

## **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 natural resources. Within those broad divisions, OTA conducts studies in energy; international security and commerce; materials; biological applications; food and renewable resources; health; communication and information technologies; oceans and environment; and space, transportation, and innovation.

More than 50 projects were in progress during the year, including 16 new studies,

In this section, the broad concerns and current work schedule of each OTA division are described for 1983 and beyond.

### **ENERGY, MATERIALS, AND INTERNATIONAL SECURITY**

#### ***The Future of Conventional Nuclear Power***

The nuclear reactor manufacturing industry is facing a period of extreme uncertainty. There have been no reactor orders since 1978, and it is quite possible that none will be placed in time to keep existing design and manufacturing capabilities intact. The principal reason has been the decline in electricity demand growth, which has greatly reduced the near-term need for new generating capacity. Other factors and perceptions about nuclear power—e.g., safety concerns, costs, reliability questions—have also contributed to the industry's difficulties. In order for the nuclear option to be available, and be acceptable to the utilities, regulators, and the public, substantial technical and institutional changes may be needed.

This assessment will examine the major technical considerations about the future of conventional nuclear power and how these technologies can affect economic, regulatory, and institutional (e.g., Government and industry responsibilities) issues that govern that option.

Technical issues to be studied include potential improvements to existing reactors such as higher fuel burn up and increased reliability; reoptimized and standardized light water reactors; and different reactor types such as HTGR or CANDU reactors. The consequences of these possible changes on licensing, reactor costs, safety, industrial structure, and public perception will be examined.

***Industrial Energy Use***

This project examines the four most intensive U.S. industries (pulp and paper, steel, petroleum refining, and organic chemical production) for their potential to use energy more efficiently and the probable impact of selected legislative options on energy use and efficiency.

OTA will examine the available technologies designed to improve energy efficiency, as well as the barriers to the implementation of such technologies. The legislative options to be examined range from tax policy changes such as accelerated depreciation to institutional changes in capital financing methods. Each option's effects will be evaluated through a series of case studies in which corporation executives, consultants, and computer-modeling techniques are used to project the effects of possible congressional action. Options will also be examined at the industry, industrial sector, and national energy use and economic levels using a similar series of modeling, management, and consultant evaluations.

***Industrial and Commercial Cogeneration***

The need to reduce U.S. dependence on expensive and scarce petroleum as a primary fuel in the industrial, commercial, and electric utility sectors has created a resurgence of interest in cogeneration—the combined production of both electric power and heat or steam in one technological process. Because the total amount of fuel needed to produce both power and heat/steam in a cogenerator is less than the total fuel needed to produce the same amount of power and heat/steam in separate technologies (e.g., a powerplant and an industrial boiler), cogenerators can contribute to the Nation's efforts to use fuel more efficiently. Moreover, problems faced by the electric utility industry, including rapidly rising capital costs, long leadtimes for powerplant construction, and difficulties in finding suitable sites, may make cogenerators an attractive alternative to conventional central station powerplants. This assessment will examine the role that cogenerators could play in providing electric and thermal energy for industrial and commercial facilities while distributing electricity to the utility grid. It will review the economic, environmental, social, and institutional consequences of cogeneration, with a special emphasis on the potential effects on the electric utility industry's planning and operations. Finally, the study will analyze policy options that Congress may wish to consider in addressing the issues about the development of cogeneration systems.

The assessment will examine the technical features of commercial and advanced cogeneration technologies, including requirements for connecting cogenerators to the utility grid and technologies for stor-

ing thermal or electrical energy. It will then evaluate the economic and technical effects of grid-connected cogeneration systems on electric utilities using a computer model that minimizes the costs of providing electric and thermal power. A major focus of this evaluation will be the potential effects of oil- and gas-fired cogenerators on overall oil/gas use. Finally, a series of issues on the incentives for cogeneration in the industrial and commercial sectors, and on the economic, environmental, and social effects of cogeneration will be examined.

### ***Strategic Responses to an Extended Oil Disruption***

Over the next decade, there is the possibility that the Nation will experience a disruption in imported oil of a level that will exceed the capabilities of the Strategic Petroleum Reserve and seriously affect the economy.

This assessment examines the opportunities and problems that characterize various technical responses that could supplement the Strategic Petroleum Reserve to meet such an interruption. The objective will be to determine what available resources might be expanded, the technical limitations for fuel substitution and switching, the physical constraints of stockpiling resources, and the impacts of accelerating the use of these technologies. Technologies to be considered will include enhanced oil recovery; adapting industrial boilers to dual-fuel capacity; biomass production; high-voltage transmission; hydro; wind; direct solar; vehicle retrofits; photovoltaics; retrofitting building envelopes and heating/cooling systems; retrofitting vehicles to improve mileage efficiency; and switching capacity of petroleum refineries. The study will be done at national and regional levels.

