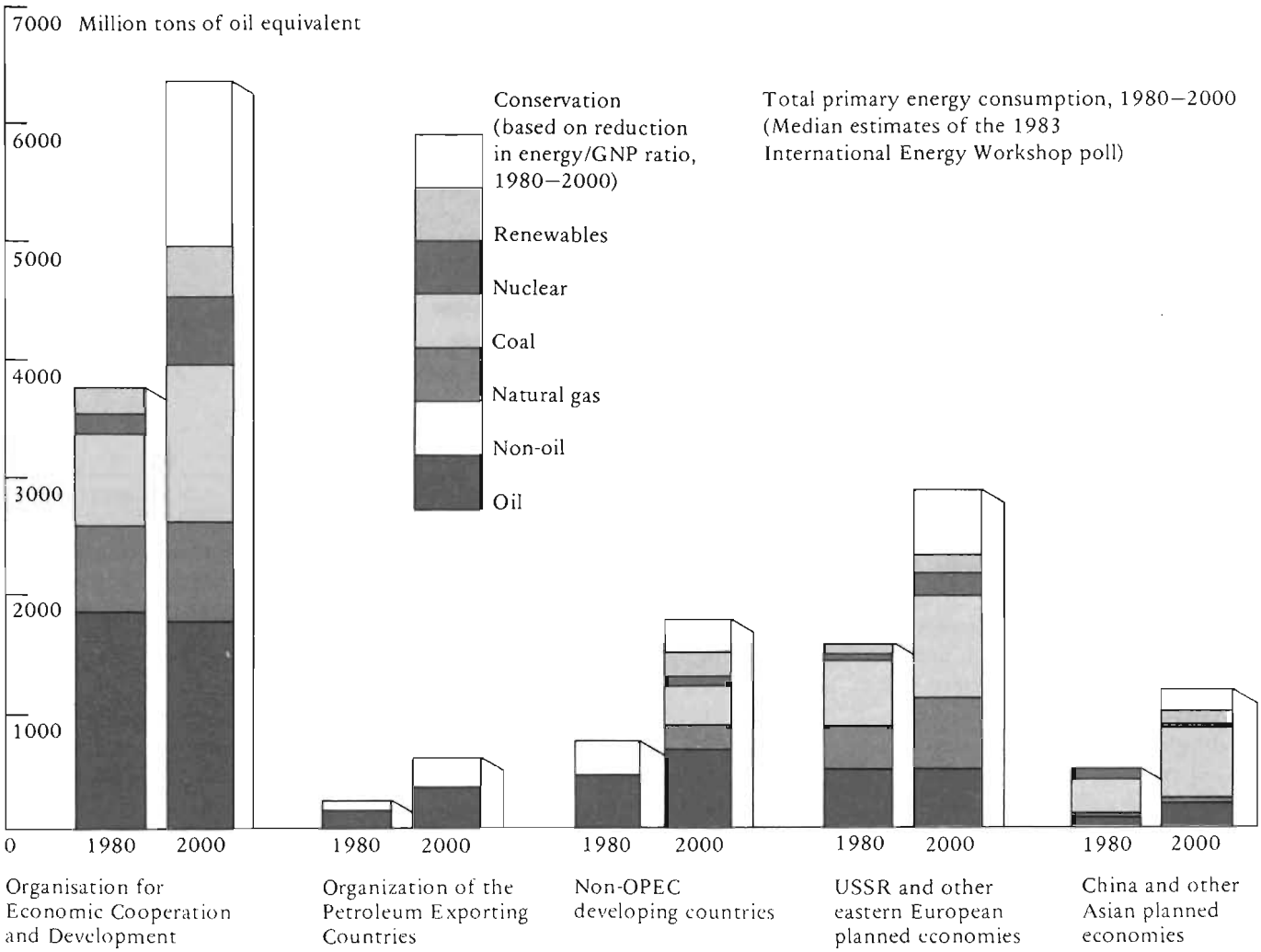
International
Institute for
Applied
Systems
Analysis

OPTIONS



The International Energy Workshop

Energy specialists debated future energy trends at a meeting in June at IIASA of the International Energy Workshop organized by **Alan Manne** and **Leo Schrattenholzer**.

Most experts expect oil prices to rise again in the mid-1980s and to accelerate throughout the 1990s. Projections differed widely – in extreme cases by a factor of three – with the median representing an approximate 50 percent increase in the real (inflation-adjusted) price of crude oil by the year 2000. This is equivalent to a 2 percent price hike annually from 1980 to 2000. "Conventional wisdom" holds that prices will escalate as the demand for oil increases with economic growth and supplies of conventional oil and gas resources dwindle. These forces will eventually outweigh the price-dampening effects of energy conservation and the availability of alternative energy sources.

The possibility of a changed set of conditions altering what is now deemed the conventional wisdom was raised by many at the meeting. Mr. Gerald Davis of Shell International in the Netherlands mentioned a number of critical and uncertain factors in the political and economic spheres, including the state of "disrepair" in the international economic order established after World War II, which could profoundly influence future levels of economic activity

CONTENTS 1983/3

and energy demand. "In the event that we are slow to establish an international economic framework to underpin faster economic growth, there is a possibility of lower levels of economic activity than previously envisaged. Such circumstances, together with moderate to high conservation, could lead to soft energy markets well into the 1990s. These would place strong pressures on the existing structure of the oil market and, as a consequence, oil prices could be in decline in real terms throughout most of this period. At a time when the future structure of oil markets and thus the dynamics of crude oil prices are highly unpredictable, the challenge to the oil industry is to take a position that will ensure that the necessary forward investment commitments are made. This is no easy task."

Professor Peter Odell, Director of the Centre for International Energy Studies in the Netherlands, rejects this near-consensus belief in the inevitability of high oil prices and the conviction that oil production will peak shortly. He argues that such views emerge from analysts falsely extrapolating pre-1973 conditions of oil supply concentrated in only a few countries and high energy demand – conditions that cannot occur again. The mistaken assumption that the oil price shocks of the 1970s signalled a physical scarcity of resources, together with errors in overestimating demand and underestimating supply, threw the oil market into a state of severe disequilibrium that will most likely persist until the beginning of the next century, or until there is an equilibrium in the cost of producing oil and its market price. He believes the key question hanging over the oil market is not whether oil prices will decline over the next twenty to thirty years, but rather whether prices will collapse under the pressure of competition from an expanding number of countries supplying oil, or whether prices will decline slowly in the context of supply and price agreements between the largest oil exporter, OPEC (the Organization of the Petroleum Exporting Countries), and the largest importer, the OECD (Organisation for Economic Cooperation and Development).

Frequency distributions and median values of international oil price estimates, 1980–2010
(1983 International Energy Workshop poll)

There were several explanations offered for why there was such a broad variance among the fifty-five projections of international crude oil prices. Dr. Mohammed Mimouni of OPEC maintains that since most of the projections were made in 1981 and 1982 they are "heavily weighted by the events of the late 1970s associated with the oil price adjustments or the effects of conservation and/or interfuel substitution." Professor Takamitsu Sawa of Kyoto University, Japan observed that recent projections of crude oil prices tend to be lower than, say, those made at the time of the first Workshop poll in 1981. Professor Alan Manne and Dr. Leo Schrattenholzer cited evidence that the longer the time horizon, the lower the forecast of total energy demand and the higher the projection of crude oil prices. Other more elusive factors were seen as operating among the community of energy analysts, including the inclination of some forecasters to focus exclusively on good news or conversely to predict that doomsday is at hand. While the Workshop polling process cannot eliminate biases or other subjective influences on projections, it can contribute to a greater awareness of their existence.

World Energy Trading

Oil's dominant position in the international energy market can be expected to continue throughout this century – and for good reasons. Oil is high quality energy that surpasses both natural gas and coal in the relative ease and low cost of its long-distance transportation and storage. Oil is the commercial fuel to which the world has become accustomed, around which major infrastructures have adjusted, and on which highly mobile lifestyles are based. Currently there are no commercially available substitutes for oil as a motor fuel and in certain cases as a petrochemical feedstock. Although there are good prospects for the large-scale use of methanol in the transport sector, most experts do not foresee a near-term shift to a global liquid fuel market dominated by it or any other synthetic fuels. Thus for some time oil will remain the principal fuel traded internationally.

