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August 1, 1975

prepared for
Outlook for Aeronautics Study
National Aeronautics and Space Administration
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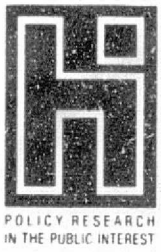

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DOMESTIC AND WORLD TRENDS (1980-2000) AFFECTING THE FUTURE OF AVIATION

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I. SUMMARY

A. Purpose and Scope:

To identify, analyze and interpret domestic and world economic, technological, political and social trends which may affect U.S. aviation development and growth during the period 1980-2000.

B. Methodology:

Identification of key variables and trends and projections of possible future environments based upon extrapolations of selected quantifiable and qualitative variables.

C. Some Key Trends:

1. Development of some degree of weather control and/or climate modification

2. Continuation of industrial development

3. Expansion of international trade and travel among the countries of the Pacific Basin

4. Expanding role of multinational corporations

5. Short-term technological crises of various sorts

6. Alleviation of food shortages through development of improved distribution systems and continuation of the "green revolution"

7. Continuation of the sunbelt shift in the U.S.--development of South and Southwest and relative decline of parts of North and North-Central U.S.

8. Continuing decline in the rate of U.S. and world population growth

9. Continued growth of U.S. GNP, probably at about 3 percent annually.

10. Continued availability of critical resources well into the next century--no serious shortages developing

11. Development of adequate alternative energy sources by century's end

12. No major wars--no major peace. Defense spending continuing at present levels, possibly rising over time if crises occur

D. Best Estimate of World Future:

Continued economic growth in West and accelerated industrialization of developing countries as multinational corporations grow and expand operations abroad

Pacific Basin Growth sparked by Japan

Decline in World Energy Prices over time as oil production in non-OPEC areas increases and use of coal and other substitutes expands

GNP Growth in U.S. and world continues, but at slightly slower pace

World Population Growth rate turns downward and moves toward ultimate stability, but population growth remains as problem in the year 2000

International Relations should stabilize as U.S.-S.U. relationship normalizes

Few Radical Political Changes outside third and fourth worlds

Development of Megalopolises in U.S. and developed world--sunbelt shift continues

E. General Impact on Aviation:

Military R&D will remain principal focus of R&D efforts.

U.S. will continue to dominate world aviation market.

U.S. will emphasize tactical air defense.

Major breakthroughs possible which could drastically alter military posture; e.g., V/STOL.

Air Transport growth to continue at about 9 percent per year.

Emphasis on greater comfort, economy, efficiency, rather than speed in new transport designs.

Civil Aviation's market should steadily expand as world economies grow.

II. INTRODUCTION

This report presents the results of a study of variables affecting aviation in the United States during the last fifth of the twentieth century. Its purpose is to present estimates of relevant future developments and identify their probable impact on the aviation industry in this country. Toward this end, a series of key trends relating to economic, social, political, technological, ecological and environmental developments have been identified and are discussed with relation to their possible effects on aviation. From this analysis a series of scenarios has been developed representing an array of possibilities ranging from severe economic depression and high international tension on the one hand to a world of detente which enjoys an unprecedented economic growth rate and relaxation of tensions on the other. A "surprise free"* scenario is presented which represents our best judgment to the manner in which events will most probably develop and the effect on the aviation industry such developments will likely produce.

Projections of the future environment of an organization, or group of organizations, like the aeronautical industry, depend upon extrapolation of certain relatively predictable variables, such as envelope curves for computer capacities, but also upon extrapolation of such unstable social variables as lifestyles. Thus the unpredictability of key variables introduces enormous uncertainties into complex projections. Second, and frequently more important, the environment can change because of conscious policies, and those policies are frequently unpredictable. Thus, it is impossible to provide any degree of certainty to projections of most variables, it is impossible to generate a precise range of probabilities for the major alternatives, and important variables always will depend upon the vagaries of political decision. Nonetheless, even among complex social processes influenced by political decisions, there exist relatively stable trends because of long lead times for decisions to be implemented and because those decisions have effects over still longer periods of time. There is a common fallacy that quantifiable variables are invariably easier to predict than qualitative variables, because we have seemingly sophisticated methodologies for the projection of numerical variables such as gross national product, population, or computer capacity. In fact this is not so, because qualitative variables often behave in much more stable fashion. Culture, values, lifestyles, national character, and other similarly difficult-to-quantify variables frequently are much easier to predict because of their greater stability. For example, a scholar writing in 1830, as de Tocqueville did, would find it much easier to predict the degree to which Americans in 1975 would emphasize democracy, achievement, egalitarianism, economic attainment, and the rule of law as central values of their lives, than he

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*Although we always expect the future to bring surprises, the least-surprising scenario is clearly the "best estimate" for planning purposes. See Herman Kahn and Anthony Wiener, The Year 2000: A Framework for Speculation (New York: Macmillan) 1967.

would to predict the population of the country in 1975. Moreover, the rising sophistication of demographic projection techniques throughout this century has not proved very successful at enhancing the accuracy of middle- and long-range projections.

The report is organized into three basic sections; identification of key trends, an examination of world futures growing from these, and the possible impact on aviation growth of the projected developments. Appended are detailed examinations of factors which may have particular significance in future developments relating to aviation.

III. KEY TRENDS

Demographic and Social Trends

Basic Values

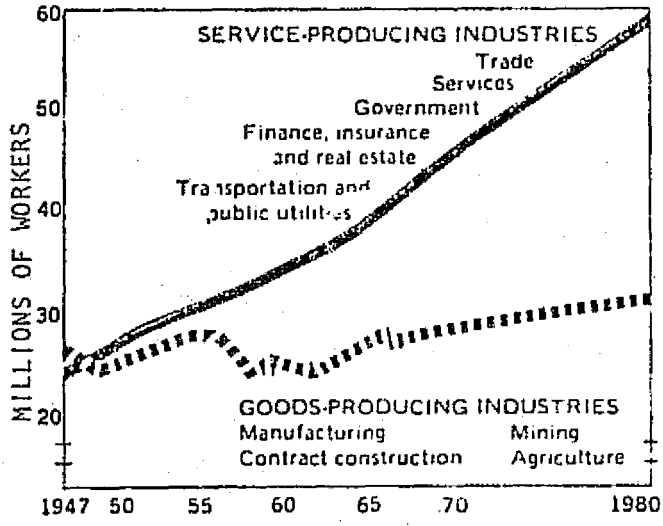
The most stable social trends are those concerning basic values, including fundamental views of the goals of life, the nature of the family, and the nature of society. Basic values do change, for instance as a series of generations move from being peasants to being urban workers to being middle class businessmen to being upper middle class professionals. But the values of classes and of whole societies change very slowly indeed. In recent years semi-popular literature has arisen suggesting that the U.S. and the world are undergoing fundamental changes of values away from middle class economic striving and toward "Consciousness III" or "quality of life" or "steady-state" or even "hippy culture." But the fundamental fact is that most of the population of the United States remains solidly committed to classical middle class economic striving as the basic way of life. In other industrialized countries the commitment to this classic style of life is even more profound, because these other countries have not yet attained the material levels, and the security of prosperity, which is a prerequisite of the shift to non-economic values. The current world recession demonstrates vividly how profound the commitment to these economic values remains, and how threatened the industrialized world becomes when these values are threatened. Finally, and most important of all, the vast majority of the world's people are just entering the initial phases of commitment to bourgeois values, and as they taste the first fruits of economic growth (riding bicycles instead of walking, then riding cars instead of bicycles) their commitment will intensify. Thus the most profound global trend in basic values is movement into middle class economic striving, not movement away from it, and the consequence will be worldwide pressures for economic growth, for the communications and transport systems upon which such growth depends, and for the consumer goods and tourism that are the fruits of such growth.

Super-Industrial Society

The structural economic consequence of this rising pressure of economic striving will be what we call the super-industrial society. The phrase "super-industrial" refers here to both the scale and the scope of technology. In super-industrial society the scale of technology rises to the point where the U.S. space program, the million ton tanker, and the trillion dollar Japanese infrastructure development plan become economically and technologically feasible. Likewise, in super-industrial society the scope of industrial society spreads from the currently industrialized countries until it covers most or all of the world. The continued rise of the super-industrial society carries with it rising affluence for humanity, rising ability of man to control nature and his own destiny, and also the problems of pollution, resource bottlenecks and scarcity, and loss of nerve, all of which are concomitants of the positive achievements.

Figure 1

THE U.S. WORK FORCE



SOURCE: THE U.S. ECONOMY IN 1980, BULLETIN 1673.

The rise of the super-industrial society brings with it a rising shift from primary extractive industries and secondary manufacturing industries into service industries. (See Fig. 1.) The service industries require different styles of work and stimulate different habits of mind than the earlier forms of human labor, and thus the, make possible certain shifts of attitudes and values. Societies in which services have become the employers of most of the population have come to be labeled post-industrial societies, and it is fair to label some of their associated values as post-industrial values. Thus, as societies become affluent and educated, more and more people concern themselves with non-economic values, emphasizing "quality of life" rather than "standard of living."

These latter emphases, and the rising ability of the affluent to choose among alternative lifestyles rather than simply grinding away at manufacturing jobs, have given rise to the literature on the passing of middle class economic values. But what this literature sometimes forgets is how tiny a proportion of U.S. and global population really possesses these new values and choices. In the most affluent lands post-industrial society does not replace super-industrial society; rather, it depends upon the super-industrial society and coexists with it as a tiny, rather isolated pocket of post-economic values. And for the vast mass of humanity, industrial society and middle class values constitute an optimistic view of the future rather than an obsolete civilization. The most outstanding example of this upward thrust of much of the world into industrial civilization is the phenomenon Hudson Institute has labeled the rise of the Pacific Basin. This example is discussed in detail under International Trade.

Technology Related Crises

Although we project long-term growth, and the continuing emergence of the super-industrial society, short-term setbacks may occur, or crises of great importance may make fairly serious alterations in the patterns and rates of growth. More fundamentally, the rise of the super-industrial society ensures that mistakes, as well as successes, will be of great magnitude. Massive pollution, nuclear accidents, culturing and release of mutated viruses, and other disasters become possible in the super-industrial society, as do political explosions resulting from competition to take advantage of the new opportunities opened up by technology--for instance, new opportunities to exploit the seabed. Some of the possible crises are listed in Table III on "1985 Technological Crises," the name of which is taken from von Neumann's famous article predicting that 1985 would see the rise of crises of excessively large-scale technology.*

A second kind of crisis can also have important consequences for high-technology organizations. This second kind of crisis occurs not in the super-industrial states, but in the emerging industrial states. Wherever health technology has outrun food technology and other forms of economic development, great masses of poor and sometimes starving people result, and when this happens the post-industrial world focuses its attention on the crisis and comes to regard high technology and dispensible post-industrial programs as "frivolous." And even in the super-industrial, post-industrial parts of the world, whenever recession or crime or power shortages or some other social phenomenon threatens basic middle class comforts, attention focuses on the immediate crisis; post-industrial esthetics and super-industrial triumphs become expendable.

Desire for Land

Only slightly less predictable than the overall, worldwide pressure for continued growth, and at least as predictable as the continuation of such trends as Pacific Basin takeoff, are certain basic demographic patterns. In the U.S., suburbanization is such a pattern. Suburbanization derives from a deeply ingrained American desire for living space--as shown in Tables I and II. Although sometimes characterized by those who dislike it as a relatively ephemeral phenomenon of "flight from the cities" or as a consequence of certain post-World War II government policies, suburbanization dates back to colonial times. Continued suburbanization will lead to the formation of vast megalopolises, such as those Kahn and Wiener called in The Year 2000 (op.cit) "San-San" and "Boswash." Continuing suburbanization is facilitated by various economic and technological trends, including improved communications, the rise of a service economy, and the vitality of electronics and other industries which do not require large factories, because these trends facilitate the movement of work to the suburbs and to quasi-rural areas.

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*These issues as well as those related to changing values are explored by A. J. Wiener in "Faust's Progress Report: Technology, Changing Values, and the Reactions Against Rationality," a draft report to the National Endowment for the Humanities.

Rural Migration--Re-Urbanization

This trend of work moving out of the central cities to where people live should continue and accelerate. As a result the populations of the centers of the biggest cities are not likely to rise. Because commuting has become so time-consuming, satellite cities like White Plains, Framingham and San Jose will develop and prosper. For the same reason, many of those who continue to work in the central cities will intensely desire to live closer to their work, and as a result a vast rebuilding of the residential areas of the central cities will soon begin to progress rapidly. This phenomenon of white, upper middle class influx into, and rebuilding of, formerly black, lower class areas has already begun to occur in many of the largest cities, for instance in the Capitol area of Washington, D.C. The formation of new ghetto areas should be greatly reduced, because the plight of present inner cities was the consequence of a vast migration that is now topping out--namely, the migration of poor, black, uneducated Southerners from the low-welfare, poor-wage states of the South to the comparatively high-welfare, high-wage cities of the North and the coasts. Likewise, white migration from the rural

Table 1

THE DESIRE FOR LAND

PREFER	1966	1960	1971	1972
CITY	22%	18%	17%	13%
SUBURB	28	26	26	31
SMALL TOWN	31	31	31	32
FARM	18	24	25	23

SOURCE: GALLUP POLLS

	LIVE NOW	PREFER
LARGE CITY OR SUBURB	27%	14%
MEDIUM SIZED CITY OR SUBURB	28	22
SMALL TOWN OR CITY	33	30
OPEN COUNTRY	12	34
	100%	100%

SOURCE: O.R.C. 1971

Table II

PREFER TO LIVE IN:
(In Percent)

	CITY	SUBURBAN	SMALL TOWN	FARM
NATIONAL	17	26	31	25
RACE				
WHITE	16	27	31	25
NON-WHITE	26	21	32	20
EDUCATION				
COLLEGE	17	33	32	17
HIGH SCHOOL	16	26	32	25
GRADE SCHOOL	17	20	29	34
OCCUPATION				
PROF. & BUS.	18	31	31	20
WHITE COLLAR	18	32	32	18
FARMERS	2	-	12	86
MANUAL	14	27	33	26
AGE				
18-20	18	22	30	30
21-29	13	28	30	29
30-49	16	29	31	23
50 & OVER	19	24	33	24
RELIGION				
PROTESTANT	13	24	31	32
CATHOLIC	21	32	32	15
OTHER	(38)	(25)	(31)	(4)
POLITICS				
REPUBLICAN	19	24	33	24
DEMOCRAT	17	27	32	24
INDEPENDENT	13	28	30	28
REGION				
EAST	18	32	33	16
MIDWEST	14	26	29	31
SOUTH	17	21	29	33
WEST	20	26	35	18
INCOME				
$15,000 & OVER	20	37	24	18
$10,000-$14,999	15	30	33	22
$ 7,000-$ 9,999	12	31	30	26
$ 5,000-$ 6,999	14	22	38	26
$ 3,000-$ 4,999	18	17	29	36
UNDER $3,000	23	14	35	28
COMMUNITY SIZE				
1,000,000 & OVER	28	31	29	11
500,000-999,999	27	44	17	12
50,000-499,999	23	35	29	12
2,500- 49,999	10	13	51	26
UNDER 2,500, RURAL	2	15	31	52

SOURCE: GALLUP POLL, 1971 ( ) ESTIMATED

Table III

1985 TECHNOLOGICAL CRISES

By 1985 the Following Areas are Likely to Give Rise to Special Technological Dangers

1. Intrinsically dangerous technology
2. Gradual worldwide and/or national contamination or degradation of the environment
3. Spectacular and/or multinational contamination or degradation of the environment
4. Dangerous internal political issues
5. Upsetting international consequences
6. Dangerous personal choices
7. Bizarre issues

1. Intrinsically Dangerous Technology

A. Modern means of mass destruction
B. Nuclear reactors—fission or fusion
C. Nuclear explosives, high-speed gas centrifuges, etc.
D. Research missiles, satellite launchers, commercial aircraft, etc.
E. Biological and chemical "progress"
F. Molecular biology and genetics
G. "Mind control"
H. New techniques for insurgency, criminality, terror or ordinary violence
I. New techniques for counterinsurgency or imposition of order
J. New serendipities and synergisms

2. Gradual Worldwide and/or National Contamination or Degradation of the Environment

A. Radioactive debris from various peaceful nuclear issues
B. Possible greenhouse or other effects from increased CO_2 in the atmosphere, or new ice age because of dust in stratosphere, etc.
C. Other special dangerous wastes—methyl, mercury, DDT, etc.
D. Waste heat
E. Other less dangerous but environment degrading wastes such as debris and garbage
F. Noise, ugliness and other annoying byproducts of many modern activities
G. Excessive urbanization
H. Excessive overcrowding
I. Excessive tourism
J. Insecticides, fertilizers, growth "chemicals," food additives, plastic containers, etc.

3. Spectacular and/or Multinational Contamination or Degradation of the Environment

A. Nuclear war
B. Nuclear testing
C. Bacteriological and chemical war or accident
D. Artificial moons
E. Projects West Ford, Storm Fury, etc.
F. Supersonic transportation (shock waves)
G. Weather control
H. Big "geomorphological" projects
I. Million-ton tankers (Torre Canyon was only 111,825 tons) and million-pound planes
J. Other enterprise or mechanism of "excessive" size

4. Dangerous Internal Political Issues

A. Computerized records
B. Other computerized surveillance
C. Other advanced techniques for surveillance
D. Excessively degradable (or unreliably reassuring) centralized capabilities
E. Improved knowledge of and techniques for agit-prop and other means of creating disturbances
F. Improved knowledge of, and techniques for, preventing disturbances
G. Complex or critical governmental issues leading to either "technocracy" or "Caesarism"
H. Nuclear weapons affecting internal politics
I. Excessively illusioned attitudes
J. Other dangerous attitudes

5. Upsetting International Consequences

A. Both new and "traditional" demonstration effects
B. Technological obsolescence of "unskilled" labor
C. New synthetics—e.g., coffee, oil, etc.
D. Forced modernization
E. Growing guilt feelings by many in wealthy nations—particularly among the alienated or young
F. Inexpensive and widely available "realistic" communications and physical travel
G. Accelerated "brain drains"
H. Cheap (synthetic?) food
I. Cheap education
J. Control and exploitation of the oceans, space, moon.

6. Dangerous Personal Choices

A. Sex determination
B. Other genetic engineering
C. Psychedelic and mood-affecting drugs
D. Electronic stimulation of pleasure centers
E. Other method of sensual satisfaction
F. Excessive permissiveness and indulgence
G. Dropping out and other alienation
H. Excessive narcissism or other self-regard
I. Super-cosmetology
J. Lengthy hibernation

7. Bizarre Issues

A. Generational changes; e.g., extended longevity
B. Mechanically dependent humans; e.g., pacemakers
C. Life and death for an individual; e.g., artificial kidneys, etc.
D. New forms of humanity; e.g., "live" computers
E. "Forcible" birth control for "impossible" groups
F. Other external controls or influence on what should be a personal or even institutionally private choice
G. Life and death or other control of "outlaw" societies which have not yet committed any traditional crime
H. Even the continuation of the nation-state system
I. Controlling and limiting change and innovation
J. Radical ecological changes on a planetary scale
K. Interplanetary contamination

South to the North has ended, and black migration from the inner cities of the North to northern suburbs is beginning and should accelerate rapidly whenever the national economy is prospering.

Effect of Climate on Demography

The old movement of the poor from the South to the North is increasingly being replaced by a new movement of the rich from the North to the South, a movement we call "The Sunbelt Shift." (See Table IV.) The reasons for this movement include rising cultural emphasis on recreation and informal leisure, increasing numbers of older people (who find the South more healthful), and basic economic considerations having to do with a shift from the 19th century industrial base centered on Northeastern coal, steel, and shipping, to employment increasingly dominated by services and by light, high-technology manufacturing with low transportation costs.

In addition to the personal and social benefits of good climate, there are considerable economic benefits which are very important. Construction can be undertaken year-round and building standards need not be as severe. Heating costs are lower, but are cancelled out by the costs of air-conditioning. In many small ways the costs are lower. People can wear fewer and cheaper clothes; medical bills are lower; there are no snow clearance costs; cars last longer. Warm areas are better places to be poor--a substandard dwelling is less intolerable when the temperature stays high. We believe that the benefits of living in warmer climes will encourage a southerly migration for the remainder of this century. At some time, probably not in the next decade, white southbound migrants will be followed by the more prosperous non-whites.

Climate is much more important than it was in the past because people are relatively more important to our developing service economy than are raw materials. The jobs go where people want to be, rather than vice versa. Road and air transport permit much more flexibility in location than sea and rail did. Other technological changes permitting movement toward leisure areas involve communications, medical services and recreational vehicles. Moreover, new resort areas have been given widespread publicity.

Most of the rural areas and small towns of America are in decline, but there are many interesting exceptions which may herald a strong trend in the future. Certain areas which ought to be declining are indeed prospering because they support great leisure activities. The best example is the hilly areas of New England, which have been undergoing outward migration for well over a century, yet in recent years have seen a reversal as farmers have been replaced by increasing numbers of skiers. The same is true of the ex-mining communities of Colorado and California. The former fishing and whaling communities on Cape Cod have converted long ago to leisure use. Flourishing beach areas throughout the country are other examples, as are the rapid development of Florida and many desert areas of the Southwest. (See Table V.)

Table IV

THE SUN BELT SHIFT

Urbanized Areas over 1/2 Million Population	POPULATION GROWTH 1950-70	AVERAGE JANUARY TEMPERATURE
RAPID GROWTH (OVER 100%)		
Phoenix	300%	50
Miami	250	67
Sacramento	200	45
St. Petersburg	195	55
San Diego	177	56
Houston	137	54
Dallas	136	46
Atlanta	132	45
Los Angeles	123	54
Jacksonville	118	56
Norfolk	116	41
Denver	110	28
Oklahoma City	110	37
MODERATE GROWTH (50-100%)		
Seattle	99%	38
Hartford	97	26
Dayton	97	32
Washington	93	37
San Francisco	83	51
Columbus	80	30
Twin Cities	73	12
Memphis	64	42
Indianapolis	63	29
Portland, Ore.	61	38
San Antonio	61	50
Kansas City	58	32
Cleveland	55	28
Louisville	55	35
Milwaukee	51	21
SLOW GROWTH (UNDER 50%)		
Akron	48%	29
Rochester	47	25
New Orleans	46	55
Chicago	44	26
Detroit	44	27
Springfield, Mass.	44	24
Philadelphia	38	32
Cincinnati	37	34
Baltimore	36	35
New York	34	32
St. Louis	34	32
Providence	33	29
Birmingham	26	44
Boston	25	30
Buffalo	21	25
Pittsburgh	20	29

Table V

U.S. REGIONAL POPULATION CHANGE

	1950 (MILLIONS)	1970 (MILLIONS)	% CHANGE 60-70	NET MIGRATION 60-70 WHITE	NET MIGRATION 60-70 BLACK
REGION					
NORTHEAST	39	49	10%	-1%	20%
MIDWEST	44	57	10%	-3%	11%
SOUTH	47	63	14%	4%	-12%
WEST	20	39	24%	9%	28%
NATION	151	205	13%	-	-
LARGE STATES					
CALIFORNIA	11	20	27%	11%	31%
NEW YORK	15	18	9%	-4%	28%
PENNSYLVANIA	10	12	20%	-4%	3%
TEXAS	8	11	17%	1%	-
ILLINOIS	9	11	10%	-2%	12%
OHIO	8	11	10%	-2%	6%
MICHIGAN	6	9	13%	-2%	17%
NEW JERSEY	5	7	18%	6%	23%
FLORIDA	3	7	37%	33%	-4%
MASSACHUSETTS	5	6	10%	1%	30%

OTHER RAPID GROWING STATES	1960-70 CHANGE	SLOW GROWING STATES	1960-70 CHANGE
NEVADA	71%	W. VIRGINIA	-6%
ARIZONA	36%	N. DAKOTA	-2%
ALASKA	33%	S. DAKOTA	-2%
COLORADO	26%	IDAHO	1%
MARYLAND	26%	MISSOURI	2%
DELAWARE	23%	IOWA	2%
HAWAII	22%	MISSISSIPPI	2%
VERMONT	22%	KANSAS	3%

In addition, communities devoted to certain recreational facilities may spring up within urban areas. We are already noticing small boating communities around marinas. In the Midwest there is a strong tradition of "a cabin in the woods" for hunting, fishing, and getting away from it all.

Generally, this is a favorable development: these leisure opportunities provide numerous service jobs for the local indigenous population. The old inhabitants live off the new settlers. Note also the long history of summer resort areas within range of metropolitan areas gradually being transferred from seasonal to permanent occupancy. As the cities spread out, we may expect this process to continue. In our surprise-free projection, these trends continue:

1. The sun belt shift--a continuing growth of most of the warmer areas of the U.S.

2. Further growth of other quaternary* areas--desirable places because of their natural environment (e.g., the ski-belt areas such as the Colorado Rockies, the California Sierras and Vermont; in general, the beach and lake areas), or because of their cultural environment (e.g., San Francisco and posh areas of Manhattan).

3. Growth of the Southern Piedmont--from the Shenandoah Valley through the Carolina "ring city" and Atlanta to Nashville. The area has an excellent climate, relatively good race relations, increasingly better education, a fine labor force, and a favorable attitude toward business.

4. The development of Northern Florida--as Southern Florida is filling up.

5. Development of the Pacific slope, which has good weather, beaches and outdoor recreation.

6. The growth of Eastern Arizona and Western New Mexico, spilling over from Southern California and Western Arizona.

7. The development of the Boston-to-Washington Piedmont fringe--from Maine down through West Virginia--involving very low density summer and ski homes, and more long-distance commuting to major centers.

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*Quaternary means services to services and to other post-tertiary economic activities.

8. The growth of state capitals: big employment centers as state governments enlarge their functions.

9. Development of the Gulf Coast--through the dynamic economic expansion of coastal Texas (especially Houston), and Louisana. Cheap air conditioning makes the area more pleasant; beaches and waterways make it desirable.

By comparison, we list below areas that are most likely to be declining or stagnant.

10. Old ports: traditional shipbuilding and shipping are on the way out. Only a few large deep-water ports will maintain their current importance.

11. Old coal-and-iron areas (e.g., West Virginia, Pittsburgh, Duluth). Even a major revival of coal mining will be very capital-intensive and will require much less labor. The peak of out-migration, though, is probably past, and the old crisis may revive investment in some old coal fields, as well as open many new ones.

12. The Great Plains--modern farming requires fewer farmers per year. Most of those employed in "agriculture" will work in factories making machinery and fertilizer.

13. The black belt of the South--the penetration of modern mechanized farming into the rural South will displace traditional labor. But white out-migration has already ended and the rush of black out-migration is also probably over.

Table VI summarizes our projections for regions and a few key rapidly growing states.

Thus the demographic prospects for the United States over the next quarter century are for greater spread, lower population densities, decentralized industries, satellite cities, rebuilt inner cities, an end to the vast migration of the poor from the rural South to the urban North, and--as we have emphasized elsewhere--accelerated migration of the relatively affluent from the cold North to the warmer southern states. These projections are somewhat sensitive to energy prices, since the decentralized demographic pattern depends upon cheap transportation, but as we shall argue below long-term energy prices are likely to fall as low as pre-OPEC cartel prices.