### ***Potential U.S. Natural Gas Availability***

In the past few years there has been a change in the outlook about the potential for natural gas production in the lower 48 States. Recent optimistic projections by some groups have stimulated efforts to revise current natural gas policy so that natural gas can play a bigger role in reducing this country's oil imports. There remains, however, considerable uncertainty about how much the United States can rely on natural gas, which is tempering this optimism. This assessment is designed to help determine domestic (lower 48 States) onshore natural

gas availability over the next few decades, and to help understand the factors that affect this availability. The OTA assessment will:

1. analyze the key technical and physical parameters that determine the resource base, production rates, and costs of all categories of below-ground natural gas;
2. critically review current estimates of the resource base, estimate the potential production rates of natural gas, and analyze the uncertainties in these estimates;
3. assess future technology trends, research and development needs that may accelerate these trends; and
4. analyze the institutional and policy issues appropriate for a Federal role in dealing with barriers to production.

### ***Technologies To Reduce U.S. Materials Import Vulnerability***

The United States currently imports over one-half of its consumption for each of a number of commonly used materials. Included among those imported are several considered to be vital for national defense and the U.S. industrial economy. Several of the most important defense-related materials have only a small number of supplier countries, and these are largely southern African nations, other developing countries, and the U.S.S.R. Raw material supplies are not the only strategic concern. For example, because of the changing world economy, the United States has lost a considerable portion of its capacity to produce ferromanganese and ferrochrome to foreign competition.

The focus of the study will be on technical opportunities to reduce U.S. vulnerability to interruptions in supply of strategic and critical imported materials in the longer term (5 to 25 years) through, for example, substitution, including materials; process and product substitution; improved mining, processing, and recycling technologies; and more efficient fabrication and design.

The study will also identify major changes in materials vulnerability that are likely to occur over the next 25 years because of advances in such fields as electronics, energy, and transportation.

### ***Nonnuclear Industrial Hazardous Waste***

Many nonnuclear industrial hazardous waste must be stored or disposed of with great care or they may constitute a threat to health and the environment. Information on the nature and magnitude of the

hazardous waste disposal and abandoned site problem will be reviewed. The reliability and efficacy of present containment, abatement, and disposal measures will be assessed. This information, coupled with criteria and techniques to judge relative health and environmental hazards of a given waste, will assist in identifying those wastes that could be reduced at the source—by modifications in process technologies, by recycle, or by an end-use substitution. Approaches for reducing hazardous waste generation with minimal undesirable economic effects on domestic industry will be identified.

This assessment has four objectives: 1) to assess criteria for defining hazardous waste and for judging the relative health and environmental hazards of a given waste; 2) to evaluate technologies for cleaning up present waste disposal sites that are hazardous to health and the environment; 3) to assess technologies and approaches for the safe storage or disposal of hazardous waste being presently generated; and 4) to assess technologies and approaches for reducing the volume of hazardous waste. The possible economic impacts on domestic industry of various approaches will be evaluated.

The project will focus initially on understanding the adverse consequences of present disposal strategies and techniques, and next on ways of reducing generation of industrial hazardous waste economically. Alternative options will be developed to cope with hazardous waste disposal in the short run and hazardous waste generation in the long run.

### **Wood: The Material, The Resource**

The United States has 483 million acres of commercial forestland: 14 billion cubic feet of timber were harvested in 1976. However, the United States still imports nearly 30 percent of its softwood lumber, approximately half of the wood pulp, and significant quantities of plywood. The forest industry and Government experts state that with new technologies for improved forestry practices, better wood utilization, and new product development the United States could become at least independent of wood imports and possibly a net exporter of wood. If domestic wood production is to be increased significantly, policies will be needed to: 1) improve the management of timberlands; 2) resolve conflicts among the users of Federal public lands; and 3) investigate new uses and applications of wood materials. New technologies for the use of wood, which is a renewable resource, may also hold promise as substitutes for nonrenewable energy and materials resources in some applications.

This assessment has six objectives:

1. explore the properties, uses, and technologies for using wood as a material and its potential for substituting for nonrenewable materials;
2. assess the future demand and supply profiles of wood and identify future problems;
3. evaluate the capability of forest management technology to increase production;
4. analyze the forest management policies on forestlands in reference to wood production and other forest uses;
5. assess the national technology for wood and forestry R&D; and
6. review public policies that affect forest production and the use of wood as a material and identify policy options for dealing with future problems.

### ***Technology Transfer to the Middle East***

During the last decade, the Middle East has been the world's fastest growing market, one which West European, Asian, and Communist as well as U.S. enterprises have all sought to penetrate. The oil-rich nations of the region have the financial resources to purchase the most advanced equipment and technology, both civilian and military. Technology transfers on such a large scale may have important implications for both the recipient and supplier nations. However, there has been little systematic study of the extent or effectiveness of transfers of Western technology. OTA's assessment of the commercial and strategic ramifications of transfers of advanced Western technologies (in sectors such as operation and maintenance of aircraft, petrochemical production facilities, nuclear powerplants, communications, and service systems) will help to provide a foundation for U.S. policy development.

The objectives of OTA's study are to assess past experience with technology transfers to the Middle East, to investigate the capability of these nations to effectively absorb advanced Western technology, to evaluate the likelihood of continued and expanding transfers in the years ahead, and to discuss the implications for American foreign and international economic policy.

The following questions will be addressed:

- How extensive have transfers of advanced Western technology to the Middle East been in recent years, what factors have determined which nations supply which technologies, and through what channels has transfer occurred?
- What factors inhibit or enhance the ability of Middle Eastern nations to absorb and master Western technology? Has it been the case that transfers in certain technology sectors have been par-

ticularly “successful,” or that the experience of various recipient nations differ significantly?