OPTIONS

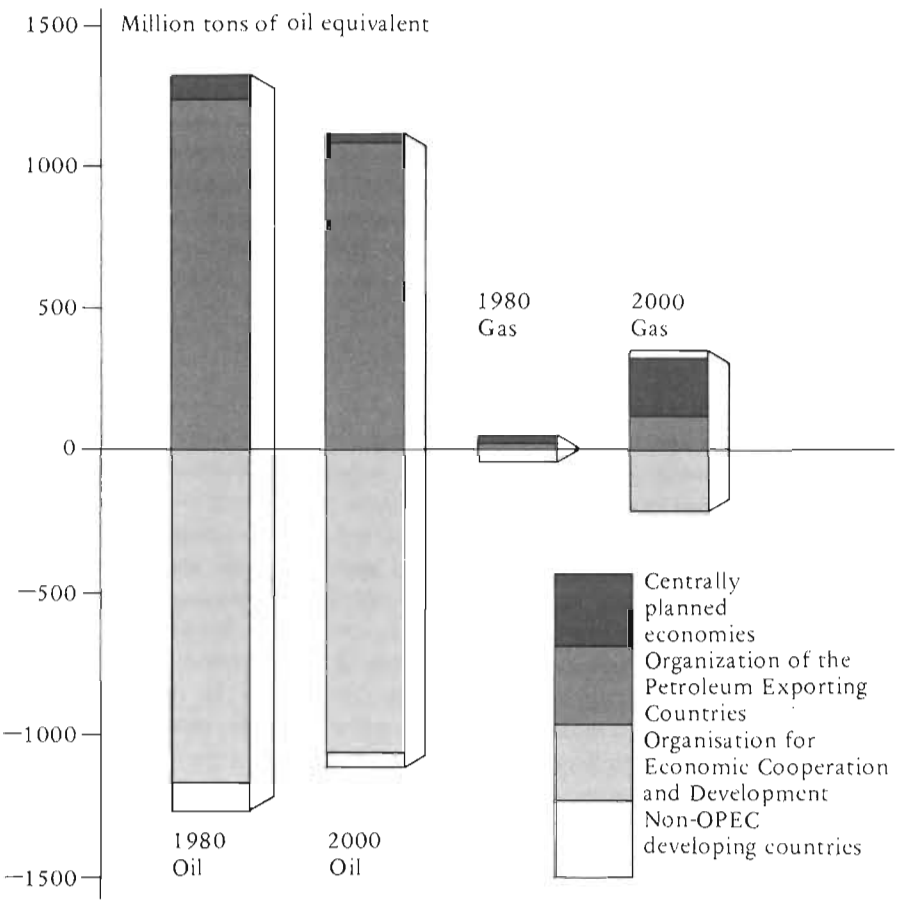
ISSN 0252-9572

is produced quarterly by the
Office of Communications, IIASA.

Editor: Roberta Yared
Managing Editor: Derek Delves
Designer: Martin Schobel
Photographer: Franz-Karl Nebuda
Printed in Austria

The Workshop median estimates of interregional shipments of oil and gas (see figure on this page) show a continuing dependency of the OECD countries on oil exports from OPEC countries, despite a slight decline in the level of OECD oil consumption. Net exports of oil from the centrally planned economies, which were relatively small in 1980, are generally expected to wane over the next twenty years. The oil imports of the non-OPEC developing countries – a heterogeneous aggregation of some one hundred economies at various stages of development and with large differences in the levels of their indigenous energy resources – will depend on their income growth and balance-of-payment constraints. The median suggests a decline in the amount of oil imports. Opinions differed on whether the major cause would be expanded domestic oil production, energy savings from shifting to less energy-intensive lines of development, or an economic reality of having to "do without". As Mr. Edward Flom of the Standard Oil Company of Indiana, USA observed, forecasting the demand and supply patterns of these countries as a group is one of the most complex, yet critical, areas in developing a consistent global oil projection.

A striking feature of the energy trade pattern suggested by the figure is the substantial increase expected in net exports of gas from the centrally planned economies and an almost equal increase in export volume from the OPEC countries. This gas, destined primarily for Japan and western Europe, is transported mainly by pipelines. It was generally conceded that resources should not constrain the development of an international market for gas. The Soviet Union, for example, has vast proven reserves of gas. Academician Mikhail Styrikovich of the Presidium of the USSR Academy of Sciences pointed out that these are sufficient to meet projected medium-term domestic and international demands for gas as an energy source and as a substitute for oil in many industrial applications. Several recent energy studies, including the International Energy Agency's *World Energy Outlook* and the *IIASA '83 Scenario of Energy Development*, conclude that the near-term challenge facing gas on energy markets is maintaining competitive prices in the light of the relatively high costs of producing gas at wellhead and transporting resources by onshore and offshore pipelines or by liquefied natural gas tankers. Dr. Hans-Holger Rogner, Leader of the IIASA Energy Systems Group, believes that despite anticipated increases in the consumption of gas at local and regional levels, an international market for gas is not likely to exist by the year 2000. Most experts judged the longer term prospects for gas to be more promising.

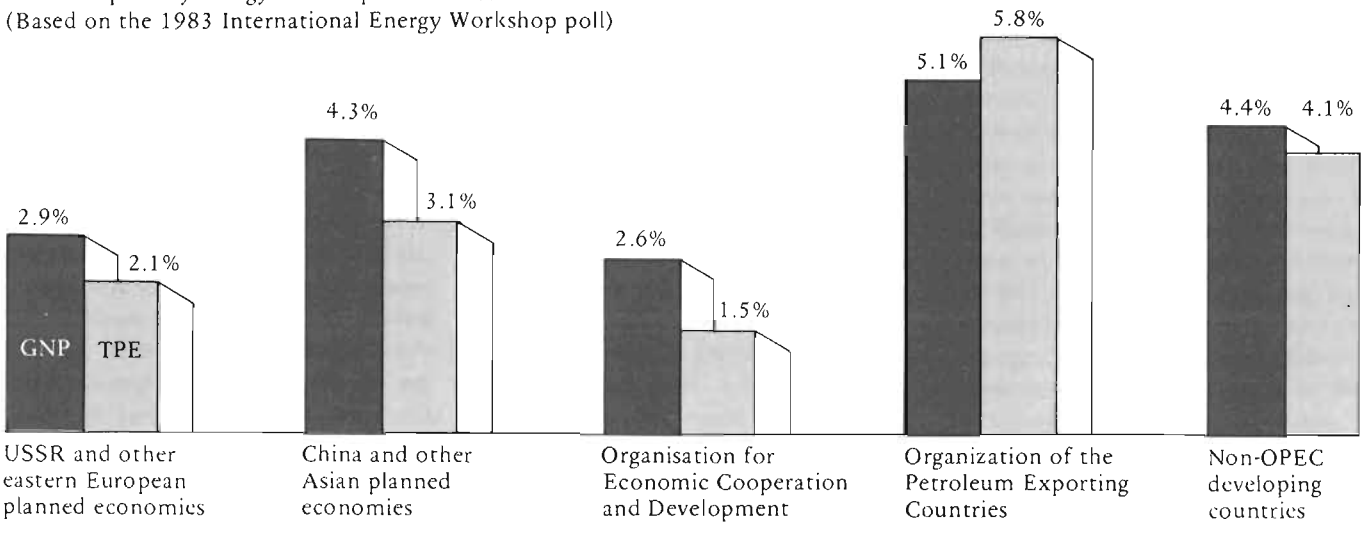


Net exports and imports of oil and gas, 1980–2000
(Median estimates of the 1983 International Energy Workshop poll)

In quantitatively assessing supply and demand conditions, analysts have to take into account possible effects of major technological advances on the availability and desirability of energy sources. Professor Harvey Brooks of Harvard University, Massachusetts, USA notes that many analysts tend to be over-optimistic about technologies they know and far too conservative about those that have a good chance of being on the scene in thirty to forty years. As Mr. Edward Schmidt, a New York-based energy consultant, appraises the situation for gas, the technologies for deep drilling in many parts of the world and for transporting large quantities of methane over long distances are as primitive as aircraft engineering and the aviation industry were in the 1930s. He believes that the exponential growth of these young technologies over the next three to four decades – analogous to progressing from propellers to jumbo jets – will lead to major increases in gas reserves, continuous cost reductions in production and transportation, and the steady market penetration of natural gas.

The fact that coal shipments turned out to be insignificant at the level of the Workshop aggregation does not imply that this giant resource will be an unimportant commodity in energy trading. Coal trade will be essentially intraregional. The bulk of imports to western Europe and Japan will origi-

Average annual growth rate of gross national product (GNP) and total primary energy consumption (TPE), 1980–2000 (Based on the 1983 International Energy Workshop poll)



nate within the United States and Australia, allowing the OECD to be largely self-sufficient in terms of coal over the next two decades.

Energy Conservation and Interfuel Substitution

The breakdown of global primary energy consumption (see figure on page 1) summarizes each region's prospects for meeting the projected increases in energy demand through energy conservation and interfuel substitution. These two forces do not operate independently, but are a direct consequence of the oil price shocks of the past decade and the expectation of future real oil price increases.

Except for the rapidly expanding economies of OPEC, the demand for energy is expected to grow at a slower rate than economic growth (see figure on this page) as economies become less energy-intensive than they were in the past. Conservation is defined by Professor Manne and Dr. Schrattenholzer as a residual, calculated as the difference between the projected energy consumption in the year 2000 and the demand for energy that would have occurred if the ratio of energy to GNP (gross national product) had remained constant throughout the period 1980–2000. Energy is saved through the combined effects of improved technologies for its production and use and of changes in the product mix of an economy.