World Populations Trends

Another trend that tends to be relatively predictable, although far less than the above, is world (or major country) population. It is worth noting that past predictions of future American population growth

Table VI

REGIONAL POPULATIONS
(MILLIONS)

	1975	1980	1985
NEW ENGLAND	12.5	13.2	13.9
MIDDLE ATLANTIC (NY-VA.)	49.0	51.0	53.9
FLORIDA	7.5	8.3	8.9
REST OF SOUTH	33.4	34.5	35.6
MIDWEST (OHIO-MINN.)	53.9	56.0	59.6
PLAINS	7.6	7.8	8.1
TEXAS	12.0	12.8	13.6
SOUTHWEST (N.M.-NEV.)	3.6	3.9	4.2
COLORADO	2.4	2.6	2.8
REST OF MOUNTAINS (IDA-UTAH)	2.9	3.0	3.2
PACIFIC NORTHWEST	5.9	6.4	6.8
CALIFORNIA	22.1	24.2	26.4
HAWAII & ALASKA	1.1	1.2	1.3
TOTAL U.S.	213.9	224.9	238.3

Source: Hudson Institute projections from U.S. Bureau of the Census data.

have generally turned out very poorly. However, demographic knowledge is improving. Certain of the discontinuities, such as the so-called demographic transition, which were poorly understood in the past are now better understood. On a global basis trends are much more stable than they are in any single country.

Within the population of a single country there is a fundamental division in predictability of certain parts of the population. Those who will be over twenty-five in the year 2000 one can predict fairly assuredly because they have already been born, and age-specific death rates may not vary much. On the other hand, those who have not been born--i.e., those who will be under twenty-five in the year 2000--are much more subject to decisions whether or not to have children, which in turn are heavily influenced by expectations, food shortages, and economic growth trends of various kinds.

In any case, we believe that the world is now going through an inflection point. The growth rate of world population seems to be as high as it ever has been and as high as it ever will be. There should be a relatively stable trend toward decreasing rates of population

growth in the future. This projection results from two phenomena. The first is the so-called demographic transition: when countries become relatively more affluent, welfare systems and other social mechanisms tend to replace the traditional functions performed by children, such as support in old age, support in times of sickness, and so forth. At the same time, education of children becomes necessary and expensive and thus becomes a deterrent to having too many children. Thus there is a tendency for relatively affluent populations to decrease their rates of population growth. An opposite trend which has the same influence over population growth rates is the occurrence of food shortages and starvation in those countries which have greatly overpopulated themselves, particularly the Indian subcontinent and parts of Africa. In these countries survival has become so difficult, especially for the very young children, that because of malnutrition disease tends to increase the death rate to the point where net population growth rates are much lower than they might otherwise be. Thus we project a world population continuing to rise but with a rate of growth decreasing continuously over a very long period of time.

As shown in Table VII on "Declining Birth Expectations," the expectations of fertile U.S. women regarding the number of children they will bear have been steadily dropping toward the rate where population growth will cease. When 1974 data are available we expect them to show a drop below the zero population growth level. But this drop does not of course mean immediate cessation of population growth; the large bulges in the age distribution of Americans depicted in Figure 2 on "Distribution of the Total Population," must first work themselves up through the childbearing age brackets, resulting in larger numbers, through smaller rates of birth. We expect low birth rates to continue because of the changing role of women--with less emphasis on children and more emphasis on and opportunity for work. Moreover, in the short run economic troubles should cause a further dip in the birth rate.

Table VII

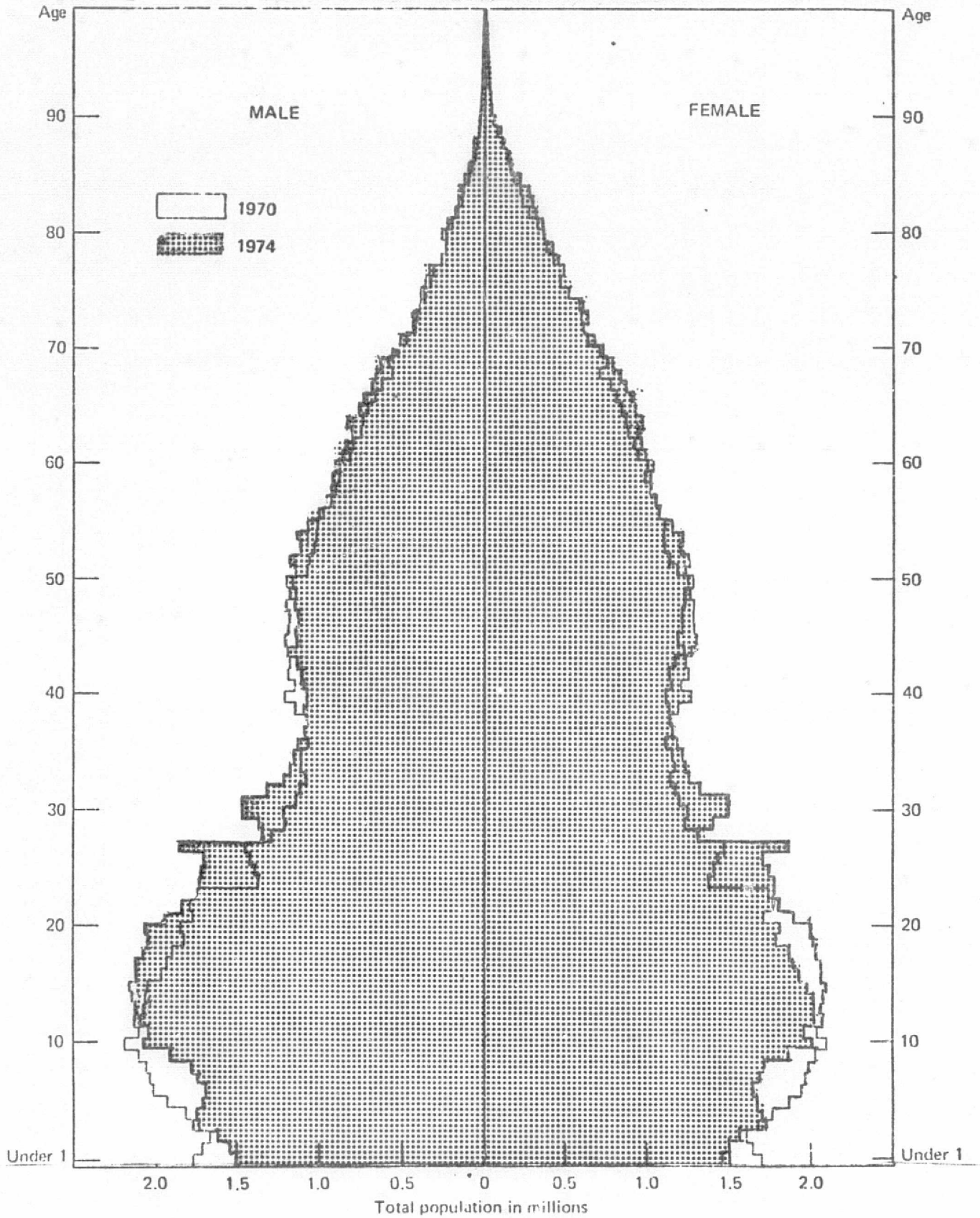
DECLINING BIRTH EXPECTATIONS

	CHILDREN EXPECTED	
	BY WOMEN AGED 18-24	BY WOMEN AGED 25-29
1960	3.1	3.4
1965	3.1	3.4
1970	2.5	2.8
1971	2.4	2.6
1972	2.3	2.5
1973	2.3	2.4
"ZPG" LEVEL	2.1	2.1

SOURCE: U.S. CENSUS BUREAU P-60#254

Figure 2

DISTRIBUTION OF THE TOTAL POPULATION, BY AGE AND SEX:
APRIL 1, 1970 AND JULY 1, 1974



As the population "bulge" does work itself up into the older age brackets, distinct changes in the cultural style of the population will occur. Not surprisingly, when the bulge representing the post-World War II baby boom was in its teens, the whole American culture reflected an emphasis on youth and the teen-age years. As this generation has grown older (see Table VIII), articles in popular magazines, advertisements on television, and important economic markets have shifted to reflect, first, the style and problems of people in their twenties and now, increasingly, the tastes and concerns of people in their early thirties. This bulge in the population distribution thus determines the style of mass culture.

Table VIII

AGE COHORTS

BORN IN:	AGE IN:			
	1965	1975	1985	1995
BEFORE 1900	65+	75+	85+	95+
1900-1910	55-65	65+	75+	85+
1910-1920	45-55	55-65	65+	75+
1920-1930	35-45	45-55	55-65	65+
1930-1940	25-35	35-45	45-55	55-65
1940-1950	15-25	25-35	35-45	45-55
1950-1960	5-15	15-25	25-35	35-45
1960-1970	0- 5	5-15	15-25	25-35
1970-1980	---	0- 5	5-15	15-25
1980-1990	---	---	0- 5	5-15

Age Cohorts

An equally important phenomenon tied to age cohorts is the style of the executives running the country's major organizations. Top executives tend to be picked from the age cohort that is in its mid-fifties, and middle range executives tend to be in their mid-thirties. Since executives, like other people, tend to carry throughout their life the expectations and perspectives formed in their adolescent and college years, we can identify the cultural styles of future executives to some extent by looking at the key experiences which occurred in their late adolescent years. Table IX, "Changing Executive Generations," illustrates this phenomenon.

Table IX

CHANGING EXECUTIVE GENERATIONS

THE "55 YEAR OLD" EXECUTIVE IN:			
	1965	1975	1985
BORN	CIRCA 1910	CIRCA 1920	CIRCA 1930
CHILDHOOD	WWI	PROSPEROUS 20s	DEPRESSION
YOUTH	PROSPEROUS 20s	DEPRESSION	WWII
EARLY CORPORATE MILIEU	DEPRESSION	POST WAR BOOM	"ORGANIZATION MAN"
RETIRES	CIRCA 1975	CIRCA 1985	CIRCA 1995
THE "35 YEAR OLD" EXECUTIVE IN:			
	1965	1975	1985
BORN	CIRCA 1930	CIRCA 1940	CIRCA 1950
CHILDHOOD	DEPRESSION	WAR	PROSPERITY
YOUTH	WWII & COLD WAR	"SILENT GENERATION"	CAMPUS UNREST
EARLY CORPORATE MILIEU	"ORGANIZATION MAN"	TURBULENT 60s	?
RETIRES	CIRCA 1995	CIRCA 2000	CIRCA 2105

Localism

An important consequence of rising population, spreading population, environmental concern, rising political organization, and many other currently important trends, is the accelerating influence of what we label "localism." Localism is a defense of narrow local interests at the expense of the broader needs of the community. Almost everyone gains by having highways, moderate income housing, factories, airports, and power plants somewhere in their region. Almost everyone loses by having these same kinds of infrastructure located in their neighborhood. Until the last decade this conflict has not been severe. The needed

regional facilities have almost always found a place. But recently a series of events and trends have greatly strengthened the hand of local obstructionists:

1. Disillusionment with progress. "You can't fight progress" is no longer an unanswerable argument.

2. Environmentalism. Everything pollutes some way.

3. Anti-auto, anti-noise agitation.

4. Community control. This concept did little for the poor, but middle-class communities can use it with a vengeance.

5. Widespread disillusionment with institutions.

6. Flaccid and sometimes stupid leadership. You <u>can</u> beat city hall.

7. Discretionary behavior. You can fight city hall <u>and get away with it</u>.

Thus it becomes more difficult to install and expand the infrastructure needed for economic development. The problem may be compounded by tax equilization, revenue sharing, and other legislative or judicial acts which decouple local revenues from local economic activity, thus reducing the incentives for local development.

Economic Trends

GNP Projections

Another variable which is relatively predictable over long periods of time is gross national product. Gross national product, however, is much more sensitive to phenomena such as national power and availability of inexpensive energy, which are relatively hard to predict, than are the variables we have discussed earlier. The projection of GNP is best done not by simple extrapolation but by looking at likely population growth, labor force participation rates, and rates of productivity increase, and multiplying these together to obtain projected GNP. Gross national product growth is, of course, subject to business cycle fluctuations but is much more stable over the long-term than these fluctuations would suggest. The rate of growth of GNP tends to become institutionalized by the social structure. Britain, for instance, because of fundamental characteristics of its society such as antagonism between businessmen and laboring groups, has tended to grow fairly stably at two percent per year for at least two centuries. However it is worth noting that, particularly in modernizing countries, dramatic changes can sometimes occur in national growth rates. For instance South Korea after a period of chaos which slowed growth became in the late 1960s and early 1970s the fastest growing economy in the world. Thus one must be relatively careful about projecting the economies of countries which are going through massive socio-political changes in short periods of time.

It is obvicusly more difficult to project reliable GNP per capita than it is to project either population or GNP because the uncertainties in the estimates of GNP and of population tend to reinforce one another. Again, obviously, adding more inter-acting variables makes the scenario more realistic and useful but at the same time more complex and uncertain.

On the following page (Table X) we have projected three alternative growth rates for the United States, two percent GNP growth per year, three percent growth and four percent growth. Over a long period of history U.S. growth rates have fluctuated around three percent in real terms, and despite some decrease in work-oriented values, despite energy shortages, and, in the opposite direction, despite the institutionalization of better mechanisms for absorption of technological changes, there is reason to believe that over a long period of time these growth rates should remain approximately what they have been in the past. At least, this is the least bad of all alternative assumptions for long-range planning purposes.

We have also provided estimates of disposable income over this 1980-2000 period of time. We believe that if gross national product grows at a relatively slow rate, for instance at two percent, then increasing demands will be put on government for welfare and other measures, and the federal budget will grow at relatively high rates.

Table X

ECONOMIC CONTEXTS 1975-2000[1]
(All estimates are in constant 1973 dollars)

		1975	1980	1985	1990	2000
U.S. GNP [3]	I.	1225	1350	1490	1650	2000
	II.	1260	1460	1700	1950	2650
	III.	1299	1580	1920	2350	3450
U.S. DISPOSABLE INCOME	I.	845	930	1030	1150	1375
	II.	870	1010	1170	1350	1825
	III.	895	1120	1390	1775	2900
U.S.[2] BUDGET	I.	305	370	410	450	550
	II.	315	365	420	500	650
	III.	325	355	430	525	800

[1] Case I. assumes GNP average growth of 2 percent/year
Case II. assumes GNP average growth of 3 percent/year
Case III. assumes GNP average growth of 4 percent/year

[2] Case I. assumes Budget = 27.5 percent GNP
Case II. assumes Budget = 25 percent GNP
Case III. assumed Budget = 22.5 percent GNP
(in 1975 all are taken as 25 percent of GNP)

[3] Disposable income is assumed to remain at 69 percent of GNP. There are, of course, complex transfer payments between federal, state, and local governments (e.g. revenue-sharing) and from the federal budget to personal disposable personal income (e.g. social security). These can be expected to increase, and the total will increasingly be greater than GNP.

Inflation

The difficulty of making long-term forecasts in a rapidly changing environment has increased recently. During the 1960s, rising awareness of the need to protect the natural environment led to private and public decisions which threw monkey-wrenches into many long-term projections. The 1974-75 inflationary recession has made economic forecasting doubly dismal: now econometric modelers must attempt to forecast economic variables in a period of extreme uncertainty and anamolous expectations.

Until the late 1960s, post-war American economic history has consisted of reasonably stable growth, relatively full employment, and slowly creeping price inflation; macroeconomic policy, both fiscal and

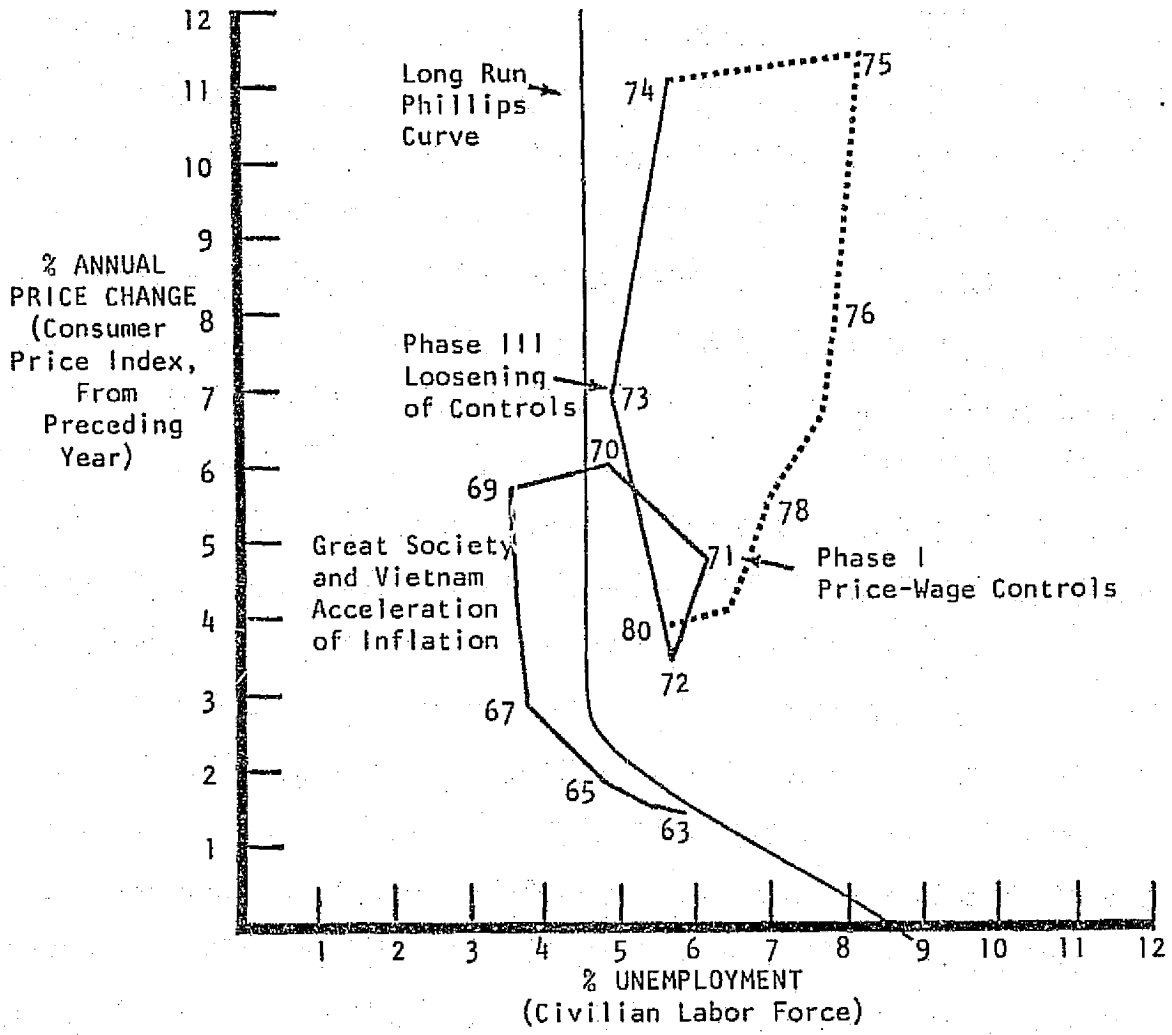
monetary, had successfully moderated the business cycle to insure against repetition of the 1930s. Until Great Society programs and the Vietnam war accelerated price and wage inflation, the thought of price-wage controls in peacetime was inconceivable. By 1969, however, the annual rate of inflation passed 5 percent and monetary restraint was applied to bring inflation back down to previous levels. While unemployment increased to over 6 percent in early 1971, inflation did not subside; in August 1971, President Nixon announced his "New Economic Policy" which included price-wage controls (see Figure 3, "U.S. Inflation and Unemployment, 1963-1974").

In January 1973, Phase III of the price-wage controls was implemented, permitting food and commodity prices to explode. With the quadrupling of oil prices in late 1973, the stage was set for evolution of the American economy to its present worsening situation of high inflation, high and rising unemployment, and sharply dropping GNP. Several alternative scenarios suggest the possibilities open to the American economy during the next few years (see Figure 4, "A Reflationary Scenario"). Judicious macroeconomic policy might accomplish a soft landing after inflation decreases and unemployment drops slowly, following the onset of recovery, projected by the Ford Administration. On the other hand, recovery might be too sharp, leading to an investment boom which reflates both GNP and prices too quickly, at which point inflationary expectations and corporate illiquidity might combine to force output sharply down. Finally, recovery might not quite set in at all, leading to persistent high unemployment and probably price deflation (a mini-depression). Figure 5 illustrates the two scenarios in terms of macroeconomic parameters.

Obviously, the American economy has entered a new period in which the primacy of economic anomolies has rendered conventional econometric models less than meaningful for the purpose of forecasting. The hazards of making business-as-usual long-term forecasts based on traditional economic (and other) trends need not be elaborated, since they ought to be clear at this point in time. Future behavior of the economy will depend on private spending, saving and investment decisions, as well as on public fiscal and monetary policies. Due to the current high level of confusion in energy and economic affairs, it is probably safe to assume that there is no single set of policies which is both optimal and politically practical. The next few years will see much experimentation as economic and energy policymakers attempt to sort out the complex new interactions and to formulate policies and programs that minimize collateral damage in other areas.

Figure 3

U.S. INFLATION AND UNEMPLOYMENT, 1963-1974
AND AN OFFICIAL OMB FORECAST, 1975-1980

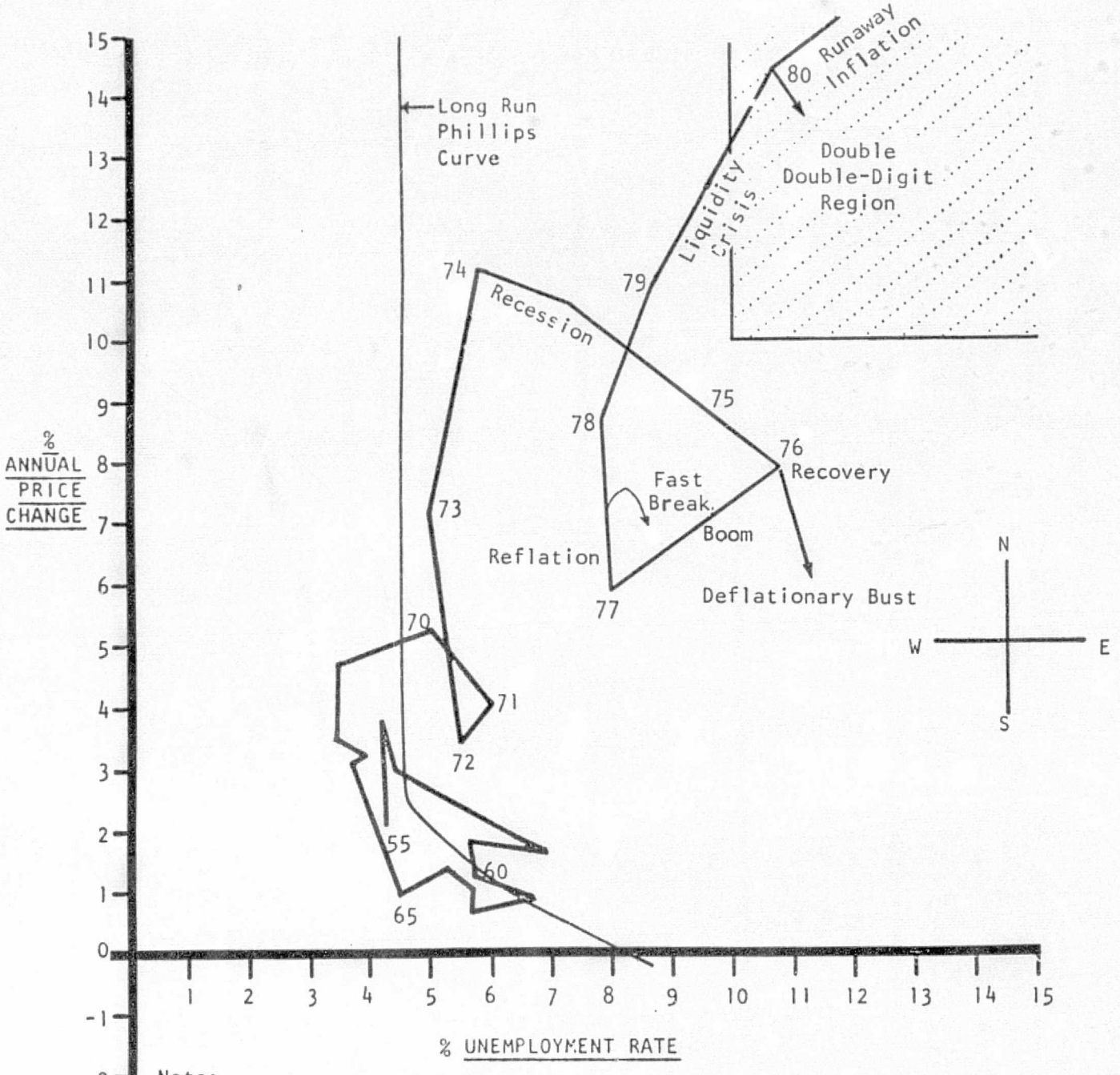


FOURTH QUARTER 1974:

Rate of Real GNP Growth:	- 9.1%
Rate of Change of GNP Deflator:	14.4%
Increase of Unemployment, October to December:	6.0% to 7.2%
(Unrevised January 1975 report:	8.2%)

Figure 4

A "WORST PLAUSIBLE CASE" FOR CORPORATE PLANNING:
THE REFLATION CYCLE SCENARIO



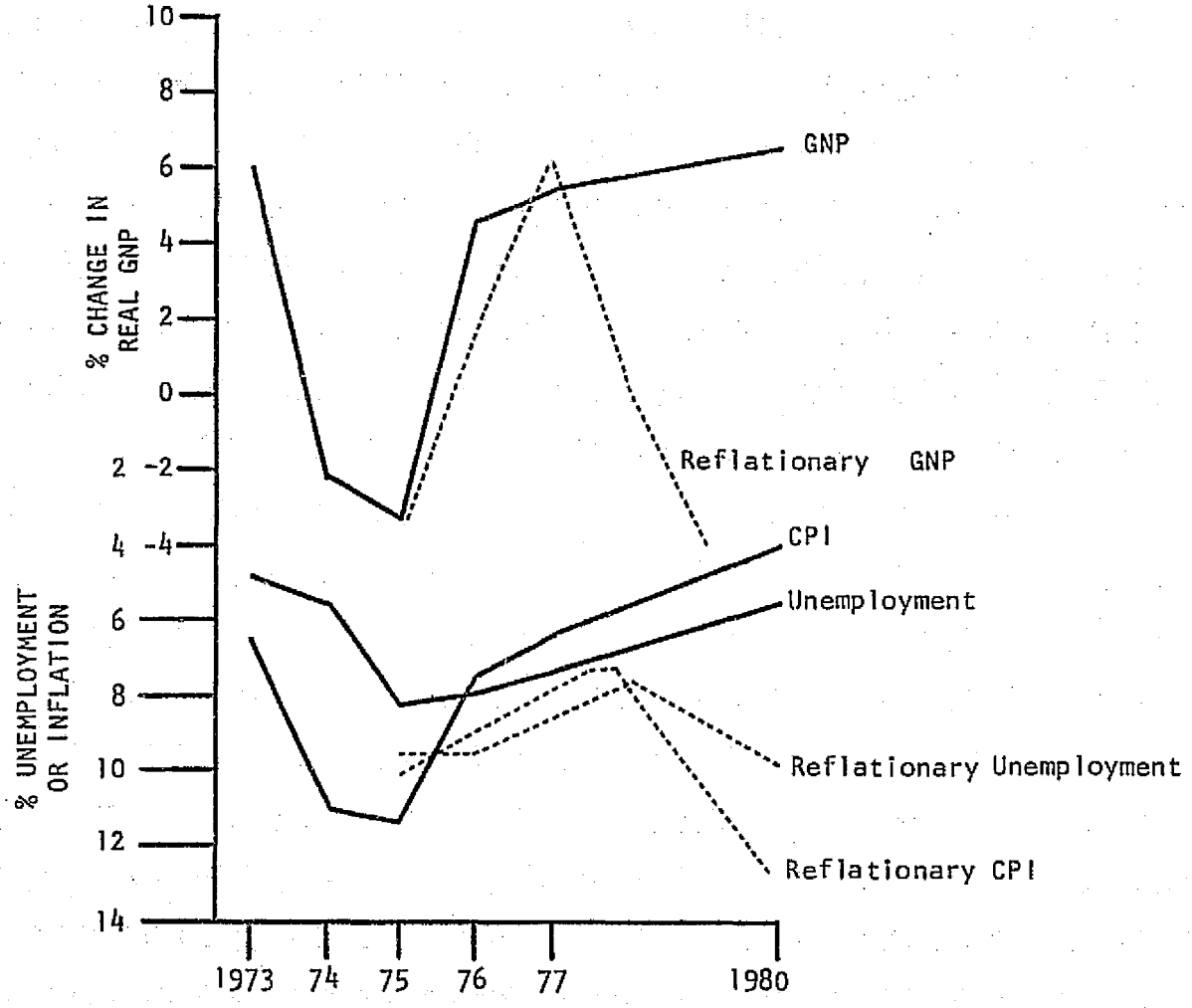
Note:

Political responses to point of greatest pain (unemployment (E) inflation (N)) creates monetary and fiscal policies that work, but only after time lag. During the lag, pain intensifies, and attempts to correct are re-doubled. System is impatient, lacks foresight, ultimately over-corrects, and "hunts."