- How effectively have U.S. firms transferred technology and competed with Asian and West European firms for sales?
- What have been the effects—economic, social, and political—of advanced technology transfers on both “recipients and suppliers?”

In some sectors, such as petrochemical production, technology transfers augur shifts in world markets; while in other sectors, such as medical services, they promise improvements in local living conditions. Nuclear technology transfers, in contrast, raise critical strategic questions. This study will evaluate the opportunities and liabilities which advanced technology transfers portend for U.S. foreign and commercial policy in the years ahead.

### ***Impact of Technology on Competitiveness of U.S. Electronics Industry***

There is a growing concern that key U.S. industries are declining in their international competitive positions. The electronics industry is particularly significant because it occupies a strategic position as a technological driving force for other industries that use products like semiconductors and computers. The OTA assessment looks at three sectors of this industry: consumer electronics (where the United States has suffered heavily from Japanese competition); semiconductors (where a strong U.S. position is under challenge); and computers (where the United States still appears to lead the world).

The assessment focuses on those major contributors to the competitiveness of the electronics industry that could most readily be affected by U.S. Government policy. In each case, a comparison is made between the United States, Japan, and, to a lesser extent, Western Europe. These major factors are: 1) commercialization of research, development, and design; 2) manufacturing techniques and resources; 3) finance, including both private and public sources of funds; 4) human resources, both quantity and quality; and 5) governmental/industrial policies.

### ***Strategic Command, Control, Communications, and intelligence (C<sup>3</sup>I)***

U.S. strategic nuclear forces are intended to deter hostile Soviet actions, and to do so in a way that contributes to international stability. Their ability to meet these objectives depends not only on the character and capabilities of the weapons systems themselves, but also on the

character and capability of the supporting C<sup>3</sup>I systems. Specifically, both deterrence and stability may depend on: 1) the reliability with which a Soviet attack can be detected; 2) the timeliness and quality of the information about such an attack that can be assembled; 3) the speed and reliability with which this information can be communicated to the National Command Authorities; and 4) the immunity to disruption of communications between the National Command Authorities and the strategic forces.

The purpose of the study is to assess the technical capabilities and vulnerabilities of present U.S. strategic CSI systems. The study will identify needs and opportunities for improvement in the present systems, with special emphasis on additions to the system that could usefully be made in the near term with available technology. promising avenues of research for future improvements will also be identified.

### ***International Cooperation and Competition in Civilian Space Activities***

Over the next decade, the United States will face strong commercial competition from foreign space technology, and considerable interest from developing countries in cooperative ventures in space science and space applications technologies. This project will evaluate the current status of international competition and cooperation in key areas of space technology, in space science, and for educational and scientific exchange. It will investigate ways in which space technologies and their products could be used as instruments of U.S. foreign policy, and examine military space activities insofar as they affect civilian programs and international commercial and political relations. The project will also assess the implications of various policies to enhance cooperation and/or competition with foreign entities. There will be two distinct but related parts, one assessing U.S. relations with industrialized countries, the other with developing countries. The former will focus on French and Japanese space technology and the institutional mechanisms that have made them strong competitors with U.S. aerospace firms. The latter will focus on the uses of space technology in less developed countries, and evaluate the technical and economic issues that were evident in the United Nations Conference on the Peaceful Uses of Outer Space (UNISPACE '82).

Concern over the U.S. competitive stance vis-a-vis foreign space technology will be a part of the congressional agenda for the next several years, prompted by the development of the space shuttle and by con-



cern over the U.S. position as an international leader in advanced technologies, Whether we are making the best use of space technology and space science as elements of our foreign policy, growing military space activities, and whether the United States is well enough prepared for international technical conferences such as UNISPACE are also of concern to Congress,

## HEALTH AND LIFE SCIENCES

### ***Impact of Technology on Aging in America***

The aging of the American population raises critical concerns for employment, the retirement system, transportation, health care, recreation, and housing. The large increase in numbers of the 65 year and older age group has occurred because of technological advances that have resulted in better control of infectious and chronic diseases and improved standards of living. New technologies under development today suggest continued change in longevity and functional capacity.

Most current projections of the impact of our aging population assume an elderly population with characteristics similar to that population today—withdrawal from the work force, declining health, increased needs for hospitalization and nursing care, and other characteristics that suggest a highly dependent 65 year and older age group. However, improved health care, increased understanding of the physiology of aging, and other advances in technology may alter the characteristics of the elderly of the future. In addition, applications of computers, robotics, telecommunications, and other technical innovations in the home and workplace may provide new opportunities for increasing the independence, productivity, and quality of life for this segment of our population.

Four areas where the impact of technology will be assessed are health and life sciences, employment, housing and public services, and international aspects (examples of responses to elderly populations in other industrialized countries).

