

Population and the International System: Some Implications for United States Policy and Planning

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CONTENTS

The Problem: Political Consequences of
Population Growth 253

Energy Production: The Interactive Effects
of Population Growth and Advances in
Technology 254

Environmental Resistance: Pollution and
Resource Depletion 255

Effects of Population and Technology:
National Institutions and International
Behavior. 256

Expansion, Conflict, and War 259

International Implications: Dependency
Relationships and Major Power Competition . . 267

Future Perspectives: Some Implications of
Scientific Innovations 270

Future Perspectives: Some Imperatives of
Systemic Change 273

REFERENCES 276

Population and the International System: Some Implications for United States Policy and Planning

Politics has been defined in the past in terms of who gets what, when, and how.¹ Such a definition was adequate as long as goods and services were perceived as being created and exchanged in the absence of any direct ecological constraints. Today, it is evident that politics refers to decisions by human beings about the control, allocation, and distribution of resources, and the manipulation and utilization of the natural environment. And since resources and the planetary environment are finite, the size and growth rates of human populations are basic variables, as are the levels of their knowledge and skills. In these terms, politics not only bears on ecology, but will increasingly involve the regulation and management of population growth and distribution, of resource usages and allocations, and of technological advancement and applications.²

This paper will present a partial theory linking population growth, advances in technology, and availability of resources with considerations of domestic and international politics. It will also provide empirical data to show the strong influence which levels of population and rates of population growth, in combination with the other initial variables, have had upon the international system, and upon the United States and other countries within the system. From this evidence, it will then be possible to evaluate the problems that confront us and propose some major considerations and specific recommendations for the future. By describing and documenting the network of interdependencies involving the size and rates of change of national populations, we shall try to elucidate some of the other problems that the United States is likely to confront if certain current trends persist.

In undertaking this task, we shall bring together important concepts, assessments, and evidence already put forward by scholars in a number of disciplines and indicate the ways in which they bear upon the control and distribution of resources, international competition and conflict, arms races, and war. In addition, we shall draw upon quantitative data from our own studies which document several of the complex relationships involved and suggest lines for further investigation, analysis, and action.

THE PROBLEM: POLITICAL CONSEQUENCES OF POPULATION GROWTH

If one surveys all the major changes for which man has been responsible over the millions of years of his existence, they seem to emerge from two primary sources: changes in his numbers; and changes in his technology, or knowledge and skills, including his ability to organize socially, politically, and economically. But none of these changes would have been possible without a wide range of resources from the earth. The full meaning and implications of the population problem for the present and future thus depend upon close interdependence of population with technology and resource variables.

The long-term increase in human population has been spectacular, but a large part of this growth in numbers has come about in comparatively recent times. Over the centuries, the rate of human population growth increased slowly—almost imperceptibly at first—then somewhat faster, and now at a rapid rate. One or two million years ago, the human population may have numbered about 125,000 individuals.³ By 10,000 B.C., the numbers may have increased to around one million people.⁴ At this moment, the population of the world is increasing at the rate of 50 million a year, 140,000 (the size of a small city) every 24 hours, 6,000 per hour, or, as pointed out by Sir Julian Huxley, at the rate of “ten baseball teams complete with coach every minute.”⁵

The situation might be much worse than it is. If it were not for various checks on human population growth—limitations imposed by local food supplies, disease, floods, earthquakes, wars (to a lesser extent), and other phenomena—“the living descendants of the 10 million persons who lived 7000 years ago would be astronomical in number—indeed, they would weigh more than the combined weights of all the stars in our visible universe.”⁶ In spite of these adjustments, however, the levels and growth rates of the world's population have put strains upon many natural resources and, in some localities, have damaged the environment in ways that make living conditions less agreeable and sometimes hazardous. But there are other implications—political,

economic, and social—which make population problems one of the most urgent considerations of our time.

The key variables in this report are population, technology, and resources. A combination of growing population and developing technology places rapidly increasing demands on resources, often resulting in domestically generated pressures—that is, a tendency to extend activities outward. The greater the pressure, the higher will be the likelihood of extending national activities outside territorial boundaries—provided the society has achieved the capabilities to do so. To the extent that two or more countries with high capability and high pressure tendencies expand their interests and psychopolitical borders, there is a strong probability that sooner or later the two opposing spheres of interest will intersect.

The more intense the intersections, the greater will be the likelihood that competition will assume military dimensions. When this happens, we may expect the competition to be transformed into conflict and perhaps an arms race or crisis. At a more general level of abstraction, provocation will be the final act that can be considered as the stimulus for large-scale violence or war. Major wars often emerge from a two-step process: in terms of internally generated pressures; and in terms of the reciprocal comparison, competition, rivalry, and conflict on a number of salient dimensions. Each of these two processes tends to be closely related to the other; and each, to a remarkable degree, can be accounted for in terms of relatively nonmanipulable variables (such as population growth) or variables that are controllable only at high cost.

Analyses of linkages involving population, technology, resources, capabilities, and violence are only a first step. The projection of current trends into the future represents a second step. A third step might involve the generation of large numbers of alternative probability statements on an “if this, then that” basis.⁷ There are many uncertainties, but to date this much is clear: The population of the world is growing rapidly. According to some calculations, “. . . only about 100 years is required to reach a 40 billion population, which will require about ten times the existing facilities just to maintain the present quality of life.”⁸

Technological changes have also been spectacular in recent decades and, short of nuclear devastation, the trend is almost certain to continue. In the future, technology will bring both great benefits and serious dangers to the United States, to other societies, and to mankind as a whole.⁹ The problem is to identify and make explicit the interactive effects of population, technology, resources, capabilities, and violence, and find ways in which undesirable outcomes can be brought

under better control. This is an effort, the magnitude and implications of which appear to have no obvious precedent. We cannot afford technologies which continue to advance indiscriminately, without consideration for side effects or gross damage to the environment.

Our view of technology in the past has tended to be nondiscriminating and oversimplified—almost tantamount, in our minds, to unlimited resources. Such an assumption is dangerously incorrect. As human populations grow and as techniques advance, it seems increasingly possible that man may so alter his surroundings that he can no longer survive in them; it is also plausible that—by making the correct choices—he may enhance the rewards of living beyond most past expectations. But whether or not he will make the right decisions soon enough is still uncertain.

ENERGY PRODUCTION: THE INTERACTIVE EFFECTS OF POPULATION GROWTH AND ADVANCES IN TECHNOLOGY

Although modern man often likes to think of himself as master of his physical environment, many developments of recent times have reminded him that he is still a creature of his surroundings. Man cannot damage his environment or even alter it without risking injury to himself or his children or grandchildren.

Man (and indeed all animal life) operates, day by day, as part of complex food chains, which include plant life that depends on soil, water, and sunlight;¹⁰ on substances from animals that eat plants (or that eat other animals that eat plants); and so on.¹¹ To the extent that man occupies a relatively high level in a given food chain, there is considerable degradation through transfer up to the point where he acquires nourishment.¹²

The demands and drains of a single individual or a few individuals upon a bountiful environment would appear negligible: Relatively speaking, the amount of degradation will not have much effect upon the natural surroundings. If the number of people are increased, however, until there are thousands or even millions where only a handful lived previously, then the requirements of food and other resources will begin to place a considerable drain upon the energy sources. However, man has been able to acquire other, harder-to-get materials through practical application of his technology, or knowledge and skills. Historically, he has depended upon energy in various forms to do much of his work.¹³ The larger a society's energy support, the more energy is available to help people organize themselves for difficult, more or less cooperative tasks, including efforts at modifying and controlling the

surroundings in various ways.¹⁴

In the physical sciences, energy is a term referring to accumulated mechanical work. Each transfer of mechanical energy—like each transfer of energy in a food chain—involves some amount of degradation from a more usable to a less usable form. There are various measurements of mechanical energy: Oil and other fossil fuels, for example, are often assessed in coal equivalents. Ultimately, however, all types of mechanical energy are measured in terms of work. Each transfer of mechanical energy—like each transfer of energy in the food chain—involves some amount of degradation, even when energy is used for positive purposes such as irrigating a desert, or cleaning up yesterday's pollution. Some applications, such as the explosion of nuclear weaponry, are wholly degrading of energy in that they do not help produce food, clothing, or any useful artifact, but instead destroy plant, animal, and human life and, at the extreme, might render large portions of the earth virtually uninhabitable for human beings.

For millennia, man had to use his own muscles or those of his slaves or beasts of burden. In low-energy societies, there was little surplus for community innovations or other complex organizational activities. Whatever was available had to be used for mere survival.¹⁵ The substitution of mechanical energy for animal and muscle power made it increasingly feasible to tap resources which would otherwise be unreachable.¹⁶ Generally, however, it was only with the invention of the steam engine that the use of mechanical energy began to increase significantly. Other types of motive power were developed thereafter.¹⁷ With these changes in technology, the importance of the manmade factors of production (such as capital and skills) has tended to increase relative to the importance of the few natural facilities which once were the only ones that more primitive techniques could support.¹⁸ Every such practical application of knowledge and skills requires resources from the environment. The more advanced the level of technology—from the stone axe to the nuclear reactor—the greater the variety and quantity of resources that are likely to be demanded.¹⁹

In general, we may expect this trend to continue—although, as we shall note further along, future developments in nuclear technology may bring about some notable changes. But up to now, at least, the more advanced the level of technology in a given society, the greater the range and quantity of things the people perceive themselves as needing, and the greater, also, the capability of such societies to secure disproportionate shares of the world's total available basic resources.

At least some advances in technology yield greater economies in the transfer and utilization of primary

energy,²⁰ that is, greater utility of output is achieved for each unit of resource input.²¹ The efficiency of a machine is the ratio of the mechanical work done by the machine to work done on the machine. Overall, however, *each major development in technology has tended to catalyze innumerable others*—each requiring resources, whether for structure (machines, tools, plant equipment), for fuel (wood, coal, oil), or for processing (wool, cotton, iron ore, raw rubber, and so forth); and *each development has placed an added burden on the natural resource base.*

ENVIRONMENTAL RESISTANCE: POLLUTION AND RESOURCE DEPLETION

The highly industrialized countries of today have been developing and applying science and technology with little serious thought for how this activity has affected—or may in the future affect—their own ecologies or the world environment in terms of pollution and resource depletion.²² Much of what we call production involves, in fact, extraction which depletes resources and leaves scars upon the earth.²³ Pollution and depletion should not be confused. The former is the outcome of defiling or corrupting the air, water, soil, or other aspect of the environment either by human beings directly or as the result of their technology; the latter refers to the exhaustion of a given resource or of the more readily available supplies or deposits of a given resource. This is a global problem which is exacerbated by population growth.

A large increase in the world's population—especially as it is coupled with advances in technology—will increase demands for food, fertilizer, farm equipment, water, irrigation, industrial raw materials, transportation and communications equipment, medical supplies and facilities, and so forth. This implies increased demands for electricity, oil, and other forms of primary energy,²⁴ as well as metals, fibers, and the like.²⁵ Such demands tend to create a vicious cycle, in that greater energy consumption implies increasing industrialization for material goods and services which, in turn, results in the further consumption of nonrenewable resources.²⁶ This is not to suggest that we have already exhausted nonrenewable reserves, or that they are about to be exhausted. But if current trends continue, it will be necessary to process materials that are less accessible or of lower grade; and costs—both in monetary terms and in damage to the environment—will tend to rise. By making critical resources more scarce or more expensive, such destructiveness in a given locality—along with rising demands and capabilities—is likely to aggravate the tendency of people to extend their activities beyond home boundaries in search of new

materials. Under such circumstances, competition for nonrenewable resources is likely to increase; and it will probably be necessary to reassess production priorities, budgetary allocations for research and development, and national policies that depend on access to critical materials.²⁷ Also, since resources are not evenly distributed, the search for new supplies will almost certainly aggravate great power competition over access to and control over sites—such as oil-rich regions of the Middle East, Latin America, East and Southeast Asia, the Arctic or the ocean floor—some of which previously were not considered vital.