Result: turbulence, long-term varying but high inflation (long-term shift towards NNE)), periodic liquidity (NE) and employment crises (E), reductions in unemployment and recovery (SW movement) followed by reflation and boom (NW movement) followed by restrictive policies and liquidity problems, producing clockwise turn to NE and finally E and SE as in winter 1974-5. Cycle may be repeated or may lead to depression. Average real GNP growth low until recovery to "acceptable" rates of unemployment and inflation, as in the 1955-68 period.

Figure 5

TEMPORAL EVOLUTION OF PRIMARY MACROECONOMIC PARAMETERS IN THE TWO SCENARIOS



The solid lines show OMB projections (1975-80) and the dotted lines show the reflationary scenario. Precise timing and rates of change could vary considerably, of course. Rise in the rate of change of real output is generally preceded or accompanied by a drop in the rate of change of prices. The lagged change in the unemployment rate in any year is approximately given by one-third of the difference between the rate of change of real GNP and 4 percent (the productivity trend), according to Arthur Okun's well-known rule of thumb.

International Trade

Pacific Basin

One of the largest-scale long-term phenomena that Hudson Institute has identified has been the acceleration of economic growth in the Pacific Basin. Because of the influence of rapid Japanese growth, rising availability of capital in the region (from both American and Japanese sources) improved transportation, and the peculiarly adaptable traits of Chinese culture for industrial development, the Pacific Basin region has begun to grow very rapidly and is likely to continue to grow very rapidly in the future. This means that commercial transport needs will rise dramatically in the next generation. It also means that tourism is likely to experience an extraordinary development. We have already seen the initial phases of this dramatic increase in commerce and tourism. It is possible that straightforward projection of these increases would greatly underestimate the eventual strength of the trend. We include a chart showing one scenario for Japanese tourism which could apply to Korea but possible even more likely to Taiwan. As can be seen the effects of vast numbers of Japanese tourism would have a remarkable influence over Korean and Taiwanese development and over the development of transportation networks in North East Asia. (Cf. Figures 6 and 7 which show several examples of the rapid growth of tourism.) Detailed economic projections for the Pacific Basin and selected other regions are shown in Appendix III. The Pacific Basin phenomenon could be discontinued by prolonged, severe depression, by major war, or by a major confrontation between Japan and Southeast Asia (e.g., over use of the Malacca Straits), but should continue otherwise.

Multinational Corporations

Great multinational corporations, which originated in the United States, Japan, and Western Europe, will likely continue to expand their role as the leading edge of technological progress; the major determinants of the structures of national economies and the world economy; and the principal instruments of economic development in the non-communist world. The multinationals possess extraordinary comparative advantages in raising and investing capital; in creating and managing organizations; in obtaining information and using it for corporate planning purposes; and in innovating and transferring technology. They have superior facilities for distributing, maintaining, marketing, and financing their products. They furnish local elites with extraordinary career opportunities and therefore attract the finest talent available in much of the world. They have created successful and sophisticated systems for educating and upgrading blue-collar, white-collar, and management talent. Increasingly they provide governments with major inputs of savings and taxes.

The rise of the multinational corporations is favored by continued world peace, by political stability in most countries, and by a prosperous world economy. They obtain advantages from those new technologies

which require large amounts of capital and advanced technological skills, and from those which provide great economies of scale. They are favored by relative decreases in transportation and communication costs and by dispersion of resources and markets throughout the world. They are also favored by increasing standardization of markets for many kinds of products throughout the world, as well as--somewhat paradoxically--by their exceptional ability to adapt to changes in those markets. Hitherto the multinationals have benefited from the lack of pervasive or effective interference from political authorities, but one of the great imponderables in their future is the extent to which political authorities will act to limit the growth and capacities of the multinationals. The home countries of the multinationals, principally the U.S., Japan, and Western Europe, have increasingly become sensitive to the alleged avoidance of taxes and export of jobs to other countries. The host countries in both the developed and developing world have become sensitive to what some perceive as the exploitation and dependence that result from the activities of multinational corporations whose gross sales are frequently larger than the gross national products of the host countries.* The degree to which these political sensitivities will inhibit the growth of the multinationals is difficult to project, but even if the effect is fairly strong the multinationals are likely to continue growing at a relatively rapid rate.

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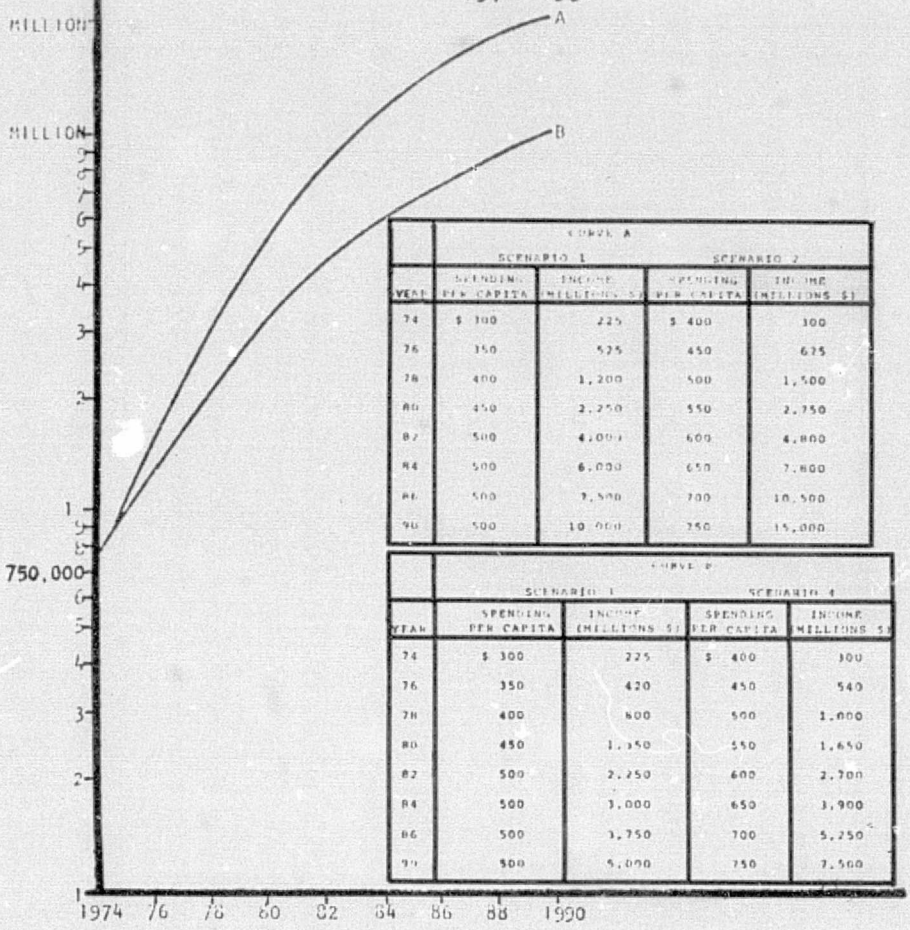
*Such statistics, which show General Motors as "larger" than Switzerland, have often been invoked to suggest that G.M. is somehow more powerful than Switzerland. This is obvious political nonsense, at least within the territory over which the Swiss government exercises sovereignty and the unchallengeable power to exclude, regulate, tax, or even expropriate G.M. Moreover, the relevant economic comparison to GNP is not gross sales, but value added, which requires subtracting the company's purchases ("imports") from sales.

PROJECTED GROWTH OF TOURISM IN KOREA 1974-1990



	CURVE A			
	SCENARIO 1		SCENARIO 2	
YEAR	SPENDING PER CAPITA	INCOME (MILLIONS $)	SPENDING PER CAPITA	INCOME (MILLIONS $)
74	$ 300	225	$ 400	300
76	350	525	450	675
78	400	1,200	500	1,500
80	450	2,250	550	2,750
82	500	4,000	600	4,800
84	500	6,000	650	7,800
86	500	7,500	700	10,500
90	500	10,000	750	15,000

	CURVE B			
	SCENARIO 3		SCENARIO 4	
YEAR	SPENDING PER CAPITA	INCOME (MILLIONS $)	SPENDING PER CAPITA	INCOME (MILLIONS $)
74	$ 300	225	$ 400	300
76	350	420	450	540
78	400	800	500	1,000
80	450	1,350	550	1,650
82	500	2,250	600	2,700
84	500	3,000	650	3,900
86	500	3,750	700	5,250
90	500	5,000	750	7,500

1970 U.S. $

ENTRIES

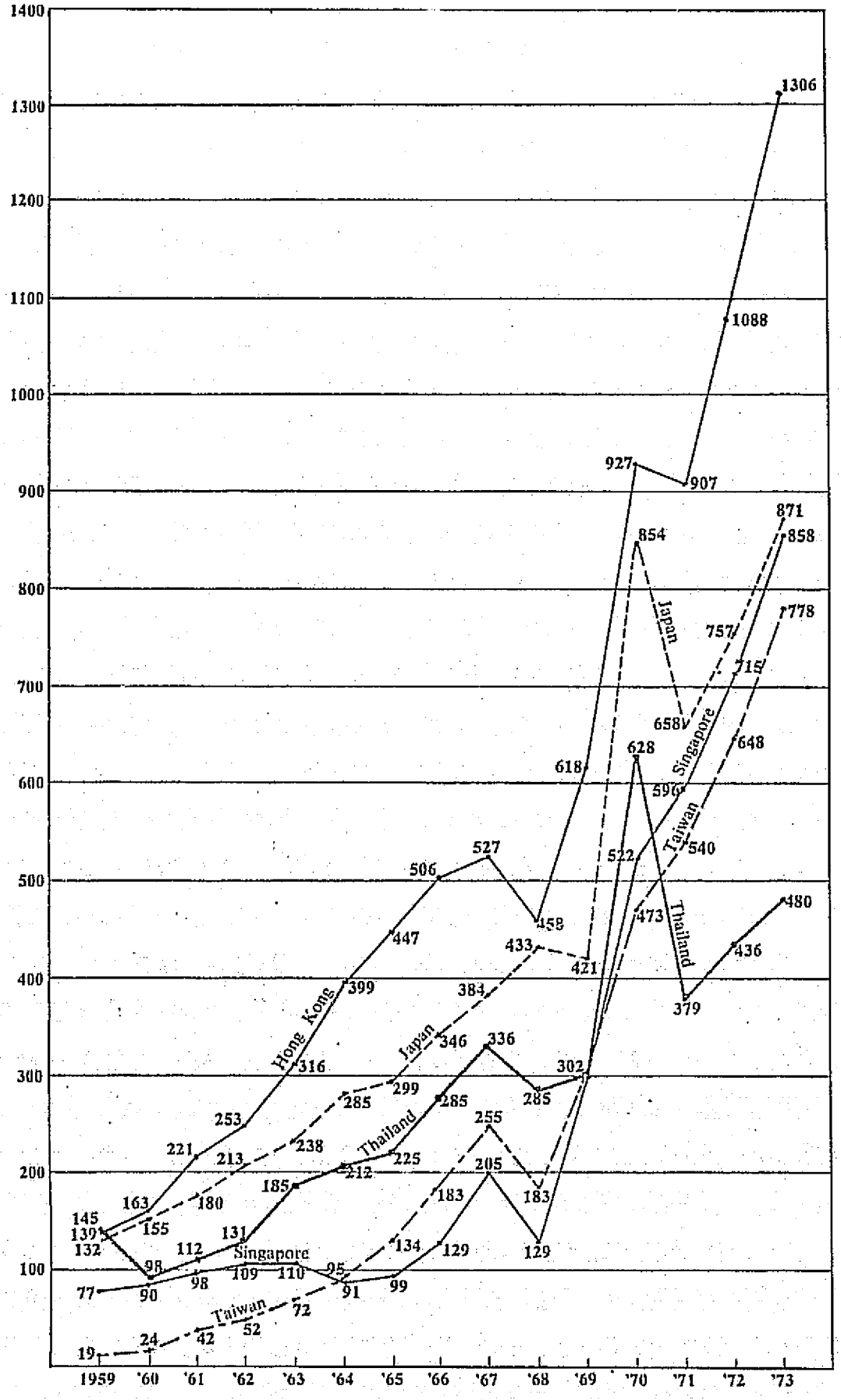
	KIMPO AIRPORT SEOUL	PUSAN AIRPORT	PUSAN SEAPORT	CHEJU	INCHON SEAPORT	OTHER	TOTAL
1969	102,419	14,868	8,819	-	567	13	126,686
1970	132,135	24,198	14,225	1,969	793	15	173,335
1971	165,736	43,955	18,129	3,959	998	18	232,795
1972	266,120	61,329	29,815	5,205	8,157	30	370,656

TOURISTS TO KOREA

	KOREANS ABROAD	U.S.	JAPAN	EUROPE	TAIWAN	OTHER ASIA	OTHERS	TOTAL
1962	2,246	7,328	1,825	1,609	645	617	840	15,110
1964	6,357	11,530	2,280	1,918	1,322	894	645	24,946
1966	12,005	30,226	16,873	3,275	2,109	1,920	1,609	68,017
1968	18,445	41,823	25,219	5,182	3,797	5,164	3,118	102,748
1970	33,797	55,352	51,711	8,158	8,636	8,793	6,514	172,961
1972	55,280	63,578	217,287	10,148	7,263	10,500	6,590	370,646

Figure 7

TRENDS IN TOURISM
(thousands of arrivals)



Modern Asia, August 1974.

Defense Trends

Defense problems are among the least predictable, but unfortunately most important, areas of projection. Our surprise-free projections excluded both major war and major peace. We exclude major wars because nuclear weapons are so devastating that major powers are deterred from involvement in confrontations which might escalate uncontrollably; of course, this does not mean we can rest free from fear in this regard. When we exclude major peace we mean that small wars continue to be likely, and that major power tensions are very unlikely to disappear or to become ameliorated far beyond the present situation. This implies that there will continue to be large markets for military aircraft. Here it is worth noting that the recent NATO jet fighter decision has implications for the U.S. or the French aviation industry that could have a ten-to-twenty year impact.

The international situations which would most likely disprove our projection of "no major war" would likely occur because of Middle East confrontation, a change in the international posture of Japan, the disintegration of India as a nation-state, or the disintegration of NATO's southern flank and one or more communist takeovers in Italy, Spain or Portugal.

It is also possible to imagine relatively large military campaigns, such as extended anti-submarine warfare operations, which would consume military material like wars but which would be unlike big wars in their effects on trade and on civilians. Similarly a major rise in tension, for instance, in Central Europe, might have war-like consequences for the defense industry, including massive increases in military spending.

Nuclear Proliferation Potential

Perhaps the international situation with the most complex consequences for the aviation and space industries will be nuclear proliferation. Before the end of the century, countries like Taiwan, Argentina, Brazil, South Africa, Israel, Egypt, India, Pakistan and Iran are likely to possess at least primitive fission weapons. Terrorist groups may well possess, or attempt to capture, nuclear weapons also. The net effect of such proliferation will be to make the U.S. and other countries terribly vulnerable and to place an enormous premium on systems for detection of attempts to convey nuclear weapons into the country. When one reflects on the enormous expenditures and organizational effort precipitated by a few aircraft hijackings, the potential response to a nuclear threat or to a single clandestine nuclear attack strikes home. Truly vast expenditures for high technology monitoring equipment and low technology interception equipment could result.

Defense Budget--Support for Aeronautical R&D

The U.S. defense budget depends upon the international environment, which we have acknowledged as unpredictable, and upon domestic political events, which are if anything less predictable. Nevertheless, defense

budgets have typically fluctuated between five and ten percent of GNP. The current defense budget runs about 5.6 percent of GNP and is very unlikely to go much lower. We would expect a gradual rise over the next few years, with dramatic increases in the event of any important crisis that is resolved adversely. (See projections in Tables XI and XII.)

Historically a very large part of the income of the U.S. aerospace industry has been from defense products. This situation will probably continue, if indeed the balance does not tip further towards defense. Therefore, it is likely that the great bulk of useful aerospace R&D will be defense-oriented, and indeed that companies and the Congress will find it easiest to fund new technology for defense first; commercial applications will be largely by spin-off. Let us consider some possibilities.

Important questions for the health of the aerospace industry itself include the probability of long production runs of individual aircraft or missiles and the avoidance of a boom-bust economic pattern. It would seem, then, that the aerospace industry may have a strong interest in driving down individual airframe costs. At present a major part of airframe cost is avionics cost; and a major reason for short production runs is the need to make major airframe or engine changes to accommodate new avionics. A useful way out would be accelerated development of the new miniaturized integrated electronics. It is in the direct interest of the aerospace industry to concentrate on driving down the unit cost and size of electronic components. Such advances will very possibly do more good for the industry than will any other technical achievements.

The next best prospect is for multi-purpose and modular engines, as engine standardization can drive up engine production runs and hence further cut unit costs.

Any reduction in the unit cost of U.S. military aircraft helps us compete in the foreign market. We estimate that there is a good chance for U.S. dominance of this market. At present military sales are a primary factor in the recycling of Arab oil money, hence in the stability of U.S. foreign exchange. In general high technology, including high aerospace technology, has been and probably will continue to be the greatest source of U.S. trade abroad. In this judgment we include the agricultural plenty produced by an advanced technology.

We can expect a fairly consistent development from currently fielded military systems. This judgment is a consequence of the long lead times and high unit cost of military hardware. No radical changes are very likely unless there is a war demonstrating the bankruptcy of current concepts.

Potential Weapon System Developments

Current lines of development include greater accuracy in all types of missiles and the proliferation of powerful surface-to-surface and air-to-surface weapons placing small demands upon their launch platforms. Such

Table XI

NATIONAL DEFENSE BUDGET
ACTUAL* 1939-1975; PROJECTED 1975-2000

Year	Gross National Product (A)	National Defense Budget (B)	B/A (%)
1939	90.5	1.2	1.3
1940	99.7	2.2	2.2
1941	124.5	13.8	11.1
1942	157.9	49.4	31.3
1943	191.6	79.7	41.6
1944	210.1	87.4	41.6
1945	211.9	73.5	34.7
1946	208.5	14.7	7.1
1947	231.3	9.1	3.9
1948	257.6	10.7	4.2
1949	256.5	13.3	5.2
1950	284.8	14.1	5.0
1951	328.4	33.6	10.2
1952	345.5	45.9	13.3
1953	364.6	48.7	13.4
1954	364.8	41.2	11.3
1955	398.0	38.6	9.7
1956	419.2	40.3	9.6
1957	441.1	44.2	10.0
1958	447.3	45.9	10.3
1959	483.7	46.0	9.5
1960	503.7	44.9	8.9
1961	520.1	47.8	9.2
1962	560.3	51.6	9.2
1963	590.5	50.8	8.6
1964	632.4	50.0	7.9
1965	684.9	50.1	7.3
1966	749.9	60.7	8.1
1967	793.9	72.4	9.1
1968	864.2	78.3	9.1
1969	930.3	78.4	8.4
1970	977.1	74.6	7.6
1971	1,055.5	71.6	6.8
1972	1,155.2	74.4	6.4
1973	1,288.2	74.2	5.8
1974	1,348.7	78.6	5.8
1975 (est.)	1,431.1	85.3	6.0

1939-1974 National defense budget figures are net of government sales.

Source: Economic Report of the President, February 1974.

*Current U.S. Dollars (Billions)

Table XII

PROJECTED NATIONAL DEFENSE BUDGET

	1975	1980	1985	1990	2000
Case I a	61	68	75	83	100
II a	63	73	85	98	133
III a	65	79	96	118	173
Case I b	92	101	112	124	150
II b	95	110	128	146	200
III b	97	119	144	176	260
Case I c	123	135	149	165	200
II c	126	146	170	195	265
III c	130	158	192	235	345

Case I assumes GNP average growth of 2 percent/year
Case 2 " " " " " 3 " "
Case 3 " " " " " 4 " "

a = National Defense Budget assumed to equal 5.0% of GNP
b = " " " " " " 7.5% " "
c = " " " " " " 10.0% " "

Estimates in constant 1973 dollars - Billions

weapons promise great if transient military power to small nations at a low initial cost. To counter them we are likely to invest heavily in tactical air defense systems, which will possibly include destructive lasers. The most radical technical innovations will probably be made in tactical air defense.

The growing accuracy of strategic missiles may encourage a change in our current deployment of strategic missiles. Probably there will be a new generation of mobile ICBM's; there may also be a resurgence of interest in a combination bomber/missile launcher. That in turn means more money spent on precise air navigation devices.

The proliferation of command-guided air launched missiles will probably mean that even more money will be spent on various forms of ECM. Once more this means that avionics is more significant in some ways than is aerodynamics. Interesting ECM ideas might include attempts to jam airborne or ground computers. Great advances along these lines might jeopardize military fly-by-wire.

At present there seems to be some hope in the aerospace industry for a revival of very long production runs through the adoption of cheap RPV's. We would suspect that ECM will largely negate the promise of the RPV. But it will render absolutely vital the discrimination of the pilot on the spot.

Another development of interest is the use of fields of sensors in land combat and anti-submarine warfare. The sensors are typically air-delivered and are often monitored by airborne vehicles. They offer large opportunities both for automating warfare and for achieving decisive results via electronic countermeasures and deception. At the least they will probably mean a shift to more elaborate and expensive (and aerospace-oriented) systems in ground combat. There may be some large production runs of a multiservice data processor as well.

One interesting airframe consequence of growing attack missile accuracy may be more popularity for VTOL/STOL aircraft, on the theory that large air bases make inviting targets. In naval warfare, VTOL makes possible the projection of naval air power without the expense of big carriers. But the reader is cautioned that those sentiments have been widely expressed for quite some time, without any V/STOL boom. An important factor in the future of military V/STOL is payload capacity. If new developments such as the Rockwell FV12 demonstrate that the load and speed drawbacks of previous VTOL's have been overcome, then probably these aircraft will come to dominate the tactical aircraft market.

In that case there will be a demand for the re-equipment of most tactical air fleets, i.e., a great surge in the international aircraft market.

Foreign Military Needs

These general technical conclusions must be tempered by a projection of U.S. and foreign military needs in the rest of the century. We would expect few radical political changes, except for a gradual enrichment of the "Third World" (not the "Fourth World" of resource-poor LDC's) via increased sales of raw materials. Such an enrichment will quite probably be channeled into arms procurement, probably including nuclear arms in many cases. The existence of a high level of armaments in any one country of the "Third World" will almost certainly encourage arms procurement in its neighbors; and most of these arms are likely to come from the U.S. and Soviet aerospace industries. Probably the rate of war in the "Third World" will increase, and that increase will accelerate various arms trends already in evidence.

We project large U.S. arms sales abroad, not because this country has some desire to enrich itself at the expense of others, but because increasingly the refusal of arms sales will be seen as a distinctly hostile act by suppliers of vital materials. Moreover, the performance of U.S. or Soviet weapons in these small wars (e.g., the Middle East War of October 1973) is the only way in which the quality of our weapons and hence the effectiveness of our own prices can be proved to the other side. Ultimately it is that quality which guarantees much of the stability of

such vital fronts as that in Central Europe. Weapon quality is of singular consequence to a power which relies, as we do--and the Soviets do not--on technology in place of manpower.

Outside Europe we can expect more and more concern for the safety of our seaborne commerce, as we grow more dependent upon foreign suppliers. This in turn means a larger fleet; but warships are so expensive that no large naval expansion is feasible unless a far cheaper approach is tried. That returns us to the absolute need for lower unit costs via compact electronics, and, quite probably, small aircraft carriers with VTOL's.

Resource Trends

Food Supplies

When the world faces severe food shortages or famine, the attention of the public, of politically active elites, and of decision-makers quite naturally becomes focused on that problem, which can have enormous influence over the budgets of apparently expendable programs. If the crisis is short run the public will probably prove slow to perceive that many of the difficulties are actually distribution problems rather than supply problems. But a persistent crisis, one which lasts for many years, is likely to produce intense awareness of distribution problems and lead to creation of new programs to distribute grain and other foods quickly to crisis areas. More generally, the recurrence of any kind of resource shortage due in substantial part to a distribution problem is likely to produce a demand for redundancy of distribution systems. Thus areas threatened by starvation because roads are subject to washout may demand emergency airlift capabilities. Periodic shortages of various kinds of materials, including food, petroleum and other resources, are likely to lead to increasing demands for all kinds of stockpiles. There may be special kinds of distribution issues raised by the necessity for maintaining such stockpiles and for insuring that they are useable in a crisis.

Although many people currently believe that rising population and rising shift in newly affluent countries from cereals to meat imply permanent food shortages for much of the world, Hudson's studies indicate that food problems are probably temporary and that such shortages as do occur in coming years will likely result more from the failure of distribution systems than from any worldwide scarcity of food. Food shortages in Africa have proved to result almost exclusively from distribution system failures. The food shortage of 1974 resulted in substantial part from an unlikely combination of unwise cultivation patterns in certain parts of Africa; bad weather in China, the Soviet Union, and other places; American production policies; windfall purchasing by the Soviet Union; and overfishing off Latin America. Much of the 1974 aura of doom has already been dispelled by rising production in the United States, by the cancellation of Soviet and Chinese grain orders, and by falling agricultural prices in much of the world. Nonetheless food shortages will recur perhaps for over a period as long as 15 years, especially in countries such as India and certain African countries whose distribution systems are incompetent. High petroleum prices will, if they persist, continue to slow down the rate of agricultural modernization in developing nations by raising the price of fertilizer. Population growth and shifts from grain to meat will continue to press demands on world agriculture upward. Nonetheless a gradual evolution of fertilizer technologies should greatly improve the availability of fertilizer over a period of 15 years. Officials of the International Rice Research Institute in the Philippines believe that new strains of rice, which are great improvements over what was so recently called "miracle rice," provide the

technical possibility of multiplying world rice output by a factor of 4 over a period of a decade; such production would of course so far outstrip world demand for food that an increase of this magnitude would never occur. Systematic management of ocean products should greatly enhance the contribution aquaculture makes to world food production as indicated in Appendix II of this report on aquaculture. Overall, then, we project recurrent food crises in some parts of the world for a period of up to 15 years, but believe that food production is likely to vastly outstrip population growth and to rise to meet increased demands from increasingly affluent populations.

