit analysis in health care decisionmaking. In addition to a report addressing the above issues and setting out policy options, the assessment will produce a methodology and literature review; a report of an international comparison of use of cost-effectiveness analysis and other mechanisms for managing medical technology; and about 20 case studies of specific medical technologies. The assessment is expected to be completed in late spring of 1980.

Technologies **for Forecasting Physician** *Supply and Requirements*

Reauthorization of the Health Professions Educational Assistance Act is scheduled for 1980. Essentially, the Act reflects Congress' policies toward medical and other health professions education support and toward identifying and addressing the problem of rural and urban areas that lack adequate medical care. Forecasts of future requirements for physicians in the United States are needed by Congress to help determine its policies in the next decade.

Estimates of the distribution of physicians by specialty and geographic location, as well as aggregate numbers, are necessary for this task. Several models have been developed and used to predict both the supply of and requirements for physicians. However, these forecasting methods can yield very different estimates, and considerable debate surrounds the interpretation of these results, leaving Congress in doubt about their implications.

Consequently, the Senate Committee on Labor and Human Resources and its Subcommittee on Health and Scientific Research have requested assistance in interpreting different forecasts of physicians' supply and requirements. The House Committee on Interstate and Foreign Commerce and its Subcommittee on Health and the Environment have also expressed support for the request.

The assessment will consist of three tasks:

1. Specification of forecasting *models.* Explicit assumptions used in the models, as well as the results, will be compared in a quick reference format.
2. *Technical review of models.* The results of each model will be compared to ascertain the relative importance and weighting of

model components and underlying assumptions.

3. *Implications of predictive models.* The implications for policy of relying on different models will be considered. The effects of changing the assumptions underlying the estimates for the aggregate number, the number of primary care physicians, and the geographic distribution of physicians will be analyzed.

The assessment is expected to be completed in the spring of 1980.

Technologies for Determining Cancer Risks From the Environment

Prevention of cancer has become a prominent aspect of public health thinking during the past 20 years. Reducing exposure to agents that cause cancer requires the identification of causative agents, assessment of their potency, and location of sites of exposure. In addition, regulations to reduce exposure must be politically and socially acceptable.

The assessment will include the following parts:

- *Assessment of the estimates of cancer risk* from different exposures. Estimates of the percentage of cancers caused by environmental factors vary widely: the most commonly quoted range between 60 and 90 percent. Different data sources and different methods for making projections have produced divergent estimates for the risk from each component of human environment—the air and water, the workplace, radiation, personal habits, and diet. The data sources, the methods, and the use of the estimates in public policy discussions and decisionmaking will be examined and compared.
- *Assessment of cancer-testing technologies.* Technologies used by the Federal Government and the private sector for the identification of carcinogenic chemicals will be analyzed. Recent initiatives and alterations in the carcinogen-testing policies of the Federal Government, and heightened interest in short-term tests for carcinogenicity make this study particularly timely.
- Assessment of extrapolation techniques. Carcinogenic chemicals are tested in animals and lower life forms. The assessment will analyze existing and potential methods that may be used to translate test results into estimates of potential human hazard. Issues and controversies regarding these methods will be examined.
- *What is "unreasonable risk?"* If science were perfect, and society knew that a chemical caused a number of cancers, society might still have a problem. If the chemical is essential and, at the same time, a risk, what should society do? The Federal Insecticide, Rodenticide, and Fungicide Act as well as the Toxic Substances Control Act require that the Administrator of EPA decide a chemical is an unreasonable risk before moving against it. Unreasonable risk can be defined from a number of perspectives including public health, legal, economic, and ethical. Comparing, contrasting, and merging these views will provide a useful foundation for policy decisions about risk.

The House Subcommittee on Health and the Environment and the Senate Subcommittee on Health and Scientific Research sent letters of endorsement for the assessment. The Senate Committees on Commerce, Science, and Transportation and on Agriculture, Nutrition, and Forestry have also expressed support. The assessment is expected to be completed in late 1980.