The production, conversion, and consumption of energy are responsible for a large part of our environmental problems.²⁸ Environmental resistance takes on many forms. Mankind is taxing the capacity of the rivers, lakes, oceans, and atmosphere to absorb and to transport away from areas of high population density the enormous amount of waste exhausted into it.²⁹ For example, the major sources of air pollution in the United States are transportation (59.9 percent), industry (18.7 percent), electricity generation (12.5 percent), and space heating (7.8 percent), amounting to a total of 125×10^6 metric tons per year.³⁰ Urban buildings, streets, and other pavements which are considered essential cover the soil and prevent its use for food production.³¹ Furthermore, the effects of population increases and indiscriminate production affect water consumption and the quality of water. Beyond this, there lies the further paradox that recycling and the replacement of waste disposal with waste conversion exact their own costs in that energy will be required.³² Indeed, large amounts of energy-producing and other resources will have to be used to clean up the air and water, refurbish soil, and recycle wastes. This means that *differential levels and rates of resource usage and extraction and critical elements in assessing national demands, capabilities, lateral pressures, and competition for (and possibly conflicts over) resources*. Rates of resource extraction and usage also give rise to differential levels and rates of usage and depletion, and also to differential levels and rates of environmental resistance and related diseconomies. *Thus, in the world of the late twentieth century, pollution and depletion rank along with population, technology, and resources as master variables requiring measurement and regulation by one means or another.*

These considerations suggest the desirability of applying sustained cost-benefit analyses to various specific uses of technology to determine whether or not the outcomes justify the depletion, pollution, or other environmental and human costs incurred. As a part of such an undertaking, we need to find out which sources of energy production are most polluting—or which types

of pollution are least intolerable in terms of the costs and benefits associated with each. This type of analysis—like all investigations and assessments of population-technology-resource relationships—should be done in a worldwide context in order to reveal any differential effects (including those involving conflict and potential violence) from country to country and region to region.

EFFECTS OF POPULATION AND TECHNOLOGY: NATIONAL INSTITUTIONS AND INTERNATIONAL BEHAVIOR

Very little systematic research has been done on the long-range effects of population, technology, and access to resources on values, custom, law, domestic institutions, and forms and procedures of government; and whatever is formulated about such relationships must be accepted as largely hypothetical, if not speculative. It appears certain, however, that if patterns of authority are inconsistent with the hard facts of budgetary distribution the system will fail. Similarly, if technology is applied inappropriately in terms of population or available resources (for example, if a complex of steel mills is built without an available labor force, or where appropriate fuel is not available at any tolerable cost) the application will, again, most certainly fail.³³ *To a large degree, the politics of a society, as well as its economics, will depend on its prevailing technology, on who controls its primary energy and other resources (and by what means), and on its budgetary distributions and other major allocations.*

Over centuries, increases in the numbers of people and advancements in technology have contributed directly to more complex divisions of labor, and to the need for more laws, more elaborate methods of enforcement, more elaborate systems of organization, vastly larger bureaucracies, larger and more complex military establishments, and incomparably more lethal weapons.³⁴

Both the numbers of people and the characteristics of the prevailing technology influence the way a society organizes itself. Particular technologies require particular divisions of labor which often become institutionalized, affecting how people live and often providing the structure for economic, social, and political hierarchies. Even the form of government will be affected by the size and density of the population and by the technology and the work people do. As population increases, the percentage of the population in cities tends to increase; and this tendency affects living styles, facilitates communications, encourages new technologies, and requires new forms of organization and regulation.³⁵

At the same time, however, the growth and densities

Governance and Population:
The Governmental Implications of Population Change

of human populations are influenced by opportunities available for economic growth,³⁶ and by the modes of resource control and management. Population concentrations can, to a very large extent, be explained by the level of technology of a society, by territorial size, by trading relations, and by the nature of the indigenous resource base.³⁷ Feedback effects operate from population, resources, and technology to politics, and from politics, culture, and society to these more aggregate and basic master variables. Any marked or significant changes in either the master or the institutional variables will have reverberating effects throughout the system as a whole. Part of the problem lies in the fact that, without the assistance of high speed computers, it is very difficult to appreciate or understand the full implications of continuing trends and/or of strong modifications or reversals. Moreover, the long time lags involved make it even more difficult to recognize undesirable effects of technological developments or of population growth. And once the interactive feedback dynamics are set in motion, it is extremely difficult to slow them down or to channel them in new directions.

Increases in population force some commensurate organizational change.³⁸ Over the long sweep of human history, the increasing numbers of people have required the development of new institutions and forms of societal regulation and control: Early band and tribal forms of governance become wholly inadequate as the numbers of people surpassed certain thresholds. Growing populations create new problems for both local and national governments. *And to the extent that the world population continues to increase as projected, we may expect further strains on political, social, and economic institutions on all levels, including national governments.* This means that current and future increases in the world's population will require the modification of many institutions and the development of new social, economic, and political forms.

Much the same thing can be said about technology. Advances in knowledge and skills—often a kind of social learning—stimulate change and tend also to provide the techniques of organization, production, transportation, communication, commerce, and finance that are required as human demands, tasks, and expectations become greater and increasingly complicated. Advances in technology, like increases in population, give rise to new divisions of labor (which tend to become institutionalized), new styles of government, new methods of warfare, new forms of military organization, and new weapons. These tendencies have characterized human history as far back as we can trace; and *there is every reason to believe that future advances in technology will also require the modification of many institutions and*

*the development of new social, economic, and political forms.*³⁹

During the Old Stone Age, the largest human organizations were hunting and gathering bands of from 80 to 150 or so people.⁴⁰ Later, as populations grew and as people acquired new knowledge and skills, bands became inadequate regulators of affairs and were often integrated into tribes.⁴¹ Still later, however, tribal forms were no longer adequate for regulating the larger communities that came about partly because of further increases in population and partly because additional advances in knowledge and skills made it feasible for more people to live together and sustain themselves in an appropriate locality.⁴² Chiefs in these larger, more advanced communities functioned as redistributors, increasing the exchange of produce or artifacts obtained by different specialists, such as fishermen, hunters, gatherers, and farmers.⁴³ But even these "superchiefs" lacked the authority and coercive power required as communities became still larger and more complex. Thus, in many societies, they gave way to kings, who enjoyed monopolies of armed forces enabling them to back up their rulings and decisions with coercion or the threat thereof. Then, as now, *those who achieved control over the acquisition, control, allocation, and distribution of resources tended, directly or indirectly, to exert political and military power as well.* Or, conversely, those who sought power by military or political means had to increase their control over resources or risk losing whatever power they had temporarily gained.⁴⁴

Arnold Toynbee has indicated how the Athenians, in seeking to provide for increasing numbers of people, solved their problem economically but, in so doing, created a new political problem which they failed to cope with successfully:

The Athenians had discovered how to solve the Hellenic problem of overpopulation by an intensification of economic productivity through specialized production for export; and through this discovery an economic problem received a complete economic solution. But this economic solution of an economic problem at once created a political problem which could only be solved on political lines. For the economic change from a system of local autonomy to a system of intercourse and interdependence demanded a corresponding change on the political plane. An inter-city-state economy could not be carried out effectively without the provision of some kind of political framework in the shape of an inter-city-state regime of law and order. The

Athenians failed to respond successfully to this political challenge which arose out of their successful response to the foregoing economic [and demographic] challenge, and this failure resulted in the breakdown and disintegration of the Hellenic Civilization.⁴⁵

In this last respect, at least, the Romans were more successful than the Greeks. The food requirements of increasing populations on the Italian peninsula, combined with demands generated by Roman technological genius, gave powerful impetus to Roman commerce and conquest. As Roman capabilities increased on military and other critical dimensions and as their power was extended, the Italian peninsula suffered depredation from overgrazing, denuding of forests, soil erosion, and neglect of rational agriculture. For a time, this wastage contributed to foreign conquest, domination, and exploitation; but in the longer run, it rendered the Empire "hollow" at the center, and probably contributed much to its downfall. In contrast to the Greeks, however, Roman leaders achieved an effective political response to the economic and demographic challenge: The Empire, consolidated and enforced through Roman legions and law, provided a vast and dominating framework for Roman efforts (lateral pressure) extending from Gibraltar to Mesopotamia and from Egypt to Britain. Today we face a problem somewhat analogous to that of the Athenians, in that international political institutions are not adequate to support and protect the worldwide economic and other functions that are being performed.

Any strong environmental feature or any peculiarity of population, technology, or availability of resources that stimulates recurrent behavior—especially perseverant interactions among numbers of people—influences a society's customs, laws, institutions, and other domestic structures. And these, in turn, shape and constrain behavior, control resource distributions, and regulate relations established in part, at least, by divisions of labor.⁴⁶

The overall demands of a society represent some blend of consumer demands and demands of industry and government. Theoretically, if individuals in a society make no demands, there will be no external activity, nor will there be any given activity unless the appropriate specialized capability has been developed to carry it out. (Thus, a society with no navy will not fight a Battle of Trafalgar.) China at the beginning of the twentieth century may be viewed as a society generating high demands but lacking the specialized capabilities for meeting them. On the other hand, a combination of high demands and highly advanced specialized capabilities

may be expected to yield high levels of both domestic and external activity.

These considerations suggest that *the behavior patterns of a society will be powerfully influenced by the physical environment (climate, terrain, resources), the demands which the people make, the prevailing level of knowledge and skills, and the investments that are made in particular specialized capabilities.*

The total demands of a society, when combined with the specialized capabilities that have been developed, will exert a powerful influence upon the activities that are, in fact, undertaken. The budgetary distributions and other allocations that a society chooses to make thus provide a fairly accurate measure of a nation's operational (as opposed to its professed) values. These values may or may not be appropriate to the needs, demands, and fundamental realities of the society, but they reveal with some fidelity its basic characteristics, dispositions, and professed values. *This suggests that a change in the overall behavior of a society—or a major change in its institutions—is not likely to take place unless a major change has taken place in budgetary distributions and major resource allocations.*

Social and economic hierarchies within a society are often gradually internalized by large numbers of the populace, thus becoming part of the conscience collective—a sense of shared values, reciprocal expectations, and common community—to the point where each individual becomes so totally immersed in the system that he does not question it, but may even defend it against some of his own best interests.⁴⁷ So, too, whole societies may internalize the rationale of their exploiters or despoilers for long periods of time. It is a commonplace of history that peasants and other politically or economically oppressed people have often rendered deep loyalty and even devotion to the monarch who has taken advantage of them. In this way, the differential capabilities, the differential accesses to resources and benefactions, and the consequent hierarchies (political, economic, and social) may become mirrored in the consciousnesses of large numbers of people in a society to the point where major changes in such arrangements and relationships are difficult to achieve.