Petroleum Energy Supply

All of these projections depend, of course, on the availability of adequate energy and other materials to feed growth at the rates indicated. The view that adequate resources will not be available has become widespread, based on two distinct arguments. The first argument is that the world is expending resources as such a rapid and accelerating rate that by the end of this century resources of many kinds will be exhausted. The second argument is political, holding that other cartels will follow the lead of the Organization of Petroleum Exporting Countries (OPEC) and create cartels which limit the availability of materials, or raise their prices so high that growth is slowed.

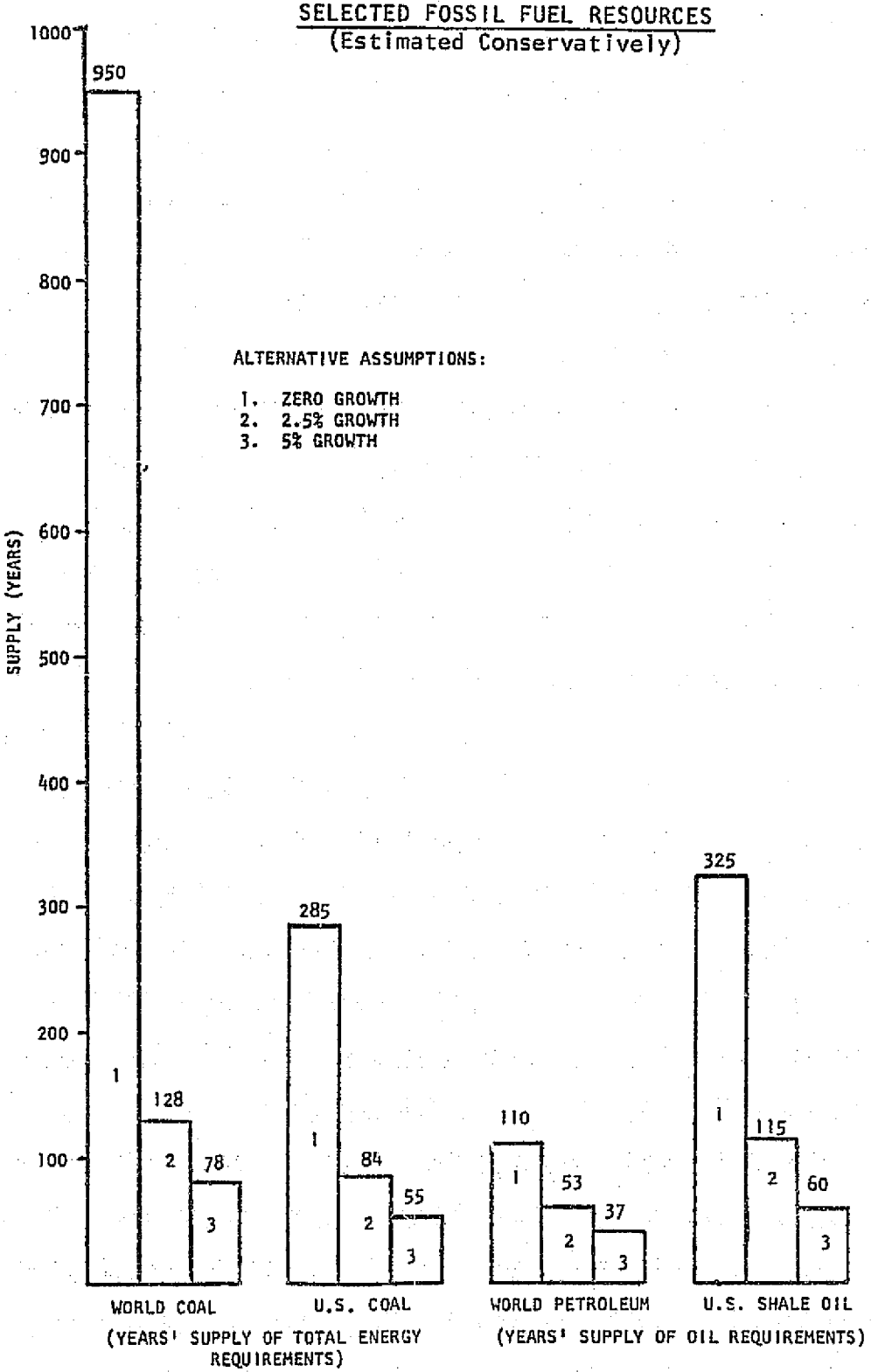
Our judgment of the first argument is that it is based upon basic analytic errors. Most fundamentally, it is based upon an assumption of "resources" as fixed quantitites not subject to technological multiplication and on "pollution" as a fixed product of economic growth not subject to technological diminution. Using the logic of the most forceful presentation of this first argument, in The Limits to Growth, which projected 130 years ahead and found sudden economic collapse, a Shell team went back 130 years and found that the methods predicted exhaustion of resources long before the present. (New Scientist, 27 July 1972.) Likewise, for pollution, Norman MacRae has pointed out that an extrapolation of the trends of the 1880s would show today's cities buried in horse manure; in this perspective the automobile is a highly successful pollution control device.

We have illustrated in Figure 8, "Selected Fossil Fuel Resources," three conservative estimates of world and U.S. fossil fuel resources, under alternative assumptions of zero growth, 2.5 percent growth, or 5 percent growth in world energy demand. World petroleum at a growth rate of 2.5 percent or 5 percent can run short early in the next century, but it seems clear that the supplies of coal for the world and the U.S., and the U.S. oil shale supply, will last far into the period in which they are expected to be displaced by newer sources of energy.

A second error of those who believe we are running out of resources has been misunderstanding of the concept of "proved reserves." The amount of known energy resources at any time is not a fixed quantity; it involves the concept of reserves, which is an economic concept similar

Figure 8

SELECTED FOSSIL FUEL RESOURCES
(Estimated Conservatively)



to that of a business inventory. In fact, a number of different ideas are involved in the concept of reserves. The American Petroleum Institute distinguishes these as follows:

> "Oil in place is the amount of oil present in known reservoirs. Proved reserves are the estimated quantities of crude oil which geological and engineering data demonstrate with reasonable certainty to be recoverable from known reservoirs under existing economic and operating conditions."

Proved reserves are bound to increase according to the economic and operating conditions of the time. They will be closely related to energy prices and technology:

> "Proved reserves at any time are quite distinct from forecasts of what will be made into reserves later. Recent discoveries in Northern Alaska were originally said to 'contain' from 5 to 10 billion barrels. This was the amount expected to be developed in the course of years. Eight months later there was an implicit reserve forecast, when it was announced that a pipeline built from the area would have a capacity of 2 million barrels daily (MBD), which indicates about 15 billion barrels forthcoming in 20 years. It would be a mistake to compare either forecast with proved reserves or with oil-in-place."*

Reserves of any useful resource will be somewhat larger than the minimum needed for economic planning. In the U.S., the reserves of oil have historically been about 12 times annual production; when they have fallen below this amount, it has been a sign of incipient shortage and a future price increase. When the ratio of reserves to production is much larger (e.g., in the Middle East, it is now about 70 years' reserves), it indicates that resources will not be devoted to finding new sources for the immediate future, since the reserves are adequate and a shortage will not appear for a long time. This means that it has not been possible so far to project when oil reserves or other resources might be exhausted. New resources and new reserves are discovered as further investments are made in exploration.

In sum, known energy resources seem to be adequate for the reasonably foreseeable future, as we have listed in the foregoing Figure 8.

Petroleum Energy Cost

Figure 9, "Future Petroleum Prices," indicates a variety of possible oil price scenarios. Although there is a great deal of variation in the prices in the 1975-1985 period depending on the scenario, one notices that the prices tend to cluster at the $3/barrel (in 1950 dollars) level

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*M.A. Adelman, "Is the Oil Shortage Real?" Foreign Policy, 10, 1973.

as one approaches 2000. The exception is the OPEC business-as-usual scenario which hypothesizes lack of production coordination among the OPEC countries leading to a glut of world oil supply, rapid conservation and substitution, and thus a precipitous decline in world oil prices. Notice, however, that if the OPEC nations learn their lesson from this experience and are able to militarily dominate the Persian Gulf, the rapid decline in prices in the late 1970s could serve as a surrogate for the first step in an anti-Project Independence strategy. This would enable those who control Persian Gulf supply to once again control world price at high levels, with variations of price to keep competition off balance and/or to meet temporary internal needs.

"Petroleum Supply," Figure 9, indicates the supply side of the above four scenarios. These indicate that without OPEC production control, petroleum supply should be adequate to meet future world needs. The OPEC control scenarios indicate that world supply would be either very unstable in the 1975-1990 period or very low throughout. In either case it would be desirable for the U.S. to have a fall-back position for meeting its fuel needs.

Nuclear Energy

Turning from petroleum to nuclear energy, Figure 10, "Selected Nuclear Energy Resources," demonstrates that adequate nuclear fuel exists for many years of continued growth. The problem with nuclear energy has not been lack of fuel, but rather difficult engineering and safety problems. An initial phase of very optimistic projections of U.S. nuclear power generation has passed, as shown by Figure 11, graphing changes in official estimates of U.S. nuclear power capacity in 1980. However, it is not impossible that a few technological breakthroughs, together with the price incentives provided by OPEC, will change the longer run outlook for nuclear power. In the meantime, the U.S. has enormous reserves of coal which can carry it well into, and perhaps through, the next century.

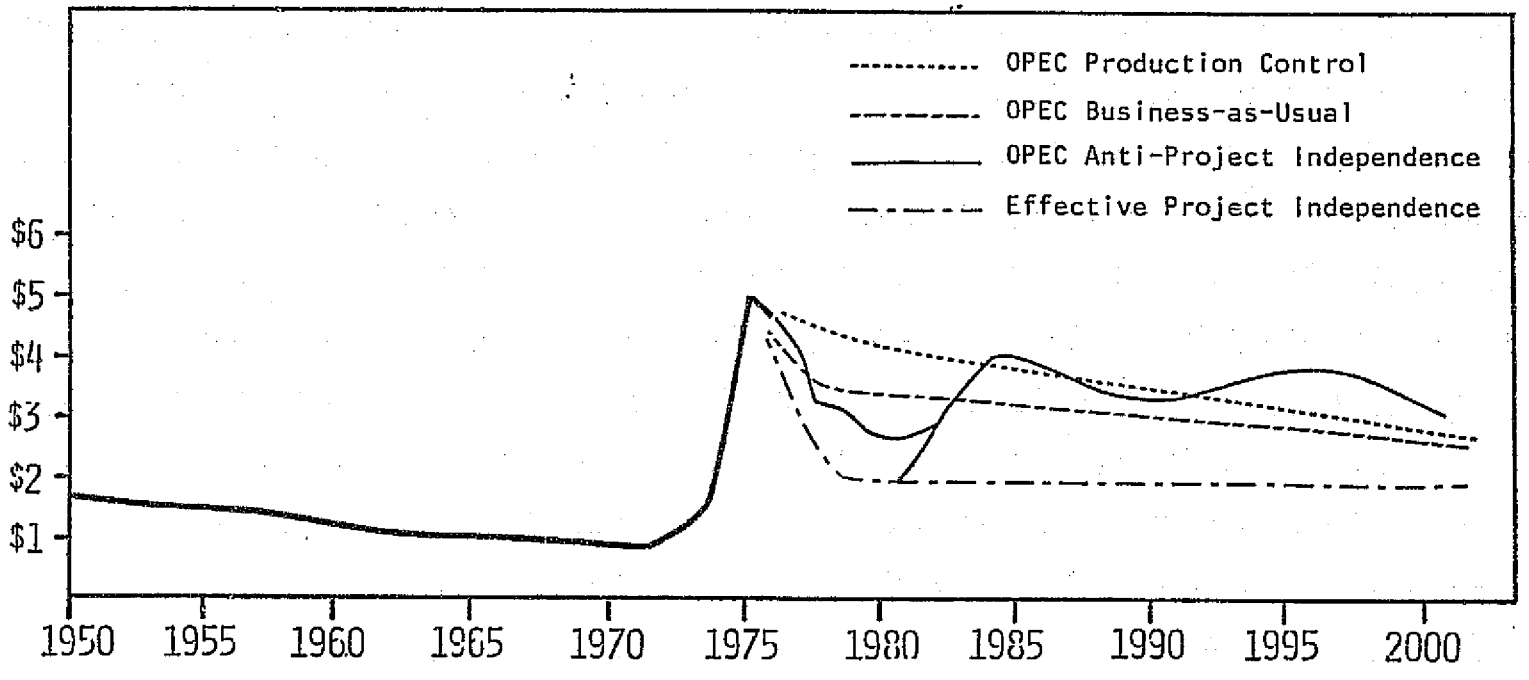
Resource Cartels

The success of the OPEC cartel and the rising demand for other resources have raised in many minds the question whether other resources are not also subject to cartelization. Will we indeed have one, two, many OPECs? Our conclusion is that petroleum is rather unique in this regard, that most other resources will not be subject to easy cartelization, and that there is not likely to be any persistent or widespread shortage of raw materials in the world during the last quarter of the 20th century. This does not mean that there will not be temporary bottlenecks which could prove very disruptive in the short run. Because of the possibility of such bottlenecks it is possible that stockpiling of various key materials may once again be a wise policy and a policy increasingly adopted by the U.S. government and by governments throughout the world. We are aware that the present trend in the United States is to diminish stockpiles of many kinds of materials because they are believed not to be necessary for defense, but we also believe that an economic rationale is substituting for the old military rationale and that eventually some of these stockpiles--especially of food--will be restored.

Figure 9

FUTURE PETROLEUM PRICES AND SUPPLY TO YEAR 2000

PRICES
(CONSTANT 1950 DOLLARS)



PETROLEUM SUPPLY

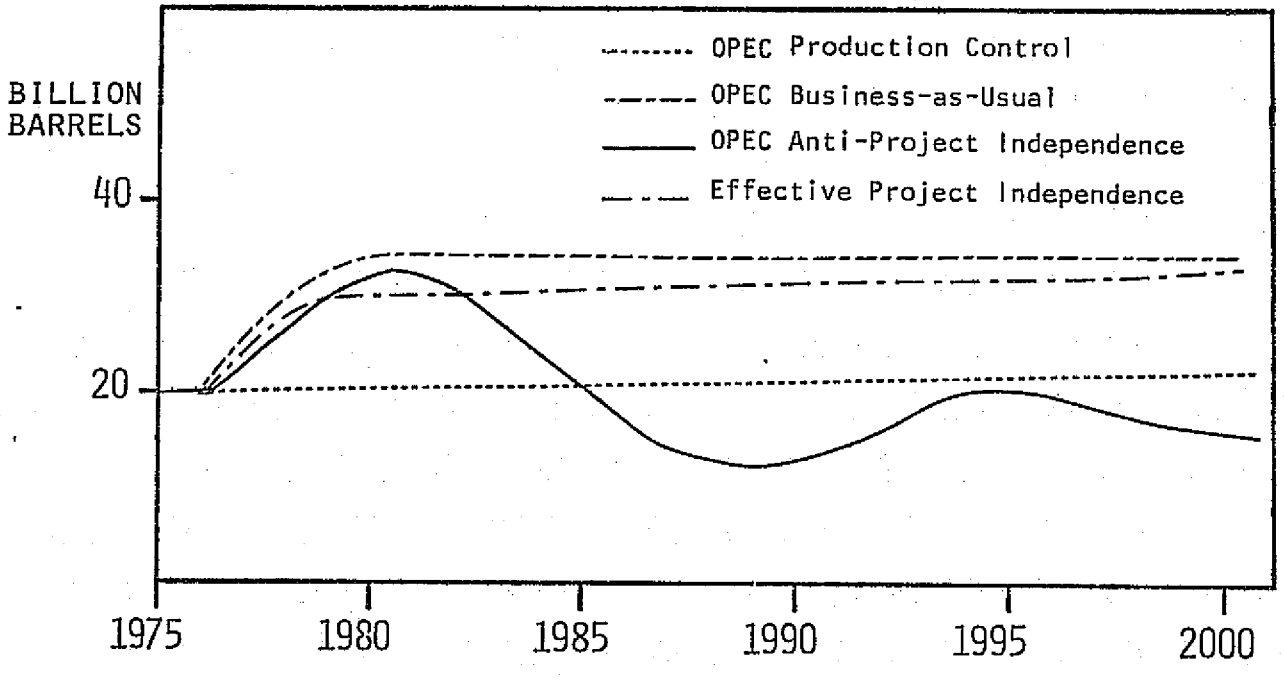


Figure 10

SELECTED NUCLEAR ENERGY RESOURCES

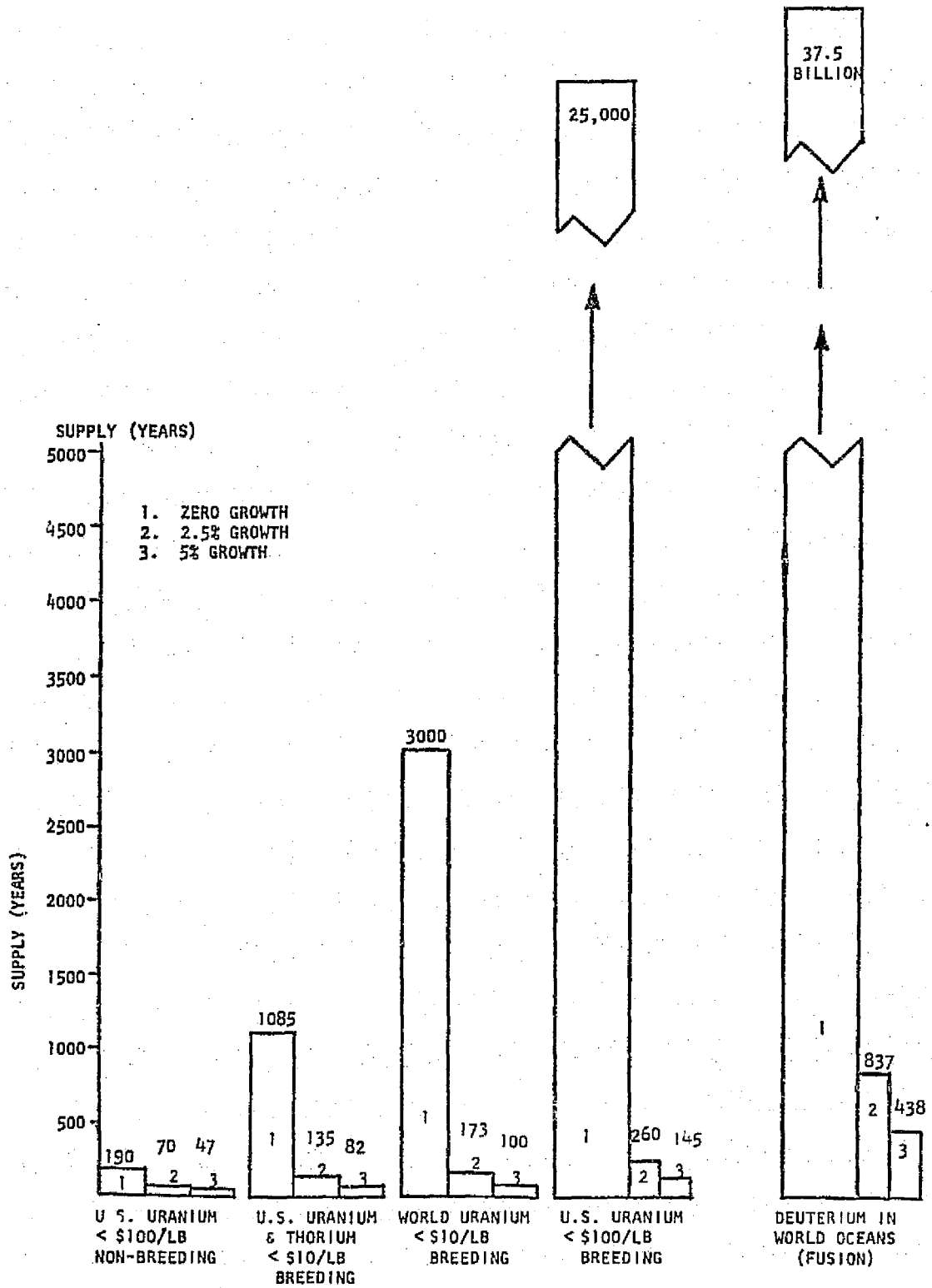
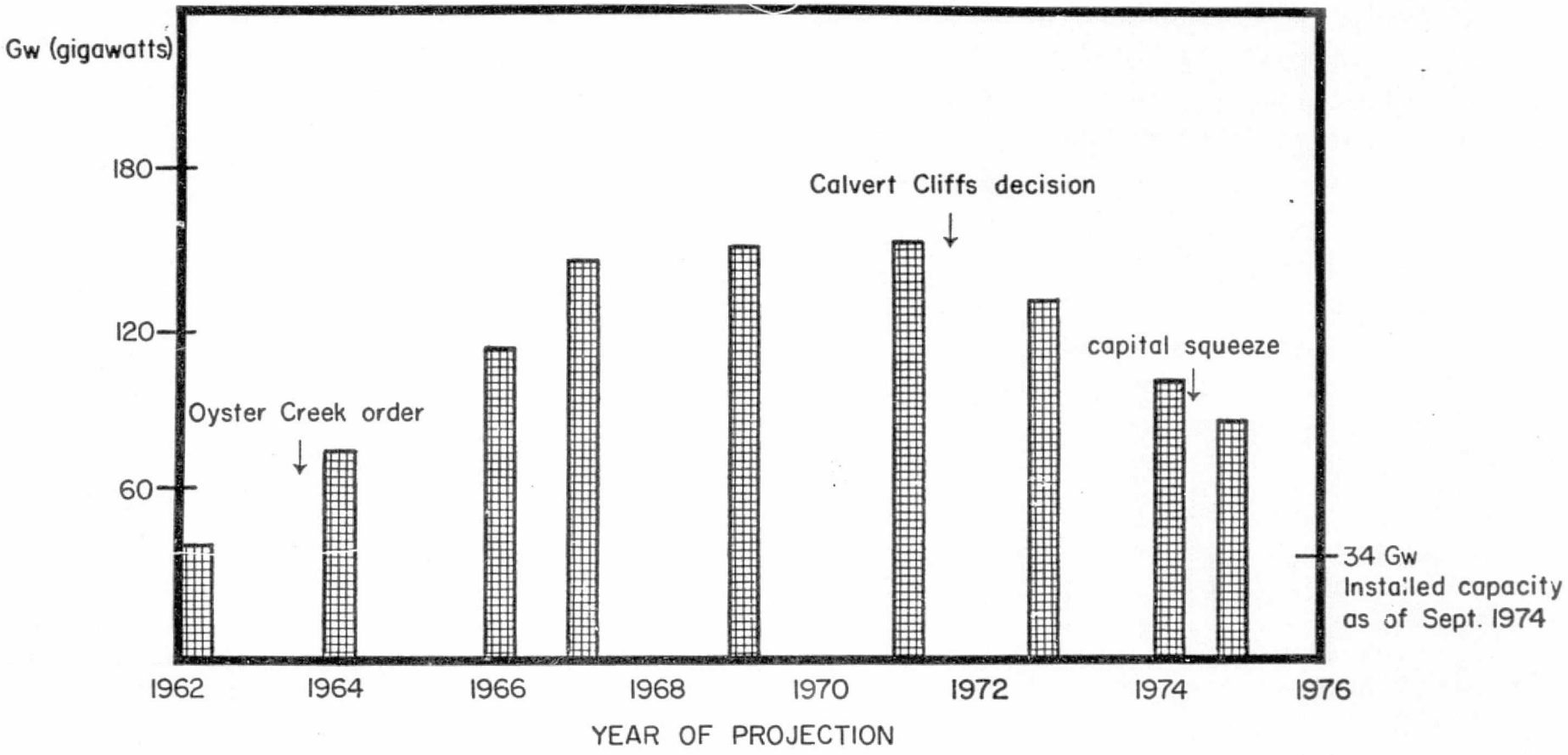


Figure 11

HISTORY OF A.E.C. PROJECTIONS FOR 1980 NUCLEAR ELECTRIC GENERATING CAPACITY IN THE U.S.



Data for 1962-1975 is derived from various issues of The Nuclear Industry, an annual publication by the U.S. Atomic Energy Commission, with the exception of the data point for early 1974. That point was provided by J. Conner, Director of the USAEC Office of Planning and Analysis, in a talk prepared for the Atomic Industrial Forum's International Conference on Uranium Enrichment, Washington, D.C., April 24, 1974.

In Table XIIi we provide for comparison a list of the metals most subject to cartelization, and a list of the metals most critical to aeronautics. Chromium, mercury, nickel, titanium and tungsten appear on both lists. Stockpiling and also research on substitutes for vulnerable metals should perhaps be a high priority task. Appendix III provides a more detailed look at the prospects for raw materials.

Table XIII

THE ELEVEN MINERALS MOST VULNERABLE TO CARTELIZATION OR EMBARGO

MATERIAL	VULNERABILITY INDEX	PRINCIPAL OR MAJOR EXPORTERS
CHROMIUM	34	USSR, R. OF S. AFRICA
PLATINUM GROUP	32	USSR, CANADA, R. OF S. AFRICA
TUNGSTEN	27	CANADA, PERU
MANGANESE	23	BRAZIL, GABON
ALUMINUM	22	JAMAICA, CANADA
TITANIUM	20	AUSTRALIA, CANADA
COBALT	20	CANADA, ZAIRE
TANTALUM	16	CANADA, BRAZIL, ZAIRE
NICKEL	14	CANADA, NORWAY
MERCURY	11	CANADA, MEXICO, SPAIN
TIN	6	MALAYSIA, THAILAND

SOURCE: ALWYN H. KING AND JOHN R. CAMERON, "MATERIALS AND THE NEW DIMENSIONS OF CONFLICT," NEW DYNAMICS OF NATIONAL STRATEGY (NEW YORK: CROWELL, 1975) p. 95.

MINERALS IDENTIFIED AS PROBABLY CRITICAL TO AERONAUTICS, 1980-2000

ALUMINUM	COAL	MERCURY
*ANTIMONY	COPPER	MICA
*ARSENIC	*GALLIUM	MOLYBDENUM
ASBESTOS	*GERMONIUM	NICKEL
BERYLLIUM	*INDIUM	TITANIUM
BORON	IRON	TUNGSTEN
CADIUM	LEAD	VANADIUM
CHROMIUM	MAGNESIUM	ZINC
		ZURCONIUM

*AVIONICS AND RELATED AIRCRAFT SYSTEMS.

Effect of Climate

A very predictable trend is the trend of long-term climatic change. Scientists tend to agree that no major ice age is likely to be forthcoming for a period on the order of three to thirty thousand years, but many believe that there is a shorter-term current trend toward gradual cooling and drought. If this trend continues, then food shortages will become more probable in bad harvest years in this century; this will require more effort from policymakers, and will exert increasing influence over public attitudes. Food shortages have a particularly powerful effect on public opinion even in countries which are not particularly affected by those shortages. In particular it seems true that when food shortages exist people's sense of priorities tends to lean rather heavily toward supply of these basic needs at the cost of what many see as less immediately needed projects.