Several analysts expressed concern about the Workshop median estimate of some 4 percent growth in total primary energy use in the non-OPEC developing countries, particularly in view of the growth aspirations and energy requirements for building up the industrial bases of these countries. Dr. Arshad Khan of the Pakistan Atomic Energy Commission argues that "Energy projections about the developing countries made by those in the industrialized world may be biased in favor of their own experiences, which cannot be automatically transferred to the developing world." He believes that in projecting a declining ratio of energy to GNP for this group of developing countries, analysts may have inadequately considered the supply role of noncommercial energy sources (e.g. animal and farm waste). In his view, noncommercial energy consumption will probably remain relatively stable over the next two decades, while the use of commercial energy sources will increase at a faster rate than economic growth.

Virtually all projections indicate significant economic growth worldwide over the next twenty years, despite little or no increases in global oil supplies on the international market. Natural gas, coal, and nuclear energy are the major substitutes for oil, although their relative contributions vary. There was general agreement that supply from renewable energy sources (hydropower, solar, biomass, fuelwood) would be relatively small at the world regional level. Professor Manne and Dr. Schrattenholzer attribute this outcome of the Workshop analysis to the inherent limitations of these technologies based on decentralized supply systems. There were also major definitional problems encountered for renewables in 1980 base-year statistics.

In line with the mixed supply pattern of energy projected for the Soviet Union and eastern European planned economies, Professor Alexander Nekrasov, Deputy Director of the Moscow Power Institute, USSR, outlines his country's energy policy goals as the stabilization of oil consumption; the further expansion of natural gas production; the development of nuclear energy, especially in the European area; the increased production of coal, mainly from the open mines of the eastern area; and the harnessing of hydropower and geothermal and solar energy on a limited scale for heating purposes.

According to Professor Lü Yingzhong of the Institute of Nuclear Energy Technology in Beijing, China's known recoverable resources of oil and gas will probably be insufficient to meet the estimated domestic demand for energy. Thus national plans call for a doubling of today's rate of coal production by the year 2000, full exploitation of the country's large hydropower resources, and the construction in the mid-1980s of two nuclear stations in

The International Energy Workshop is an expanding network of analysts concerned with international energy issues. Its aims are to compare published energy projections and to understand the reasons for diverging views on future developments and thus on current energy policies. Participation in the Workshop is open to any individual or group prepared to contribute to these goals.

Created in 1981 jointly by IIASA and Stanford University, California, USA, the Workshop process entails iterative polling of projections of crude oil prices, economic growth, primary energy consumption and production, and energy trade. Successive meetings assess the implications of the comparative projections. The first meeting was held at Stanford University in 1981, dealing mainly with the projected energy futures for the countries of the Organisation for Economic Cooperation and Development (OECD). To provide the global comprehensiveness necessary for consistent energy analysis, a second Workshop poll was conducted in 1983 that included energy projections for all world regions – the Soviet Union and the eastern European planned economies, China and other Asian planned economies, the OECD, the Organization of the Petroleum Exporting Countries (OPEC), and the non-OPEC developing countries.

Seventy groups and individuals participated in the 1983 poll, generally providing a reference (surprise-free) scenario and, in some instances, disruption and/or alternative growth scenarios as well. No probability estimates were attached to the projections, which either were generated by formal models or resulted from the interaction of analytic methods and human judgments. The period covered was 1980 to 2010, with relatively few responses recorded for the year 2010. A summary report of the 1983 poll responses, prepared by Professor Alan S. Manne of Stanford University and Dr. Leo Schrattenholzer of IIASA, served as background to the discussions at the June Meeting.

Shanghai and Guangdong province.

The OECD will continue to use the lion's share of global energy supplies. Projections for this group show oil and gas consumption remaining relatively constant, while that of coal and nuclear energy increases significantly. For some experts, the prospects of growth for the nuclear industry were somewhat surprising in view of the sociopolitical controversy surrounding the further development of this energy source. "Pessimistic views about the future of the nuclear industry are dictated mainly by its current situation in the United States," argues Professor Wolf Häfele, Director General of the Jülich Nuclear Research Center, FRG. Globally the picture is more sanguine, he explains, as there has been an uninterrupted increase in the number of plants commissioned and ordered throughout the period 1965–1982. The share of nuclear energy in global primary energy supply is presently some 5 percent and is increasing, particularly in the eastern European planned economies and in western Europe. By the end of the 1980s, nuclear energy is likely to hold some 9–10 percent of the primary energy market, in view of the total installed capacity of the plants now firmly ordered, under construction, and in operation worldwide. Referring to the market penetration studies of IIASA's Cesare Marchetti, Professor Häfele maintains that once a commodity has cornered this much of the market, it will not disappear.

Latin America's dependence on oil and to some extent on gas is likely to continue, observes Dr. Ulises Ramirez, Executive Secretary of the Latin American Energy Organization (OLADE). But the region's active program to exploit its huge hydropower resources is expected to increase hydroelectricity's share in primary supply to around 22 percent by 2000. For example, when the hydroelectric project at Itaipu (on the border of Brazil and Paraguay) goes into operation late in 1983, its generating capacity will be equivalent to the output of some ten large conventional power units. Dr. Ramirez is confident that Latin America has the appropriate institutional and human resources to be energy self-sufficient in the near term.

A Word on Energy Forecasting

Energy forecasting is a risky business in which the chances of being "right" are virtually nil. Some forecasters even consider it immaterial whether the numerical projections match reality – their goal is to understand the qualitative circumstances underlying these quantitative scenarios. Others see the value of forecasting as setting in motion the forces that will actually prevent a projection from being "right". Dr. Daniel Dreyfus, Director of Energy Forecasting and Analysis at the Gas Research Institute in Washington, DC, USA considers the soul-searching on the part of forecasters about why they were wrong in their forecasts of the 1970s an aberration. "Projections made at this time were based on the conventional belief in an oncoming disaster – that oil prices would soar to US$100 a barrel and that the world's oil production capacity would be stretched to its limit. Everything about this future was generally considered unacceptable, and decisions were made to keep the scenario from coming true. Had the trend lines continued unchanged, circumstances would have been a great deal worse, but the forecast would have been right."

Notwithstanding how one defines the value of forecasting, the International Energy Workshop process of comparing energy projections provides an automatic global consistency check on independent estimates which benefits planning in both the public and private sectors of the world's economies. As Professor Manne and Dr. Schrattenholzer conclude, "rational decisions cannot be based on scenarios that fail the test of logical consistency. Individual projections will continue to differ, but it is worthwhile to attempt to understand why."

Jeanne Anderer

The "Summary Report of the 1983 Poll Responses" by Alan S. Manne and Leo Schrattenholzer will appear shortly in the *Energy Journal*. An Executive Summary of the June International Energy Workshop will be published shortly by IIASA. Copies of the individual 1983 poll responses and the frequency distribution of projections can be ordered at a cost of US$30 from the Publications Department, IIASA.

Transborder Data Flows

Istvan Sebestyen, author of recent IIASA studies on information technology and transborder data flows, describes some long-standing international networks as a contribution to the information policy debate.

Baron Paul Julius Reuter, a Berlin bookseller, used carrier pigeons to send stock market prices from Aachen in Germany to Brussels in Belgium in 1851. In the same year he established an agency in London and began transmitting stock prices between the English and French capitals on the cross-Channel telegraph cable that had just been laid between Dover and Calais. The British-based Reuters international news agency must have inherited its founder's business acumen; spotting a growth area in the market in 1964, it introduced computerized financial services to gather and distribute stock and commodity prices worldwide.

Computerized communication networks are changing the traditional nature and practices of news gathering. Several major news agencies now use computerized data bases and message systems not only to distribute news but also to provide subscribers with information on foreign exchanges, trade, balances of payments, consumer prices, and money supply and reserve figures. Reuters launched its Monitor Service in 1973 to provide subscribing exchange dealers, bankers, commodity traders, and brokers with up-to-the-minute market news. The Monitor Money Rates Service has over 5,000 subscribers and with the Dealing Service subscribers can transact business with each other through the Reuters network of leased lines and computers. Additional Monitor services include the Oil Service (prices, news, and economic indicators) and the Commodities and Shipping Services, while other agencies are competing with services of their own. A US subsidiary of Reuters, IDR Inc., uses satellite communication technology to transmit full-channel teletext news in the USA and over the border to Canada through the Canadian cable television network. This is interesting, and rather sensitive, from the point of view of information policy, since it bypasses the present intermediaries such as government news agencies and local newspapers. These are examples of the growing ability of news agencies to supply business and even residential end-users directly by means of new information and telecommunication technologies.

By 1982 the Reuters network incorporated 31,000 terminals, and the company had increased its turnover from US$5 million in 1962 to US$330 million. By riding the crest of the technological wave in telecommunications, Reuters, which had been losing money, has become a world leader in international information exchange.