The strength of a society's conscience collective can be assessed, in part, by the extent to which it shapes or constrains individual behavior and the behavior of the society in relation to its external environment. Societies depend upon such tendencies in order to maintain stability and integrity; but, if the population-technology-resource balance is severely altered or if other major changes take place, the old institutions and

habit structures may become increasingly dysfunctional.

The operational values of a nation are strongly affected by its levels of population, technology, territorial size, and access to resources. The values of a society are also profoundly influenced by the prevailing technology—whether it is agriculture, commerce, or other—and by that technology's particular modes and requirements.

Democratic processes—including political negotiations and bargaining, concepts of political equality, elections, and jury trials—seem to have developed most frequently in societies where commercial techniques and practices were highly developed. In ancient Athens, for example, emergent political practices were roughly analogous to many practices of the market place. On the other hand, as Toynbee suggested with respect to Athens, commercial societies seem to have had difficulty in expanding without the fracturing off of their colonies or offspring towns into independent city-states. Notable exceptions to this general incapacity include England and a number of similar societies where growing commercial elites have succeeded in developing an institutionalized *modus vivendi* with sectors of a powerful agrarian elite.⁴⁸

The demands which a society generates—both the level and the nature of what is demanded—and the specialized capabilities which have been developed will help determine what role the country will play in the international system. A comparison of a country's demands and capabilities with the demands and capabilities of other countries may also reveal whether it is a status quo power, or whether it tends to challenge the prevailing system. Moreover, a major change in a country's capabilities relative to the capabilities of other countries will force a change, sooner or later, in the role it is able to play. In general, those societies (and those sectors of a given society) which are more effective in their employment of technology, development of specialized capabilities, and ability to acquire resources, are likely to dominate those which are less effective. And societies with high population growth and lagging technology—such as China in the late nineteenth and early twentieth centuries—are vulnerable to penetration by countries with greater capabilities.

Major changes in the population-technology-resource balance of a society (or in the prevailing technology) force changes in operational—if not in professed—values. If rates of change in population and technology are sufficiently rapid, the strain is likely to be felt in terms of the individual psyche; and institutional change in the society as a whole is likely to lag quite far behind technological change and population

growth. Times of rapid change thus require special ingenuity and effort if values, customs, laws, and institutions are to be adequate for human needs and feelings of well-being. Thus, a new, rapidly growing, but still relatively unimportant nation is likely to reveal operational values that are quite different from those of a major power committed to the status quo. At almost any stage in a country's development, however, very rapid changes in prevailing technology or fundamental changes in population-technology-resource ratios will tend to erode older values and institutions or place them under severe strain.

Current strains and loads on the political, social, and economic systems in the United States and many other countries are already very high. Even more rapid changes are likely to take place in the immediate future. The forms and practices of government will undoubtedly be called upon to meet rising needs and demands. The larger the increases in population, the greater the likely strains on existing institutions and necessity for change. Such developments will almost certainly cause disruptions in society and create a considerable gap between the old values, institutions, and practices and the urgent requirements of the new situation.

EXPANSION, CONFLICT AND WAR

A society may be unable to satisfy its demands because (1) appropriate resources do not exist domestically; (2) although present, they are too difficult to acquire economically; (3) rising and broadening demands outstrip availability; (4) domestic supplies are being depleted; or (5) some combination of these circumstances.

A large part of the activities undertaken by a society in order to meet both public and private demands will be carried on domestically. A society is likely to turn outward, however, to the extent that (1) demands cannot be met by domestically available resources; (2) such resources can be acquired more economically outside territorial limits (either directly or through exchange in foreign markets); or (3) in one specie or another, a more favorable return on investment of resources or effort can be achieved by so doing. Such efforts may take the form of such activities as exploration, discovery, conquest, emigration, commerce, or investment.

Historically, the disposition to reach outside home territory for resources has often been associated not only with population growth and advancement of technology, but also with environmental pollution and depletion of domestic resources. For convenience, we shall refer to the general inclination to extend activities as lateral pressure. Such pressure may find expression in

one mode or another—or, again, overt activity may be blocked or frustrated by some obstacle or through constraints imposed by another actor.

Such tendencies have been ubiquitous through time and across cultures. Thus, Arnold Toynbee has described how, in response to overpopulation, the Ancient Greeks sought extensions of their arable land by conquest and later, in the case of Athens, by development of commercial capabilities—with momentous consequences for the structure and life styles of the people.⁴⁹ The expansion of Rome and of many other empires in ancient times, and on down to the present, can be largely explained in somewhat similar terms.

Usually, the first disposition of a high capability society with resource (and market) needs is to extend its efforts into regions and societies where capabilities are relatively low. In part, this tendency can be explained by the expectation that competition and resistance will be lower and returns on investment higher in such regions. And the more the lateral pressure generated by a given state or empire, the greater will be its tendency to extend influence into (and often domination over) territories and countries with a lower level of capacity. Rome followed this pattern in expanding across North Africa, into the Middle East, and northward into Europe centuries later. In part, this would explain also the westward drive during the first half of the nineteenth century of a rapidly growing and vigorous United States into the Mississippi Valley and on to the Pacific. Such penetrations of low capability regions by high capability, high demand societies often give rise to important political, social, economic, and even military outcomes.

A society surrounded by countries with capabilities greater than its own—especially military capabilities—may find itself penetrated and perhaps dominated by one or another or all of its neighbors. Or it may find ways of strengthening its position through alliance arrangements. Or it may work out trade agreements which enable it to acquire resources without suffering domination by its higher capability neighbors. If none of these alternatives appears satisfactory (and if it is able), the society—like Japan in the 1930's—may undertake an extraordinary military buildup program with the hope of breaking out of its perceived encirclement.

In principle, a society can express lateral pressure in any mode it pleases provided the appropriate knowledge, skills, and resources are available. On the face of it, leadership seems to have free choice, constrained only by whatever influences the rank and file of constituents can bring to bear on policy making. In line with our discussion of the multiplicative effects of unsatisfied demands and specialized capabilities, however, we would expect that the relative amounts of knowledge, skills,

resources, and capital that a society has allocated, distributed, invested or expended—whether by individuals, by private firms and corporations, or by one or another of several branches and levels of government—in the development of different specialized capabilities will strongly influence the modes in which lateral pressure is expressed. If by far the greater amount has been invested in agriculture, for example, rather than in commerce, then lateral pressure will be expressed in terms of the acquisition and cultivation of wider expanses of arable land. In an advanced industrial society, lateral pressure is likely to be expressed in a combination of modes, but strong predispositions will be set according to how knowledge, skills, resources, and capital are invested. Over a considerable period of time, such more or less institutionalized distributions (both in terms of government budgets and private investments and expenditures) become parameters for day-to-day decisions of state.

The modes in which lateral pressure is expressed will also be strongly influenced by already established budgetary distributions and priorities, by the aggregation over time of small incremental decisions by government, and by policy shifts brought about by thrusts of decisions of implementation (as distinct from the original goal that was originally set). Moreover, the implications and significance of the demands, prevailing technologies, specialized capabilities, and lateral pressures of a given country will be affected, as pointed out above, by those of neighboring countries.

Although the vocabulary is somewhat different and the variables stated in more detail, these considerations are substantially in line with concepts put forward by other scholars. At least two major explanations are commonly offered to account for the competitions, conflicts, and violent interchanges of nations. According to one view, “. . .struggles for power arise because men are seekers of power.”⁵⁰ According to the other view, if there is competition for scarce resources but no one to serve as arbiter, a struggle for power ensues among the competitors. Thus, an “. . .absence of sufficiently powerful normative and coercive forces at the international level compels nations to rely heavily (some might say exclusively) upon their own power as a means of protecting their interests . . .”⁵¹ This means that anyone who accepts the first idea “will define national interest in terms of power, because men naturally seek power.”⁵² Anyone who accepts the second idea “will also define national interest in terms of power, but this time because under certain conditions power is the means necessary to secure the ends of states.”⁵³—whether influence, status, prestige, or security.

The implications are unmistakable: Whatever con-

tributes to or detracts from the power of a nation-state or empire will influence its definition of interests and patterns of behavior. In this respect, population size and rates of growth or decline (combined with levels and rates of technological growth and distribution of resources) are powerful factors—but not necessarily in the ways that are frequently attributed to them; that is, *a very large population may, under certain circumstances, severely detract from a country's power rather than contribute to it.*⁵⁹

For most states and empires the overriding values have involved national (or imperial) interests and survival. According to Hans Morgenthau, the "survival of a political unit, such as a nation, in its identity is the irreducible minimum, the necessary element of its interests vis-a-vis other units." This means that "all nations do what they cannot help to do: protect their physical, political and cultural identity against encroachment by other nations."⁵⁵ The modes they choose and the direction of their efforts are strongly influenced, however, by costs—not only monetary costs, but also costs in resources, effort, sacrifice, and even human casualties. Thus, whatever a country's major policies may entail—exploration, conquest, investment, colonial domination, or aid to client states—they are likely to change when the costs of pursuing them become too high or when new, lower cost alternatives are identified. For example, sometime after the Napoleonic Wars, Sweden reached the conclusion that foreign conquests were not worth the cost, and alternate political, military, and commercial policies were devised. More recently, in the late 1960's, increasing numbers of United States citizens began to feel that the costs of pursuing, by military means, the country's established objectives in Vietnam were far outweighing the benefits. History provides many other examples of ways in which mounting costs have brought about major changes in national policy.

In terms of differing national interests and international competitions and power struggles—so ubiquitous in human history—Morgenthau believes, along with many others, that as long as the world is "politically organized into nations, the national interest is indeed the last word in world politics."⁵⁶ And since the national interests of one country are often at serious odds with the national interests of some other country, many bitter and often violent conflicts develop.

Nevertheless, no matter how uniform the ultimate overriding values of survival and national (or imperial) interest among nation-states and empires, there are identifiable differences in the foreign relations of countries. These differences in behavior seem to emerge from differences in capabilities and in measures that are

undertaken in order to satisfy domestic demands. Historically, resources (population, technology, territory), trade patterns, and other modes of internal and external investments and activities have combined in various ways to yield characteristic patterns and predispositions of behavior of which the following are suggestive:

<i>Population, Resources, and Technology</i>	<i>Behavior Patterns</i>
1. Moderate and stable population; high and growing technology; "adequate" territory and resources; high and favorable trade.	Prosperous, progressive, non-aggressive society; high standards of public welfare (Sweden today).
2. Large and growing population; low and lagging technology; resources perceived as inadequate; possible large underdeveloped territory; low or unfavorable trade.	High basic demands, but low capability involving a mass society near subsistence level; disintegrated political and economic systems; "warlordism"; penetration from outside by aggressive, high lateral pressure states (China, 1912-1924).
3. Large and rapidly growing population; rapidly growing technology; resources perceived as inadequate; limited territory; low, unfavorable, restricted, or at least "inadequate" trade relative to demands.	Centralized, aggressive, militaristic society; likely to feel "surrounded," blocked; likely to seize first opportunity for expansion (Japan, 1930); Japanese trade could be viewed as high, but insufficient for rapidly increasing demand for resources. ⁵⁷
4. Large and growing population; high and rapidly developing technology, high level of resources from outside; large territory (or colonial holdings); high trade.	Great power with considerable lateral influence and pressure; strong generator of energy; prime candidate for great power competitions, arms races, and the like (Great Britain at the beginning of the twentieth century and the United States and the Soviet Union now).