Prior to the year 2000 there may be significant changes in weather and in man's control over weather. Here it is useful to distinguish climate change (natural or unintended modification of weather patterns), climate control (deliberate alteration of major climatic patterns), and weather modification (deliberate alteration of short-term weather). Various scientists have asserted that some climate change is occurring, and in particular have warned that the climate may become gradually colder; such possibilities are still too unproven to constitute a basis for serious planning, but they must be monitored because of the extraordinary implications of even small climate changes for food production.* Similarly, assertions that man-made increases in atmospheric dust and carbon dioxide could cause serious cooling or warming of the earth, respectively, need monitoring but cannot be substantiated as a basis for planning decisions at this time. Likewise, the long-term weather effects of the warming of rivers by power plants and the 5 to 10 degree warming of the atmosphere around major cities may be of great but currently unknowable significance. When the causes of weather patterns, and the effects of human technology upon those weather patterns are better understood, the prospects for deliberate climate modification may loom larger than they do today.

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*Cf. Harold M. Schmeck, Jr., "Climate Changes Called Ominous," The New York Times, January 19, 1975, p. 8.

Transportation Trends

The standard approach to forecasting future transportation needs is to estimate future requirements for various kinds of services in terms of what people will produce, distribute and consume and where they will do so. This requires a systematic analysis of the present and potential economic base of the area of interest, the spatial distribution of population, patterns of land use, and for freight, a "base survey" which would normally include an appraisal of natural resources, population and labor force, and the existing and potential industrial infrastructure. From this, estimates of future transportation requirements are generated. Available transport systems are then evaluated against existing and anticipated future requirements for the area in question and major technological improvements in different forms of transportation are analyzed to select the best mix of existing and potential future transportation modes. This approach is illustrated in Figure 12, a typical demand forecasting model.

In selection of the modal structure, other considerations also come into play. Ecological considerations are of increasing importance, as are energy requirements. These tend to dictate the directions which transportation evolution may advance. Table XIV lists some of these directions and the anticipated time period for their development. Availability of discretionary income will have a pronounced effect on the futures of the air transport industry. This aspect is examined in Appendix IV.

In the United States, the principal urban transportation mode is the private automobile. In modified form, to cope with environmental and energy factors, it is expected to remain dominant, with at least 75% of the total urban transit burden by 1990.* Thus no more than 25% of urban area trips are anticipated to be handled by mass transit in that time frame. That this will impose a tremendous load on the urban and suburban highway systems of the nation goes without saying, and measures have been tried in many areas for many years to divert travellers from private to public mass transportation. Moves in that direction often take the form of new high speed rapid transit systems such as San Francisco B.A.R.T. and Washington, D. C.'s new subway system.

High Density Intercity Transportation

In developing magalopolises such as the U.S. northeast corridor and California's San Diego to San Francisco strip, inter-city travel is on the upswing and systems are developed to cope with the situation. In these instances, air and high speed ground transportation often compete. Thus the Metroliner connecting Boston, New York and Washington, D. C. with a New York to Washington trip time of 3½ hours, as

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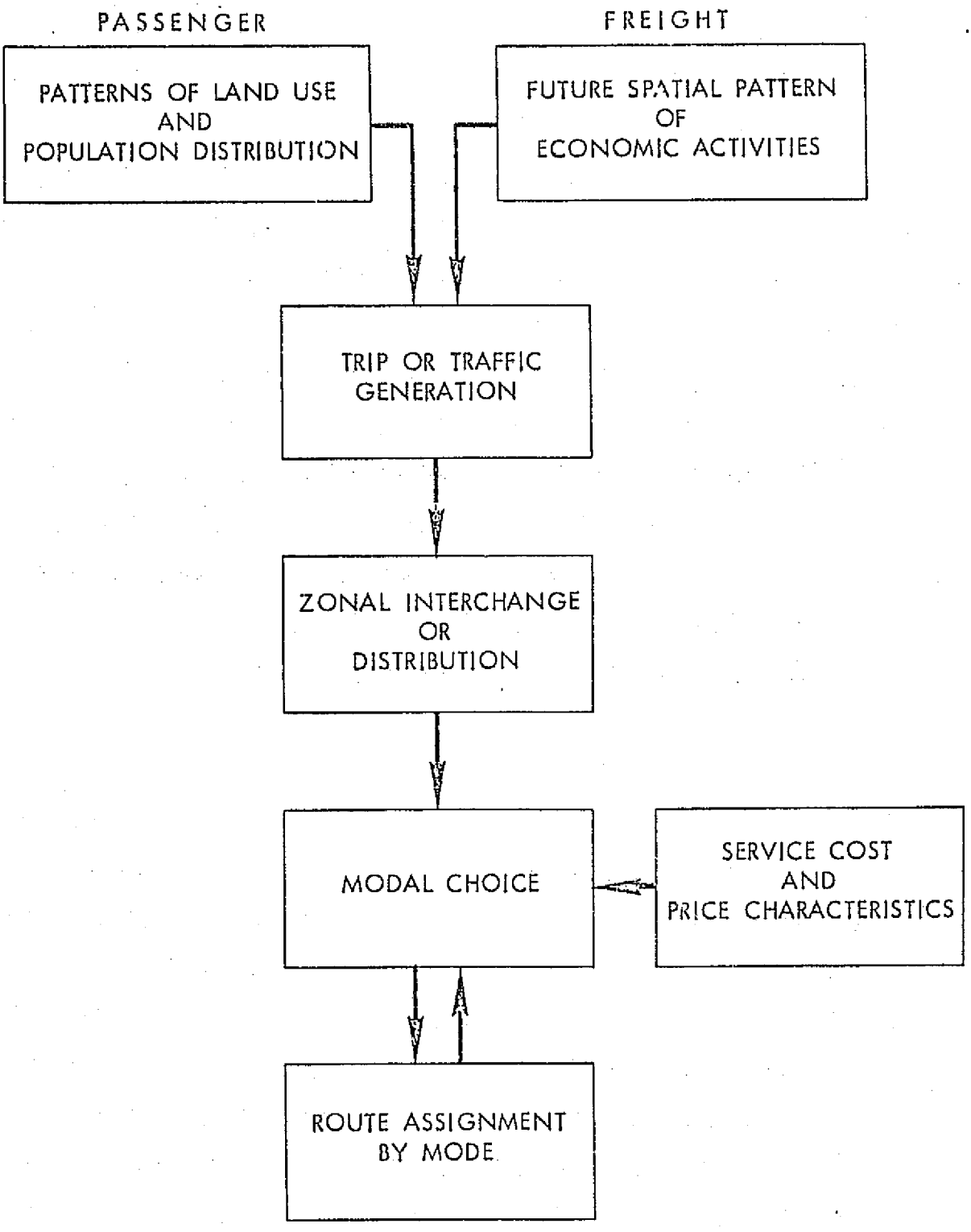
*The Effects of Varying Policies and Assumption on National Highway Requirements, by D.S. Gendell et. al., U.S. Department of Transportation, Federal Highway Administration. Presented at Highway Research Board Conference, Washington, D. C. January, 1973.

Figure 12

DEMAND FORECASTING MODEL



SOURCE: THE FUTURE AND ITS IMPLICATIONS FOR REGIONAL TRANSPORTATION PLANNING, JOHN R. MEYER, IN PROCEEDINGS OF A CONFERENCE ON REGIONAL TRANSPORTATION AND PLANNING: THE RAND CORPORATION, JANUARY 25-27, 1971.

Table XIV

DIRECTIONS IN TRANSPORTATION EVOLUTION

	TIME FRAME
° GASOUS FUELS IN URBAN FLEET SYSTEMS	CONTINUING
° GROWTH OF URBAN MASS TRANSIT SYSTEMS	CONTINUING
° ELECTRIFICATION OF CORRIDOR RAIL SYSTEMS	CONTINUING
° GAS TURBINES IN INTERCITY TRUCKS AND BUSES	MID-70'S
° SMALLER, LESS POWERFUL AUTOS (NO SPEED SACRIFICE)	LATE-70'S
° ELECTRIFIED MASS TRANSIT; ELECTRIC AUTOS IN URBAN RENTAL FLEETS	EARLY 80'S
° IMPROVED HIGH SPEED GROUND SYSTEMS IN CORRIDORS	EARLY 80'S
° REPLACEMENT OF MODIFIED S.I, ENGINE WITH INHERENTLY LOW EMISSION ENGINE (GAS TURBINE OR STIRLING)	MID-80'S
° SIGNIFICANT USE OF SYNTHETIC PETROLEUM	1990
° POSSIBLE USE OF NON-PETROLEUM FUELS IN FLEET SYSTEMS	1990
° H_2 FUEL CELLS FOR INTERCITY/RURAL AUTO	2000

REFERENCE: "U.S. TRANSPORTATION--SOME ENERGY AND ENVIRONMENTAL CONSIDERATIONS" BY W.E. FRAIZE, THE MITRE CORPORATION, SEPTEMBER 1971, M72-164.

compared with an Eastern Airlines shuttle flight with an air block time of 35 to 50 minutes, depending on equipment used. Total travel time from city center to city center may not be too far apart, however, when rush hour traffic departure and en route flight delays are considered. Thus a traveller leaving New York on a Metroliner at 9:00 a.m. would arrive in downtown Washington at 12:30 p.m., while the same traveller opting for the shuttle might miss the 10:00 a.m. shuttle due to surface traffic between Manhattan and La Guardia airport and arrive in Washington no sooner. Even if he makes the 10 o'clock shuttle, departure delays might see him airborne at 10:30 and in the Washington area by 11:15, but arrival delays could further slow him so as to bring him into Washington at the same time as the Metroliner, but considerably more frustrated. This situation may become more favorable for the train as the railroad roadbeds are improved to the point where the Metroliner can realize its full 150 mph potential. Thus in determining the modal developments of the future, the theoretically fastest mode may be supplanted by another which offers competitive travel time with perhaps greater comfort and less expense.

Modal Interface

The interface between existing transportation modes is an area where much needs to be done. People who would use public mass transportation of all sorts often fail to do so because they cannot park their cars at their nearest station, nor can they walk because of the distance involved. Thus they drive to work. Flying from point to point in megalopolis areas is often frustrating as pointed out above because of long surface and en route delays. In most cases in the United States and abroad, airports are located far from the cities they serve or if close in, have poor surface transportation interfaces, making the city-airport travel on both ends of a flight a time-consuming and frustrating exercise. When terminal delays at both ends of the flight are added, it is easy to understand the logic of the slogan "time to spare? go by air!"

International Air Travel

The growth of the Pacific Basin has important implications for air travel. Infrastructure requirements will mount much faster in this region than in others, particularly because existing levels of infrastructure reflect the recent and frequently continuing poverty of many regions of the Pacific Basin. Demand for air transport of valuable electronics, art, perishable foods, and many other categories of merchandise, is likely to continue to rise even faster than trade itself as facilities for air transport improve and as the possibilities of air transport become visible to broader spectrums of merchants. "Passenger travel in the region has been growing at a rate of 27% a year, sharply higher than the 7% a year in Europe, for example."* Rising revenues for Asian air lines are listed in Table XV.

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*Seth Lipsky, "Asia Fastens the Seat-Belt," Far Eastern Economic Review, February 14, 1975, p. 53.

Table XV

INTRA-ASIAN REVENUE ON TON-KILOMETRE BASIS

	AVERAGE 5-YR. GROWTH 1968-73 (PERCENT)
AIR VIETNAM	10
CHINA AIRLINES	37
CATHAY PACIFIC	23
GARUDA	19
JAPAN AIRLINES	21
KOREAN AIRLINES	106
MALAYSIAN AIRLINE SYSTEM	69 (EST.)
PHILIPPINES AIRLINES	14
QANTAS	13
SINGAPORE AIRLINES	69*
THAI INTERNATIONAL	24

*GROWTH FROM MSA.
SOURCE: ORIENT AIRLINES ASSOCIATION.

As the volume of East and Southeast Asian traffic rises it will gradually come to approximate the intensity of air traffic in Europe, and the intense competition within the region is likely to ensure that costs per mile drop to roughly intra-European and transatlantic rates. This drop in costs should in turn accelerate use of aircraft. Eventually we anticipate that this intense, competitive, long-range Pacific Basin air traffic will provide the principal justification for building an SST. The huge distances involved in Pacific travel imply huge losses of time for executives who must commute from the United States to Asia, from Japan to Australia, and so forth. Typically the executives whose time is lost are highly paid men to whom the day or two wasted in trans-Pacific flight is worth several times the current price of an air ticket. Thus, as prosperity multiplies the numbers of such executives and increases their salaries, the pressure for more rapid travel will eventually become overwhelming--unless Pacific Basin growth is disrupted over a long period of time by a serious depression, or unless some ecological or other argument of great force absolutely prohibits SST development, or makes it prohibitively costly.

IV. WORLD FUTURES

Most Probable Future, 1980-2000

Our best estimate of the world, 1980-2000, is that presented in the preceding pages, which can be summarized as follows.

1. Demographic Prospects for the United States include development of megalopolises, lower population densities, decentralized cities, satellite cities, rebuilt inner cities, sunbelt shift, decline of some areas.

2. Development of Megalopolises in the U.S. and developed world should proceed apace as the trend toward suburban living continues (despite predicted reversals from some quarters). Satellite cities should develop to service far flung suburbs while central city areas are rebuilt to meet changing requirements. Transportation facilities, rail, road and air should develop and expand to meet requisite needs.

   Sunbelt Shift in the U.S. will promote development of presently sparcely populated areas such as the Southern Piedmont, Southwest, Northern Florida. Other quaternary areas such as the Colorado Rockies, New England and California mountains, beach and lake areas grow because of their recreational potential.

3. Decline Sets In in other areas such as old seaports, old coal and iron mining areas, the Great Plains, the Southern black belt as their utility declines in the face of change. Changing shipping methods, mechanized farming and mining methods will create population flow towards developing areas, largely in the sunbelt.

4. Population Growth rates have been increasing at a much slower rate than many had predicted in the past and have begun to decline in many areas, including the U.S. and much of the West. It appears that we may be approaching (if we haven't already reached) an inflection point in the population growth curve. If the trend continues the long range effect will be stabilization of population on a worldwide basis. This is not likely to occur by the year 2000, but the trend should be well established and the phantom of world overpopulation and overconsumption of resources laid to rest.

5. The Super-Industrial Society should continue to develop and expand as the shift from primary and secondary to tertiary and quaternary industries continues, with Post-Industrial societies emerging in the U.S. and elsewhere toward the end of the time period. This will be accompanied by an accelerated industrialization of developing countries as multinational corporations grow and expand their operations abroad, stimulating local economies and developing trained labor pools.

   Because the principal, worldwide, social, and economic phenomenon will be the spread of the superindustrial society, the principal value changes will be in the direction of industrial values. Hard work, hierarchical organization and saving will be the principal economic values. Likewise because most of the world will consist of nations which are consolidating their nationalism for the first time the principal political value will be nationalism. Despite this in the most advanced societies, namely the U.S., Europe, and Japan, there will be influential groups, including most of the intelligentsia and the media which will espouse post-economic values and internationalist or sub-nationalist loyalties.

   Radical Political Changes are not anticipated on any significant scale. "Third World" countries are expected to become gradually richer through sale of resources and concomitant industrialization. General prosperity should prevent the rise to power of radical elements in most instances. At the same time, however, the new prosperity may lead to arms races which could in turn result in local wars in various parts of the world.

6. GNP Growth in the U.S. and the world should continue, but at a slightly slower pace. The U.S. should continue its historic 3 percent yearly growth rate for much of the period while the world rate should average about 5.5 percent through 1985 and decline to about 5 percent after that. World trade should increase at a faster rate than GNP. By 1985, the farthest out one may predict with reasonable assurance, the 22 leading countries in the world in terms of GNP might look as follows, within perhaps plus or minus 20 percent.

   $2000 Billion - United States
   1000 Billion - Japan and U.S.S.R.
   500 Billion - France and W. Germany
   250 Billion - China, Canada, Italy, United Kingdom
   120 Billion - Brazil, India, Mexico, E. Germany, Poland
   60 Billion - Netherlands, Sweden, Belgium, Australia, Argentina, Iran, and perhaps Switzerland and Indonesia

Today, 30 percent of the world population lives in "rich" countries, while 70 percent live in "poor." Applying present day standards, by the year 2000, 66 percent of the world population should live in rich countries and only 33 percent in poor. This ratio might more realistically by 70:30.

7. Pacific Basin Growth should accelerate dramatically with Japan, the U.S. (and possibly Brazil) as spark plugs. Improvements in transportation, communications, serve as catalysts. Tourism should expand greatly. Growth in the region could be explosive, with accompanying problems, but long term prospects look good.

8. International Relations should stabilize as the U.S. and S.U. normalize their relationship and bury cold war differences. This does not imply entente, since basic political and economic philosophies still differ, but neither nation is apt to be seen as determined to dominate the world. U.S. relations with China may also tend toward normalization, but probably to a lesser degree. China and the Soviet Union will probably remain at loggerheads for the foreseeable future but no major armed confrontation is anticipated. Local unrest in various parts of the world remains probable throughout most of the period, however.

9. No major War is anticipated for the period but numerous small wars are likely as developing nations experience growing pains. Thus no major peace is expected either. The possibility of large scale confrontation will continue, however, and could develop from

   Mid-East conflict
   Change in the international position of Japan
   Disintegration of India as a nation or of NATO's southern flank
   Communist takeovers in Italy, Spain and/or Portugal.

10. U.S. Defense Spending should continue at the present level in terms of percent of GNP, or at about 5.6 percent. Recent trends have been toward greater personnel expenditures at the expense of new equipment and R&D. This will probably stabilize and swing back the other way as technological advances tend to reduce unit and upkeep costs for equipment, freeing more money for R&D.

11. Resources should prove quite adequate, with no serious shortages developing. New sources coupled with more efficient use of raw materials and development of substitutes should assure very adequate supplies. Fears

of new cartels forming after the manner of OPEC should prove unfounded because of the wide dispersion of most resources coupled with market conditions. OPEC itself should decline in effectiveness rather rapidly and most probably will dissolve or become meaningless in the next decade as new petroleum sources develop and come on line and substitutes become economically competitive.

12. World Energy Prices should decline over time as oil production increases in non-OPEC areas and new energy sources are developed. Increased utilization of coal, other cheap fuels should also lower prices, but probably not to the 1972 levels.

13. Air Transport growth is expected to average about 9 percent annually for the next quarter century, a ten-fold increase in revenue passenger miles by the year 2000. Availability of discretionary income and projected increases in business and leisure travel and in tourism are the root causes. This is roughly consonant with the ICAO projections for the period, although arrived at by a different methodology. It is considerably below the level which would be reached if historic growth trends were to continue.

Less Probable Futures of Consequence

The above discussions constitute a best estimate of the future environment of aviation. As has been discussed, predicting future developments is at best a very "iffy" exercise. A great number of developments might take place, any one of which or any combination of which could drastically alter the course of the future. Some of these are listed below, in random order.

Significant changes in GWP

More cartels form; resource prices escalate

Collapse of the oil cartel

Increased sale of military aircraft

Brush fire wars in critical areas:
- Mid-East
- Southeast Asia
- Korea
- Africa
- South America

Major political changes:
- China
- India/Pakistan
- Mid-East
- Russia
- Europe
- Japan
- Southeast Asia
- United States

Further dramatic oil price increases

Ecological crises--Ozone layer, etc.

Widespread famine

Widespread plague

Major technological developments
- New synthetic materials
- "cheap" fuels
- New propulsion means

New transport means
- Zeppelins
- Giant surface effect craft
- Low boys

Major new weapons
- Death rays
- Long range lasers
- Super-accurate missiles of all sorts
- "Doomsday" devices

High level of international tension--mobilization
Large scale quantitative and qualitative arms race (worldwide)
World depression
Great prosperity
Surprise solutions to present development obstacles
Ideological revulsion against technology--"Limits to Growth" philosophy
Ideological hostility against government, industry, growth, technology, taxation, etc.

It is obvious that occurrence of one of these could logically entrain others for a cumulative effect which would probably be much greater than individual effects. For example, a major political change, say a revolution in China, could bring about a major level of international tension leading to general mobilization on the part of several countries. This, in turn, could lead to formation of new cartels as suppliers take advantage of the situation, which could in turn lead to military action in critical areas as countries seek to secure their supply of critical materials, and so on. Similarly, dramatic new oil price increases could lead to formation of new cartels, leading to overall resource price escalation, which could bring about a significant downward shift in GWP, which could cause a world depression, bringing about widespread famine, which in turn--etc. Thus there are an infinite number of events which could trigger dramatic departures from what we have indicated is our best estimate of the probable course of events for the next 25 years.

Examining the above list of possibilities, certain ones appear to stand out. These include both optimistic and pessimistic possibilities, such as:

High level of international tension

Mobilization

Large scale quantitative and qualitative arms race

Material shortages

Major technological developments

Surprise solutions to present development obstacles

General prosperity

It is clear that a high level of international tension would have the effect of stimulating the defense industries of the countries involved. With the possibility of hostilities present, governments would of necessity examine their nations' combat readiness and take steps to ensure that they would be in the strongest possible position in the event of the outbreak of fighting. In the process, major funds would be directed to the defense establishment and R&D efforts would be stepped up across the board. The duration of the tension would

naturally determine the degree t, which such stepped-up activities would be pursued, but once programs were started many or most of them would probably be carried by inertia and by economic considerations that would militate against writing off the investment already made if results appeared probable in a reasonable time period.

In the event of mobilization, which traditionally is the last step before outbreak of hostilities, it seems reasonable to assume that the nations concerned would shift to a war footing and focus every effort on preparing for the outbreak of hostilities. This would result in establishment of crash weapons development and improvement programs on which few financial restrictions would be imposed, within the limit of available funding. Here again, R&D of all types would increase as major efforts were expended to plug gaps in weapon capability. Whether or not war actually occurred, if the state of mobilization were of long duration, R&D efforts would be significantly stimulated and an end of the crisis short of war would again find many projects too far along to be summarily cancelled. It is probable that in either of the above events, a state of tension would continue to exist far beyond the defusing of the specific crises which brought them about, as was the case with the Korean War outbreak in 1950, which resulted in a major modernization of U.S. weapons systems, in particular the air force.

A large scale qualitative and quantitative arms race could result from a number of developments which might fall short of either of the first two possibilities. Nervousness or over-reaction of a major power to a crisis might be sufficient to trigger such a race which once started, would be hard to stop as each side played catch-up in reaction to advances by the other. Reestablishment of the cold war could also trigger such a race, as could depressed economic conditions or the ascension to power of a paranoid personality in a major nation, i.e., a new Hitler or Stalin.

Material shortages could come about as a result of cartel actions, other market developments or a de facto "Limits to Growth" situation where it is discovered that critical resources are really in short supply and will soon run out. Whatever the cause, the effect would be similar. If the shortage was of a critical material, such as petroleum or aluminum, a major R&D effort would be required to develop substitutes. Since in such an event the entire economy and modus vivendi of the developed nations of the world would be affected, it is reasonable to assume that every effort would be made to find a solution.

Major technological developments would also have a significant effect, the degree and direction depending on the nature of the development. Historic examples are not hard to find. Invention of the automobile assembly line put the nation on wheels and created a major industry. The computer revolutionized industry and opened up possibilities undreamed of prior to its invention. Sputnik precipitated the space

race and all the fall-outs resulting therefrom. Thus it is not hard to imagine a similar development in the next quarter century, although what form it might take and what the results might be is a little more difficult. Should such an event occur, however, it would certainly act as a significant spur to many fields.

The next example, surprise solutions to present development obstacles, is somewhat similar, since it implies some sort of technological breakthrough, but here it focuses on known situations. A cheap new fuel might prove the solution to the current energy crisis, for example, sparking major research efforts to develop or adapt equipment to utilize it. A viable means of cheaply harnessing solar energy would also have widespread effects on the industrial world and would stimulate the development of practical uses for the new energy source.

In a situation of great prosperity, everything benefits, not least R&D. With rapid economic growth, availability of work reduces welfare requirements and promotes general well-being. Socially oriented programs would tend to lose their emphasis as the perceived need for such programs faded. Emphasis would be on development and expansion of industry and strong market competition would spur development of new products. Consumer demand would create a large-scale, worldwide increase in the numbers of people who could afford air travel for business, family, or touristic reasons, spurring the development of improved aircraft to meet new airline requirements in every category of size and range. Ecological considerations would loom even larger as the economy expanded, bringing about redesign and replacement of much equipment which contributes to pollution but with which we must presently live for economic reasons. With funds available, the Defense Department would move to modernize military equipment and developments presently seen to be far down the road would probably be advanced in time. Thus all aspects of development, military and civilian, would benefit.

A Stagnation or Erosion Future

The most pessimistic R&D outcomes are not those which would result from sudden or immense disaster but from what we might label "the erosion of the West." This erosion scenario can best be summarized by simply referring to the differences from the best estimate scenario.

In the erosion scenario the world does not go into an immediate deep depression but "stagflation"* persists and deepens. The U.S. and Western Europe and most of the Pacific Basin fail to solve their major economic problems and as a result find themselves locked into stop-and-go policies and failure of growth similar to that which Britain has experienced in the last decade. High rates of inflation are attacked by policies which lead to high unemployment; as soon as inflation begins to abate slightly the various economies are reflated at a speed which reduces unemployment rapidly but restarts the fires of inflation. Public confidence in industry and government declines further and further and left-wing regimes take over in France, Italy and Japan. These regimes make international cooperation much more difficult but make no more progress than their predecessors in solving the basic economic problems. In the Pacific Basin, instead of having a group of economies which fuel each other in the manner of a firestorm, one finds interdependence among stagnant, inflating economies dragging all the countries of the region down in a vicious circle. The principal airlines and shipbuilders of the region, caught by the momentum of a decade of extraordinary expansion, find themselves facing bankruptcy because of excessive capacity. In the less developed world, food shortages become chronic instead of being alleviated, and birth rates, which were beginning to decline because of the demographic transition that occurs with increasing prosperity, instead begin to climb once again and these higher birth rates aggrevate low incomes and food shortages.

Throughout the world the concept of progress through saving and technology becomes increasingly discredited, and the ideology of emphasizing redistribution rather than growth as a solution to world poverty which began to coalesce as a major ideology among the developing nations during the early 1970s becomes dominant throughout the non-communist world. Lack of growth makes it difficult to cope with pollution and other problems of industrial society and as a result the "limits to growth" ideology becomes more and more widespread. Thus slow growth leads to attitudes which impede growth still further and exercise particularly strong inhibitions against emphasis on technology as a solution to man's problems.

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*The term stagflation refers to the present economic situation in the U.S. and the Western world in which inflation continues in an economy which has become stagnant. This is not in consonance with historic trends in which depression has resulted when the economy ceases to grow.

A Prosperous Future

In an unexpectedly prosperous world recovery from the current period of stagflation would be unexpectedly quick and subsequent economic growth rates would be unexpectedly rapid. Japan would return to its previous growth rates of 10 to 12 percent per annum and carry with it South Korea, Taiwan, Hong Kong and Singapore at similar rates of growth and most of Southeast Asia at rates above 6 percent per annum. Much of Western Europe would grow at 6 to 7 percent per annum and the United States would grow at an annual rate of 5 percent or better. The developing nations would take on an optimistic perspective and emphasize growth first, for the sake of redistribution later. In the developed nations growth would provide the resources to cope with pollution and would provide the funds for technological change which would solve many of the key noise, pollution, and social issues which had previously justified the spread of anti-industrialist, anti-growth, and anti-technological attitudes. Rapid economic and technological progress would ensure high morale and support high defense budgets throughout most of the non-communist world and thus provide the strength to ensure continuation of detente with the Soviet Union. Growth would fund technological progress and geological exploration as a result rapidly relieve the United States and more gradually the rest of the world from excessive dependence upon OPEC petroleum, thus diffusing another major source of possible international strife. A combination of diffuse high morale and specific technological successes would dissipate the anti-technological fervor that was tending to spread throughout the west in the early 1970s.