### ***Comparative Assessment of the Commercial Development of Biotechnology***

“Biotechnology” refers to the use of biological techniques such as recombinant DNA technology, cell fusion, fermentation, and enzyme technology to produce chemicals, pharmaceuticals, or other substances to act on the environment to increase the quality of life (as in pollution control), or to improve the characteristics of economically important plants and animals. Advantages of biological production over the alternative methods of chemical production or extraction of substances from living tissues include reduced dependence on petroleum substrates or on large quantities of sometimes scarce plant, animal, or human tissues. Estimates of yearly potential markets for substances that could be produced from applications of recombinant DNA technology in just the chemical and pharmaceutical industries are \$15 billion and more in the next 20 years.

The potential of biotechnology has stimulated a great deal of corporate activity in the United States in the last 2 years. Many new small firms have been formed and large corporations are developing capability in biotechnology. Foreign activity in the field is intense, especially in Japan, West Germany, France, and the U.S.S.R.

This assessment will evaluate whether biotechnology and associated research and development are developing in the United States in such a way that this Nation is likely to be in a competitive position with other nations in the years ahead. The keys to competitive development of the biotechnology industry in the United States are basic research and the transfer of basic research into commercial application. One major influence on development of the industry in the United States is Government policies on funding of research, patents, health and safety regulations, antitrust laws, and taxation. Equally important and significantly influenced by Government policy are industrial/academic relationships and their influence on funding, research, manpower training, and information flow. New developments in the technology and in support technologies are important to the growth of the industry and will also be examined as part of this assessment. Analysis along the same dimensions as those above will be conducted for selected other countries in order to estimate the probable U.S. position in the biotechnology industry in the next 10 years.

It is also important to consider areas of application in the public interest. Attractive commercial applications may so engage industry that some areas, of great public benefit but higher commercial risk, could languish. The possible Government role in such areas will be investigated.

### ***The Role of Genetic Testing in the Prevention of Occupational Disease***

One of the most difficult problems in regulatory policymaking is determining what is a safe level of exposure to chemicals in the workplace. For any particular chemical, the scientific evidence on risk is often conflicting, and the cost of each incremental lowering of exposure levels becomes increasingly expensive. Further, because of the natural variability of humans, what may be safe for one person, or even the vast majority of people, may be hazardous to another. Accordingly, some occupational health specialists have advocated both genetic screening and cytogenetic surveillance of workers as a means of identifying high-risk individuals and environments where the entire work force may bear risk. The use of these techniques is controversial because the ability to actually identify high-risk workers is a matter of scientific dispute

and the identification of such workers, if possible, could place their interests in opposition to those of the company.

This assessment will examine the following questions: What is the technological state of the art? Do the claimed associations in fact exist between certain recessive genes or chromosomal abnormalities and increased risk of harm from certain chemicals? If these associations exist, do genetic screening and cytogenetic surveillance offer a cost-effective way to enhance worker health and safety, given the economic and technical fact of life that workers will face some exposure to chemicals? What are the alternatives, regulatory or otherwise? What responsibilities might companies have toward high-risk workers? How might these tests be done in order to protect the interests of all parties?

Specific conditions for which screening tests are available will be examined in detail. They are G-6-PD deficiency, methemoglobin reductase deficiency, alpha-1—antitrypsin deficiency, and aryl hydrocarbon hydroxylase inducibility.

### ***Plants: The Potentials for Extracting Protein, Medicines, and Other Useful Chemicals***

Land and marine plants are known to contain some valuable chemical substances that are used in foods for humans and animals, or in pharmaceuticals, pesticides, chemicals, and other products. These compounds are synthesized naturally using the energy from the Sun. Plant products range from oils, gums, and resins to important drugs. Only certain of these naturally occurring compounds have been synthesized in the laboratory. Further, an unknown but probably vast resource of such compounds remains uncharacterized and undeveloped.

Today, renewed attention is being directed to the identification and extraction of plant chemicals and to devising systems for multiple use of a plant's various components. For example, some research points to the possibility of growing tobacco specifically for the purpose of extracting protein from the leaves. The protein that might be extracted from plant leaves could be used to supplement human and animal food, and possibly aid in the treatment of kidney disease.

OTA conducted a workshop designed to identify technological opportunities and constraints for commercially developing protein, pharmaceuticals, chemicals, and other associated extracts from plants generally and tobacco specifically. The study will examine the potential impacts that such technologies might have on improving nutrition and food quality by increasing the availability of high-quality protein. Issues addressed will include: 1) quality of current data bases on chemistry of plant extracts; 2) status of bioassay technologies; and 3) possible

social, economic, environmental, and political impacts that such new technologies might generate.

### ***Water-Related Technologies for Sustaining Agriculture in U.S. Arid and Semiarid Lands***

Freshwater is a controlling factor of U.S. agricultural productivity. In recent years, the availability of high-quality freshwater for agriculture, especially in the arid and semiarid United States, has become a major concern. In particular, competition for available water supplies, overdraft of underground aquifers, and deteriorating water quality have contributed to severe water supply problems for arid and semiarid U.S. agricultural lands (those receiving about 20 inches or less of rainfall annually).