The Netherlands emerges as a country with a small but densely populated home territory, a relatively high technology, and high demands. The country thus requires "large chunks of the earth's resources and vast areas of land not within its borders to maintain itself."⁵⁸ Israel and numbers of other countries represent variations on this basic model.

These diverse patterns and predispositions hold only on an extremely broad and general level; and in all cases, cognitive, affective, and other psychological factors would almost certainly perform powerful mediating functions. Historical and cultural differences (shaped in part by populations, technologies, territories-resources,

and trade patterns of the past) yield more differentiated details of predisposition and behavior. Also, the styles of operation selected by the leaders of nation-states and empires, and the commercial, diplomatic, and military theories relied upon to justify their activities, tend to change through time. These changes are associated with changes in the population-resource-technology calculus. So, too, in a general sense, major wars emerge from (1) differential levels and rates of change in population, technology, and access to resources and (2) policies which national leaders have designed in order to cope with change and achieve goals and objectives shaped, in part, by new implications of the environment.

National leaders are motivated in many ways. Enhancement of state power and the defense and furtherance of national interests are normally major goals.⁵⁹ To simplify the problem temporarily, we may view them as operating to minimize or close one (or a combination) of three fundamental types of gap: (1) a gap between resources that are "needed" or demanded and those that are actually available;⁶⁰ (2) a gap between an expectation and the reality that materializes, as, for example, when climbing productivity tapers off;⁶¹ and (3) a gap between the resources or growth rate of one's own country and that of a competitor or rival. *To the extent to which appropriate capabilities are available, each of these three types of gap may lead toward a reaching out for resources—whether domestically or beyond national boundaries or by some combination of both.* If capabilities are inadequate or wholly absent in one or more critical specializations, the tendency will be to invest in programs for their development. If this is impossible—whether for lack of resources, appropriate knowledge and skills, or other reason—the country is likely to become a victim or host, that is, vulnerable to influence, penetration, or exploitation by more powerful states.

States are thus constrained by (1) their capabilities relative to the capabilities of their rivals and (2) the willingness of their populations to support national policies. In general, "... nations will be more inwardly or outwardly oriented, depending on the mixture of incentives and restraints present in the system. . . ."⁶² More specifically, one may expect them to be more outwardly oriented to the extent that (1) demands cannot be met domestically and specialized capabilities exist for reaching outside; and/or (2) specialized capabilities are high, and significantly better returns on investment can be achieved outside, rather than at home.

In improving, or seeking to improve, its position, a country is pursuing its national interests. In terms of the individual human being, "interest denotes . . . the ensemble of an individual's chances for improving or

maintaining his position against all competitors, and thus, indirectly, the amount and effectiveness of disposition of his resources applicable to the competitive situation in which he finds himself."⁶³ In situations where resources are plentiful, competitions among individuals may have possibilities of benign outcome. *But as resources become more scarce, the competition will be transformed into conflict, and the gain of the more successful few is made at the expense of the less successful many.* Something similar can be said for nation-states and empires. The individual is usually constrained in his efforts, however, by the laws, customs, and sanctions that come to bear on him from his society and government; the interactions of nations, however, are not regulated or monitored by the force of institutionalized authority at the international level. There are, of course, many more specific gaps that could be identified.

The main point to be made here is that, in seeking to close any gaps or combination of gaps, a national leader must either use the specialized capabilities that are available to him, strengthen certain ones (perhaps at the expense of others), or develop new ones. In doing so, he draws upon the level of knowledge and skills in his society and the resources that are available. The higher the level of technology, the greater the resource extraction and utilization rate is likely to be.

To the extent that nations find themselves unable to close important gaps through trade or other relatively peaceful means, they may consider it necessary to increase their military capabilities. Other nations, especially close rivals, tend to follow suit. Such a decision may lead toward international conflict, crises, perhaps an arms race, even war.

International conflict and warfare have been accounted for in many different ways—in terms of aggressive instincts, territoriality, population growth, the search for basic resources or seaports, the protection of sea routes, psychopathological deviations, plunder and profit, a drive for imperialist control, and so forth. Some writers have emphasized grievances, competition, anxieties, tension, threats, and provocations as being of special importance. Others have stressed national power or capability, military preparedness, strategic considerations, and competition for dominance. Probably most, if not all, of these factors are relevant. The problem is to pull them together and relate them in some plausible, systematic way. The difficulties in this respect are compounded by the fact that the various causes of war tend to be intensely interactive: They affect each other in a multitude of ways and are therefore difficult to untangle and assess in terms of importance. The problem is to find out, if possible, which variables are

Governance and Population:
The Governmental Implications of Population Change

contributing most to international violence and in what proportion. The intent of this report is to take a step in this direction by presenting (1) some tentative findings of current research which suggest partial explanations, and (2) some implications and difficulties for national policies.

Our own research has revealed that differential levels and rates of population growth are critical to international conflict and violence—but only when combined in certain ways with differential levels and rates of change of technology and access to resources. This is discussed later on.

According to Alfred Sauvy, past president of the United Nation's Commission on Population, the theory "that overpopulation causes war is attractive at first sight: when men lack room they are held to feel the need to spread out and take the land and wealth of others."⁶⁴ In seeking to account for wars and conquests of the past, historians have often referred to "overpopulation" as an important contributing factor. On the other hand, it is possible to identify undeniably "overpopulated" countries which have not been expansionist or aggressive, and other less populated countries which were notably belligerent; "... wars are not due to unrest of compressed populations," according to Sauvy, "but to differences of pressure." An acutely overpopulated society is not likely to command the specialized capabilities or resources for sustained military aggression or conquest. Citing moderate rather than extreme population as a major factor contributing to war, Sauvy has drawn attention to

...the three fascist powers that started the Second World War: Germany, Italy and Japan attacked Poland, Ethiopia and China. Germany was less populated than Poland, or, more precisely, demographic pressure was smaller there. Polish miners came to work in the Ruhr, and not the reverse. Neither was Italy more overpopulated than Ethiopia: its birth rate was lower. It probably hoped to find there badly exploited natural resources that it could use to help reduce its own unemployment: but such an expedition must be financed out of the national income, with money that could be used to feed and employ more people at home. Overpopulation thus had to be moderate for war to be possible.⁶⁵

Thus, *war and conquest as responses to the proliferating demands of a growing population are feasible only to the extent that appropriate and sufficient capabilities are available or can be readily developed.* Similarly, population control, per se, does not detract from a nation's

power. In some cases, population control might enhance a state's capabilities.

The optimum of resources for political power is always higher than the economic optimum. It is only reasonable, according to Sauvy, for the attitude of a population to vary with its numbers. If the numbers of people are equal to the economic optimum, the best policy lies in the improvement of living standards. "If they equal the power optimum warlike expansion may be the course chosen." Relative overpopulation is thus more conducive to war than acute overpopulation.⁶⁶ A growing population with commensurate advances in technology not only generates increasing demands but also yields the capabilities required for effective action. But there are important qualifications.

A state like China around the last turn of century may have a large and growing population generating many demands, but may lack the knowledge, skills, and specialized capabilities for altering the situation. Today, the situation is different. Because of their increased effectiveness and capabilities, the Chinese are no longer subject to direct penetration and control. Another state may have a considerable population coupled with a reasonably advanced technology and specialized capabilities—sufficient to generate high levels of "felt" lateral pressure, but not powerful enough to overcome the constraints imposed by more powerful neighbors. *It could thus be seriously misleading to focus on a single country's levels and rates of growth in population, technology, and specialized capabilities, without reference to and comparison with the levels and growth rates of other countries.*

Historically, lateral pressure has helped generate two types of hostilities: colonial wars and wars between major powers. In the past, conquest or other acquisition of territory by high capability countries has often led to the subjugation, and even the extermination, of low capability populations. This was a ubiquitous pattern for ancient empires in Egypt, Mesopotamia, Persia, India, and China. The expansion of Rome followed a similar pattern; and a millenium and a half later, the overseas empires of Spain, England, France, and Holland resulted from comparable dynamics. In North America after the Revolutionary War, the United States extended its activities and interests westward, pushing aside or eradicating Indian tribes, colliding with Mexico and Canada, and absorbing California, Nevada, Utah, Colorado, Arizona, and New Mexico. In these terms, the dynamics of imperialism are often similar to, if not identical with, the dynamics of growth and development.

For Britain and France during the nineteenth and early twentieth centuries, the exploration of remote

African and Asian territory, the establishment of military outposts, the acquisition and administration of colonies and protectorates, and the search for possible new territories was a concern of day-to-day policy. Between them, they extended their territories over a large part of the globe. Between 1870 and 1914, Britain expanded more than three times (from an already large base) and France expanded over 20 times. Other countries tried to emulate this pattern, but increasingly there were no more territories to acquire. To a considerable extent, World War I and World War II may be viewed as outcomes on the part of less successful colonial powers to redivide the earth.

Those powers that expanded most widely were also those that were growing most rapidly in domestic population and/or technology and production. Between 1870 and 1900, the colonial populations under British control more than doubled (accompanying a slightly larger increase in colonial territory); 75 percent of the variance in this expansion can be accounted for by (1) the differential between domestic population growth in relation to home territory, (2) technological advancement, (3) the combined effects of population and technology, and (4) military preparedness.⁶⁷ The remainder of the variance—the unexplained 25 percent—may well be accounted for by conscious decisions on the part of the national leadership and policy calculations. A slight variation in this and the following percentages arises as a function of methodological and technical considerations. But with so much of the variance accounted for by relatively nonmanipulable variables, decision latitudes appear to have been considerably reduced. This expansionist tendency stood in sharp contrast to the patterns of Sweden and other Scandinavian countries, which were inclined to rely on trade rather than upon colonial acquisition for the satisfaction of needs and demands.⁶⁸ This contrast underscores the possible range of variability of external behavior associated with levels and rates of growth, technological development, and resource needs and usages. In 1960, the combined population of the Scandinavian countries was almost 10 million lower than Great Britain's population one century earlier.

Eighty-five percent of the variance in the colonial population under French control from 1902 to 1914 can be accounted for by technological advancement, the combined effects of population and technology, and increases in military capability.⁶⁹ These variables were even more significant during the earlier years when French colonial expansion was at its height. The remainder of the variance, though unexplained by these variables, is nonetheless constrained by one basic, relatively nonmanipulable master variable (technology)

and one more readily manipulable variable (defense expenditures). But, as has been pointed out above, severe constraints can sometimes operate so as to limit seriously the decision latitudes of the national leadership.

Well over 60 percent of the variance in German expansion by 1892 can be accounted for in terms of gains in home population (relative to home territory), technological advancement, and the interactive effect of population growth and industrial production. These are relatively nonmanipulable variables in that they are not susceptible to change at the discretion of political leaderships. To complicate matters even further, more readily manipulable variables, such as military expenditure and defense capabilities, are normally subject to technological, resource, and cost constraints. Today, however, political processes and interactions are becoming increasingly concerned with the regulation and monitoring of just those variables which previously have been considered nonmanipulable.