A Desperation Future

A deep depression could cause civil unrest in Europe, Japan, Southeast Asia and elsewhere. The Soviet Union could perceive such disarray as an opportunity to spread its influence or hegemony and a return to a period of intense military tension would occur. This military tension could be expressed not only by great power rhetoric and specific great power confrontations, but also by specific conflict and outbreaks of warfare in the developing world and in Europe. In consequence, military budgets would skyrocket and R&D would be emphasized as a necessity for survival. Technological change, particularly in high technology industries, would proceed at rates comparable to those which occurred during World War II and in the middle of the cold war.

Under these same scenarios any sense of international cooperation would be minimized and deliberate trouble-making would be maximized. Opponents might very well attempt to disrupt one another's trade and Soviet encouragement of the formation of cartels and of a Third World emphasis on retaining natural resources as a natural patrimony could be expected. Because of intense fear of resource shortages, with or without the actual occurrence of such shortages, intense research and development would be devoted to finding substitutes for scarce or politically vulnerable materials. The emphasis would be on those materials vital to national defense, including energy and the metals vital to high technology industries.

The Prospects for Foreign Competition

We would be surprised to see the United States lose its dominant position in the West in aerospace, electronics and other forms of high technology by 2000. Probably the Soviets will be our main competition, and the Japanese may have some effect; but we would be dubious of the competitive viability of the West European industries. This view is based on a combination of post World War II trends and a perception of the European attitude toward technology.

We take as a measure of national aerospace attitudes, the status of the national military aerospace industry. A very good measure of that industry, since 1945, has been the will and the ability to produce independently fighter aircraft of modern design. The requirement for such aircraft--usually for interceptors--has been universal, and does not carry the emotional cargo associated with sophisticated bombers. At the same time an interceptor requires for its design and production the most sophisticated aerospace products; only a healthy industry can produce a good fighter. To some extent this view of fighters as indicators of the prestige and power of aerospace industries is confirmed by the actions of a number of the lesser powers. At various times since 1945, Argentina, Egypt, India, and Spain have regarded native fighter-production capability as an important measure of national prestige.

In 1945 virtually every nation in Western Europe had the independent capacity to design and build fighters. The design process was relatively simple, and construction was cheap. The maintenance of an independent military aircraft R&D establishment entailed no great sacrifices. One might say that the cost of entry into the aerospace arms industry was low. Each country has attained a substantial manufacturing capacity, but that has been used to manufacture aircraft of foreign--often U.S.--conception. Choices between indigenous capacity and economy seem generally to have been decided in favor of economy, as long as the numbers of factory jobs remain.

As this capacity has been allowed to die, the initial cost of starting up a serious military aircraft industry has risen. Decisions which may have seemed quite temporary have become less and less reversible. A good illustration of this cost phenomenon may be Japan's efforts to produce her own combat aircraft. Her own quite modest lightweight fighter has virtually prices itself out of her military budget, although she is still able to buy U.S. Phantoms.

One can see similar trends in other arms industries requiring a high research investment. Most European effort has gone into the development of relatively simple tactical missiles, a notable export success being the French Exocet naval missile.

To these countries we must contrast the Soviets. Quite obviously the Soviets, however expensive or ineffective their weapons, cannot buy U.S. equipment. They must maintain a powerful indigenous capacity, which means that for the foreseeable future they will probably be our chief competitors in selling aerospace products to the neutral world.

Until very recently the Soviets have regarded such sales as a way of influencing the buyers. They have often very nearly given away equipment made surplus by their huge production runs. At the same time their product has been unattractive to potential paying customers because of serious inadequacies in post-sales support: there has, for example, been no serious Western market for Soviet airliners. This may no longer be entirely the case. For example, the Soviets have made strenous efforts to market their recent commercial aircraft in non-Communist countries; but inherent deficiencies continue at present to plague them (e.g., Egyptian dissatisfaction with the TU 154).*

The Soviet Union has, and for quite some time is likely to have, an underdeveloped civilian economy in great need of hard foreign currency. Her major manufactured export beyond her own client states is arms, and recently she has begun to ask realistic prices for this product, as

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*Aviation Week, 16 December 1974, p. 13.

during the October (1973) war. If the Soviets can succeed in depoliticizing this product, we can expect them to try very hard to seel it at commercial prices throughout the neutral or semi-neutral world.

Of course, the Soviet military industry provides them a base for the development of commercial aircraft; and here we are beginning to see serious sales activity. An interesting correlate of such attempts may be a decline in the security-mania of the Soviet military.

These are all trends which are only beginning in 1975, but we would expect them to be well established by 2000. That is:

In most countries the choice of high-technology products will be U.S. vs. Soviet. Europeans will participate heavily in high-technology programs, but they will initiate few of them; one might take some of the IBM projects as prototypes. The lower the entry cost, the better the chance that a class of indigenous R&D will exist in a European nation, but European governments are likely to be most interested in the manufacturing end of high technology.*

However, certain countries, for reasons of prestige, will attempt to maintain entirely indigenous high technology industries. Probably such attempts will involve such denials of technological reality as protected (if inferior) arms industries.

The Japanese are a separate, and ambiguous, case. Japan has deemphasized military and aerospace technology for a generation, but has demonstrated high and increasing capability to produce high technology. Presently they manufacture, but do not devote much effort to developing, aerospace technology. Superficially this resembles the European pattern, but the superficiality of the resemblance is crucial, for in other areas the Japanese have demonstrated the will and creativity to develop their own products, and even to exceed the U.S. in key areas, whereas the Europeans generally have not. Nonetheless, because of the long lead-times involved in creating a base for aerospace research and development, because of the continuing inhibitions on most military research, and because Japanese sensitivity about exporting armaments increases their net R&D costs, the Japanese are unlikely to be major competitors of the U.S. before the end of the century.

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*That is, the less government effort is required, the better the chance that some private company will go into high technology. Hence one would expect a decline in European technology as European economies became socialized, as may occur in the U.K. This would be a cultural, not in fact an economic, phenomenon. The most likely way of reversing such a trend would be a strong anti-U.S. and pan-European political movement, i.e., a national combination which would have no choice but to support strong indigenous R&D. Such a combination seems unlikely at present.

V. POSSIBLE IMPACT ON AVIATION GROWTH

During the course of the study a number of factors have been identified which should have an effect on the future growth of aviation. In this section some of these are examined. For purposes of discussion they have been divided into three basic categories: those which should have the effect of promoting aviation growth; those which might tend to restrain growth; and those which should affect the future of aviation but which do not clearly fall into either of the above categories.

1. Factors Promoting Growth

Growth of the Pacific Basin--As has been discussed, the anticipated growth in the Pacific Basin over the next 25 years should have a significant impact on aviation growth. In addition to the obvious increase in air travel fostered by the spectacular growth in tourism in the region and the dramatic increase in air freight, the market for all kinds of aircraft, from transports to agricultural aircraft should be significant. As oil exploration expands in the area, for example, helicopters are increasingly required to service off-shore rigs and remote exploration sites. As commerce and industry expand, so does the demand for business aircraft. While some home-grown aircraft manufacturing may be anticipated, notably in Brazil, the U.S. aviation industry can expect the lion's share of the new business since we build better aircraft in most categories and generally sell them for less. Even in the case of Brazil, U.S. manufacturers benefit by assisting in development of local industries which manufacture U.S. designs under license. In view of the cost of design and development of new aircraft, this pattern may be expected to continue in those countries which attempt to develop their own aviation industries.

Intercity Transportation--With the growth of megalopolises in the U.S. and the concomitant growth in travel among and within the city centers, growth of supplementary transportation systems may be expected. One of the more obvious approaches would be utilization of STOL or V/STOL aircraft operating from STOL strips at or near city centers. One such system operates between Montreal and Ottowa at present and provides city center to city center service which is significantly better than competing modes.* Development of such a system within the Northeast corridor, for example, would itself create a significant market for STOL

*"Total travel time, door to door between comparable downtown hotels in each city, involved 2 hours 35 minutes by bus, 2 hours 24 minutes by train, 2 hours 20 minutes by automobile, 2 hours by conventional aircraft (DC-9 with a 30 minute block time between existing airports) and less than 90 minutes by an Airtransit Twin Otter (with 45 minutes block time between STOL ports)." Davidson, Vic, "Canadian STOL-Commuter Service Demonstrates Early Success," ICAO Bulletin, December, 1974, p. 14.

transport aircraft which could provide a highly competitive alternative to existing systems such as the Eastern Airlines Shuttle and the Metroliner. Continued development of wide-bodied, short-range aircraft of the Lockheed 1011 variety for intercity and inter-megalopolis utilization may also be anticipated, as travel demand grows and existing facilities prove inadequate. Increased utilization of business aircraft may also be expected, particularly as industry continues its trend toward decentralization of facilities and relocation in suburban areas.

Population and Economic Growth--As has been discussed, we believe that the rate of increase of population growth in the United States is turning downward and may have already reached or dropped below the no-growth point. It was also pointed out, however, that the population will continue to increase despite this until the present bulge advances past the child-bearing age (Figure 2). This will not occur before the end of the century. Thus an increasing population will require more transportation facilities of all types, including aviation. When this is coupled with the expanding economy, with its accompanying increase in personal disposable income, it is clear that there will be an increase in the demand for services of all sorts, including transportation. Economic growth should thus promote growth in the aviation industry as demand increases for all types of aircraft from small private planes to large transports.

Defense--The impact of defense considerations on the aviation industry has been discussed. Despite the ongoing detente, it is highly unlikely that defense spending, and aviation's proportion thereof, will decline in the next 25 years. Events in Southeast Asia serve to underscore this. It is quite possible, if not probable, that a dramatic increase in defense spending may develop in the future as a result of communist gains in various parts of the world and the perceived danger to our security relating thereto. Thus Sir Robert Thompson, in reference to Congressional refusal to vote more aid for South Vietnam, "Now, for the sake of $1 billion or $2 billion it will cost the United States $50 billion to $100 billion more annually in defense costs if credibility is to be restored."* This is probably an extreme view, but the trend suggested remains a possibility, although not necessarily at the levels predicted. Thus is seems likely that defense requirements will continue to stimulate the aviation industry for the next quarter century.

Desperation--The Desperation World scenario was discussed earlier and its effects on aviation highlighted. Although this would be a very unpleasant world in which to live, it would prove very stimulative to aviation, especially in connection with military technology and research. In such a world the industry, in common with other defense-oriented industries, would be operating under what would amount to wartime conditions in terms of emphasis on production and development. Civil

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*Thompson, Robert, "Retreat," Op. Ed. Page, The New York Times, April 3, 1975. Of course, there is serious doubt that another $1 or $2 billion would have been enough to maintain the credibility of U.S. commitment.

aviation growth would probably not be markedly enhanced and might indeed be restricted, but the growth on the military side would probably more than offset any losses in civil aviation growth.

Developments--Some of the developments which might lead to an increase in aviation growth have been discussed in some detail. Thus they will be listed here as indicative of the type of occurrences which, while often highly undesirable otherwise, would probably lead to a marked expansion of the aviation industry.

High level of international tension
Mobilization
Large-scale quantitative and qualitative arms race
Material shortages
Major technological developments
Surprise solutions to present development obstacles
General prosperity

Agriculture--It seems reasonable to expect that as developing nations expand their agricultural production the airplane will become increasingly important, both for distribution and for spraying. As new agricultural methods are introduced in developing nations, large-scale cooperative farming operations often develop to take maximum advantage of economies of size. In such cases, traditional hand methods of sowing, weeding, fertilizing and harvesting generally must be discarded. Use of modern farming equipment is often limited because of cost, inability to properly operate and maintain the equipment and, frequently, terrain characteristics which limit such use. Aircraft, however, can often do the bulk of the necessary jobs, freeing available manpower to handle those tasks which cannot be done from the air. The versatility, relatively low cost and tremendous productivity of aircraft, both in the dusting and logistics roles, would appear to assure a profitable future for the light aircraft industry in the years to come. This optimism does not, of course, mean that aircraft will soon become profitable for high density crops like rice in the extremely poor areas (China, India, etc.) which constitute most of the third and fourth worlds, except as means of distributing the produce where the existing transportation infrastructure is inadequate for the job.

Weather Modification--The impact of weather modification on aviation is somewhat indirect but could prove significant. If means of dissipating fog are developed, for example, it could result in elimination or drastic reduction in down time for airports in areas subject to fog. Means of diverting or limiting snow and hail could have similar results, as could hurricane diversion or modification. In addition, development of weather modification techniques could create new uses for aircraft perhaps resulting in new designs and production of significant numbers of weather modification aircraft. Such techniques would probably spread quite rapidly, particularly in developing countries with food shortage problems, creating a worldwide market for weather modification aircraft.

Civilian aviation requirements are likely to have a beneficial effect on aviation, especially in a climate of prosperity. Emphasis is

likely to be placed on development of quieter, cleaner, more economical and efficient power plants. New materials and construction techniques are also apt to be highlighted as cost reducing factors. Automation of airway traffic control systems is another probability, coupled with development of cheaper, more efficient and more reliable avionics components for the general aviation market. STOL and V/STOL developments are very likely to come along in the next few years, creating new markets and expanding existing ones. Air cushion vehicles, while not strictly aircraft, are likely to be developed and produced by aviation firms and their future appears rather bright as obstacles to their design and development are overcome.

2. Factors Constraining Growth

Just as there are foreseen factors which should tend to promote aviation growth, there are some which might tend to have the opposite effect. Some of these are briefly discussed below.

Decline in development and production might be brought about by a general and prolonged economic recession or depression or by long-term economic stagnation which produce close to a zero growth rate. In such a situation the general effect would be to cut back on all unessential activities and to ride out the storm as well as possible. Should such an economic climate persist for a protracted period, it would doubtless have a long term depressing effect on aviation development and would probably seriously damage the industry. In this environment it is hard to foresee any significant progress being made.

Institutional Factors which could adversely affect the aviation industry might include increased and repressive government regulation which could stifle the industry. The ascendance of a "limits to growth" philosophy might result in imposed restrictions on the degree and type of development which would be permitted, which could have the effect of reducing new developments to the vanishing point. Basic changes in the U.S. political/economic structure, e.g., a shift from traditional support for investment, research and development, and increases in productivity, to an increased emphasis on redistribution and social welfare, could retard economic progress and lead to a decline in the aviation industry as well as others. (Such a shift can take place with or without increased direct government control of the economy.)

Material shortages could have a very restrictive effect on aviation growth if substitutes could not be developed. The most obvious is a shortage of fuel, which could seriously curtail flying activities of all sorts. Materials critical to aircraft production, such as metals, minerals, fibers, petro-chemical products could also prove restrictive to development if in short supply, if no viable substitutes were to be developed. Such shortages might be produced by source restrictions, by diversion of available supplies to other use areas, or by cartel actions designed to force prices up. Whatever the cause, the effect could be extremely deleterious to aviation development.

Improved Ground Transport might well lead to a reduction in the aircraft market through provision of cheaper and/or more efficient transportation. Thus improvements in existing mass transit systems such as the Metroliner in the Northeast Corridor might lead to a decline in systems such as the Boston-New York-Washington Air Shuttle. New systems might be developed and superimposed on the existing transportation infrastructure with the same effect as development of high speed hydrofoils and surface effect machines. Development of automated highways, making it possible to travel long distance rapidly and safely in private automobiles could also adversely affect aviation growth. Although it is not likely that surface transportation will seriously challenge long haul aviation, especially for passenger movement, it is possible that much of the short and medium haul market could be captured by future surface transportation developments.

3. Other Factors Affecting U.S. Aviation

There are several other factors which might affect U.S. aviation development in a manner less easy to identify than the above; i.e., they could produce either adverse or beneficial results, depending on the way in which they developed. Three of these are discussed below.

Foreign Competition could prove to be either a stimulus or a serious challenge to the U.S. aviation industry. Although the U.S. presently dominates the world civil aviation market and more than holds its own in the military, this could change in the future either because of competition developing in the Western world, the communist world or both. It doesn't appear that such competition will develop to the point where the U.S. industry could be seriously hurt, but rapid expansion of world markets could lead to expansion of foreign industries to fill the void which limits to U.S. production couldn't fill, thus creating a competitive base which presently doesn't exist. It is also possible that another country could achieve a major technological or production breakthrough which would enable it to corner a significant portion of the market before the U.S. industry could develop a matching capacity. A third possibility is a major effort by communist countries, Russia in particular, to undercut U.S. market dominance by flooding the market with cheap but good aircraft of various types which would significantly undersell competitive U.S. models. Such a possibility becomes more likely if the technology transfer trend develops, affording the Russians technological capabilities they presently lack. A precedent exists in the automotive field where Fiat constructed auto plants in Russia and trained Russian workers in their operation. Today Russian-built Fiats undersell Italian versions in several European and African markets.

On the other hand, competition has historically promoted industrial expansion and product improvement and there is no reason to believe that this wouldn't continue to be the case in the aviation industry. Development of significant foreign competition might very well prove a stimulus to U.S. aviation, promoting the growth of the industry.

Ecology has become increasingly significant of recent years and has had a market effect on the aviation industry. Thus the focus on cleaner, quieter, more efficient power plants, the demise of the U.S. SST and the current efforts to ban foreign SSTs from U.S. airports and airways. Here too it is difficult to say what will be the long-term effects of ecological considerations on the aviation industry. That they can be restrictive is clear from the SST and from various prohibitions to aircraft operations which have been imposed from time to time, and place to place. On the other hand, aviation has unquestionably advanced as a result of such developments as more efficient and quieter power plants. While ecological considerations might combine to produce a restrictive effect on aviation developments (or a serious, long term effect such as deterioration of the ozone layer in the upper atmosphere could result in serious curtailment of flight activities), the likelihood is that as ecological dangers are identified, technological advances will serve to alleviate or negate them, permitting the industry to grow to meet future demands.

Energy is clearly an area which could prove quite critical to future developments of all kinds. If there were to develop a serious shortage of petroleum products, for whatever reason, aviation would be adversely affected, since it would be difficult to convert aircraft to alternatives such as coal synthetics or methane. Since many manufacturing facilities are dependent on petroleum products (including natural gas), production would also be curtailed until such time as conversion to coal could be made or coal liquefaction and gasification techniques developed to the point of providing for requirements. Shortages of other energy sources could have similar effects. Development of substitute fuels, such as hydrogen, for aircraft utilization are anticipated to take considerable time, on the order of one to two decades. When this is coupled with the need to design and produce power plants capable of using the new fuels the time and investment required becomes very large. A serious energy shortage could clearly cripple industry in general and aviation in particular for the rest of this century, should it develop. On the other hand, known reserves of all types are more than adequate to handle projected needs well into the next century, and when new source discoveries are added, it seems clear that de facto energy shortages, if they develop, will be man-made. Hence they can be alleviated by appropriate action. The most probable development in the energy picture is pursuit of Project Independence goals to the point of U.S. energy partial self-sufficiency within one or two decades.

Appendix I

PACIFIC BASIN AND OTHER INTERNATIONAL DEVELOPMENT TRENDS 1972-2000

We highlight the prospects for Pacific Basin development because we believe that it is the area of most dynamic development for the last quarter of the century. The large travel and transport distances imply significant increases in aviation needs to meet the special requirements of the area, such as the SST.

The last chart shows development in Europe and the developing countries for comparative purposes.

International Development Projections

This section focuses on development projections for the Pacific Basin Trading and Investment Area. The Pacific Basin Trade and Investment Area is a functional group of "key countries" contained in or bordering on the Pacific Ocean. Included in this grouping are Venezuela and Brazil which, while not geographically located in the Pacific Basin, do a major portion of their trading with the PTIA and thus constitute a significant factor in the growth and development of the region. Also shown are projections for the China Trading Bloc and for comparison, some European and third world projections.

GROSS NATIONAL PRODUCT, GNP/CAP, AND POPULATION PROJECTIONS
BY COUNTRY AND REGION - ANNUAL GROWTH RATE (%) 1972-2000
(GNP FIGURES IN CONSTANT 1972 DOLLAR EQUIVALENT)

COUNTRY/REGION		1972	%	1975	%	1980	%	1985	%	1990	%	2000
U.S.A.	GNP (BIL.)	1155	2.0	1225	4.5	1527	4.2	1876	4.0	2282	4.0	3378
	GNP/CAP.	5532	1.5	5750	3.5	6830	3.2	7995	3.1	9315	3.2	12765
	POP.(MIL.)	209	1.0	215	1.0	226	1.0	238	0.9	249	0.8	270
JAPAN	GNP	335	6.0	399	9.0	614	8.0	902	7.0	1265	6.0	2265
	GNP/CAP.	3165	5.2	3685	7.9	5390	7.2	7630	6.2	10310	5.3	17280
	POP.	105	1.2	110	1.1	115	0.8	120	0.8	125	0.7	135
CANADA	GNP	103	3.0	113	5.0	144	5.0	184	5.0	235	5.0	383
	GNP/CAP.	4696	2.1	4998	3.3	5879	3.4	6949	3.5	8253	3.6	11755
	POP.	22	1.7	23	1.7	25	1.6	27	1.5	29	1.4	33
AUSTRALIA	GNP	50	2.5	53.8	5.0	68.7	5.0	87.7	6.0	117.4	6.0	210.3
	GNP/CAP.	3924	1.8	4140	2.9	4776	3.0	5537	4.1	6769	4.2	10214
	POP.	13	2.0	14	2.1	16	2.0	18	1.9	20	1.8	25
BRAZIL	GNP	49.5	6.0	59.0	8.0	86.7	8.0	127.4	8.0	187.2	8.0	404
	GNP/CAP.	495	4.8	570	5.1	730	5.2	940	5.4	1222	5.7	2130
	POP.	98	2.8	105	2.9	120	2.8	140	2.6	160	2.3	200
MEXICO	GNP	40	4.0	45	7.5	65	7.5	93	7.0	130	7.0	256
	GNP/CAP.	750	3.0	820	4.1	1002	4.2	1230	4.0	1497	4.3	2280
	POP.	53	3.4	59	3.4	70	3.3	82	3.0	95	2.7	125
INDONESIA	GNP	10.6	4.0	11.9	5.5	15.6	7.0	21.9	8.0	32.2	8.0	69.5
	GNP/CAP.											
	POP.											
SOUTH KOREA	GNP	10	7.0	11.6	9.0	17.9	9.0	27.5	8.0	40.4	7.5	83.3
	GNP/CAP.	294	4.8	338	6.6	465	6.7	644	6.0	862	6.0	154.4
	POP.											
NEW ZEALAND	GNP	9.5	2.5	10.2	4.0	12.4	4.5	15.5	5.0	19.8	6.0	35.5
	GNP/CAP.	3359	1.5	3512	2.2	3915	2.6	4451	3.2	5210	4.3	7938
	POP.	2.9	1.7	3.1	1.8	3.4	1.9	3.7	1.8	4	1.7	5
PHILIPPINES	GNP	8.3	5.5	9.8	5.5	12.8	6.0	17.1	6.5	23.4	7.0	46
	GNP/CAP.	202	2.0	214	2.0	236	2.6	268	3.6	320	4.5	497
	POP.	41	3.5	45	3.5	53	3.4	63	2.9	73	2.5	93
TAIWAN	GNP	7.69	6.0	9.2	9.0	14.2	8.0	20.9	7.5	30	7.5	61.8
	GNP/CAP	508	3.5	563	5.8	746	6.0	998	5.8	1323	6.2	2414
	POP.	15	2.2	16	2.2	18	2.0	20	1.7	22	1.3	25
THAILAND	GNP	7.7	5.0	8.9	6.5	12.2	6.5	16.7	7.0	23.4	7.0	46
	GNP/CAP.	195	3.0	213	3.4	252	3.5	300	4.3	370	4.6	580
	POP.	38	3.3	42	3.1	49	3.0	57	2.7	65	2.4	82
SINGAPORE	GNP	2.6	9.0	3.4	9.0	5	9.0	8	8.0	12	7.0	23
	GNP/CAP.	1200	6.7	1500	6.7	2200	6.9	2900	7.2	3900	5.6	6400
	POP.	2.1	2.3	2.2	2.3	2.5	2.1	2.8	1.8	3.1	1.4	3.6

SOURCE OF GNP DATA: GROSS NATIONAL PRODUCT; GROWTH RATES AND TREND DATA BY REGION AND COUNTRY-RC-N-138, MAY 1, 1974, BUREAU OF PROGRAM AND MANAGEMENT SERVICES, A.I.D.