These are aspects of the "information society" being spawned by the microelectronics revolution in general and by new computer and telecommunication technologies in particular. In many countries information already permeates the entire economic, political, cultural, and social structure, and information gathering, processing, storage, transmission, and accession have become important policy issues. Rights to individual privacy, national security considerations, crime prevention, and proprietary interests clearly require the limitation of access to some information flows, and this is a topic increasingly on the agenda at national and international meetings.

A number of international organizations, including the Organisation for Economic Cooperation and Development, the UN Center for Transnational Corporations, UNESCO, the General Agreement on Trade and Tariffs (GATT), the Council of Europe, and

European Space Agency

The first image from METEOSAT 2, the European Space Agency meteorological satellite, received and processed on 28 July 1981.

the Intergovernmental Bureau for Informatics, have tried to establish a viable set of principles to govern information policy. The issues raised are complex ones of liability, ownership, and proprietary rights. Furthermore, there is no international legal structure to control information flows, nor is there any organization of agencies, courts, and lawyers to administer such a system.

The nature of problems in the field of transborder data flow is changing rapidly with the accelerating pace of technological progress, which makes legislation obsolete almost before it comes into effect. Many current proposals to regulate data flows are based on technologies that are already outdated. Policies will need to be flexible and recognize the diversity of information. While there are general problems, many will be specific to a particular class of user, and the international codes, agreements, and agencies involved in the solution of conflicts will need to differ accordingly. The policy makers' task is compounded by the interdisciplinary nature of transborder data flow: the topic has technical, economic, political, legal, social, and cultural aspects.

Given this minefield, it may be surprising that there are, in fact, several functioning transborder data flow networks as precedents to guide us. This article describes how such networks work in practice in the fields of meteorology and aviation.

Meteorological Networks

Hurricanes caused the deaths of 5,000 people in Texas, USA in 1900 and 1,900 people in Mexico in 1959. In the mid-1960s satellites began keeping track of hurricanes by radar; as a result of early warnings, Hurricane Camille, the worst storm of the century, caused minimal loss of life in 1969. East Asia's yearly storm damage is over US$3 billion; a cooperative typhoon warning system based on satellite imaging is being implemented, and should substantially reduce the destruction.

Today's twenty-four hour weather forecasts are as accurate as twelve-hour forecasts were fifteen years ago, as a direct result of data acquisition by meteorological satellites and analysis by computer. In another fifteen years global satellite imaging should make possible five-day forecasts of the same accuracy. This would translate into savings of over US$5 billion in agriculture and aviation in the USA alone.

Dr. Istvan Sebestyen, of the Computer and Automation Institute of the Hungarian Academy of Sciences, joined IIASA in 1978. He has worked for the United Nations and at several other international organizations as an expert consultant on computer information systems and related matters. He is currently Visiting Professor at the Institute for Information Processing of the Technical University of Graz in Austria and with the Institute for Applied Information Processing of the Austrian Computer Society, where he is primarily concerned with the development of new generation videotex systems.

New computer and space technologies have transformed meteorology, which is one of the oldest applications of international information exchange. Weather-observing stations first became widespread between 1850 and 1875, and national weather charts and official forecasts date from this period. Weather observations could first be exchanged internationally by telegraph; this was coordinated by international conferences in Brussels in 1853 and in Vienna, Austria in 1873. The Vienna conference established the International Meteorological Organization, forerunner of the UN World Meteorological Organization (WMO) founded in 1947.

With the invention of radiotelegraphy, ships and, later, aircraft were able to provide weather reports by radio from the oceans. The deployment of radiosondes (instrument-laden balloons) from 1930 onwards permitted atmospheric soundings. Information on clouds and precipitation could be gathered with the invention of radar, which by the end of the 1950s was being used to locate and track hurricanes.

In the 1950s leased point-to-point telegraph and telex circuits carried the bulk of the daily traffic between the various national meteorological centers. By the end of the 1960s this network was becoming increasingly overloaded. Electronic computers capable of handling vast amounts of data improved the processing and exchange of meteorological information and led to the continued expansion of the international network of observation stations and telecommunication services. Perhaps the greatest advance of all has been the success of satellite meteorology in monitoring atmospheric conditions globally.

Space Technology in Weather Forecasting

Information received from satellites represents a special category of transborder data flow. Observational data from most meteorological satellites are freely available to any surface station equipped with the appropriate dishes, receivers, and other equipment. Other satellites operate in a point-to-point mode; most of these are geostationary ("fixed") high-orbiting satellites, but there are also some low-orbiting meteorological satellites. Data from these can only be shared through the WMO network.

Both the USA and the USSR operate polar-orbiting meteorological satellites – the TIROS-N and the METEOR-2 series respectively – which because of the earth's rotation can provide pictures of its entire surface and make atmospheric soundings. The picture resolution is about one kilometer, but both satellite series carry reduced resolution image systems to transmit medium resolution (4 km) images as acquired. The ground equipment need-

ed to receive these is relatively simple and inexpensive, and many countries benefit from direct reception of images of their own regions.

The USA, Japan, and the European Space Agency operate geostationary meteorological satellites – GOES East and West, Himawari ("Sunflower"), and METEOSAT respectively. These have much in common and there is a high degree of collaboration between the operators. They provide visible and infrared images of the areas viewed; the latest US satellites are also able to make atmospheric soundings of temperature and humidity. The USSR with GOMS and India with INSAT are both intending to launch similar satellites.

Against this background of rapid technological development and rising demands on existing facilities, the Fifth World Meteorological Congress met in Geneva, Switzerland in 1967 and established the World Weather Watch program under the WMO. This provides meteorological information for general purpose weather forecasts and for extended forecasts used, for example, in the long-term planning of agriculture or water resource management.

The essential elements of the program are a global observation system, a global data processing system, and a global telecommunication system. The Global Observation System presently includes 9,000 surface weather stations and 750 radiosondes, together with meteorological satellites, ships, and commercial aircraft.

The Global Data Processing System operates on three levels, linking world, regional, and national meteorological centers. The world centers are in Melbourne, Australia; Moscow, USSR; and Washington, DC, USA. The centers provide back-up for short-term forecasting and storm warning services; they improve operational forecasts by incorporating new methods, such as new modeling techniques; and they develop ways of processing, storing, and retrieving data for meteorological, climatological, and other purposes. The WMO's philosophy and practice is that processed "value-added" information for meteorological forecasting should be fed back into its telecommunication network to be freely available to all meteorological centers. For instance, the large mainframe computers in Offenbach, Federal Republic of Germany, Moscow, and Washington, DC are used to run complex weather models for forecasting purposes, and the results are communicated to other national centers.

The main function of the Global Telecommunication System is to distribute raw and processed data to the meteorological centers; it makes use of international cable, radio, and communication satellite circuits. To give an idea of the speed of the system, information from all Hungarian meteorological observation posts is in Washington, DC within an hour, and observations from US ships in the Atlantic can be in the Hungarian Meteorological Office in Budapest within forty minutes.

The European Center for Medium-Range Weather Forecasting

Another transborder meteorological network is that of the European Center for Medium-Range Weather Forecasting, based in England. Its main regular service is to provide one-week to ten-day weather forecasts for its European member countries. How many days ahead the weather can be realistically simulated depends on the speed and power of the computer. The European Center receives around 35,000 separate weather reports each day from the WMO's World Weather Watch Program. These supply the Center's Cray-1 computer with 80 million bits of weather data for each model run. To predict atmospheric behavior ten days in the future requires 500 billion separate arithmetical operations and over three hours of computer time. The Center's forecast is sent each day to its seventeen member states, who pay fees totaling about US$11 million per year, and in part to the WMO free of charge.

Traditional meteorology, based on mutual dependence and the cost-free exchange of information, has often been cited as an example of international cooperation. However, the technological advances of the past thirty years or so, although they have benefited all countries greatly, have reduced this interdependence. The predominant role of local observation has declined in relation to the increased use of space technology and new data processing and telecommunication technologies. The major developed countries need to rely less and less on international cooperation, but the smaller countries depend increasingly on raw and processed data from them. The amount and complexity of data have increased enormously, and the information that is made available may often not be utilized by the developing countries because they lack the technical, financial, and frequently the intellectual resources necessary to take advantage of it. Although satellite images are regularly carried on the network, poorer countries rarely have the necessary computer systems to process these data for their own needs. Because of their lack of storage and archiving facilities, developing countries often have to buy back from developed countries the data that they originally fed into the network. This is not an easy problem to solve; someone has to pick up the bill for the spiraling costs of providing, and also utilizing, these new, more advanced services.

A further cause of concern to developing countries is that high resolution remote-sensing satellites can reveal more about their natural resources and crops than they know themselves. The data acquired by such satellites, besides their strategic aspects, have obvious commercial applications. The question of how the capturing, processing, and dissemination of remotely sensed data should be controlled has been a hot potato for several years.