The principal farming systems in arid and semiarid U.S. lands are irrigation agriculture, dryland farming, and ranching. Irrigation agriculture is one of the most seriously affected by reduced water supplies. This farming system accounts for over 80 percent of all consumed water withdrawn from streams and underground aquifers. About 90 percent of U.S. irrigated land is in the 17 Western States where water is in short supply. In California, Arizona, New Mexico, Nevada, Utah, Wyoming, and Idaho, for example, over 80 percent of the crops are produced with irrigation. Agricultural water supplies suffer from declining water tables as well as agriculture's inability to compete on the open market for the water that is available. Energy costs become a particularly critical factor as water must be transported from greater distances or lifted from deeper aquifers. In addition, many conventional agricultural systems use available water inefficiently. The seriousness of the problem necessitates an assessment of present and emerging water-related technologies and their potential for sustaining arid and semiarid agriculture in the United States.

This assessment will focus on the opportunities of present and emerging technologies to provide long-term sustainable agricultural productivity by increasing efficiency of water use and reducing agricultural water demands in arid and semiarid U.S. lands. The ability of such technologies to improve water quality of agricultural runoff and the associated socioeconomic impacts also will be examined.

Technologies considered will include those that require modification of existing systems to maintain the present style of agriculture and those that involve fundamental changes through the adoption of low-water-demand biological technologies and systems. The assessment will include a critical review of data on the magnitude of the arid/semiarid water problem, potentials for alternative supplies, and possible legal

and institutional mechanisms supportive of the adoption of sound agricultural water-related technologies.

### ***Technologies To Sustain Tropical Forest Resources***

Each year 1 to 2 percent of the world's remaining tropical forests are converted to other land uses or to wasteland. Where cleared land is developed for sustained agriculture, deforestation can be beneficial. But most land now being cleared cannot sustain farming or grazing with available technologies, so it is abandoned after a few years. Often the forests do not regrow because of highly weathered soils and harsh climates. Thus, highly productive but underused forest resources are giving way to grasslands and deserts of low productivity.

Deforestation has economic and environmental consequences that jeopardize U.S. imports of agricultural germ plasm, pharmaceuticals, chemical feedstocks, foods, drugs, animals for medical research, tropical hardwoods, and veneer and wood products. Also in jeopardy are U.S.-funded development projects in tropical countries, U.S. migratory wildlife species, and stability of global climates. Tropical deforestation places pressure on world oil supplies and is an important causal factor in the increasing number of refugees seeking U.S. entry.

The U.S. Agency for International Development (AID), the United Nations (U. N.) agencies, and the World Bank have increased funding for forestry severalfold in the past 5 years. American corporations and nonprofit institutions also have been increasingly involved in the search for solutions to tropical deforestation problems. Most importantly, many tropical nations' governments recognize that deforestation constrains their economies and their development options; they are now making institutional changes to slow deforestation and to accelerate reforestation.

The United States is recognized for its leadership in bringing the deforestation problems to world attention and for the technical versatility it has to address the problem. Sustaining tropical forest resources can be helped or hindered by applications of certain technologies. OTA will assess:

1. dimensions of the tropical deforestation problem;
2. impacts of technologies, both conventional and new, that the United States may apply to enhance use and management of forest resources;
3. the role that U.S.-funded agencies, such as AID, Peace Corps, the U. N., and the World Bank, play in developing improved technologies;

4. improved mechanisms for transferring such technologies to tropical nations and to tropical regions of the United States; and
5. the special strengths of U.S. institutions in relevant science and technology.

### ***Federal Policies and the Medical Devices Industry***

During the past two decades, technologies such as automated blood chemistry analyzers, ultrasound imaging, and cardiac pacemakers have become common elements of medical diagnosis and therapy. The growth of the industry that manufactures such technologies has paralleled the growth of expenditures for medical care. The industry's sales totaled an estimated \$13 billion in 1981, more than three times the 1972 level and 11 times the amount in 1958.

Congress is continually called onto develop policies that will affect the medical devices industry, but in the past has lacked adequately analyzed information to appropriately deal with the subject. Federal policies related to the research, marketing, location, and financing (medical insurance) of medical technologies, as well as to the taxation, patenting, and foreign trade of all technologies, affect the development, manufacture, and sale of medical devices.

This assessment will eliminate some of the gaps in basic information about the medical devices industry and analyze the implications of alternative Federal policies. The assessment will develop information about the nature of firms that manufacture medical technologies, conduct case studies of selected medical devices, and examine present and proposed Federal policies that influence the medical devices industry and in turn the cost and effectiveness of medical devices.

### ***Medical Technology and Costs of the Medicare Program***

The costs of the Medicare program have been rising rapidly, and medical technology is a prime component of this increase. Of the \$247 billion spent on national health expenditures in 1980, the Federal Government paid more than \$70 billion, and of that amount nearly \$37 billion was for Medicare. A substantial portion (perhaps as high as 50 percent) of increases in total health care costs has been attributed to an increase in the use of new and existing medical technologies.

Reimbursement policy has, in the view of many, led to rapid adoption and often excessive use of medical technologies. One approach to curtailing the growth of costs in the Medicare program is to change the ways in which medical technologies are added to Medicare coverage and the ways in which their use is paid for. For example, certain prospective reimbursement schemes (such as the use of diagnostic-related groups) or the encouragement of cost-reducing technologies have been suggested as ways to reduce Medicare costs. The project is analyzing a broad range of mechanisms to reduce or limit Medicare costs related to medical technology. In addition, it includes case studies of particular medical technologies. Four have been specifically requested: plasmapheresis, alcoholism treatment, variations in length of hospital stay, and continuous ambulatory peritoneal dialysis.