With all this expansion taking place, it is not surprising that the colonial territories and perimeters of interest of major powers have tended to intersect. During the pre-World War I decades, such confrontations—many of them taking place in distant frontiers of Africa, the Middle East, and Asia—gave rise to local conflicts and colonial wars. Great Britain became engaged in 14 such wars involving somewhere around 3,000 casualties; France had nine wars, and Germany, Russia, Austria-Hungary, and Italy, one war each at that casualty level. Other wars of the period were those between the major powers themselves, or between client states of major powers. These tended to come about somewhat indirectly. Between 1870 and 1914, Great Britain became involved in nine such wars, incurring between 3,000 and 31,000 casualties each; Russia and Austria-Hungary had four wars each on this general level; and France, Germany, and Italy each had three wars.⁷⁰

Today, the nineteenth century pattern of colonial expansion is no longer feasible. Along with other factors, the growth of population and even modest technological advances in the colonial regions made the old style of imperialism costly and difficult to maintain. Increasingly, through modern communications, colonial people developed more cohesive feelings of nationalism, organizational techniques for resistance, and greater local capabilities. With these new strengths and with the possibility of exploiting conflicts between the major powers, more and more of them were able to break out of their previous status and establish themselves as national states.

Under these circumstances, major powers after World War II—in pursuing and protecting their vital

interests—relied more and more on trade and aid programs, military assistance, relations with client states, establishment of links with local political parties and movements, and maintenance of overseas air or missile bases. Today, “Conquering a market or natural resources may be equivalent to annexing new territory.”⁷¹ These modes of external behavior and control are less costly and the returns on investments are greater than those associated with direct colonization.

As a state or empire extends influence (and hence its interests), there frequently develops a feeling among the leaders (and also often among the rank and file of citizenry) that this ought to be protected. This predisposition may thus give rise to extending military or naval forces, policing areas beyond the legal boundaries of the state or empire, and feeling responsibility for regional or even world “law and order.” With the virtual disappearance of colonial empires after World War II, *the critical issues with respect to overseas interests—whatever they may consist of—tend to be whether or not the home country is disposed and has the capability to defend them.* The extension of United States and Soviet interests into Southeast Asia and the Middle East are cases in point.

To the extent that two (or more) countries with high capabilities and high lateral pressure tendencies expand their interests and psychopolitical borders, there is a strong probability that sooner or later the two opposing perimeters of interest will intersect. When this happens, we may expect the competition to intensify and become transformed into conflict, or perhaps a so-called cold war or arms race. In such circumstances, “. . . one nation’s security must inevitably be—in an environment of relative anarchy—another nation’s insecurity.”⁷² The extension of Israeli territory after the 1967 war—rationalized in terms of Israeli security—was perceived by Egypt as a clear threat. The establishment of Soviet missiles on Cuban territory, the Chinese crossing of the Yalu during the Korean War, and the United States’ presence in Southeast Asia are other cases in point. During the late nineteenth and early twentieth century, much conflict among major powers took place in colonial regions. Something similar could be said with respect to the post-World War II period during which Soviet-American and Sino-American conflicts have found overt expression in Korea and Vietnam.

Competition—especially for scarce resources or for resources that are perceived as scarce (including prestige, influence, or power, or the more tangible resources perceived as contributing to prestige, influence, or power)—may thus give rise to hostile interactions. No matter which side starts it, the process tends to become reciprocal. “When one side criticizes, distrusts, ridicules

or denounces the other, the other side is likely to reply in kind.” The more intense the competition, the greater is the probability of a change in the character of the interactions “from insult to injury.”⁷³ Thus, competition often leads to nonviolent conflict, which leads in turn to an arms race, which may then lead to crisis, which increases the probabilities of war.⁷⁴

Such a reaction process opens the possibility that Country A’s defense operations system—undertaken for security, and not for aggressive purposes—may incite Country B to responses which will, in the long run, bring about warfare which the initial system was designed to inhibit. Such, in essence, were the circumstances under which Great Britain, Germany, France, and other European powers were operating throughout the decade or so prior to World War I.

During the 1870-1914 period, for example, each power predicated its naval policy on the naval policy of its perceived adversaries—although in various degrees and with various intensities. For Great Britain, the Three Power, Two Power, and eventually the “twice Germany” standards provided basic decision rules.⁷⁵ By the turn of the century, Germany’s decision rule was to attain—and maintain—a strength within a margin of .6 of Britain’s defense increases. Such calculations were based on specific predictions of their respective rates of change and of variable performance. This essentially reciprocal arrangement amounted, in one sense, to a loss (or self-denial) of decision latitude on the part of both (but especially the British) leaderships. At the same time, however, budgetary constraints operated so as to minimize the probabilities of marked deviations from previous patterns on the downward swing. Thus, one year’s increases tended to be matched by further increases during the next year, over and above those imposed by the reaction process or sensitivity to the adversary’s increases.⁷⁶

Even in what may be identified as an arms race or other intensely competitive situation, however, a considerable part of each country’s behavior is attributable to internal processes, such as population growth, technological development, and advancing capabilities. During the Anglo-German arms race prior to World War I, for example, each nation’s armament increases were intimately related to its own previous allocations, as well as to the allocations of the adversary. In each case, the correlations between population, technology, expansion, and defense expenditures were extremely high. The correlation coefficient between population and national income (and, in separate analyses, steel production as an indicator of technology) for each of the major powers—Britain, France, Germany, Russia and Italy—is .90 or over. The correlation between

population and the defense budget (expenditures allocated to both army and navy) is, again, over .90 for four of the five powers, and over .75 for the fifth. The correlation between national income and defense expenditures, again, is .90 or over for four powers and .78 for the fifth. These correlations drop somewhat when partialling out intervening effects, but still remain substantially high. Correlations of rates of change are considerably lower than absolute levels; and the relationships tend to be inverse rather than positive, thus pointing to the importance of differentials and imbalances in rates of increases. In each case, percentage rates of increases between advancing capabilities and defense expenditures were also revealing. Thus, the interdependencies and interconnections between internal capability variables and military expenditures illustrate the ways in which an arms race is, in fact, intimately related to and dependent upon levels and rates of growth of population, technology, and other capability dimensions.⁷⁷

Similarly, high interdependencies are found during the post-World War II period. The correlation between population and technology—indicated by Gross National Product (GNP) and, in a separate analysis, by steel output—is over .90 for the major powers—the United States, the Soviet Union, China, Japan, France, and Great Britain—and drops only slightly when intervening effects are controlled for. The correlation between population and energy consumption (as an indicator of resource utilization) is also extremely high, ranging between .80 and .90 for these six countries. The correlation between population and defense expenditures is, again, extremely high—positive for the United States and China, but negative for Great Britain and France. The coefficient for Russia is also negative, but when one controls for intervening variables, the relationship between population density and defense expenditures appears both positive and significant.

Correlation does not imply causation. However, the high degree of interdependence between basic variables and defense expenditures increases the probability of causal pathways between population, resources, and technology on the one hand, and a nation's budgetary allocations to defense and its external behavior, on the other. The interlocking nature of arms race phenomena or reaction processes—whereby one nation's defense measures trigger off counter-measures by the adversary—further complicates the network of relationships between internal attributes and capabilities, and external behavior.

Preliminary statistical analyses of the budgetary allocations to defense needs for both the United States and the Soviet Union suggest that changes in the rates of

change in United States defense expenditures may be determined by changes during earlier years rather than by changes in Soviet military expenditures.⁷⁸ Thus, the dynamics underlying United States arms expenditures may be generated more by domestic demands, bureaucratic habit patterns, and organizational impulses and constraints, and not so much as is generally assumed by the United States response to the Soviet buildup. This, coupled with the high interdependence among the more basic master variables, illustrates the distinctly political implications of population dynamics, technological advancement and, as we shall point out later on, resource extraction and utilization as well.⁷⁹

Sino-Soviet relations offer another case in point. In extensive but preliminary statistical analyses of Chinese and Soviet Russian reactions to each other's capabilities and power over the past 20 years, we found that Soviet conflict behavior toward the People's Republic (defined in terms of actions and events, and measured systematically over time) is associated first and foremost with the size of the Chinese population rather than with indicators of technological growth and economic development. The correlation between Russia's actions toward China and the size of the Chinese population is .71. In other words, one of the best predictors of Russian conflict behavior toward China is the size of the Chinese population together with increases in that population. At the same time, China's behavior toward the Soviet Union is strongly associated with the Chinese population size. The correlation is .86. In each case, therefore, the Chinese population appears to be the single most important predictor of mutually directed conflict behavior.

It appears, on statistical grounds alone, that the Chinese, in turn, have been responsive to increases in the Russian population; but our measures are not sensitive enough to capture more detailed nuances such as mutual reactions to changes in population distribution, labor force, or industrial centers. The correlation between China's violence behavior toward the Soviet Union and the size of the Russian population is .89, thus indicating, statistically at least, that the Chinese are as concerned with growth in the Russian population as are the Russians with the growth of the Chinese population. These interdependencies are all extremely complex, however, and more detailed analyses are required.⁸⁰

Our statistical investigations have also indicated that the Chinese demonstrate considerable concern with both the level of and increases in Russian technical capabilities (as reflected in Soviet GNP and steel production)—even more than is demonstrated by the Soviets vis-a-vis Chinese technical capabilities. Nor are the Russians unconcerned with increasing Chinese

capabilities and effectiveness. Quite the contrary. The correlation coefficient between Russian conflict behavior toward China and Chinese steel production is .60.

In multiple regression analyses, 65 percent of the variance (R^2) in Russian conflict behavior toward China is accounted for by the level of the Chinese population, China's GNP, and China's steel production. Of these, the Chinese population appears to have the greatest impact on Russia's conflict behavior toward China (the t statistic for the population coefficient is 2.86 and is statistically significant). The same explanatory variables account for 82 percent of China's violence toward the Soviet Union; and, again, the single most important variable is the size of the Chinese population (the t statistic in this case is 4.86 and is statistically highly significant). Details of our analyses are presented elsewhere.⁸¹ We have conducted for China parallel analyses of these interrelationships employing three different population estimates—high, medium, and low—and two different Chinese GNP series in the attempt to determine whether differing assessments of levels and trends make any difference in the net relationships at hand. We found that the three population series (obtained from different sources) correlated very highly (.98 and above) as did the GNP series.⁸² We also found that the dependencies noted above hold across series. In other words, the effect of the Chinese population is extremely strong, regardless of the particular series one chooses for analysis.

INTERNATIONAL IMPLICATIONS: DEPENDENCY RELATIONSHIPS AND MAJOR POWER COMPETITION

Countries with efficient technologies enjoy a crucial advantage in obtaining resources that are difficult to reach or which require high levels of knowledge and skills and expensive machinery for processing. Writing in 1966, Henry A. Kissinger noted that the "mere act of adjusting perspectives" to the huge scale of our times would produce major dislocations. But the problem has been "compounded by the near doubling, since 1945, of the number of states participating in the international system."⁸³ This proliferation in itself has multiplied and vastly complicated the process of international intercourse, and is further exacerbated by vast differentials in population, technology, and level of development.

In 1954 Harrison Brown made the suggestion that

As time goes on the effects of increasing population, decreasing resources, disappearing markets, and waning possibilities of importing food and raw materials from abroad should

produce levelling effects that will simultaneously decrease the probability of war and increase the possibility of obtaining federation.⁸⁴

Our analyses so far lead us to expect almost the precise opposite: The combination of increasing populations, decreasing resources, and disappearing markets will create more conflict and more large-scale violence, rather than less. Conceivably, over the long run, Brown's prediction may be correct—once it becomes fully evident to sufficient numbers of people on earth that international cooperation and the sharing of resources offer the only remaining means of decent human survival. Until that lesson is widely perceived, internalized, and acted upon, however, we would expect an exacerbated population-technology-resource imbalance to aggravate conflict and violence rather than alleviate it.