New Information and Data Communication Technologies for Civil Aviation

The aviation industry has always been a major user of information – on the weather, for navigation, and for passenger and freight schedules. Most major airlines have computerized reservation systems; several have their own worldwide telecommunication networks. In order to allow the different airline computers to communicate, the industry association IATA (International Air Transport Association) set up

an interlinking data network operated by SITA, the non-profit organization founded in 1949 to meet the airlines' need for telecommunication services.

Although SITA has since developed into a worldwide computer-based information network – in fact the world's largest private telecommunication network, serving 241 member airlines in 154 countries – its present infrastructure is still inadequate to meet the rising demand for services. A new network architecture capable of fulfilling future needs is presently being developed and implemented.

SITA's Gabriel reservation system, used by smaller airlines that do not lease or own private reservation systems, is based in Atlanta, Georgia, USA. Other small carriers join in with larger airlines. The British Airways system is host to eight small carriers, and Swissair and Austrian Airlines operate a joint system in Zurich, Switzerland. The Yugoslavian airline has its reservation system under the KLM (Royal Dutch Airlines) system in Amsterdam, the Netherlands. The German Democratic Republic's line Interflug uses Aeroflot's system in Moscow in the USSR; all the other East European carriers use Gabriel. As well as flight reservations, the system provides communications services relating to flight operations and safety, aircraft movements, flight services and status, and administrative matters such as lost baggage.

SITA is developing a digital communications service AIRCOM for implementation in 1984 that represents a new type of information flow across national boundaries, in the sense that it will provide a means of transmitting digital data between fixed ground stations and aircraft. Until recently operational communication requirements could only be met by voice transmission using VHF or HF radio. The first air-to-ground digital service was introduced in North America in 1977. AIRCOM will be able to transmit automatically acquired data, permitting the progressive automation of airline operations. This will help airline crews and land-based personnel to cope with the profusion of flight information; it should also save energy and materials, and make new services available without threatening jobs.

One problem area is the flow of data for passenger reservations across borders, which falls into the sensitive category of the transfer of personal information abroad. This flow is primarily for transactional purposes, but in principle the archiving of such information could cause major concern in countries with privacy legislation. For example, if the letter of the law were to be followed, then no one could fly from Sweden to the GDR by Interflug, since the transfer and storage of reservation data abroad would infringe Swedish privacy protection legislation.

It is a routine aspect of airline operation that data base services containing passenger lists (personal data) are set up in foreign countries, and that personal data flow between two countries is routed through a third, where the information may be stored for networking purposes. Thus some types of transactions that are of concern to information policy-making bodies are everyday practice in SITA and seem to work to everyone's general satisfaction. This suggests that the regulation of transborder data flows would probably be better approached not on a universal basis but from the point of view of different major applications.

Again, as in meteorology, the spread of new information technologies in aviation trails in its wake a growing dependence of the developing countries on the developed. Problems with export and import embargoes and other trade restrictions are also familiar in this field. Nevertheless, international civil aviation would simply not be possible without transborder data flows.

Austrian Airlines

At the Austrian Airlines booking office in Vienna: the clerk checks at the terminal whether seats are available on the flight and makes a reservation; the computer updates the passenger list and issues a printed ticket.

Essential Exchanges of Information

Economic advance is becoming increasingly linked to the development of information resources and technologies, and no nation will be able to insulate itself from the changes. Legitimate fears about the societal impacts of new information technologies and the power they confer – about the nature of the "information society" – inevitably give rise to the desire to control their spread. Proposals to restrict transborder data flows or the use of telecommunication technology, for example to protect a domestic data service from foreign competition, have included legislative and fiscal means and the imposition of trade barriers. The question of what are reasonable controls on the free flow of data across international boundaries is a complex one, and it will not be readily resolved. It should not be overlooked, though, that there have long existed several specialized applications of transborder data flows providing what have come to be regarded in the modern world as basic services – international news, weather forecasting, and civil aviation. We not merely benefit from but depend vitally on the free exchange of information between countries.

Kenneth E. Boulding
National Defense through Stable Peace

Professor Boulding delivered a series of lectures during a recent visit to the Institute, and has kindly given IIASA permission to publish them. The following is an abridgment of his "Stable Peace as a Realistic Objective for National Defense Policy".

Are there policies that would lead to a more optimistic long-term view than the present world situation would suggest? I have been arguing that we are in the middle of a very profound change in the state of the planet: this happens every now and again in the evolutionary process. It certainly happened with the first DNA, and it happened with the first *Homo* (and *Mulier*) *sapiens*. Sometimes there is change in the system itself, and this is what we have right now. It is painful, it is hard to learn from it, but it is something with which we have to come to terms. When we have a change in the parameters of the world system that profoundly changes the costs and benefits of various institutions, then we can look for further change. (I am enough of an economist to think that costs and benefits are important. And that, while people do not always maximize anything, if we have large changes in the system of costs and benefits then changes in institutions are almost sure to follow.)

Now I argue that the world system of what I call NDOs (national defense organizations) is precisely in this position. The system of national defense has been undergoing an enormous change in its parameters. Thus, although it is not true, as Henry Ford said, that history is bunk, history has changed and the parameters of the past may no longer apply to the future.

A great deal of this has happened in my own lifetime, and still more during my grandfather's lifetime. The world has become a single system for the first time in human history. This began with Columbus, I suppose, but I would say that the world only became a single system in a certain sense in the twentieth century. At the time of Charlemagne, the Mayan Empire could collapse – one of the great catastrophes of human history – without bothering Charlemagne at all, because he did not know anything about it! ... Now there are no unknown places on the map of the earth or Mars, and not even very many on Venus. This is an extraordinary expansion of human knowledge.

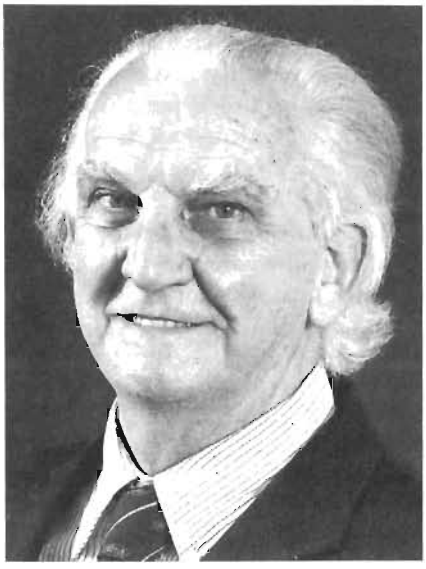
We see this in what I sometimes call the "superculture" – the science-based culture of airports, radios, television, automobiles, and so on. ...

The uniformity of the world "superculture", however, can be exaggerated. There is now a very legitimate upsurge of what we call "ethnicism" – interest in local culture and languages. We see this in the recent revival of Welsh, Irish, Breton, Provencale. ... This I find very desirable because the last thing I want is a uniform world. It is getting to the point where it is hardly worthwhile going anywhere because when you get there it is just like home. I certainly do not want uniformity to go that far. I very much want Japan to stay Japanese, Austria Austrian, and Wales Welsh. But local cultures now operate as enclaves in this great network of the world culture and we can no longer pretend that they are wholly independent and self-sustaining. Once we have transistor radios we are part of the world society.

This actually means that wars of conquest are likely to be highly unprofitable. This has not always been the case in the past, although it has frequently been so. But such wars have virtually disappeared in the twentieth century simply because of the unification of the world. The world is now reasonably full; there are no great empty spaces any more. There are a few half-empty ones, like where I live in Colorado, or in Brazil, or Queensland, but these are really very small. There is no frontier. The world is full and is likely to be getting fuller, so if anybody conquers anybody else, all they make for themselves is trouble! They will get nothing else out of it. This was not always true, although it was truer than most historians think. We can see this in the collapse of empires all over the world: this happened mainly because imperialism just did not pay. ...

The technical developments in weaponry and national defense organizations have clearly destroyed the unconditional viability of all states. The great justification of war was that it pushed violence beyond your borders, so that you could preserve peace at home by having war somewhere else. ...certainly in any major war this is no longer feasible. Nuclear war would be everywhere; the whole concept of defense through war has really collapsed because of the increase in the range and the deadliness of weapons. We saw this a little even in the First World War; it was still more obvious in the Second, and certainly a nuclear war would make the Second World War look like a Sunday School picnic! ...

What we have now is deterrence – that is, mutually assured destruction, properly called "MAD" – and this extraordinary illusion that deterrence can be stable. ...we can disprove this in two lines: if deterrence were stable, it would cease to deter. If the probability of nuclear weapons going off were zero, it would be the same as not having them. If we do have them, however, then there is a positive probability that they will go off in some scenario. It does not matter how low this probability is: no matter how low any probability is, if we wait long enough it will come off. So we live in a system under indeterminate sentence of death. I just do not know what the time scale



Kenneth E. Boulding is Distinguished Professor of Economics Emeritus at the University of Colorado, where he is also a Project Director and Research Associate of the Program on Political and Economic Change at the Institute of Behavioral Science. Professor Boulding is a member of the American Academy of Arts and Sciences, the US National Academy of Sciences, and the American Philosophical Association. He is a past president of the American Association for the Advancement of Science, the American Economic Association, the International Studies Association, and the International Peace Research Society.

is, but the ultimate death of nations through national defense is certain.