### ***Evaluation of Veterans Administration Agent Orange Protocol***

The epidemiologic study by the Veterans Administration of the long-term health effects resulting from exposure to agent orange was mandated in the Veterans Health Programs Extension and Improvements Act of 1979 (Public Law 96-151). The same law requires OTA to review the study design and monitor the conduct of the study. An advisory panel was assembled to carry out the review. The study design was tentatively approved in March of 1982.

### ***Health and Safety Control Technologies in the Workplace***

One hundred million Americans work. Each year there are some 2.3 million disabling injuries and 13,200 accidental deaths in the workplace, and perhaps 100,000 people die from job-related diseases. Efforts to reduce this toll involve employers, labor organizations, nonprofit institutions, insurance companies, and Government agencies. To a major extent these efforts are directed at developing and applying control technologies—engineering controls, worker education programs, and personal protection devices.

New industrial plant construction and modernization of existing plants is expected to result from interest in increased productivity and reduced energy consumption. Such construction may offer opportunities for installing new technologies to reduce workplace health and safety hazards.

This assessment would develop information about research and development, diffusion, application, and evaluation of workplace control technologies. Engineering controls, worker education programs, per-



sonal devices, and interrelationships between them will be described and their role in worker protection evaluated.

One product of the assessment would be a series of options. These are expected to address:

- improving data about workplace accidents and illnesses;
- aiding development of appropriate technologies, their diffusion, application, and evaluation; and
- making control technologies available to small firms at a price they can afford.

## Special Responses

### ***Food and Agricultural Postharvest Technology and Marketing Research***

This Technical Memorandum was requested as a follow-up to the U.S. Food and Agricultural Research assessment.

Debate continues between the executive and legislative branches on the role of the public sector in this specific research activity. This study will help to provide guidelines on the proper role of the public sector in this research area.

### ***The Impact of Randomized Clinical Trials on Health Policy and Medical Practice***

The randomized clinical trial (RCT) is an experimental method considered by many to be the sine qua non for evaluating the efficacy and safety of medical technologies. RCTs came into widespread use during the 1960's and 1970's, accounting for an increasing share of medical research moneys. In 1979 the National Institutes of Health, the largest supporter of biomedical research in this country, funded 986 clinical trials, about 60 percent of which were RCTs.

Rapid growth in technology-related medical costs and related heightening of interest in assessing medical drugs, devices, and procedures, make the RCT an ever more important tool for decisionmaking. This Background Paper examines the impact of RCTs on health policy and medical practice in the United States, based on a review

of the literature and discussions with experts in the field. The following topics are included:

- a brief history of the RCT, from simple beginnings in the late 1940's to the current sophisticated multicenter trials involving thousands of participants, along with a discussion of financial support for RCTs;
- a description of the method, and the basic arguments for and against both RCTs and the alternatives to RCTs;
- the use of RCTs in policymaking, including their role in new drug and device approval under the Food, Drug, and Cosmetic Act; and their use in coverage decisions for Medicare and by private third-party payers;
- a review of literature dealing with the impacts of RCTs in various fields;
- a discussion of the characteristics of RCTs that determine what their impact will be, e.g., the timing of the trial, the field of medicine, the type of intervention (surgical v. medical; preventive v. therapeutic), the statistical power of the study;
- the impacts of RCTs in cardiovascular disease and cancer, the areas in which the most RCTs have been done; and
- identification of strategies for improving the impact of RCTs.

### ***Information Content of Premanufacture Notices***

The Premanufacture Notice Review Program, established by the Toxic Substances Control Act (TSCA), is the U.S. Government's effort to identify toxic substances before they enter commerce, to impose controls when necessary, and thereby to reduce unreasonable risks to human health and the environment. TSCA requires that a premanufacture notice (PMN) be submitted to the Environmental Protection Agency (EPA) at least 90 days before a new chemical is manufactured or imported into the United States.

Using the information in the PMN and professional judgment, EPA reviews each PMN to determine if the chemical described in the notice may present an unreasonable risk to human health or the environment. In the event that EPA determines the substance presents or may present an unreasonable risk, EPA can regulate its manufacture.

PMNs are to contain certain information about the new chemical to enable EPA to make decisions necessary to protect human health and the environment under the provisions of TSCA. Because TSCA does not allow EPA to require that information be generated about a substance simply because the substance is new, it was expected that the amount and type of information present on PMNs would vary.

This Technical Memorandum describes the information content of all PMNs received by EPA in the first 23 months of the program's operation (July 1979 through June 1981) and those submitted in June 1982. In addition, the information reported on PMNs that describe chemicals of certain specified classes were analyzed separately. For instance, those PMNs that describe chemicals that, according to EPA records, are now being manufactured were analyzed and compared to those that described chemicals that have not yet been manufactured. EPA is considering exempting some classes of chemicals from PMN reporting requirements. PMNs submitted for the classes of chemicals likely to be exempted—chemicals used only at the site of manufacture, chemicals to be manufactured in amounts of less than 10,000 kilograms annually, and polymers—were also analyzed separately.