On the other hand, we have no disagreement with Brown's further proposition that, even if mankind should succeed in abolishing war by one means or another, "we are faced with the problem of producing sufficient food, of supplying ourselves with raw materials, and of supplying our machines with energy for the purpose of converting raw materials into finished products."⁸⁵ *But historically, population increases, coupled with advancing technology, have tended to encourage expansion of national interests, penetration and domination of low capability regions, clashes between competing major powers, crises, and war.* If we consider the world as a large and complex system of such interdependencies, it seems doubtful that increasing population, decreasing resources, disappearing markets, and waning possibilities of importing food will produce levelling effects and decreasing probabilities of war.

It is frequently suggested, for example, that continuing or widening gaps between the affluent nations and the poverty-stricken nations will lead directly into war—the implication being that the starving millions will be goaded into revolt by their misery. This is unlikely. In general, the threat emerges less from such possibilities than from continuing major power competitions and conflicts and the conflicts of their lesser power allies. The poverty-stricken countries of the world may—through their mere existence—contribute to conflicts and competitions, but probably indirectly. Many of the resources vital to continuing major power growth are located in poverty-stricken and low-technology societies. Their territories and accompanying resources supply the arenas for major power competitions and struggles, and they themselves are likely to be under great power pressure to line up on one side or another. Great power rivalries, confrontations, and crises in low capability

regions that are rich in primary energy and other critical resources run grave risks of leading into major wars.

These considerations have important economic and political consequences for the peoples involved and for the international system. Indeed, it is difficult to conceive of how a peaceful, stable, and viable world can be achieved and maintained until some of these gaps between the affluent and poverty-stricken nations can be narrowed. Up to a point, we may rely on advances in technology to help in the solution of these problems—especially as new breeder reactors become operational.⁸⁶ Because of their limited technologies, however, most countries are likely to be dependent on energy generated and controlled by a few industrialized powers.

A major part of the problem is that the highly industrialized countries, which contain only a small part of the world's population, maintain their high standards of living by (1) consuming a disproportionate share (on a per capita basis) of the world's supply of hydroelectric power and of energy generated by use of fossil fuels, and (2) relying on other basic raw materials. Thirty percent of the world's population lives in industrialized societies and consumes about 90 percent of the total global production of energy and mineral resources.⁸⁷ In many respects, the industrial superpowers are like huge vacuum cleaners sucking up resources from all over the world in order to maintain productivity, military capabilities, and consumer demands—not necessarily because of domestic shortages, but often because resources imported from overseas are cheaper.⁸⁸

There is a widespread assumption that the United States is virtually self-sufficient in basic resources. In fact, the country is highly dependent on foreign sources for its basic industrial raw materials⁸⁹—not so much because of absolute shortages, but because so many products can be acquired at lower cost elsewhere. For years, the United States has experienced trade deficits in two categories: “raw materials (because of the insatiable appetite of American industry) and manufactured products that are not technology-intensive (a function largely of comparative price levels).”⁹⁰

The overall trade balance of the United States (excluding grants, aid, and other noncommercial transactions) “made a 180 degree turn in just 6 years—from a surplus of \$1.7 billion in 1962 to a deficit of \$1.3 billion in 1968—the first such deficit in 93 years.”⁹¹ Although the commercial balance improved somewhat in 1969 and even more in 1970, it is significant that the United States had become a net importer of many of the metals and ores it uses—again, not because of absolute shortages in most instances, but because of high costs of domestic extraction. The commercial balance in 1969 remained

about \$600 million in the red; in 1970, the improvement was more dramatic—probably producing a net commercial surplus.⁹²

The population of the country is now 205 million and currently growing at about one percent a year. If this rate continues, our population will be in the neighborhood of 275 million by the year 2000. Combined with advances in technology, this growth is likely to generate rapidly increasing demands which, in combination with demands generated by other major powers (and also lesser powers), could lead to unprecedented competitions and conflicts. Currently, our widely envied level of affluence depends on the availability of relatively common resources such as iron, aluminum, zinc, phosphate rock, coal, oil, and related minerals—all critical to the industrial process. If costs associated with less available raw materials rise too drastically, this may have the effect of a substantial slowing in the rate of increase in our standard of living.

Our focus in this report is not upon what the United States needs in order to maintain its standard of living or its position as a great power, however important these issues may be from one viewpoint or another. The greater concern, in terms of our current analysis, is with the dynamics of great power rivalry and the risks that competitions involving the United States, the Soviet Union, and other countries will escalate into crises, arms races, and wars.

According to the Bureau of Mines, the United States is highly dependent on external sources for manganese, nickel, platinum, tin, zinc, bauxite, beryllium, chromium, cobalt, and fluorspar; and moderately dependent on mercury, titanium, iron ore, copper, and aluminum.⁹³ These assessments are based on a “dependency index” (DI) developed from Bureau of Mines data. We have computed DI as Imports-Exports/Consumption for each individual mineral resource to obtain these basic estimates. Because manganese is essential to steel production, it must be considered the most likely mineral constraint for the United States in this century. The major exporters are Gabon (31 percent) and Brazil (26 percent). Major exporters of other essential minerals are Canada, the United Kingdom, Thailand, Mexico, South Africa, the Philippines, Spain, and Belgium-Luxembourg. With few exceptions, exporting countries are either allied directly to the United States or lie within the United States sphere of influence. Aside from pure economic considerations, one can only speculate as to the political implications of any external threat to the continuing flow of these crucial mineral resources. On the other hand, the United States is a net exporter of molybdenum, tungsten, vanadium, coal, gold, helium,

sulfur, and magnesium. And, for other key minerals, such as iron ore, copper, petroleum, and natural gas, there has been no trend toward increasing United States dependence on foreign sources since 1958.

Measured in terms of metric coal equivalent, the United States is a net energy importer, being highly dependent on external sources for domestic consumption needs. The balance between domestic production and consumption of energy amounted to 65.27 million tons annually between 1955 and 1968. Several other industrialized countries are also extremely dependent on external energy sources. During the same period, Japan's imports of energy materials averaged 61.77 million metric tons annually. Similarly, Britain, France, Holland, the Scandinavian countries, and other industrialized societies are all net importers of energy. During this period, Communist China seems to have struck an equitable balance between production and consumption of energy, importing an annual average of only about 1.8 million metric tons. By contrast, only the Soviet Union is a net exporter, producing considerably more than is consumed domestically.

Differentials in world and regional consumption of fuel energy (coal and lignite, crude petroleum, natural gas, and hydroelectricity expressed in terms of kilograms per capita of coal equivalent) offer a rough indicator of the spread between high capability and low capability countries on this and related capability dimensions. According to United Nations figures, the United States produced an annual average of about 37.5 percent of the world's total energy supply between 1955 and 1968, while consuming a little over 39.8 percent.⁹⁴ The Soviet Union produced less than half that amount, but consumed even less. Japan produced 2.1 percent of the world's total and consumed over 3.3 percent. Other industrialized countries—including Britain, France, West Germany, Holland, and Scandinavia—all consumed a larger share of world energy than their contribution in terms of domestic production.

Some gains in energy production were made by the less industrial regions of the world, but they were not spectacular. In 1951, for example, the world per capita level was seven times the per capita level in the Far East; the North American per capita level was nearly 50 times that of the Far East. By 1967, the world level was somewhat more than four times and the North American level was a little less than 30 times the Far Eastern level. If the world were forced to depend on fossil fuels as its primary source of industrial energy, according to a 1962 report, there would be little probability of significantly improving the standard of living by industrialization of the so-called under-developed regions of the world or of maintaining, on an equal basis, the activities of the

highly industrialized areas at anything like present levels for more than a few centuries; and there are possibilities that shortages might develop before the end of the present century. The only remaining source of energy that does have the proper magnitude and does lend itself to large industrial uses is nuclear.⁹⁵

As an outcome of the close relationship between use of energy and levels of production, there tends to be a strong positive correlation between the consumption of energy and the standard of living in any given country.⁹⁶ The correlation between energy consumption and degree of economic activity has been so close that one is often used in order to estimate the other.

In the United States, each person on the average consumes more than 3,100 calories each day—"nearly twice that of the average inhabitant of India." Fewer than 10 percent of the world's people are able "to live on a standard of food intake equivalent to that enjoyed by the average American."⁹⁷ By purchasing non-renewable raw materials from the underdeveloped areas, the major powers may be decreasing Third World chances of industrializing. On the other hand, we may assume that the energy requirements of underdeveloped countries will grow in the same manner as those of the United States as these countries become industrialized.⁹⁸ It has been estimated that if present growth rates were to continue, the poorer countries would need 130 years to reach the level of per capita income which is now characteristic of the richer countries. But by that time, at present growth rates, the population of the poorer countries would reach 130 billion persons. Meanwhile, the per capita GNP's of the richer countries would approach one million dollars per person.⁹⁹ Rapid increases in world population thus impose a severe burden on efforts to raise the levels of living.¹⁰⁰ An annual population growth rate of one percent requires an annual four percent growth in national income in order to maintain the existing standard of living.¹⁰¹ And a world population of seven billion, living at the economic standard of the United States, would require about 200 to 400 times the present annual rates of production of minerals such as iron, lead, zinc, and tin.¹⁰²

Prospects for the future are complex and somewhat perplexing. According to the United Nations population projections, the largest increases in the next 10 to 15 years are expected in South Asia, followed by East Asia, Latin America, and Africa.¹⁰³ However, only giant industrial nations will be able to afford or even possess the capabilities for developing the new technologies. Nations that succeed in reducing the costs of energy sooner than others will thus be able to gain important

advantages in the world market and strengthen their industrial capability and leverages of influence in the less developed world. On the other hand, foreign aid, whether extended by the United States or by some other major power, is, in part, a means of extending influence through more advanced technology into the less developed world. This will almost certainly create or perpetuate dependency relationships and competitions among industrialized states for influence in regions of the Third World. Added to this is the consideration that instruments available to highly industrialized states for projecting their influence and power into various parts of the globe will be greatly strengthened during the next decade or two, and entirely new ones will appear.¹⁰⁴ To the extent that these trends eventuate, the dependence of poverty-stricken regions of the world will increase, thus perpetuating and enlarging the possibilities for penetration by great power interests and exacerbation of great power rivalries and conflicts. On the other hand, a global population living at an equivalent United States standard would occupy greater space, consume more resources, and disturb the ecology more.¹⁰⁵ *Equality at high levels of affluence would almost certainly create more, rather than fewer, disturbances in the international environment.* Thus, a strong case can be made for population control in terms reverse of the basic Malthusian principles. Malthus was more concerned with widespread poverty than the damage to the world's environment (to say nothing of the international conflicts) that an indefinite population growth would create. Equally, if not more critical, then, is the problem of how to control the number and appetites of the rich (and even modestly rich) whose negative impact on the environment is considerably greater than that of the poor.¹⁰⁶

In those terms, reduced population growth alone is not a total solution. Even if population size were decreased but per capita consumption remained at the same level, the effects in terms of resource extraction, diseconomies, and environmental resistance would still be extremely problematic. What is needed, therefore, is a steady and significant decrease in per capita consumption in the highly industrialized nations. And, since the cost of environmental pollution rises nonlinearly with the rate of population growth,¹⁰⁷ *the dual tasks of reduced population growth and decreased per capita consumption are necessary for controlling the present environmental crises and related social and political implications.*

FUTURE PERSPECTIVES: SOME IMPLICATIONS OF SCIENTIFIC INNOVATIONS

It is often assumed that new technologies will solve the problems created by growing populations, indiscriminate advance of techniques, and uneven access to critical resources. Technological advances related to uses and distributions of energy may come about in at least two ways: more efficient means of applications or conversion may be developed, and/or new energy sources may become available.¹⁰⁸ No doubt the possibilities are considerable, especially to the extent that (1) new methods are found for providing food and (2) breeder reactors, use of fusion, or, possibly in the long run, direct solar radiation become available.¹⁰⁹ The immediate practical obstacle to the direct use of solar radiation as an effective source of auxiliary energy is the necessity for finding some way to concentrate the available low-energy density of solar radiation economically. At this writing, the feasibilities seem sufficiently remote; so, discussion will be limited to some of the broad implications of breeder reactors and nuclear fusion.