I suggest that the only currently available method of national defense that gives any positive probability of long-run survival is a deliberate policy of increasing the probability of stable peace. All other methods would lead to certain destruction, but this gives us at least a chance of survival – not 100 percent, by any means, because anything can go wrong with anything – but given the choice of certain destruction and the chance of survival, I will take the chance of survival, no matter how low it is. I must argue here that stable peace is no utopian dream. Boulding's first law is that "anything which exists is possible" – if your theory suggests that something which exists is impossible, you had better go and look at the theory. I would also suggest that stable peace is a new phenomenon which came into being sometime after 1815 in Scandinavia, sometime after 1870 in North America, and after 1945 in Western Europe. We now have this great triangle of stable peace stretching from Australia to Japan, across North America to Scandinavia. We certainly do not have stable peace in the Middle East, or in South Asia, or even, I think, in Latin America or Africa – and of course, we do not have stable peace between the United States and the Soviet Union. It is not terribly unstable, but we could not say it is stable.

The characteristics of stable peace are fairly easy to identify. In the first place, national images and interests have to be consistent over a certain range and, as I argued previously, perhaps the most important thing we have to learn about the international system is that national interests are a variable of the system. They are not constant; they exist over a wide range, only the limits of which have some kind of objective validity. I have seen an enormous change in national interests. National interest is by definition what the nation is interested in; this can be all sorts of things and can change almost overnight. I have seen a tremendous change in my native country, Britain, in this regard. The Britain in which I grew up had a national interest in having a great empire, being a great power and all that. Then at some point the British decided to be like the Swedes and be a small, nonimperial power. The Swedish pattern paid off very well; in the nineteenth century Sweden had the highest rate of economic development in Europe. The imperial countries lagged, their empires were an economic drag, there was no question about it. Being a great power is always an economic drag, as demonstrated today by the United States and the Soviet Union. If you want to get rich you should stay at home and mind your own business well, like the Swedes, or perhaps stay at home and mind everybody else's business, like the Swiss! I think the Swedish way is probably better, but anyway both of these countries got rich. How not to get rich is to be a great power. I think this has been a pretty universal principle in human history, and can almost be summed up in a sentence: riches create power, power destroys riches.

Another important change in the national image concerns national boundaries: I suggest that one of the first steps toward stable peace should be to take national boundaries off agendas.... It would be a very good sign if boundaries became so meaningless and artificial that nobody worries about them.... It also helps if national boundaries are also cultural boundaries....

Another very important condition for stable peace is that there should be no active plans for invasion held by war departments or NDOs. I sometimes say the operational definition of stable peace is the amount of dust on the plans for invasion! ... Another element in stable peace is the development of the recognition that winning fights is only a very small part of conflict management, sometimes an important part, it is true, but by no means the whole thing. The truth is that winning fights often means losing a conflict, and that the winners are not necessarily any better off as a result.... As life becomes richer we find that there are much more interesting things to do than fight.

Can we then have a national policy for stable peace? I argue that nobody really has one yet, that stable peace broke out where we now have it largely by lucky accident. The international system in particular contains very strong stochastic elements, more generally called luck. Luck often controls who reaches positions of power. Luck also has certain prejudices; in fact I have what I call the "dismal theorem of political science", which is that "all the skills that enable people to rise to positions of power make them unfit to exercise it." There is a fair amount of evidence for this. However, if we have strong random elements in the rise to power, then we have the possibility of both good and bad luck. If we have in our society a political culture that makes the capability of exercising power very widespread, then we have a better chance of finding somebody competent. My own feeling, I am afraid, is that competence is far more important than ideology or even political views and political parties, but competence to a considerable extent is a matter of luck. How one increases the possibility of good luck is the major object of policy.

I suggest that if a government really decided that it wanted to have a policy

We certainly cannot discuss the state of the world system in the past, the present, or the future without recognizing the existence of an activity that is euphemistically called "national defense" but that more honestly we should simply call the "war industry". Preparation for war is a very ancient human phenomenon. It now forms at least seven percent of the world economy, so we cannot study the world economy without it....

One of the interesting things is that when we look at NDOs as ecological species, we find that they are ecologically cooperative with each other and competitive with their own civilian populations. The bigger the Russian NDO, the bigger the American; the bigger the American, the bigger the Russian. Each of them, of course, is a severe tax on and danger to its own civilian population. One of the ironies of the system is that, as far as I know, the Russian NDO has done no damage to any American and the American NDO has done no damage to any Russian. However, the American NDO has done substantial economic damage to the Americans (we are at least ten or twenty percent poorer today than we would have been if seven percent of the GNP had not gone into the NDO) and the effect of the Russian NDO on the Russians has been even more striking. ...the military is acting as an enormous black hole, sucking up high technology and letting practically nothing out.

for national security through stable peace, it should start with a positive, ringing declaration of policy and intent. I am a great believer in hypocrisy as an agent of social change; while there is hypocrisy, there is hope. The United States provides a good example in the matter of race relations: as long as every American child stands up in school and pledges allegiance to the flag – "with liberty and justice for all" – nobody can get up and say, "I believe in liberty and justice for some." But as long as we *claim* to believe in liberty and justice for *all*, somebody can come along and say, "Well, we do not have liberty and justice for all. You are being a hypocrite." Where there is hypocrisy, there is a fulcrum for social and political change. I have seen a great change for the better in the United States in this regard since I have been an American citizen, partly because we had statements of moral intent even though we were hypocrites. So I think there is a great deal to be said for having declarations of good intent, because this represents a "standard to which people can repair" and exerts a constant pressure toward the stated objective.

The government would also have a "scenario" of unilateral and multi- or bilateral actions that could move the system toward security through stable peace. I am not suggesting that we can ever guarantee security. All social policy can ever do is to improve the probabilities of good; we can never be certain of it, for all plans can go wrong. I would rather like to think of social policy as social agriculture – the farmer distorts the ecosystem of the field so that it grows wheat instead of brambles. Similarly, the aim of social policy is to push the ecosystem of society into better organizations, products, lives, marriages, and so on. An important component of such a policy would be an extensive educational program. Much of the education provided in the schools at present is designed to produce adults who are adapted to a system of security through national defense that has now ceased to exist. If instead we give students the idea that stable peace is possible because it already exists, this would change the attitude of the next generation of adults. We would also have to change the curriculum in the military academies, redirecting the culture and image of the military toward stable peace and conflict management rather than winning fights. This is not impossible, although it may be difficult.

Another step would be the development of nonviolent defense organizations. One of the interesting things that has happened in the last 100 years is the rise of what we might describe as "nonviolent threat systems". I rather think this began in Hungary in the nineteenth century; we see it today in the form of strikes in labor relations and nonviolent movements for political and social change. Gandhi, of course, was both a great theorist and a great practitioner of this approach; Martin Luther King was another. As a result, we now have a very large literature on the potential and limitations of organized nonviolence. I am not suggesting that this is all we need; I am not even suggesting that it is always desirable, because sometimes nonviolent threats can be extremely destructive. However, any realistic study of national security must now include nonviolence as part of the repertoire and agenda of social organization. It is just as much a part of the twentieth century as nuclear weapons, and we have to recognize this and deal with it realistically.

There is also a place for a specific scenario involving offers to opponents. This is similar to what has been called "GRIT" (Charles Osgood's Graduated and Reciprocated Initiative in Tension Reduction) and we already know something about this. Can we develop a negative arms race? There is no reason why this cannot be done. In particular, it may involve developing much more *specific* programs of threat. One of the reasons why we are in this catastrophic situation in regard to national defense at the moment is that the national defense system is a system of indeterminate threat. It says, "If you do something nasty and unspecified to me, I will do something nasty and unspecified to you." This is a recipe for an arms race, and historically arms races almost universally end in war, as the present one will if it goes far enough. If we are to reverse this trend then we have to change the pattern of thinking of the national states.

What I am arguing for is a very substantial widening of the agendas of the national defense enterprises. One country can say, "We will reduce our defense measures and then, if you reduce yours, we will reduce ours more. However, if you do not reduce your defense measures, we will increase ours," and we can spell out this program in some detail. ...the social system is an ecosystem containing populations of people, institutions, commodities, weapons, and so on. An ecosystem is basically an echosystem – that is, if I do something to you, then you do something

to somebody and he does something to somebody and she does something to somebody, and so on, the initial act echoing and re-echoing all around the system. The end result usually appears to be completely unrelated to the initial act. This is why the cause and effect argument is very weak in social systems; it really does not work very well. Everything depends on everything else, and this is the basis of the ecological approach to the social system. Of course, there is also much to be said for trying to identify what depends on what.... Every action has echoes of which we are often quite unconscious; we consider only the immediate action when in fact the consequences are felt all around the system. I think it is extremely important to increase the awareness of this fact, especially in the minds of powerful decision makers.