The results of the analyses show that the reporting of toxicity information varies among different classes of PMNs and that no toxicity data are reported to EPA on about 40 percent of new chemicals. Whether toxicity data are reported on chemicals which are of most concern (because of potential hazard) cannot be determined without reviewing the decisionmaking process for particular chemicals, which is beyond the scope of this study.

## SCIENCE, INFORMATION, AND NATURAL RESOURCES

### ***Information Technology Research and Development***

Computer and communications technologies are vital components of the domestic economy. In 1981, computers and business machines alone provided a \$6.9 billion surplus to the U.S. balance of trade. Computers and communications also form the information services network that supports and enhances productivity in every other sector of the economy. In addition, they are indispensable components of our national security system.

Underlying current U.S. leadership in information technology has been a strong national research and development (R&D) effort led in communications by the industrial sector, and in computers by both industry and Government. Those traditional patterns of R&D are likely to alter significantly due to shifts in industry structure, Federal science and technology policy, international competition, and technological advances that are now taking place. These changes will affect who will do research, what areas are chosen, levels of support, and the balance between long-term exploratory research and short-term development. They will be strongly influenced by Federal policy, both directly by trends in R&D support and indirectly by tax, antitrust, regulatory, copyright, and education policy.

OTA will characterize these shifts in R&D, project their implications for U.S. leadership in computer and communication technology, and analyze the potential influences of Federal policy on the directions and levels of R&D support.

### ***Information Technology, Automation, and the Workplace***

In this decade, new computer and communication technology will provide the foundation for a new wave of industrial automation based on such applications as computer-aided-design, computer-aided-manufacturing, robotics, and management information systems. These technologies will be merged to form flexible manufacturing systems.

While computerized (or "programmable") automation is expected to enhance the productivity and competitiveness of the particular industries that use it, it is also likely to have significant broader impacts on the Nation's economy, industrial structure, and work force. Computerized automation will thus present both opportunities and problems to Federal policymakers concerned with the state of the U.S. economy, international trade, employment, and labor training programs.

The objectives of this assessment are to analyze the following:

- Trends and the state of research and development in computerized manufacturing technologies over this decade.
- The development of industries producing computerized manufacturing equipment, software, and services.
- The potential utility of computerized automation for various categories of manufacturing industries that might use it.
- Impacts on employment—job loss, job creation, job redefinition; new skill needs; and workplace quality.
- Implications for education and training, for general technological literacy, for specialized vocational skills, and for scientific and engineering expertise.
- The impacts of Federal policy options on the development and use of computerized automation systems in U.S. manufacturing.

### ***Effects of Information Technology on the Structure of the Financial Services Industry***

The use of new telecommunication and computer technologies in the financial services industry is changing both the character of the industry and the relationships between it and its customers. The technology allows financial institutions to alter and diversify the services offered, to distribute them more broadly, and to link them together into national and worldwide networks. Technology also enables firms that have not previously offered financial services to enter the market—firms often unconstrained by the regulatory structure under which traditional providers of financial services have operated. Future technological developments may offer additional possibilities for the development of innovative financial services for both individual consumers and businesses. Thus, technological imperatives could significantly change the structure of the financial services industry, an area of economic activity that has long been of interest to Congress.

The study will examine:

1. technologies that are likely to be employed in delivering financial services in the future;
2. the nature of the services that may be provided; and
3. alternative structures of the financial services industry that may emerge as a result of applying new and existing technologies, particularly as they affect Federal policy.

### ***The Patent System and New Technological Enterprises***

Economists differ in their appraisals of the exact contribution small technologically based firms make to innovation, employment, and economic progress; however, it is possible that the contribution level is high and that these enterprises are essential to the growth and revitalization of our society. Fledgling entrepreneurs and independent innovators are frequently dependent on, and influenced by, the patent system to a much greater degree than are large, established firms. In almost all aspects of the patent system—e.g., prosecution, interferences, licensing, litigation—small firms and individual inventors face far more difficult obstacles and economic choices than do the large firms. The importance of new technologically based firms to the future economic vitality of the United States underscores the need to assess the impact of the patent system on the generation and stimulation of such enterprises.

### ***Maritime Trade and Technology***

The application of new technology within the maritime industry appears to have produced far more benefits to nations other than the United States. While the United States is the world's foremost trading nation, the ships that carry over 95 percent of that trade are registered in other countries. Shipbuilding in the United States is at a low ebb. Compared to other maritime nations, U.S. productivity is low and shipyards are technologically behind.

A number of significant changes in Federal maritime policy have been recently proposed or implemented in an effort to reduce subsidies, eliminate unnecessary regulation, and provide a more competitive and productive economic environment. While these goals are broadly supported, it is not clear which methods will be most effective for achieving them and, at the same time, maintaining an adequate industrial base. This study will analyze the status of U.S. technology in shipping and shipbuilding and compare trends in maritime trade with national and international maritime policies.

### ***Impacts of Atmospheric Alterations***

Many present-day human activities—particularly the burning of fossil fuels—are altering the Earth's atmosphere in potentially harmful ways. The precise nature and extent of such activities are unclear. However, the potential consequences are severe enough to merit careful congressional consideration of domestic and international Federal policies.