PACIFIC BASIN TRADING AND INVESTMENT AREA
GROSS NATIONAL PRODUCT - STRAIGHT LINE PROJECTIONS
1975-2000

BILLIONS OF 1972 $

COUNTRY	1972	GROWTH RATE (%)	1975	1980	1985	1990	2000
AUSTRALIA	50.00	3.5	55.44	65.85	78.21	92.89	131.03
		5.0	57.88	73.87	94.28	120.33	196.00
		7.0	61.25	85.91	120.49	168.99	332.43
INDONESIA	10.62	5.0	12.29	15.69	20.02	25.55	41.62
		6.0	12.65	16.93	22.66	30.32	54.30
		7.0	13.01	18.25	25.60	35.91	70.64
JAPAN	335.00	6.0	399.00	533.95	714.55	956.23	1712.46
		8.0	422.00	620.00	911.00	1338.56	2889.85
		10.0	445.89	718.11	1156.52	1862.59	4831.08
SINICULTURE AREA	21.00*	6.4	25.30	34.50	47.05	64.16	115.31
		8.3	26.68	39.75	59.22	88.23	195.84
		10.1	28.03	45.35	73.37	118.70	310.69
CHINA (TAIWAN)	7.69	6.5	9.29	12.73	17.44	23.89	44.84
		8.0	9.69	14.24	20.92	30.74	66.37
		9.5	10.10	15.90	25.03	39.40	97.64
KOREA (SOUTH)	10.00	7.0	12.25	17.18	24.10	33.80	66.49
		9.0	12.95	19.93	30.66	47.17	111.67
		11.0	13.66	23.02	38.79	65.36	185.58
SINGAPORE	2.60	7.0	3.19	4.47	6.27	8.79	17.29
		9.0	3.37	5.19	7.99	12.29	29.09
		11.0	3.56	6.00	10.11	17.04	48.38
SOUTH VIETNAM	3.13	3.0	3.73	4.33	5.02	5.82	7.82
		4.0	3.95	4.81	5.85	7.12	10.55
		5.0	4.19	5.34	6.82	8.70	14.18
OTHER ASIA	28.00*	4.7	31.14	40.44	50.88	64.01	101.32
		5.6	32.97	43.30	56.86	74.67	128.59
		6.5	33.82	46.34	63.49	86.93	163.29

* = ESTIMATED

CONT'D

PACIFIC BASIN TRADING AND INVESTMENT AREA
GROSS NATIONAL PRODUCT - STRAIGHT LINE PROJECTIONS
1975-2000

BILLIONS OF 1972 $

COUNTRY	1972	GROWTH RATE (%)	1975	1980	1985	1990	2000
MALAYSIA	4.25	5.5	5.55	7.25	9.48	13.07	21.16
		6.3	5.76	7.82	10.62	15.34	26.58
		7.0	5.96	8.35	11.72	17.58	32.32
NEW ZEALAND	9.50	2.5	10.20	11.54	13.06	14.73	18.92
		3.5	10.50	12.50	14.85	17.64	24.88
		4.0	10.69	13.01	15.83	19.26	28.51
PHILIPPINES	11.00	5.0	12.73	16.25	20.74	26.47	43.12
		5.5	12.92	16.89	22.07	28.84	49.26
		6.0	13.10	17.59	23.54	31.50	56.41
THAILAND	7.70	5.0	8.91	11.37	14.51	18.52	30.17
		6.5	9.30	12.75	17.46	23.92	44.91
		8.0	9.70	14.25	20.94	30.77	66.43
ARGENTINA	27.20	2.5	29.29	33.14	37.49	42.42	54.30
		3.7	30.33	36.37	43.62	52.31	75.23
		5.0	31.49	40.19	51.29	65.46	106.63
BRAZIL	49.50	5.0	57.30	73.13	93.33	119.12	194.03
		5.5	58.12	75.96	99.28	129.75	221.63
		6.0	58.96	78.90	105.59	141.30	253.05
CANADA	103.00	3.0	112.55	130.48	151.26	175.35	235.66
		4.0	115.86	140.96	171.50	208.66	308.87
		5.0	119.24	152.18	194.22	247.88	403.77
CHILE	7.68	3.0	8.39	9.73	11.28	13.08	17.58
		4.0	8.64	10.51	12.79	15.56	23.03
		5.0	8.89	11.35	14.49	18.49	30.12
MEXICO	40.00	6.0	47.64	63.75	85.31	114.16	204.44
		7.5	49.69	71.34	102.45	142.04	292.75
		9.0	51.80	79.70	122.63	188.68	446.67
UNITED STATES	1155.00	2.0	1225.70	1353.27	1494.12	1649.62	2010.28
		3.0	1262.10	1463.12	1696.16	1966.31	2642.56
		4.0	1299.22	1580.17	1922.52	2339.04	3462.35
VENEZUELA	13.41	5.0	15.52	19.81	25.28	32.26	52.55
		5.9	15.93	21.22	28.26	37.64	66.77
		6.5	16.20	22.20	30.42	41.68	78.24

PACIFIC BASIN TRADING AND INVESTMENT AREA

GROSS NATIONAL PRODUCT PER CAPITA - STRAIGHT LINE PROJECTIONS
1975 - 2000

COUNTRY	1972	PROJECTION	1975	1980	1985	1990	2000
AUSTRALIA	3924	LOW GNP-HIGH POP.	4164	4597	5076	5604	6831
		MED. GNP-MED. POP.	4288	4971	5763	6661	8952
		HIGH GNP-LOW POP.	4674	6255	8371	11202	20061
INDONESIA	84	LOW GNP-HIGH POP.	85	87	89	94	104
		MED. GNP-MED. POP.	88	95	102	110	128
		HIGH GNP-LOW POP.	89	98	108	119	145
JAPAN	3165	LOW GNP-HIGH POP.	3717	4858	6349	8298	14174
		MED. GNP-MED. POP.	3987	5858	8607	12647	27304
		HIGH GNP-LOW POP.	4259	6985	11455	18532	48506
SINICULTURE AREA	283*	LOW GNP-HIGH POP.	338	405	490	617	903
		MED. GNP-MED. POP.	372	491	653	926	1698
		HIGH GNP-LOW POP.	409	595	873	1395	3281
CHINA (TAIWAN)	508	LOW GNP-HIGH POP.	571	695	846	1029	1523
		MED. GNP-MED. POP.	605	810	1084	1451	2599
		HIGH GNP-LOW POP.	640	940	1381	2096	4827
KOREA (SOUTH)	294	LOW GNP-HIGH POP.	337	422	528	664	1051
		MED. GNP-MED. POP.	364	520	743	1062	2169
		HIGH GNP-LOW POP.	391	630	1015	1732	4701
SINGAPORE	1200	LOW GNP-HIGH POP.	1389	1773	2263	2930	4911
		MED. GNP-MED. POP.	1512	2222	3265	4797	10356
		HIGH GNP-LOW POP.	1641	2765	4659	7851	22292
SOUTH VIETNAM	225[a]	LOW GNP-HIGH POP.	228	233	238	246	256
		MED. GNP-MED. POP.	235	252	270	289	332
		HIGH GNP-LOW POP.	247	288	336	395	547
OTHER ASIA	269*	LOW GNP-HIGH POP.	285	304	324	351	397
		MED. GNP-MED. POP.	299	335	375	432	541
		HIGH GNP-LOW POP.	311	364	428	522	721
CAMBODIA	111[a]	LOW GNP-HIGH POP.	96	84	75	64	52
		MED. GNP-MED. POP.	110	111	112	113	115
		HIGH GNP-LOW POP.	121	136	152	173	212

*1969
- ESTIMATED

CONT'D.

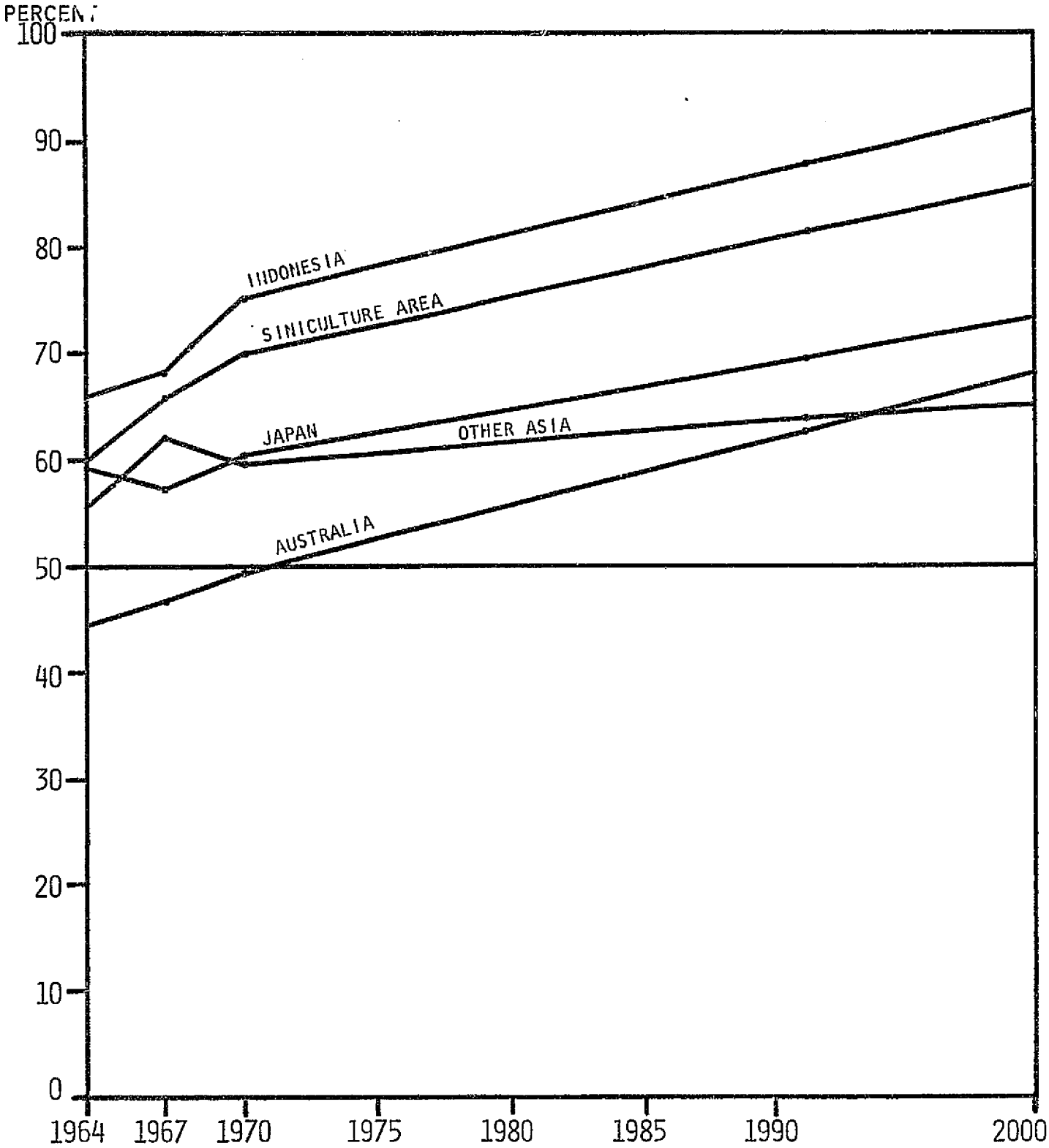
PACIFIC BASIN TRADING AND INVESTMENT AREA

GROSS NATIONAL PRODUCT PER CAPITA - STRAIGHT-LINE PROJECTIONS
1975 - 2000
(1972 $ EQUIV.)

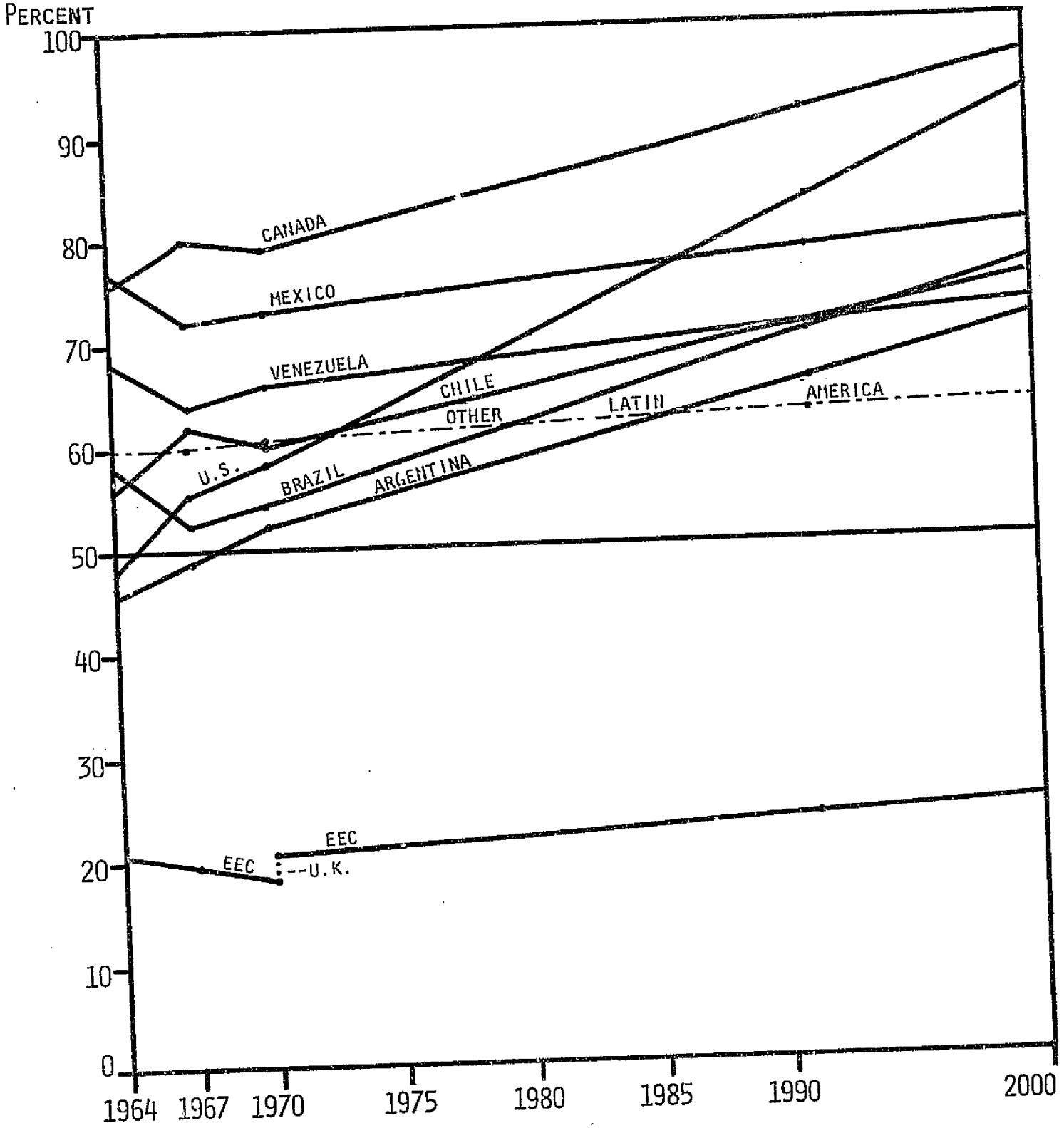
COUNTRY	1972	PROJECTION	1975	1980	1985	1990	2000
LAOS	80	LOW GNP-HIGH POP.	77	73	73	73	73
		MED. GNP-MED. POP.	82	86	90	95	105
		HIGH GNP-LOW POP.	85	94	104	115	140
MALAYSIA	457	LOW GNP-HIGH POP.	487	554	630	716	926
		MED. GNP-MED. POP.	502	599	715	853	1215
		HIGH GNP-LOW POP.	513	636	789	991	1564
NEW ZEALAND	3359	LOW GNP-HIGH POP.	3481	3695	3922	4204	4831
		MED. GNP-MED. POP.	3544	3875	4287	4632	5537
		HIGH GNP-LOW POP.	3607	4061	4572	5173	6622
PHILIPPINES	202	LOW GNP-HIGH POP.	212	229	248	269	315
		MED. GNP-MED. POP.	214	237	261	289	352
		HIGH GNP-LOW POP.	220	252	289	332	438
THAILAND	195	LOW GNP-HIGH POP.	205	221	240	260	304
		MED. GNP-MED. POP.	216	255	301	361	519
		HIGH GNP-LOW POP.	227	293	377	493	842
ARGENTINA	1095	LOW GNP-HIGH POP.	1135	1205	1279	1357	1529
		MED. GNP-MED. POP.	1183	1345	1529	1738	2247
		HIGH GNP-LOW POP.	1232	1499	1823	2218	3284
BRAZIL	495	LOW GNP-HIGH POP.	522	571	624	682	816
		MED. GNP-MED. POP.	535	608	691	786	1016
		HIGH GNP-LOW POP.	544	637	746	873	1196
CANADA	4696	LOW GNP-HIGH POP.	4867	5166	5484	5821	6558
		MED. GNP-MED. POP.	5042	5677	6392	7197	9123
		HIGH GNP-LOW POP.	5192	6136	7253	8572	12328
CHILE	795	LOW GNP-HIGH POP.	809	834	859	885	940
		MED. GNP-MED. POP.	837	917	1003	1095	1310
		HIGH GNP-LOW POP.	874	1023	1197	1402	1920
MEXICO	750	LOW GNP-HIGH POP.	810	921	1047	1191	1539
		MED. GNP-MED. POP.	849	1042	1280	1573	2373
		HIGH GNP-LOW POP.	898	1214	1639	2215	4042
UNITED STATES	5532	LOW GNP-HIGH POP.	5871	6482	7156	7901	9631
		MED. GNP-MED. POP.	6045	7008	8124	9418	12657
		HIGH GNP-LOW POP.	6187	7455	8984	10825	15718
VENEZUELA	1166	LOW GNP-HIGH POP.	1194	1243	1293	1346	1458
		MED. GNP-MED. POP.	1230	1345	1470	1608	1922
		HIGH GNP-LOW POP.	1267	1454	1670	1955	2679

*1969

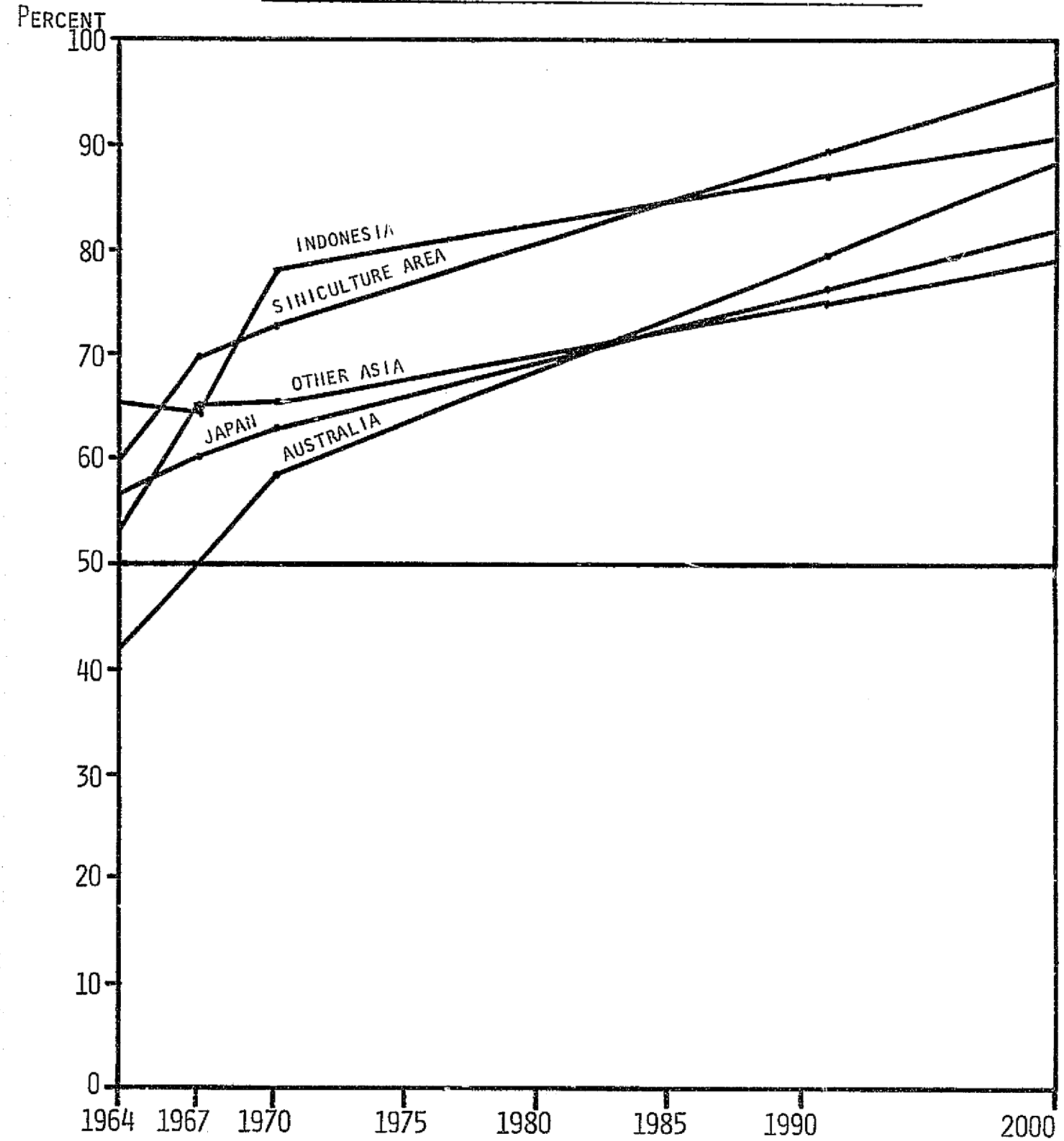
IMPORTS FROM PACIFIC BASIN TRADING AND INVESTMENT AREA
AS A PERCENTAGE OF TOTAL IMPORTS
PRINCIPAL PACIFIC BASIN COUNTRIES/REGIONS - EASTERN SECTOR



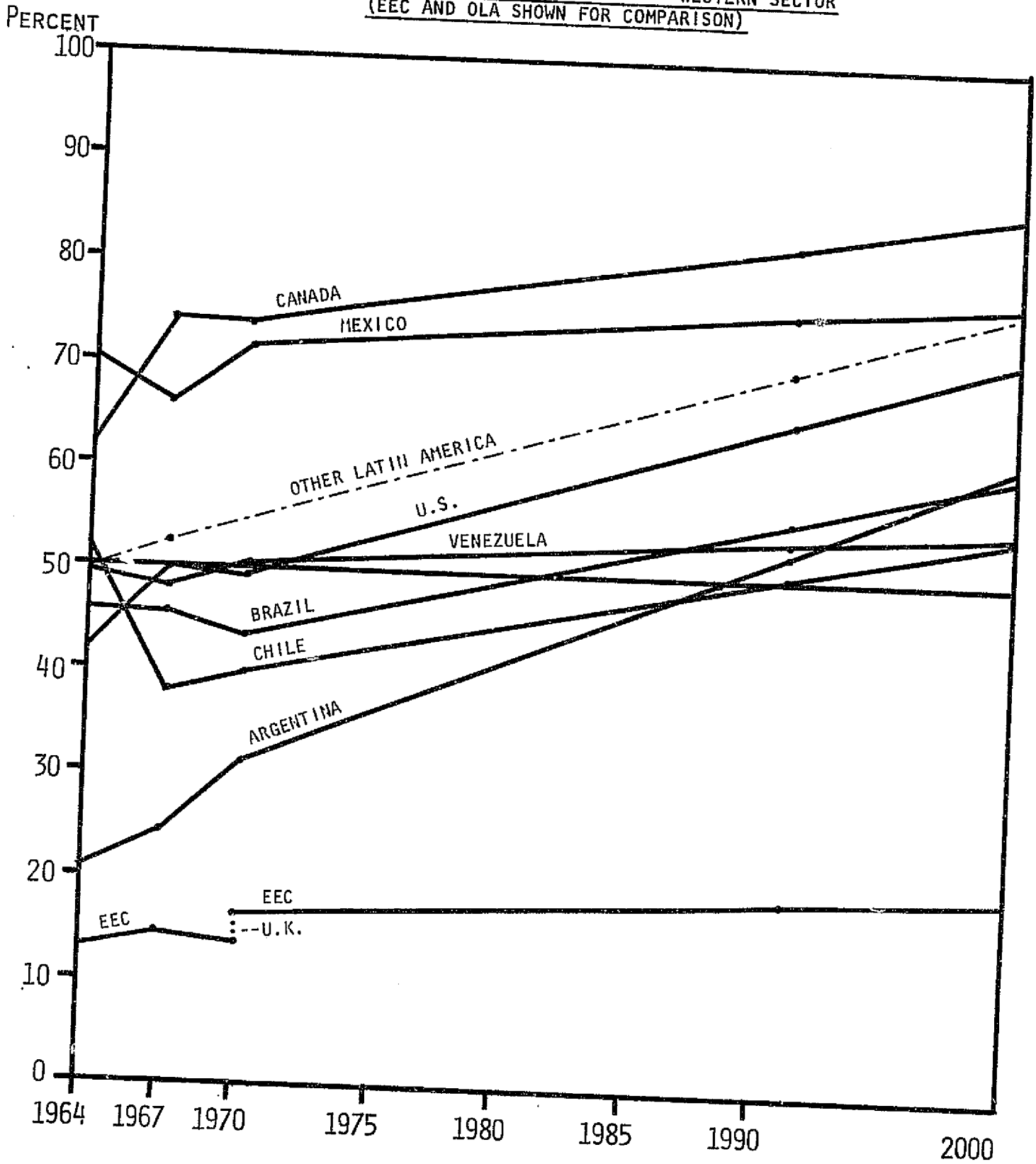
IMPORTS FROM PACIFIC BASIN TRADING AND INVESTMENT AREA
AS A PERCENTAGE OF TOTAL IMPORTS
PRINCIPAL PACIFIC BASIN COUNTRIES - WESTERN SECTOR
(EEC AND OLA SHOWN FOR COMPARISON)



EXPORTS TO PACIFIC BASIN TRADING AND INVESTMENT AREA
AS PERCENTAGE OF TOTAL EXPORTS
PRINCIPAL PACIFIC BASIN COUNTRIES/REGIONS - EASTERN SECTOR



EXPORTS TO PACIFIC BASIN TRADING AND INVESTMENT AREA
AS A PERCENTAGE OF TOTAL EXPORTS
PRINCIPAL PACIFIC BASIN COUNTRIES - WESTERN SECTOR
(EEC AND OLA SHOWN FOR COMPARISON)



CHINA BLOC TRADING AND INVESTMENT AREA
SUMMARY

POPULATION (MILLIONS)

1970		1975	1980	1985	1990	2000
835.61*		909.20	984.82	1062.06	1149.79	1347.58
		923.47	1010.92	1107.88	1214.36	1413.31
		924.23	1022.54	1131.27	1251.40	1531.52

GROSS NATIONAL PRODUCT (BILLIONS 1972 $ EQUIV.)

1970 ADJ		1975	1980	1985	1990	2000
126.40*		154.10	187.73	228.88	279.14	415.18
		169.15	226.42	303.11	406.01	728.48
		185.57	272.52	400.13	587.92	1269.28

GROSS NATIONAL PRODUCT PER CAPITA (1972 $ EQUIV.)

1970 ADJ	PROJECTION	1975	1980	1985	1990	2000
151.00*	LOW GNP-HIGH POP.	167.00	184.00	202.00	227.00	277.00
	MED GNP-MED POP.	183.00	224.00	274.00	340.00	522.00
	HIGH GNP-LOW POP.	204.00	277.00	376.00	518.00	982.00

*ESTIMATED

CHINA BLOC TRADING AND INVESTMENT AREA

POPULATION - STRAIGHT-LINE PROJECTIONS
1975-2000
(MILLIONS)

COUNTRY	1970	GROWTH RATE (%)	1975	GROWTH RATE (%)	1980	GROWTH RATE (%)	1985	GROWTH RATE (%)	1990	GROWTH RATE (%)	2000
CHINA (PRC)	800.00*	1.7	869.60	1.6	940.91	1.5	1013.36	1.5	1091.68	1.5	1266.42
		2.0	883.20	1.8	965.34	1.8	1056.31	1.5	1137.95	1.5	1320.09
		2.0	883.20	2.0	975.20	2.0	1076.80	2.0	1178.87	2.0	1449.41
NORTH KOREA	13.61*	2.4	15.31	2.4	17.24	2.4	19.42	2.4	21.86	2.4	27.77
		2.5	15.39	2.5	17.42	2.5	19.71	2.5	22.30	2.5	28.55
		2.7	15.53	2.7	17.77	2.6	20.19	2.6	22.95	2.6	29.68
NORTH VIETNAM	22.00*	2.0	24.29	1.9	26.67	1.9	29.28	1.9	32.17	1.9	38.81
		2.5	24.88	2.5	28.16	2.5	31.86	2.5	36.05	2.5	46.16
		3.0	25.50	3.0	29.57	3.0	34.28	3.0	39.74	3.0	53.39

*ESTIMATE

CHINA BLOC

GROSS NATIONAL PRODUCT - STRAIGHT-LINE PROJECTIONS 1975-2000 (BILLIONS - 1972 $ EQUIV.)

COUNTRY	1972	GROWTH RATE (%)	1975	1980	1985	1990	2000
CHINA (PRC)	140.00*	4.0	157.48	191.6	233.11	283.61	419.82
		6.0	166.77	223.14	298.61	399.61	715.64
		8.0	176.36	259.13	380.70	559.44	1207.79
NORTH KOREA	4.00*	5.5	5.28	6.90	9.02	11.79	20.14
		7.0	5.67	7.95	11.15	15.64	30.76
		8.5	6.08	9.14	13.74	20.66	46.72
NORTH VIETNAM	1.6**	3.0	1.75	2.03	2.35	2.72	3.66
		4.0	1.8	2.19	2.66	3.24	4.8
		6.0	1.91	2.55	3.41	4.57	8.18

*ESTIMATE

**DOUGLAS PIKE, "NORTH VIETNAM IN 1974," VIETNAM BULLETIN, 1 NOV 1974.

CHINA BLOC

GROSS NATIONAL PRODUCT PER CAPITA - STRAIGHT-LINE PROJECTIONS 1975-2000 (1972 $ EQUIV.)