We have shown that population growth, economic development, materials depletion, pollution, war, and the organization of society are intensely interdependent and linked with world requirements of primary energy as well as other resources. Any attempts to cope with present problems will almost certainly fail if population growth remains unchecked. Population increases place almost unsurmountable drains on those very resources and allocations needed to combat the consequences of growth. Because of these complex interdependencies, we cannot accept too readily the assumption that technological advancement, per se, will alleviate our current problems.

This suggests the importance of finding ways of coupling population problems with strategies for minimizing the burden on the environment by establishing priorities in the applications of technology and finding substitute technologies for those that are costly but necessary. With respect to the foreseeable future, the drains on resources imposed by population growth and technological development do not involve depletion in an absolute sense. It means, rather, that the more readily available, the more concentrated, the richer or the higher quality deposits have been used up so that the acquiring of further supplies becomes increasingly expensive, not only in monetary terms but, even more important, in cost to the environment. In one form or another, the earth possesses extensive resources for man's uses. *The two most critical issues are monetary and environmental costs involving the overall quality of human life and the uneven distribution of vital resources from one locality to another.*

Monetary costs will be a critical factor in deter-

Governance and Population:

The Governmental Implications of Population Change

mining whether a given community or a given society exploits resources that are near at hand or reaches out beyond its own borders to obtain them. On the one hand, if a society finds that more readily available domestic resources have been depleted, it will search for ways of acquiring them through foreign trade or conquest or other means. But if, in the longer run, the cost of acquiring the resources overseas becomes prohibitive—either in purchase and transportation costs or in political or defense costs, then the political, commercial, and/or industrial leaders of the society may be motivated to develop new technologies for acquiring the hard-to-get domestic resources more cheaply or for utilizing other resources in new ways.

On the face of it, the uneven distribution of resources implies that costs are unequal: The cost of oil to the people living in a country where there are ample supplies should be much less than the cost to those who live hundreds or thousands of miles from the nearest deposits. The flaw in this reasoning is that the cost of acquiring and processing oil and many other resources depends heavily upon the availability of appropriate technologies. For those who do not have the appropriate knowledge and skills, oil deposits 2,000 feet below the surface of the earth are not merely too costly to acquire—they are unavailable. On the other hand, possessing the appropriate technology, a society located 5,000 miles away can often acquire the oil, absorb transportation costs, expand their naval and air forces to protect access routes, and still find the operation extremely profitable.

With respect to oil, there is likely to be a concerted effort to find substitute sources through the gasification of coal, tapping deep sources of naturally generated steam, pushing ahead with breeder reactor development, and so forth. The gasification of coal offers a not untypical dilemma, however. The United States possesses large reserves of coal, but strip mining often appears to be the least costly method of extracting it. This can despoil large tracts of land for long periods of time.¹¹⁰ Already, the Black Mesa case on the Navajo and Hopi reservations is providing what may be a harbinger of things to come: In order to provide clean electric power for Los Angeles, the topsoil is being chewed up and the water table seriously lowered. More specifically, the topsoil is being replaced, but not sorted out; that is, the relatively fertile topsoil tends to become hopelessly mixed with larger quantities of materials scraped from further down. And the water reserves drawn upon to float the coal on its way toward California have accumulated over vast periods of time and are not replaced by annual rainfall cycles. So far, the Indians have confronted the threat most directly, but

they may be somewhat like the canaries that coal miners once carried into deep shafts to test for poisonous air. (When the canary collapsed, it was time for the miners to get out.) In due course, Tucson, Phoenix, and smaller white communities may also begin to suffer. The proliferation of this particular mining technique—to say nothing of dozens, perhaps hundreds, of other techniques—is likely to give us all serious pause over the next few decades.

In the sphere of new technologies, the so-called “green revolutions” in agriculture have produced somewhat controversial results. In the future, vast areas of the seas may be made available for farming—a trend that is certain to raise a wide range of new legal and political problems. In due course, it should be possible to produce foods synthetically. But any major advances in food production—like advances in other technologies—are likely to require larger amounts of primary energy.

Nuclear fuels offer important possibilities, the energy concentration being so vast that it is almost incomprehensible by conventional standards. “One pound of nuclear fuel is the energy equivalent of 2 to 3 million pounds of coal.”¹¹¹ There is wide agreement among specialists that possibilities for major reductions in the cost of nuclear power in the future depend on the development of safe and economical breeder reactors.¹¹² The possibility of establishing such new facilities holds great promise in the solution of many of our most difficult problems.¹¹³ It is expected that by 1985, numbers of fast breeder reactors will be entering the market.¹¹⁴ This is likely to facilitate a transition in the massive use of nuclear energy in a wholly new economic and technological framework. The 1985 fast-reactor fuel-cycle cost targets are lower than those of thermal reactors. By that time, then, “there should be the beginning of a market penetration which would be complete in less than 10 years. The uncertainty relates to relative capital costs of converters, breeders and fossil-fueled stations.”¹¹⁵ The outcome will almost certainly involve the daily living patterns of all of us.

Many authorities believe that the achievement of economical breeding will eliminate any danger of energy resource depletion in the foreseeable future. To “breed” refers to the ability to produce more plutonium from fertile materials than is destroyed in the chain reaction. This means that more fissionable material is produced than is consumed. As an energy source, uranium is a very cheap mineral. In the future, moreover, breeder reactors will effectively use as fuel all of the uranium, rather than the one part in 139, which is the U-235 largely in use today. To the extent that breeding is achieved, the resources of uranium and thorium will dwarf all of the

conventional energy resources by a large margin.¹¹⁶ However, as generally envisaged today, performance targets for the new technology are modest compared with potentials and also with ultimate requirements. The plutonium in the fuel cycle, as currently pictured, will reproduce itself only after a relatively long period: Most concepts with some near-term feasibility have "doubling times" of 12 to 20 years. Since world energy demand will be doubling every 10 years, the 12-20 year period is undesirably long. Furthermore, a major problem with fast breeder reactors is that large quantities of plutonium are needed; and, according to at least one authority, the most probable outcome is that "reactors will always be more expensive to build than gas or oil-fired power plants." The basic explanation is that reactors require a variety of auxiliary systems to be operable safely.¹¹⁷

Nuclear reactors require no burning of the world's oxygen or hydrocarbon resources and therefore release no carbon dioxide or other combustion products into the atmosphere.¹¹⁸ By its very nature, on the other hand, nuclear fission produces a multitude of highly radioactive waste. In addition, present nuclear plants result in 40 to 50 percent more waste heat per kilowatt; and the release of a large degree of low level radiation is not preventable.¹¹⁹ It is predicted that the release of such waste to the air by fast breeder reactors will be close to zero,¹²⁰ but assessments differ, and levels of possible health hazards and environmental costs remain uncertain.¹²¹

The timetable to fusion power is extremely difficult to predict. To reach the conditions required for controlled fusion and a net release of fusion power will require the prior development of many new technologies.¹²² Depending on underlying assumptions about the level of effort and the difficulties involved, the estimates of time required for producing a large prototype fusion reactor could range from as little as 10 years to as much as 50 or more.¹²³ David J. Rose has put forward a "guess" that fusion power will be available by the year 2000. "A few optimists propose 1990; pessimists propose never."¹²⁴

Analysis of the overall social benefits and costs is complicated enough for comparisons of breeder reactors as opposed to fossil fuel plants, and is still in an exceedingly primitive stage. The inclusion of nuclear fusion as an option will raise further complications of a highly technical character. Careful designing would be required to prevent radiological hazard from the leakage of tritium fuel from a deuterium-tritium reactor.¹²⁵

In this report, we are primarily concerned with some of the political considerations involved. From a global perspective, the development of a breeder technology in a relatively few industrial countries might

contribute to dangerous political imbalances even in a world where vast new energy potentials were being generated. If breeder technologies are built in only those relatively few industrialized societies possessing appropriate scientific and applied facilities and experience, other countries are likely to become almost wholly dependent upon these great centers for primary energy. To avoid merely exacerbating the gap between the affluent and poverty-stricken societies of the world, the foundations ought to be established soon for a world breeder facility in which all the countries could participate on a just and rational basis.¹²⁶ The definition of just and rational is, of course, a major problem requiring intensive discussion, study, and planning.

Between now and whenever the new technologies achieve effective yield, there will be a difficult period during which the countries of the world will be relying heavily on oil, coal, and other traditional resources. Although in a technical sense the energy crisis is not immediate, many of the political implications are already manifest, and large scale constraints are foreseen by the turn of the century. According to projections for the Organization for Economic Co-operation and Development (OECD) countries, continuing energy consumption will be economically feasible up to and beyond 1980—but exactly how much beyond is unclear.¹²⁷ Then, as breeder reactors—and fusion reactors in due course—begin offering practical alternatives, we may expect massive and rapid changes in the way people live. Throughout the whole span, however, from now until well after the turn of the century, man's success or failure will depend upon his ability to combine these developments with appropriate economic, social, and political change. This is true for the initial period, which is likely to be characterized by intense competitions for hard-to-get resources, and also for the subsequent development and regulation of societies appropriate to the advanced nuclear technologies.

Competition for resources will undoubtedly extend to mining ocean-based minerals and other resources. The ambiguity of present international law regarding ownership and extraction rights presents added complications for international relations in the coming decades. Short of developing such mechanisms, we may expect advanced societies to maintain a clear edge in exploitative and extraction technologies which will intensify competition among the technologically rich and widen the gap between advanced societies and technologically deficient ones.

Serious difficulties may arise, especially in terms of time lags and sequences. Years and even decades are often required to transform new theoretical knowledge into a practical application; and even longer periods of

time often elapse before sufficient numbers of people are able to understand what needs to be done, to break out of their old ways of thinking, to develop new concepts and new habit patterns, and to demand support and help in implementing new policies. It is likely to be at least a decade before breeder reactors are operational, and optimal production thereafter will depend upon typical "doubling" times. Meanwhile, the countries of the world will be generating higher and higher demands for oil, natural gas, gasified coal, natural steam, and other types of primary energy.

In view of these and other uncertainties, it is important that we develop and refine methodologies now for analyzing the relationships and interdependencies involving social organization and habit structure, the generation of demands, acquisition of resources and the pricing system, major allocations for specialized capabilities, environmental resistances, economic and population growth, and so forth. In this connection, it is crucial to consider the world as a whole, to assess the comparative advantages and costs—short-term, longer-term, monetary, and environmental—of using particular resources and particular deposits of resources, and to design alternative strategies for meeting human demands in rational and constructive ways.¹²⁸ Unfortunately, long-term interests are often in sharp conflict with more immediate, day-to-day shorter-term interests: The benefits for future generations depend upon the willingness of present generations to pay high costs, with returns that are often long delayed and difficult to visualize.