Some of the consequences, such as acid rain, are occurring today. Others, such as global climate changes due to increasing carbon dioxide concentration, may appear within the next century. Increasing sulfur and nitrogen oxides and their transformation products (acid rain and oxidants) may damage thousands of lakes, decrease crop and forest productivity, deplete soil nutrients, damage buildings and monuments, and have adverse effects on human health.

The assessment will characterize the potential benefits of acting now to abate long-range transport air pollution and the potential costs of action that may be premature. The study will: 1) identify the resources potentially at risk, as well as the societal concerns about the loss of these resources; and 2) identify broad pollution control strategies, and discuss their costs, potential effectiveness, and societal effects. OTA will develop a range of plausible, regionally oriented impact scenarios which describe the potential environmental and social consequences of transported pollutants, and actions that might be taken to control them. These scenarios will not attempt to “forecast” the future, but instead present a range of plausible consequences of these changes, in terms responsive to near-term congressional decisions.

### ***Assessment of Approaches to Wetlands Use***

Both the development and the preservation of wetlands—swamps, marshes, bogs, and other areas that are periodically saturated with water—offer benefits to individual users of wetlands as well as to society as a whole. For example, when drained or filled, some wetlands may be converted into highly productive farmland or choice residential or commercial property. Valuable oil, gas, and timber resources may also be extracted from some wetland areas. Many other technological activities, such as the construction of dams, levees, breakwaters and jetties, and bridges and highways, often take place in wetlands. Similarly, undeveloped wetlands may provide flood control, fish and wildlife habitat, erosion protection, pollution control, and ground water recharge.

In the past, the values of undeveloped wetlands have largely been ignored or seen as less than those of developed or technologically modified wetlands. As a result, approximately 30 percent of the Nation’s original wetlands have been modified in some way by various technological activities. During the last decade, the importance of the natural functions of wetlands has received increasing recognition. In

response to concerns about wetlands, many Federal and State laws now influence the development and regulate the use of wetlands through measures such as acquisition, economic incentives, and permitting.

Proposals to develop wetlands have frequently led to controversy. To provide a framework for future debates on this issue, OTA will evaluate:

- the effects of technological activities on wetlands,
- technological and nontechnological options for mitigating undesired impacts,
- the functional values of different types of wetlands,
- problems associated with weighing the benefits of technological activities in wetland areas against the functional values of the wetlands that may be lost, and
- various approaches to wetlands use.

### ***U.S. Passenger Rail Technologies***

The recent announcement by the newly formed, privately chartered, American High Speed Rail Corp. of its planned \$2 billion high-speed passenger rail corridor between Los Angeles and San Diego has stimulated existing congressional interest in the introduction of high-speed and other advanced rail technologies, including Magnetic Levitation, in the United States. This interest is also reflected in the growing number of private and publicly funded feasibility studies of these technologies in selected regions and transportation corridors. OTA will assess these intercity passenger rail technologies and the potential impacts of their introduction in the United States.

### ***Technology, Innovation, and Regional Economic Development***

In the last 10 to 20 years, several regions of the United States have developed strong local economies based on fast-growing "high-technology" firms that are engaged in the systematic development and commercialization of new products, processes, and services. These firms and the industries they compose are an important factor in U.S. international competitiveness and a major source of new manufacturing jobs. Several Federal policies are aimed at encouraging their growth. Many State and local development programs are also based in part on strategies for attracting or stimulating the formation of small, high-technology companies.



The assessment will determine where high-technology firms are appearing and what factors influence their distribution and growth, identify and evaluate the effectiveness of State and local initiatives to encourage innovation and high-technology development, explore the changing opportunities presented by new and emerging technologies such as robotics and bioengineering, and address the appropriate Federal role in affecting the conditions for such growth in the future.

### ***Civilian Space Stations***

Over the past quarter century, the United States has continued to increase its capabilities for operating in space. The success of the fourth shuttle flight has brought the vehicle to operational status. The shuttle will require a certain amount of follow-on work, but the National Aeronautics and Space Administration (NASA) is now ready to undertake a major new project, the development of a permanent manned facility, or space station, to be placed in low-Earth orbit. NASA is reportedly planning to request funds in fiscal year 1984 to initiate this program, and has already formed a task force to manage it. The overall, multiyear effort is estimated to cost a total of \$8 billion to \$20 billion.

This assessment of nonmilitary space stations addresses the following issues: What advances in science and technology, current or expected, make development of a space station attractive now? What services could a station provide to the civilian sector? Who are the potential users? Given an identified community of users, can their needs be met most effectively by means of a station? Are there additional science and applications needs that a station cannot meet? Are there alternative facilities in prospect that could meet such requirements? If so, is the argument for a space station weakened? What are the prospects for international cooperation in its construction and use? What reasonable solutions exist for potential conflicts between military and civilian interests?

### ***Airport System Development***

The National Airspace System Plan issued by the Federal Aviation Administration (FAA) in January 1982 states that "airport capacity

limitations at busy airports will be the constraining element in the National Airspace System.” FAA anticipates that few, if any, new air carrier airports will be built in the next 20 years and that capacity expansion of existing airports will be severely limited by the availability and cost of land, concern about the environment and airport noise, and land-side access constraints.

OTA will assess the technologies to be applied to increase capacity or improve service at airports and the mechanisms by which the technology can be deployed and brought to bear on the problems of civil aviation.