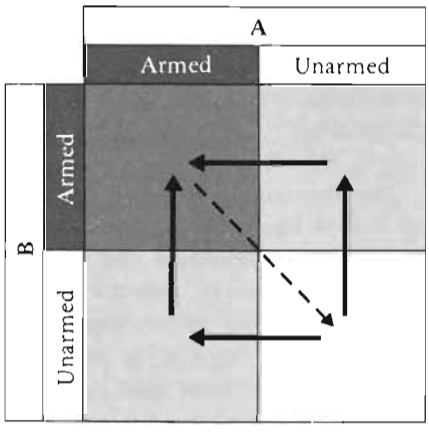
Another task is to change the military culture and to bring the military more into society as a whole. One of the great dangers to the world is that the military form a ghetto. They are very isolated from the rest of society. They live in remote barracks and missile sites; they interact with civilians very little. They talk only to each other, and this is very unfortunate....

Another valuable move would be the development of national academies of peace and conflict management....

Another important move would involve multilateral actions through the United Nations. I have been arguing for a vigorous United Nations Disarmament Organization, which would mediate in negotiations on the disarmament of boundaries. One of the early successful disarmaments was the Rush–Bagot Agreement between the United States and Britain in 1817, in which the Great Lakes were disarmed. This was one of the first successful disarmament agreements in human history, and ultimately prevented the great war between Britain and the United States that ought by most theories of the international system to have happened around 1870. What we need now is a great deal of partial and incomplete disarmament here, there, and everywhere, but particularly at national boundaries.

And then we need a United Nations agency, something like the Stockholm International Peace Research Institute, which would monitor the strain on the international system. The transition from peace to war occurs when the strain is too great for the system and it breaks. The irony is that increasing the strength of a nation weakens the strength of the system; if we simply think in terms of national strength rather than in terms of system strength, we are chasing the wrong objective. The problem of monitoring and reporting the strength of the peace system is, I think, a tremendously important task.

I hesitate to sound too optimistic, so I shall conclude with some comments on the obstacles to developing a policy for stable peace. These should be neither overlooked nor overestimated. One problem is that the achievement of stable peace shares some of the aspects of the prisoner's dilemma game. This is a positive-sum game, which can potentially make both parties better off, but more often finishes with everyone worse off. Suppose we have a matrix, as in the figure, in which A may or may not be armed and B may or may not be armed. It is clear that both would be better off if both were unarmed. However, if both were unarmed, it might pay one of them to arm. If one is armed, it pays the other to arm, and we end up in the arm–arm box where everybody is worse off and less secure (solid arrows in the figure). We certainly do not get any security out of armaments. However, it is hard to get a dynamic for disarmament (the dotted arrow) even though everybody would be better off as a result; this is one of the great tasks of negotiation. We need to support this effort by developing a dynamic of interaction that makes everybody better off. The road to stable peace is clearly a knife edge – it is easy to fall off, but this is no excuse for not trying to build a better road....



Another difficulty is that learning is very difficult when there is a system break (as I argue there is now), because we mostly learn from the past. If the past is no longer relevant to the future, it is hard to learn anything from it. The only answer to this is the development of the human imagination. How an educational system can develop imagination is a very important question. Most educational systems do not develop imagination – if anything, they suppress it to make life easier for the teachers! Perhaps part of the answer is a liberal education. If an education includes a good deal of literature and poetry, if it focuses on people who *had* imagination, then we may be able to encourage imagination in the students. This is true even in mathematics and the sciences, which also require imagination if students are to go beyond the merely mechanical. Science, as I sometimes say, is testable fantasy; without fantasy there would be nothing to test....

How, then, do we include the concept of stable peace in the concept of development itself? I argue that development is not just getting rich; it is getting wise. If we simply see development as getting rich, we will frustrate it. Development means political maturity as well as economic progress; this is hard to measure, but that does not make it any the less real....

What I am offering may seem like a slim hope, but it is a hope nonetheless. The search for peace has been rather like the labors of Sisyphus – pushing the stone uphill and always having it slip away and crash down again. But the hill has a top, and once you get over it you are chasing the stone, not pushing it. This has happened many times in human history. It happened with slavery, I suggest it happened with duelling, and it could happen with war. This, perhaps, is the most reasonable ground for modest hope.

National Defense through Stable Peace is available from the Office of Communications, IIASA.

News from the Institute

Young Scientists' Summer Program

This summer is the seventh that young scientists have been able to share in the "IIASA experience" by taking part in a combined work and study program. The forty-one participants this year, mostly predoctoral students, come from fourteen of the Institute's NMO countries.

They are working on the following IIASA projects: Patterns of Economic Structural Change and Industrial Adjustment; National Agricultural Policies; Energy Development, Economy, and Investments; Institutions and Environmental Policies; Population: Aging and Changing Lifestyles; Integrated Regional and Urban Development; Concepts and Methods: System and Decision Sciences. Research is conducted under the tutelage of senior scientists, and offers the experience of collaborating with IIASA scholars from diverse backgrounds.

Meetings

The first joint session of the International Simulation and Gaming Association, ISAGA, and the Annual Gaming Seminar of the Council for Mutual Economic Assistance was held in Sofia, Bulgaria under the auspices of IIASA's Bulgarian National Member Organization. The joint meeting grew out of contacts developed during a gaming project at IIASA. A limited edition was prepared for the conference of *Operational Gaming: An International Approach* edited by Ingolf Ståhl, who led the project, before its publication by Pergamon Press in the series *Frontiers of Operational Research and Applied Systems Analysis* edited by IIASA alumnus Rolfe C. Tomlinson. IIASA's Dr. Isak Assa, from the Institute for Social Management in Bulgaria, was elected Chairman of ISAGA.

A meeting of senior agricultural policy advisers and analysts suggested a large number of policy issues for analysis using the system of linked national agricultural policy models developed by the Institute and its collaborating institutions. It was agreed that IIASA gives high priority to investigating the effects on different countries, groups of consumers, and farmers of eliminating current protective agricultural trade practices, an issue expected to be at the center of many international negotiations in 1984. A workshop is planned in January 1984 to present the results of this investigation.

A month-long course on Adaptive Environmental Assessment and Management detailed the workshop and modeling approaches developed over the past decade's experience at IIASA and in North America to assist those responsible for developing and managing renewable natural resources.

Officials of international private firms and public enterprises met with researchers to investigate fair and economically efficient ways to share joint costs for common-use facilities. This is a continuation of earlier IIASA mathematical and gaming work on allocating the joint costs of water supply networks among several adjacent municipalities.

A course on partial least square soft modeling of socioeconomic phenomena was given by visiting Professor Herman Wold of the University of Geneva, Switzerland, and Dr. Jan-Bernd Lohmöller of the University of Berlin (West). Professor Lennart Bodin of the University of Örebro, Sweden also reviewed the current stage of algorithm developments to estimate parameters of interdependent systems.

Economists and other social scientists met to discuss structural change in the service sector, using a comparative institutional approach. Particular topics of discussion were quality control and institutional innovations in all the social services.

The International Negotiations Project held a two-week Summer Study. Attended by researchers and practitioners from several countries, the study concentrated on national styles of negotiation, negotiating technical issues, and crisis management. Another meeting is scheduled for October 1983.

MacArthur Foundation Award

Dr. William C. Clark, of the Institute for Energy Analysis in Oak Ridge, Tennessee, USA, has been honored by the John D. and Catherine T. MacArthur Foundation. Dr. Clark worked at IIASA on the adaptive management of environmental systems. His most recent books are *Carbon Dioxide Review*, which he edited for Oxford University Press, and *Redesigning Rural Development: A Strategic Perspective*, written with Bruce F. Johnston (Johns Hopkins University Press) and based on work initiated at the Institute.

Dr. Clark is the second IIASA alumnus to become a MacArthur Prize Fellow since the program began in 1981: he joins mathematician Dr. Joel Cohen, now at Rockefeller University, New York City, USA.

New Titles

International Series on Applied Systems Analysis

Volume 11 **National Perspectives on Management of Energy/Environment Systems**. Wesley K. Foell and Loretta A. Hervey, Editors. 357 pp.

Descriptions of energy/environment management practices in twelve countries show a range of responses to a common problem.

The techniques used to analyze national energy demand and supply and to assess environmental effects are presented by national analysts, with explanations of how these are incorporated into a country's institutional structure and decision making process. The nations discussed are Austria, the Federal Republic of Germany, Finland, France, the German Democratic Republic, Hungary, Italy, Japan, Poland, Sweden, the USSR, and the USA.