A major step in this overall direction has been undertaken by the World Dynamics Group at the Massachusetts Institute of Technology under the direction of Dennis Meadows. On the assumption that "actions at one point in the system that attempt to relieve one kind of disaster produce an unexpected result in some other part of the system,"¹²⁹ the Group is investigating the long-range consequences and implications of population growth on resource utilization and depletion and on environmental pollution. With the assistance of computer technology and related methodologies developed specifically for examining the interrelationships of complex nonlinear feedback systems, considerable progress toward untangling the various interdependencies has been made.¹³⁰

In collaboration with Dennis Meadows, we have begun to undertake a series of computer-based simulations of the longer-range implications of population growth, technological developments, and resource constraints for United States policies and external behavior. In a tentative and experimental fashion, we have raised a series of "if . . . , then . . ." questions pertaining to

alternative futures, costs, and feasibilities. For example, what would be the long range implications for the United States if population growth were reduced significantly or, alternatively, if consumption per capita were reduced, or if the monetary and/or environmental costs of controlling external sources of raw materials and energy producing fuels became too high?

At this writing, we cannot present firm substantive conclusions. On the basis of work undertaken during the past several months, however, we are convinced that *the appropriate technical skills and accompanying methodologies are currently available to undertake extensive investigations of alternative futures and of the implications and consequences for the United States and other nations of different options and growth and/or constraint patterns.* The problem is one of applying the methodologies and skills to the problems at hand, and not of developing the needed tools.

The transference of computer-based results from the academic community to the real world involves extensive investigations with what is known as policy analysis. One of the most sophisticated and useful of such modes is represented by alternative budgeting analyses undertaken by the Brookings Institution.¹³¹ In this context, the political and economic costs and consequences attached to "if . . . , then . . ." questions can be identified and evaluated accordingly. Equally plausible is a systematic assessment of the political costs and feasibilities of modifying national priorities and habits, expectations and institutions.

Thus, it is now possible to construct in the laboratory realistic models of social systems. Projections can be made into the real future on the basis of 100 years or so of historical data. Beyond that, however, these techniques should allow us to alter the various independent variables (insert values) in arbitrary, experimental ways—and allow us also to observe the changes that then take place, over future time, throughout the whole system. We can imagine ourselves carrying out bloodless revolutions (all quite reversible or discardable) at no cost other than human labor and computer time.

FUTURE PERSPECTIVES: SOME IMPERATIVES OF SYSTEMIC CHANGE

In political terms, the major issues of the future concern the control, allocation, and distribution of technology and resources. In the mid-1950's, identifying what he perceived as a "life-and-death problem," Lewis Mumford asserted that ". . . the greater the quantity of energy at man's disposal, the more important becomes the old Roman question: *'Quis custodiet custodias?'*" which may be loosely translated as: "Who is to control the controller?"¹³² This question pertains not only to

whatever type of international institution might be developed for the control of nuclear weaponry, but also to the regulation of energy allocated for peaceful uses—and the technology for generating and applying it. However indispensable many of them may be, the international institutions that have been developed to date are scarcely adequate for regulating the master variables that are likely to determine human futures.

World government is often put forward as the appropriate institution for controlling nuclear weaponry. On the face of it, this solution—quite apart from the problem of how nations are persuaded to give up their sovereignty—fails to stipulate adequate safeguards for preventing the central power from falling under the control of a single nation or narrow coalition of nations or into the hands of a dictator or other tyrant. There is no easy answer to the problem; indeed, it is something of a paradox.

If, through failure to control nuclear weaponry, man runs the risk of destroying his own civilization, he runs a comparable risk to the extent that he fails to find ways of regulating with more justice than is currently apparent the acquisition, allocation, and distribution of primary energy and other vital resources, and the worldwide diffusion of technology. For the evidence of this paper seems to document the proposition that *technology, primary energy, and other resources are among the critical elements of economic and political power*. The evidence also supports the corollary that *discrepancies in access to and control over resources and technology are among the major causes of conflict and violence*.

If we confront a paradox in contemplating the regulation of nuclear weapons through some centralized world authority, however, the problem of how to control—fairly and justly—the acquisition, allocation, and distribution of energy and other resources and the diffusion of technology is also paradoxical. There are no ready answers. At best, we may be able to suggest some starting points.

An immediate difficulty emerges from the fact that we do not fully understand the dynamics of the national and other systems in which we live. Whether one lives in the United States, the Soviet Union, Japan, the People's Republic of China, or in some other country of the world, he finds himself in social, economic, and political systems which he and his forebearers have helped to create but never really learned to control—nor fully to comprehend. This tends to be more or less true not only for the rank and file citizen, but also for the national leader and even for the scholar (whose discipline—history, political science, economics, sociology, and so forth—normally focuses on very limited aspects of the

total system).¹³³ Actions which citizens (or their leaders) take in one part of a system in order to relieve one kind of distress all too frequently produce an unexpected consequence in some other part of the system. If the linkages and interdependencies are not sufficiently understood, the outcomes can be as bad or worse than those that led to the initial action. The immediate problem is to identify these circular processes with the utmost precision possible and learn how to break out of them.¹³⁴

In many ways, the organization of our economy is a basic cause of environmental resistance, pollution, and large-scale dependence on external resources. This has come about because of our disregard for externalities—those consequences which are not directly included in the price system or in the dominant mode of transaction.¹³⁵ Indeed, our present property institutions are inadequate for allocating resources and minimizing residuals and externalities.¹³⁶ Furthermore, the transfer and disposal of residuals is normally undertaken at minimal—if not at zero—cost, with little regard for the imposition on the environment. If specific monetary costs were attached to environmental property and to relative burdens on the environment (by population, technological growth, and modes and rates of resource extraction and usage), the effect would be to introduce cost-benefit criteria in the manipulation of goods that have so far been considered essentially as free.

By the same token, the satisfaction of our needs and demands—depending upon how we define them—does not necessarily involve high consumption of raw materials or energy-producing fuels. The cost factor is always critical. If the pressure becomes too great, it is possible to draw on the existing fund of “substitution-ability” at both the consumer and producer levels.¹³⁷ But this would involve significant, if not radical, changes in our pattern of economic activities which we may not be willing to undertake.

In confronting the threats of population growth, the indiscriminate advancement of technology, the spread of pollution, and the grossly uneven flows of primary energy and other resources, an initial assessment requires the balancing of the short-run costs of any program (which are likely to be high) against long-run gains, and against future costs if nothing (or too little) is done now. With respect to population, there are undeniable rewards attached to continued increases (such as sales to be made from among the many categories of consumer goods), but these particular and short-term benefits will cost us dearly in the long run if populations continue to increase. Something similar can be asserted about indiscriminate technological advances and indiscriminate economic growth—including the intemperate production

of many conveniences to which we have become accustomed, but which exact heavy cost in terms of consumption, pollution, inequities, and conflicts.

In view of these considerations, *reduced population growth emerges as a crucially necessary—but certainly not sufficient—step toward the alleviation of a wide range of problems threatening the human race. Other remedies are not likely to work unless this is taken care of.*

The intensely interdependent nature of the population, technology, resource, pollution, and depletion variables will require, however, that reduced population growth is accompanied by an intense concentration on the other fundamental problems. A vast amount of research needs to be done, but new policies and new programs need not await such investigations. The next 10 years may be critical, and there will be time lags associated with even the most determined efforts.

Many people will not be easily persuaded by the desirability of inhibiting both population growth and spontaneous, indiscriminate economic and technological advancement. This situation is likely to pertain even after ways have been found for breaking out of the circular processes referred to above. Indeed, the fixed perceptions and deeply rooted habits which, to one degree or another, we all share are a part of the persisting circuitry. The following newspaper column expresses views about zero population growth that are widely shared: "I have looked into this two-kid argument, and reject both the arithmetic and the logic, not to speak of the morality of the suggestion. To say we MUST have only two children is to read the future and, baby, nobody, but nobody can do that . . . it is a deepset conviction with me that nobody *HAS TO DO anything.*"¹³⁸

The notion of zero—or at least curtailed—economic growth and highly selective technological advancement are received with similar skepticism by many people. Resistance will most certainly emerge from governments on various levels as well as among the citizenry—and from complex interdependencies between governments and their citizens. We frequently think of public decisions as being (1) made to meet a community need, (2) a response to some threat or other activity of general interest to the citizenry, or (3) directed toward certain widely shared and publicly identified goals (such as social welfare or survival of the country, the strengthening of its security, the enhancement of its trade, or the maintenance of freedom or world peace). When national goals are thus stated, national policies seemingly laid down in their pursuit appear to have resulted from careful thought, rational calculation, weighing of values, and balancing of alternatives.

In large bureaucracies, we are confronted by a characteristic type of widely dispersed, often anonymous, decision-making which originates in small increments and often then accumulates into an overall policy. This tendency is similar to what has been called disjointed incrementalism, which refers to the breaking down of large problems into smaller ones and then "neglecting the fact that the solution of one small problem is all too likely to aggravate the difficulty of another one."¹³⁹ We find a solution to the second problem, which creates a third problem. We solve that, but our actions create a fourth problem, and so on. Often the problems snowball, all the small incremental decisions giving rise to a really big problem, possibly a catastrophe. What begins as an expedient "may end as a trap."¹⁴⁰

Policies are affected in complex and sometimes powerful ways by previous decisions, by routines and other habit structures, and by disagreements, competitions, and the pursuit of personal goals in governmental bureaucracies and elsewhere in the society at large. All this suggests that many great decisions may have been made because millions of petty decisions by seemingly unimportant people had created a situation in which no other feasible alternative seemed to exist. All this suggests also that many cherished, solemnly set goals, and soberly invoked values may amount essentially to rationalizations for a nation's doing what millions of homely, unidentified, relatively private decisions have made almost unavoidable. "Today, the most exciting current contribution of Darwin is his model for the achievement of purposive or ends-guided processes through a mechanism involving blind, stupid, unfore-sightful elements."¹⁴¹

If societies are to alter current trends, a special effort will be required to correct for disjointed incrementalism, externalities, bureaucratic perseverance, and organizational drifts. To the extent that the analyses put forward in this paper are correct, the question arises, what can be done to reverse or at least deflect the current trend of events? Are there practical solutions, and if so, how do we identify them and carry them out?

The problem seems to fall into two distinct but closely related parts: (1) determining what needs to be done; and (2) finding ways of conveying to leaders and to the rank and file what the alternatives are and why certain changes are critical.

It is doubtful that, in the long run, citizens or their leaders can be moved to appropriate action by exhortation or dire prediction; nor are the populace likely to submit more than temporarily to coercion. The first task is to *find out as accurately as possible how the system is currently working and where it appears to be taking us.*

If the right combination of scholars and practitioners is mobilized immediately, and if their knowledge and skills are pooled, adequate answers could be acquired very quickly. *The second task*, derived from the first, is to generate scientifically a wide range of alternatives on an "if this, then that" basis. *The third task*, which ought to proceed concurrently with the first two, is to devise ways for disseminating this knowledge quickly, accurately, objectively, and believably in terms that can be understood by citizens and leaders alike. This last is probably the most difficult task of the three; but, with various new techniques becoming available—computer graphics, for example—it ought to be possible for large numbers of people to absorb difficult material faster and more efficiently and effectively than ever before. The main concern would then be to keep the information truthful.

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Governance and Population:
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