COUNTRY	1972	PROJECTION	1975	1980	1985	1990	2000
CHINA (PRC)	150*	LO GNP:HI POP.	165	182	201	222	269
		MED GNP:MED POP.	182	223	272	347	548
		HI GNP:LO POP.	203	275	376	528	1045
NORTH KOREA	297*	LO GNP:HI POP.	340	388	447	518	689
		MED GNP:MED POP.	368	456	566	716	1136
		HI GNP:LO POP.	397	530	707	982	1821
NORTH VIETNAM	65**	LO GNP:HI POP.	65	65	65	65	65
		MED GNP:MED. POP.	68	72	77	83	94
		HI GNP:LO POP.	74	92	115	144	223

*ESTIMATE

EUROPE

GROSS NATIONAL PRODUCT, GNP/CAP, AND POPULATION PROJECTIONS BY COUNTRY AND REGION - ANNUAL GROWTH RATE (%) 1972-2000
(GNP FIGURES IN CONSTANT 1972 DOLLAR EQUIVALENTS)

COUNTRY/REGION		1972	%	1975	%	1980	%	1985	%	1990	%	2000
W. GERMANY	GNP (BIL.)	285.6	3.0	312	5.0	398	5.0	508	4.5	633	4.0	937
	GNP/CAP.	4213	3.0	4604	4.6	5765	4.6	7219	4.1	8825	3.6	12569
	POP.(MIL.)	61	0.5	62	0.4	63	0.4	64	0.4	65	0.4	68
FRANCE	GNP	218	3.5	242	6.0	324	5.5	424	5.0	541	5.0	881
	GNP/CAP.	4200	3.0	4590	5.2	5915	4.7	7442	4.3	9185	4.3	13995
	POP.	52	0.8	536	0.8	55	0.8	57	0.7	59	0.7	63
UNITED KINGDOM	GNP	151	2.1	161	4.0	196	4.5	244	4.5	304	4.5	472
	GNP/CAP.	2714	2.1	2889	3.4	3415	3.7	4095	3.8	4938	3.9	7235
	POP.	56	0.6	57	0.6	59	0.8	61	0.7	63	0.6	67
ITALY	GNP	122.1	3.5	135	5.0	172	5.0	220	5.5	288	5.5	492
	GNP/CAP.	2246	3.0	2454	4.3	3029	4.3	3739	4.8	4727	4.9	7627
	POP.	55	0.8	56	0.7	58	0.7	60	0.7	62	0.6	66
SCANDINAVIA	GNP	96	2.5	103	4.0	125	4.5	156	4.5	194	4.5	301
	GNP/CAP.	3600	2.3	3854	3.3	4533	3.9	5489	3.9	6646	4.0	9838
	POP.	22	0.7									

DEVELOPING NATIONS

GROSS NATIONAL PRODUCT, GNP/CAP, AND POPULATION PROJECTIONS BY COUNTRY AND REGION - ANNUAL GROWTH RATE (%) 1972-2000
(GNP FIGURES IN CONSTANT 1972 DOLLAR EQUIVALENTS)

COUNTRY/REGION		1972	%	1975	%	1980	%	1985	%	1990	%	2000
PEOPLE'S REP. OF CHINA	GNP (BIL.)	140*	2.0	149	6.0	199	6.0	266	6.0	356	6.0	638
	GNP/CAP.	150	1.4	156.39	4.4	193.96	4.5	241.71	4.6	302.65	4.8	483.68
	POP.(MIL.)	780	1.6	820	1.6	885	1.5	950	1.4	1025	1.2	1150
INDIA	GNP	58	3.0	63	5.0	80	5.5	105	6.0	141	7.0	277
	GNP/CAP.	98	2.4	105	2.5	119	3.2	139	3.9	168	5.1	276
	POP.	565	2.6	610	2.5	690	2.3	775	2.1	860	1.9	1000
SOUTH AFRICA	GNP	21	2.0	22.3	6.0	29.8	6.0	39.9	6.0	53.4	7.0	105
	GNP/CAP.	891	0.5	904	3.4	1069	3.3	1257	3.4	1486	4.7	2352
	POP.	24	2.5	26	2.6	30	2.7	35	2.6	39	2.3	49
ALGERIA	GNP	7	5.0	8.1	5.5	10.6	6.0	14.2	7.0	19.9	7.5	41
	GNP/CAP.	469	1.6	520	1.9	571	2.3	640	3.6	704	4.4	1175
	POP.	15	3.4	17	3.6	20	3.7	24	3.4	29	3.1	40
ZAIRE	GNP	2.3	1.1	2.4	6.0	3.2	6.0	4.3	7.0	6	7.0	11.8
	GNP/CAP.	122	1.5	128	3.4	151	3.2	177	4.3	219	4.5	340
	POP.	23	2.5	24	2.6	28	2.8	32	2.7	36	2.5	47

*ESTIMATE

Appendix II

THE PROSPECTS FOR RAW MATERIALS

As a long term trend from 1930 to 1970, world production of raw materials has increased very markedly. Although U.S. production and consumption continued to climb after World War II, its share of world production has dropped precipitously. A curve of steel consumption showed that the peak of use of this material occurs at roughly $2000 GNP per capita, after which the increment falls off. This indicates that young economies tend to use steel more intensively than more mature economies as well as contributing to the explanation of recent rapid growth of world demand for raw materials.

On a dollar basis, the price of raw materials has roughly doubled in the last twenty years. This is an annual increase of about 3 percent, which is roughly the rate of inflation for this period. However, the largest part of these increases has occurred in the last three years. This recent development has come about for several reasons. The first is the readjustment in world currency rates which has taken place since 1971. Furthermore, the world stock of money increased as boom conditions characterized most of the world's major economies. When we look at some specific materials, we see a characteristic pattern of price changes during the last two years. Copper rose fairly stadily from the fall of 1973 and reached a peak in the summer of 1974, after which it has declined to present levels which are below those of late 1973. Tin prices rose fairly strongly during the same period but now have declined from high levels of the summer of 1974, stabilizing at levels of about 45 percent above those of the summer of 1973. Zinc prices have followed a similar pattern, while aluminum rose more gradually, and has now stabilized at a point around 46 percent above a year ago.

A chart showing the dependence of the United States on various impacted raw materials should not be misinterpreted; dependence is not the same as vulnerability. For instance, uranium becomes much more plentiful as the price increases. Both the price elasticity of supply and the volume/grade relationships indicate very long range availability of all significant raw materials.

A series of roadblocks raise serious questions about future U.S. mineral production. The first is simply a general atmosphere of uncertainty regarding the future. This is complicated by the present squeeze on capital resources and the inevitable time lag involved in construction facilities for production of raw materials. Finally, and perhaps most important, is the lack of government incentives for exploitation of mineral deposits. We therefore foresee relatively slow development of

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*This appendix was prepared by Ernest E. Schneider of the Hudson Institute, based on research by Rudy Ruggles, David Harmon, and others of the Hudson research staff. A chartbook too long for inclusion in this report is available on request.

U.S. supplies and raw materials, with little change likely for the medium run future. It follows that the U.S. will continue to depend on world markets for many of its raw materials. At present, high priority is being given to solving the energy crisis and to complying with environmental regulations.

Stockpiling is the most obvious and apparently the most effective method of insulating the U.S. against vulnerability of raw materials supplies. Current and recent policy on stockpiling has been rather confused. Whether the purpose of stockpiling should be strategic or economic has not been clear. Until the Nixon administration introduced some basic changes in stockpiling, the basic objective has been strategic, that is, the maintenance of a one-year supply as a buffer against shortages during a war time situation. The Nixon administration changed this objective to one which was basically economic. It transferred authority for stockpiles from the Office of Emergency Planning to the General Services Administration, and, in 1973, decided to reduce these stocks from the level of $6.6 billion to $.7 billion, that is, a 90 percent drop. The real objective of the change in policy was to use the stockpiles as a method of combating inflation. Among the most important arguments in favor of stockpiling raw materials are: 1) a deterrent against the formation of raw materials cartels, 2) to help American allies to meet shortages, and 3) to have a buffer stock to permit time for the development of substitute material. The strongest argument against stockpiling--that stockpiles should be liquidated to fight inflation--is, in our view, questionable. It is worth noting that a consequence of the stockpile liquidation is that it produces a one-time sort of windfall in government receipts, which helps to bring down deficits in the Federal budget. At the present time, sentiment in favor of stockpiling is becoming stronger; for example, a Congressional subcommittee recently reached the conclusion that stockpiles for only one year were inadequate and favored instead stockpiles for a three year period. If there is some cause for dissatisfaction with American stockpiling policy, it is only fair to note that no large OECD country maintains any official raw materials stockpiles. Sweden is the only example; West Germany and Japan have considered doing so but taken no action.

The Hudson position is that it is unlikely that new raw materials cartels will be formed by producing countries on the pattern of OPEC--although there will be many attempts. If one studies the main raw materials supplying countries, one finds a pretty clear pattern. They characteristically are heavily dependent upon sales of a single raw material, but are only one of several major suppliers of this same material. The recent and continuing worldwide inflation and the need to accumulate hard currencies provides, however, a strong impetus for such countries to try to form cartels in order to protect themselves. Nevertheless, the great diversity--geographic and political--that exists among countries which supply a particular material, such as bauxite, indicates that it would be extremely difficult to form such a cartel and have it operate effectively. Another impediment is that demand elasticity for most raw materials is much higher than for oil. Further,

without the ideological glue which helps to hold OAPEC together, it is difficult to arrive at the terms on which self-interest should be sacrificed to the interests of the cartel. Hudson Institute does foresee a trend towards the processing of raw materials to move away from consuming countries to producing countries. This pattern provides an incentive for "good behavior" on the part of raw materials producing countries.

So far as raw materials cartels along the lines of OPEC are concerned, we should note that a developed country, Australia, is a member of the Bauxite producers group (CIPEC). In effect the less developed areas of developed countries often produce raw materials. In the case of the tin council, Malaysia is very responsive to price changes. The United States has recently constructed a large very modern smelter in Thailand which produces an important by-product. It is interesting to note that the Peoples Republic of China is now participating in the Tungsten Committee, put together under the auspices of the United Nations.

In general we believe that prices for raw materials have crested and will probably decline somewhat from recent or present levels. Two main factors point in this direction. The slackening of the world economy, of course, brings about a weakening of demand. Meanwhile, high price levels have introduced important incentives to build up production capacity, which, within a few years, will of course produce increased supplies, reestablishing a more traditional balance.

Great progress in raw materials production is being made around the world. The U.S. certainly has no monopoly on finding and developing raw materials. The characteristics of mineral industries first require a definition of what is a mineral. In general one could say that it is some sort of rock that is found in the ground. In terms of impact, raw materials production amounts to 3 or 4 percent of the U.S. GNP but, if one considers the value added to these raw materials, it is closer to 15 percent. It is important to keep an open mind in discussion the dimensions of U.S. reserves. For one thing, real reserves are often not reported by producing companies for tax reasons. Furthermore, for some raw materials one must consider the availability of scrap. In addition, the need for supplies of various kinds of raw materials varies as technology develops. For example, the open hearth method of producing steel depends heavily upon availability of scrap. As this method is phased out, the demand for iron ore changes. Some other raw materials are truly non-renewable.

The question of availability of raw materials in this country is confused by political uncertainties. For example, a much clearer definition of rights to raw materials is needed. Furthermore, raw materials in this country are found in land which is both private and government-owned. We must remember that a very long time lag is usually involved in the development of hard rock minerals. Price considerations also play a critical role. For example, lower grade copper can become available if the price is right, but the availability goes down if an oversupply develops. Furthermore, costs often rise with higher prices. Some minerals have very high unit value while others have a very low unit

value. This consideration has a strong effect upon the practicality of transporting materials over long distances.

Statistics for 1973 and 1974 give a fairly clear picture of the present U.S. raw material situation. One can say that the total value of U.S. raw material production has gone up dramatically while production levels themselves by volume have declined slightly. Recent price increases for fuel have, of course, played a major part in this picture. Tables on the roles of materials in the U.S. economy and on U.S. foreign trade in raw materials for 1973 and 1974 indicate a general erosion of the U.S. position; this contrast is mainly a matter of prices. The U.S. deficit in foreign trade in these materials rose from $8 billion in 1973 to an estimated $23 billion for 1974, mainly as a result of a huge increase in the price of crude oil and refined petroleum imports.

In general one can say that U.S. independence in the supply of raw materials is impossible, and not necessarily desirable. The continental United States has been thoroughly explored for raw materials by conventional methods. But the adoption of new methods can certainly open new horizons. So far as processing is concerned, environmental regulations are causing very serious problems, particularly for smelting operations. Nevertheless, considerable progress in meeting this problem has been accomplished in Japan and Germany where the cost of environmental controls is considered as a normal production cost. The current energy crunch is bringing about some very significant changes in technology for raw materials processing. In reality U.S. industry is not very highly developed technologically in comparison with some foreign countries. For example, none of our blast furnaces are among the 30 largest in the world. Japan has much more advanced copper smelters than we do. One reason for the uneven development of U.S. facilities is the difficulty of writing off existing plants; this takes about 17 years. Nevertheless, the U.S. is doing very well, for example, in the development of iron into pellets, as the very rich iron ore reserves in the Midwest have become depleted. Much newer plants have been constructed in Arizona for the refining of high grade copper. In zinc we have a very serious smelter problem and many of them are shut down. The situation in lead is less unfavorable, largely through the use of scrap. So far as coal is concerned, there is the question of whether we should exploit our traditional coal mining supplies in the Western United States. Shortages of raw materials tend to go in cycles; copper is an example of this phenomenon.

So far as U.S. relations with the rest of the world in raw materials are concerned, it is obviously safer to depend upon such close neighbors as Mexico and Canada. It is very clear that we must develop superports if we are to continue to import large amounts of foreign crude oil. Massive discoveries of raw materials have occurred abroad and we should expect that further new discoveries will occur in the rest of the world. Japan, for example, is turning to South America in its search for raw materials; one reason is that there has been much less prior exploration in South America than there has been here. West Germany has been successful in making arrangements which in effect tie up supplies of certain materials for long periods of time. Although the United States in the

past has been more interested in making profits than in insuring long term rights, the U.S. is learning how to follow the German example. As world trade in raw materials has expanded, so has an international system for the transport of these materials. Many new techniques have been adopted for transport. We can anticipate that both the production and consumption of raw materials will continue to increase outside of this country. For example, Japan today is among the first three steel producers in the world. It would be erroneous to assume that we are running out of raw materials. The key need here is for good management of raw materials supply. In reality, other industrial countries are more dependent upon foreign raw materials than is the United States. At present, the less developed countries are suffering more than the United States in the raw materials market. Communist countries do not engage in raw materials trade to the extent that the rest of the world does. Their costs are more hidden, and shortages and surpluses affect these countries less than they do the rest of the world.

We can expect that the volume and value of international trade in raw materials will be very high. For example, Japan depends upon imports for two thirds of her raw materials, a total of some $35 billion annually, of which oil represents $17 billion and metals $5 billion. North China could become a very important source of raw materials for Japan. Furthermore, we are seeing major development of offshore areas for raw materials; for example, the deposits of oil which are being exploited in the North Sea. Brazil, Australia, and India have important iron ore deposits which the United States might be interested in importing. High grade copper deposits are being exploited now in Africa.

In general the importance of U.S. foreign trade in oil and iron ore is increasing. Our coal is used mainly at home but exports continue, mainly because of the quality of U.S. coal. The prices of raw materials are continuing to skyrocket. In the old days, raw materials played a rather minor role in U.S. foreign trade. Today, they are a very major factor indeed. What we need most of all is international cooperation in raw materials trade.

Institutional changes in raw materials markets are helping to aggravate price swings even beyond what would normally be expected. Raw materials constitute an important exception to the labor theory of value. Their price is determined by demand; that is, their prices can go down even though production costs rise. It was fashionable a few years ago to engage in spectrum analysis of raw materials, based upon mathematical formulae. This analysis frequently produced the conclusion that the higher the price, the greater the demand. In fact, this was tracing a supply curve, not a demand curve.

Investment in raw-materials futures by non-users and non-suppliers of raw materials has tended to destabilize markets. The prices of futures are less a function of the raw materials markets themselves than of a flow of funds throughout various money markets. (The same thing is true for the stock market.) Investments of this kind have in themselves tended to support raw material prices, by causing an inflow

of speculative funds generally. This situation is complicated by the fact that such investors are interested in a range of different materials. For example, they view gold and silver as a part of a general portfolio. The result is a highly volatile market situation in which developments in one commodity spill over into a totally different commodity market. We therefore occasionally see sudden drops or jumps in raw-materials prices, without any apparent reason. This phenomenon tends to aggravate price swings.

Theoretically, speculation in futures should dampen price swings over the long run. But in practice, projections of price trends by knowledgeable producers for raw materials have often proved to be wrong. (Copper is an outstanding example.) In general, "experts" expect current trends to continue indefinitely into the future.

The existence of national and international inventories of raw materials also can have destabilizing effects on prices. Normally, they encourage a tendency to buy when prices are low and sell when prices are high. But today, Japan is displaying an inclination to panic in both directions of the price swing: it has bought at high prices, and is now selling at low prices.

We are also seeing a change in the structure of the business cycle. Prior to about 1965, construction acted as an internal stabilizer. When interest rates fell, funds flowed into financial intermediaries and stimulated mortgage lending and new construction. Thus, as raw-materials demand fell generally, construction demand rose. Now, the entire economy tends to move into recession simultaneously. Demand for raw materials by both industry and housing rises and falls together. For example, Western Electric buys certain plastics for use in telephones. Their purchases have been cut by about 60 percent because fewer dwelling units are being built. The same phenomenon applies to copper, which is used for wiring and such appliances as air conditioners.

Furthermore, swings in the business cycle are now being aggravated by international developments. Previously, we had been accustomed to seeing a sort of see-saw movement between the United States and other developed countries. For 150 years boom conditions in the U.S. tended to increase costs and push Europe into a recession, and vice versa. Under present conditions, very close connections exist between the financial markets of the United States, Europe, and Japan, causing a parallelism in economic activity. Commodities such as copper and aluminum are tending to decrease in price under conditions of universal recession. We can expect that they will go up quite sharply if and when international business conditions improve (again in phase with one another).

Quite apart from financial considerations, institutional factors are influencing raw materials markets. In this country, there is a tendency for mineral reserves and lands to be taken over by oil companies. This results from the fact that oil companies acquire rights to the minerals in broad areas when they are primarily interested in petroleum.

New techniques are being used. For example, a mercury tracer system permits companies to explore for various minerals merely by repeated flights over the territory in question with highly sophisticated instruments. In general, since the 60s, oil companies have been characterized by high cash flows and high profitability. As energy prices have gone up, other raw materials prices are tending to decline. We are seeing something of a recession in exploration and development expenditures as demand declines.

Long term shifts are occurring in the production costs for raw materials, which serve as a floor under long-term prices for these materials. Labor costs have gone up sharply in the last seven or eight years, following increases in raw materials prices. This tends to have a sort of a ratchet effect. When prices for raw materials decline, however, labor costs do not go down accordingly. Capital costs for raw materials, mining, and processing are also going up. This can be compensated by increasing the efficiency of the use of capital in mining operations. Nevertheless, we are seeing a long term rise in the cost of such capital per pound of output, particularly as interest rates have increased. The most important single factor in current operating production costs is the sharp increase in energy prices. This is particularly true for such electrometals such as copper and aluminum, which require enormous amounts of electric power for their operation.

Less developed countries have a strong incentive to try to emulate OPEC in forming producer-cartels to improve their terms of trade. For example, while Chile has seen the price of her raw material exports go up, her food imports have risen even more. This provides an impetus for long term barter agreements. Nevertheless, cartels are not likely to be very effective in the raw materials area, because demand is a much more important factor than supply. If we look at the long term, we see no evidence that the world is actually running out of raw materials. On the contrary, new technology tends to outstrip the depletion of resources. The normal pattern is that the cost of exploiting raw materials becomes lower as the quality of the ore decreases. High-grade ore tends to be mined under conditions where labor is used intensively. In more recent years, we have seen new technology developed so that low-grade ore in the Western United States is now produced less expensively than high-grade ore in Africa. The reason is that much less labor is needed in the American operation.

We can look forward to technological breakthroughs in raw material exploitation similar to the development of pelletized steel when the Mesabi range became depleted. Right now, efforts are being made to develop non-electric modes of reducing aluminum in which a chemical process is used instead. At present, the price of aluminum is to a large extent a function of the price of electricity. We may see the development of copper shifting from copper oxide and sulfide to sulphates. There is considerable room for economies of scale in the transport of raw materials. Something like supertankers may be developed which would bring refineries closer to energy centers.

It is quite probable that we will see more bilateral arrangements between countries producing raw materials and those producing energy products. For example, Iran might make long term deals exchanging fertilizer for copper from Zaire. In any case, instability in commodity markets tends to encourage barter arrangements.

There has not been a great deal of opposition by industrial nations to higher prices of raw materials. We should not expect a sharp upswing in international trade. The time lag for developing facilities to exploit raw materials is roughly five years. Thus, we have a rather strong limit on raw materials supplies over the short run. Demand for raw materials is not merely a function of rising GNP. We also have volatile money affecting these markets very significantly.

Appendix III

DISCRETIONARY PERSONAL, TRANSPORTATION, AND AIR TRANSPORTATION INCOME TO THE YEAR 2000

The following tables indicate some of the steps required to project the amount of money that may be available for personal discretionary air transportation (i.e., non-business) travel. The projection is complex, and much depends on factors such as the possibility of public subsidy of high-speed rail connections between relatively closely-spaced city-pairs, such as those in large megalopolitan complexes, like the coastal and Great Lakes "corridors." However, enough has been done here to show that, on a range of reasonable extrapolations, the U.S. market may grow, between now and the Year 2000, by a factor of between two and five, in constant dollars. A "best estimate" would be a factor of three for the U.S., while the world market for both business and discretionary air travel may grow by a factor of ten, as discussed above, from 1975 to 2000. It is also reasonable to expect air travel prices per seat-mile simultaneously to fall, in constant (not current) dollars, as they have in the past, because of improved technology and economies of scale. This scenario could be falsified by a surprisingly cost-distorting rise in energy prices, which we consider unlikely but not impossible, for reasons discussed above.

DISCRETIONARY PURCHASING POWER AND SPENDING

Year	Aggregate Purchasing Power	Discretionary Purchasing Power	Discretionary Spending	% of DPP Spent
1946	$166.5	$ 69.6	$ 54.9	78.9
1950	222.9	91.5	82.3	90.0
1955	297.9	124.9	107.6	86.2
1960	371.6	143.6	126.6	88.2
1965	508.6	210.4	172.3	81.9
1970	723.9	288.3	240.8	83.5
1971	799.7	328.9	264.0	80.3
1972	884.3	373.7	289.3	77.4
1973 (est.)	985.4	421.2	322.1	76.5

Current U.S. dollars - billions

Aggregate Purchasing Power = national income plus increase in credit available to individuals:

e.g., individual's yearly income	$10,000
individual BankAmericard credit level is increased from $500 to $1,000	+ 500
Individual's Total Purchasing Power	$10,500

Discretionary Purchasing Power = Aggregate purchasing power less:

Essential purchases (food, clothing and "essential" transportation), fixed commitments (life insurance premia, tenant rent, interest component of mortgage payment, homeowner's taxes), imputed income (employee lodging and food, lodging and clothing for the military) and contracted savings (pension plans, Christmas clubs, etc.)

Discretionary Spending = Discretionary purchasing power less savings

Source: Conference Board's time series of "discretionary spending" Technical Paper #17.

DISCRETIONARY PURCHASING POWER AND SPENDING - PROJECTIONS
1975 - 2000

Year	Case	Disposable Personal Income	Aggregate Purchasing Power[a]	Discretionary Purchasing Power[b]	Discretionary Spending
1975	I	845	930	280 - 370	225 - 335
	II	870	955	285 - 380	230 - 340
	III	895	985	295 - 395	235 - 355
1980	I	930	1,025	310 - 410	250 - 370
	II	1,010	1,110	335 - 445	270 - 400
	III	1,120	1,230	370 - 490	295 - 440
1985	I	1,030	1,135	340 - 455	270 - 410
	II	1,170	1,285	385 - 515	310 - 465
	III	1,390	1,530	460 - 610	370 - 550
1990	I	1,150	1,265	380 - 505	305 - 455
	II	1,350	1,485	445 - 595	355 - 535
	III	1,775	1,950	585 - 780	470 - 705
2000	I	1,375	1,510	455 - 605	365 - 545
	II	1,825	2,010	605 - 805	485 - 725
	III	2,900	3,190	960 -1275	770 -1150

Constant 1973 U.S. dollars - billions

Assumptions

[a]Aggregate purchasing power = 110% of disposable personal income due to credit availability to individuals

[b]Discretionary purchasing power = 30-40% of aggregate purchasing power

[c]Discretionary spending = 80-90% of discretionary purchasing power

Source: Conference Board

PERSONAL CONSUMPTION EXPENDITURES
Total and Transportation 1950-1972

Year	Total Consumption	Transportation Expenditures:	User Operated	Purchased Local	Purchased Intercity	Airlines
1950	$191.0	$ 24.7	$ 21.9	$ 2.8		
1955	254.4	35.6	32.6	3.0		
1960	325.2	43.1	39.8	3.3		
1965	432.8	58.2	54.4	3.8		
1970	617.6	77.8	72.3	2.5	3.0	2.4
1971	667.2	90.4	84.6	2.6	3.3	2.7
1972	726.5	100.2	93.9	2.6	3.6	3.0
1973	805.2	109.2	102.6	2.6	4.0	3.4

Sources: Statistical Abstract of the United States, 1974
U. S. Department of Commerce, Washington, D. C.

Survey of Current Business, July 1974
U. S. Department of Commerce, Washington, D. C.

DISCRETIONARY TRANSPORTATION EXPENDITURES 1970-1973

Year	Total Transportation Expenditures	User Operated X 0.55[1]	Taxicabs[2]	Purchased Intercity	Total Discretionary Transportation Expenditures
1970	77.8	40.0	.8	3.0	43.8
1971	90.4	47.0	.8	3.3	51.1
1972	100.2	52.0	.8	3.6	56.4
1973	109.2	56.4	.8	4.0	61.2

Assumptions: [1]45% of user operated transportation expenditures estimated to be work related

[2]Only taxicab portion of total purchased local transportation assumed to be discretionary

[3]Current U.S. dollars - billions

Source: Conference Board

DISCRETIONARY TRANSPORTATION EXPENDITURES
Projections 1975-2000

Year	Case	Disposable Personal Income	Total Discretionary Spending	Total Discretionary Transportation Expenditure
1970		$ 691.7	$240.8	$43.8
1971		746.0	264.0	51.1
1972		802.5	289.3	56.4
1973		903.7	322.1	61.2
1975	I	845	225-335	45- 70
	II	870	230-340	46- 71
	III	895	235-355	47- 75
1980	I	930	350-370	50- 81
	II	1010	270-400	54- 88
	III	1120	295-440	59- 97
1985	I	1030	270-410	54- 94
	II	1170	310-465	62-107
	III	1390	370-550	74-127
1990	I	1150	305-455	61-109
	II	1350	355-535	71-128
	III	1775	470-705	94-169
2000	I	1375	365-545	73-136
	II	1825	485-725	97-181
	III	2900	770-1150	154-288

1970-1973: Current U.S. dollars, billions
1975-2000: Constant 1973 U.S. dollars, billions

Assumptions: Total Discretionary Transportation Expenditures:
(a) remains at 20% of Total Discretionary Spending
(b) increases to 25% of Total Discretionary Spending by 2000