There is also a retrospective look at earlier IIASA regional case studies in Austria, the German Democratic Republic, the Rhône-Alpes region of France, and Wisconsin in the USA. One example of policy transfer within this IIASA project was the adoption by Wisconsin of a French electricity pric-

ing approach leading to a time-of-day variation in cost. These regional case studies were described in Volume 5 of this series in 1979: W.K. Foell, Editor, **Management of Energy/Environment Systems: Methods and Case Studies**.

Volume 12 **Mathematical Modeling of Water Quality: Streams, Lakes, and Reservoirs**. Gerald T. Orlob, Editor. 538 pp.

The authors deal, comprehensively and clearly, with the art and practice of water quality modeling of freshwater resources – the basic principles upon which it is based, the practical problems in conceptualizing real-world phenomena in model form, and the use of models as aids in decision making.

Most of the book is devoted to specific applications of well-documented models, after a thorough review of model development procedures and the mathematical and scientific principles involved in this field. Basic formulations are presented as well as some of the most recent work in modeling toxic substances to evaluate their effects on the aquatic ecosystem and the most current quantitative statement of the component heat fluxes at the air–water interface. There are comparisons between simulated and observed measures of response.

The emphasis on useful models leads to candid summaries of their capabilities and limitations as necessary elements in environmental and resource management.

Available from John Wiley and Sons Ltd., Baffins Lane, Chichester, West Sussex PO19 1UD, UK, or John Wiley and Sons Inc., 605 Third Avenue, New York, NY 10016, USA.

Uncertainty and Forecasting of Water Quality. M. Bruce Beck and Gerrit van Straten, Editors. 386 pp.

"It is clear that the uncertainties in a model and its predictions are a function of how the model has been identified and calibrated." The authors present applicable measures – traditional and nonconventional – both for identifying (calibrating) water quality models from uncertain experimental data and for analyzing prediction error propagation.

Emphasis is on the interaction between developing approaches and methods and their application to specific cases, primarily eutrophic lakes in Europe, Australia, Japan, and North America. The problems of analysis generated during the actual case studies provide the material for methodological developments and the synthesis of a framework for modeling and forecasting environmental systems behavior.

There are critical discussions of Monte Carlo simulation techniques, recursive and off-line estimation and filtering algorithms, real-time forecasting, and the group method of data handling (GMDH).

Available from Springer-Verlag, Tiergartenstrasse 17, D-6900 Heidelberg, Federal Republic of Germany, or Springer-Verlag New York Inc., 175 Fifth Avenue, New York, NY 10010, USA.

Processes and Tools for Decision Support. Henk G. Sol, Editor. 267 pp. Proceedings of the Joint International Federation for Information Processing WG 8.3/IIASA Working Conference held at IIASA in July 1982.

This includes both theoretical work in such disciplines as artificial intelligence and decision theory and the practical experiences of those who have designed and established decision support systems. It moves from underlying theory and concepts to several design problems to case studies of specific applications.

Descriptions of nonspecific decision support systems cover the Carnegie-Mellon Robotics Institute's Intelligent Management System to explore ill-structured problems by means of heuristic problem-solving techniques; the decision table generator PRODEMO for procedural decision making in well-structured situations; OPTRANS in which the user assembles his own system from the modules provided; and an IDAMS system using the programming language APL which also allows implementation and modification by the user.

Available from North-Holland Publishing Co., P.O. Box 211, NL1000, AE Amsterdam, the Netherlands, or Elsevier Science Publishing Co. Inc., 52 Vanderbilt Avenue, New York City, NY 10017, USA.

Research Reports

RR-83-14 Investigation of the Stability of Satellite Large Angle Attitude Manoeuvres Using Nonlinear Optimization Methods. M.A.H. Dempster and G.M. Coupé. Reprinted from Proceedings of the IFAC/ESA Symposium on Automatic Control in Space, ESTEC, Noordwyk, the Netherlands, 1982.

RR-83-15 The Logic of Standard Setting: A Comparative Perspective. I. The Uncertain Logic of Standard Setting. II. Prevention and Health Standards: American, Soviet, and European Models. G. Majone. I. Reprinted from *Zeitschrift für Umweltpolitik*. II. Reprinted from *Journal of Health Politics, Policy and Law*.

RR-83-16 The Ergodic Theorems of Demography: A Simple Proof. W.B. Arthur. Reprinted from *Demography*.

RR-83-17 Estimates of the Disequilibria in Poland's Consumer Markets. L. Podkaminer. Reprinted from *The Review of Economics and Statistics*.

RR-83-18 The Automobile in a System Context: The Past Eighty Years and the Next Twenty Years. C. Marchetti. Reprinted from *Technological Forecasting and Social Change*.

All IIASA publications can be ordered from the Publications Department, IIASA.

Guest's Corner
Big Problems and a Small Institute

The world's problems are big, and IIASA is small. Its staff by itself at Laxenburg cannot hope to assure that the Institute has the far-reaching effects that it should. The Institute in its first decade has done its job and has proved the wisdom of its founders. It has produced valuable research and attracted new members; it has shown that it is no unrealistic dream, but is a model that should be built upon. That expansion is a task that has to be shared by the National Member Organizations – the task of organizing and working hard to bring more and more people into contact with IIASA and its ideals and, through IIASA and its research, with their counterparts in other NMOs and nations. It's a big task.

Particularly today, when budgets are suffering a degree of contraction, a major, immediate part of meeting this task must be the initiation and support of more and more research outside of IIASA that complements IIASA's research – especially in those areas where IIASA's resources are stretched thin. It is up to us, the NMOs, to work with everyone at IIASA to identify what complementary research we can organize at home to best assist the Institute's needs. Then we must make it happen – get the right researchers involved, get the funding, handle the red tape, and facilitate the coordination between IIASA and the NMO support. The more we can do, the less we dilute the effectiveness of IIASA's critical in-house research resources.

The founders of IIASA debated the nature of the institution to be created: should it merely be a coordinating agency and meeting place for work done elsewhere, or should it feature a vibrant in-house research activity? In my opinion, although we were right in opting for the latter mode of activity initially, in the next decade I believe we need more of the former but *not at the expense of the latter*. Indeed, a constructive networking policy should not be initiated without supportive in-house coordinated research. If we embark on a path of more vigorous networking relationships, this should enhance rather than diminish the quality, and yes, the quantity of in-house research. But with fixed finances how can both be achieved? The answer is that finances are not fixed. I fervently believe that such a policy would generate additional funding and if IIASA is to fulfill what I believe should be its updated aspirations, then we should move in this direction.

For the most part researchers at IIASA are appointed for limited time periods – often for periods that are too short to make significant impacts on the problems they are addressing. Hence IIASA now has, and always has had, a problem of continuity of research effort. If appointments were to be made only for long periods of time, however, this would seriously limit the pool of qualified researchers. One way around this impasse is to have researchers periodically returning to IIASA and working part-time at home in the interim periods on IIASA-related activities – supported, hopefully, not by IIASA funds but by additional funds generated by the NMOs. This is not a novel idea; it is already being done to some extent. But we should experiment with moving further in this direction in coordinated networking activities. This imposes additional financial and administrative obligations on the NMOs, but ones they should welcome.

There are, of course, dangers in an expanded scientific networking policy. Research directions could become more fractionated than they are now; quality control could diminish; activities in NMOs that would have been done without any IIASA connection might now be charged to IIASA-related accounts; and more besides. All this could happen; but we must see to it that this will not be the case. It is a matter of learning how to administer such a program. Perhaps we should start modestly and only grow in these directions if the experiment appears to be working. But if we are to make a dent in the real problems of the world, we simply must tap the vast reservoir of talent of those who cannot physically come to IIASA for extended periods of time but who could come periodically for shorter periods and who could work on selected problems at home in a coordinated fashion with others at IIASA. As long as we have a vigorous in-house research and coordinating activity at IIASA we should be able to master the systems problem that networking presents. It could not have been achieved a decade ago; it has already been accomplished in a modest way in the last five years; let's push further in this direction, in an experimental fashion with careful monitoring, in the next few years.

Professor Raiffa, Frank P. Ramsey Professor of Managerial Economics at the Graduate School of Business Administration and the John F. Kennedy School of Government at Harvard University, USA, was IIASA's founding Director.

At the American Academy of Arts and Sciences our Committee for IIASA, under the chairmanship of Professor Harvey Brooks, is now organizing itself to facilitate such an expanded networking role. To do this we have to exploit creatively the growing number of IIASA alumni who are eager for renewed, meaningful, continued involvement in IIASA. We have available many dedicated and capable researchers who believe in the ideals of IIASA and who want to help. Our challenge is to organize their activities in ways that will enhance the research efforts at IIASA. Our expressed aim is not to divert intellectual activities from IIASA but to deepen and support the in-house research activities. It is my assessment that this effort will help rather than hinder our ability to raise additional financial support for research at IIASA.

After a decade we have reached a plateau of activity that cannot be a comfortable resting place for the next decade. We have to aspire higher; higher quality, more relevance, more worldly impact. I believe that this can best be achieved if the NMOs organize their own internal infrastructures to encourage more collaborative networking.

Howard Raiffa