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ABSTRACT

Modern society should consider the social consequences of science and technology. Examples of problems which have recently arisen from the increased interdependence of technology and society include depletion of the ozone layer of the atmosphere by aerosol sprays, prolongation of life by artificial means, and rapidly increasing population due partially to improved medical care. A growing sense of discomfort with technology is exemplified by many social indicators, including: (1) lack of interest, despite widespread public demand, in recycling or reprocessing waste material unless it can be profitably done; (2) corrosion of folk knowledge regarding social values in response to scientific and social scientific pronouncements; and (3) a general feeling of individual helplessness in the face of phenomena such as overpopulation, hunger, resource depletion, nuclear warfare, and human cloning. The conclusion is that social policies should be developed which reflect a proper government role in areas such as economic centralization and resource allocation. These policies should aid individuals in making reasonable choices regarding housing, energy consumption, and family planning. (Author/DB)

"EXPLORING THE RELATIONSHIP BETWEEN TECHNOLOGY AND SOCIAL VALUES"

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Paper Presented to the NSF Workshops
on New Developments in Science and Social Science
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CONTEXT SETTING

Our present best guess is that we humans are the result of millions of years of accidental experimenting by nature. Most of us are familiar with the opening sequences of the film "2001: A Space Odyssey" where the scene literally jumps from an ape discovering a "tool" to a space station orbiting the earth. Dramatic as that abrupt change is, viewed from the perspective of history it is also fairly representative. Whereas early humans seemed to plod through time we now seem to be rushing into the 21st Century. In fact, the 21st Century is already underway. Children now in the first grade will be 30 years old in the year 2000 and today's high school students will be at the height of their power and responsibility. If that surprises you remember that the year 2000 is no further ahead than the year 1956 is behind.

Fed by a continual stream of inventions from scientists and engineers changes are coming so rapidly that only the reckless among us predict very far beyond the turn of the century. Whereas only a few generations ago being old meant one was wise in the ways of the world, it now means that one is out-dated, often unable to understand the contemporary world which the younger generation takes for granted. Change has become both a blessing and a curse. Our ability to invent new things seems to have outrun our ability to adjust to them and it is this social lag that I want you to think with me about today. But before we jump to, rather than into, the gap, think with me if you will about why the gap came into being in the first place.

As a people, we Americans are very technologically oriented. Foreign visitors express surprise at how our tour guides so often stress how many tones of concrete, panes of glass, and miles of wire a structure contains rather than its history or religious significance. Where other cultures adapt to the demands of nature, we Americans often fight and usually overcome it. If its too hot, we air condition it; too dark, we light it; too dry, we irrigate it; too moist, we dehumidify it; too cold, we heat it. In part, the very situation which we are discussing today results from our past successes in inventing technological solutions to many of our problems. A result is one of the most comfortable and efficient life styles on the planet.

There are reasonable explanations for our technological superiority. The very fact that our culture, excluding native Americans, got off to a late start was itself an advantage. Cheap, abundant energy, plenty of room for expansion, and a work ethic supported by religious beliefs provided us with the raw materials for a technological take-off. Our relatively open class system and a competitive economic system also helped make us a nation that until very recently was the envy of much of the world.

But during the last few years it sometime seems that technology, and the science upon which it is based, has tricked us. While technology produces the expected results, for example, a dye that makes meat look nice and fresh, it also produces unexpected side effects. Aerosol sprays provide another example of these side, or "surprise", effects. It was so handy to spray deoderant under our arms, fat into fry pans, control onto hair, cheese onto crackers, and oil onto bolts that it seemed we were well on our way to putting almost everything into spray form. Then someone discovered that the propellant used in aerosol sprays just might be depleating the ozone layer which surrounds and protects us. Surprise, how about those for interesting side effects! For at least some people it seemed that our technology was on the verge of getting out of control. What, they asked, had gone wrong?

WHAT HAS GONE WRONG?

Perhaps it is not that technology has changed as much as the setting in which we employ it. As our society has become increasingly interdependent, the tendency for changes to ramify has also increased. For example, if one charts new drugs and life saving and sustaining machines like pacemakers and artifical kidneys one finds that results form the ever present "J-Curve", the graphic representation of exponental growth.[1] These drugs and machines have lowered death rates and prolonged life, both intended results. But their use has rippled into unexpected areas of our lives. For example, through the use of these marvelous

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[1]Footnote numbers refer to the graphs and tables which are appended.

machines, we can keep people alive when perhaps they ought to be allowed the right to die. We certainly haven't heard the last of the "pull the plug" cases in the courts. In the developing world the new drugs have made possible dramatic declines in the death rates.[2] But when death rates decline and birth rates remain high, population growth rates soar. In Latin American the population is doubling every 25 years, in Africa every 28 years.[3] The drama of such growth is apparent when one considers that our own population takes 87 years to double at present rates, but even we are not spared the side effects of this technology. The population profile of our country shows that we are becoming a population with a growing proportion of older persons.[4] Political scientists are predicting some fundamental changes in our political climate as a result. Policy makers have just recently abolished mandatory retirement at age 65, and the economists warn us that our retirement programs will be under increasing pressure as fewer and fewer young workers must support a growing number of retired workers.

The social impact of this technology has just begun to be felt.

A second factor, in addition to our growing interdependence, is that our social values have not kept up with technological change. Technology has provided us with disposable everything, from Dixie cups to razors and even paper clothing. If one follows the trail of the pull-tab opener it leads to a pile of discarded aluminum cans. When we can produce an aluminum can from raw ore, fill it with Coke, and sell it for 25¢ and still make a profit; now that is technology! But it is also very energy wasteful, so we have invented a technology to recycle aluminum cans using only about 5% as much energy as it took to make the original can. We can recycle many other items with similar savings. The technology is here.

The disjuncture between technology and our social values is also illustrated by the way we deal with radioactive waste from our nuclear power plants. After one abortive effort in New York State to deal with nuclear waste we currently are allowing such waste to accumulate at nuclear power plants all over this country. We have the technology to reprocess spent nuclear fuel but it cannot be done profitably, a basic value in our society.

The values which support a recycling life style lag far behind our capacity to do it. Americans still tend to judge the quality of life by material standards, by how much one has or uses. I think some of us will live to see the day when the "good" and "important" people are those who can get along with less, but in the meantime, the gap between our technology and values will lend support to the notion that science and technology have gotten out of control.

A third factor contributing to our growing discomfort with technology has to do with the corrosive effects of science and social science on our long held folk knowledge. All cultures try to make the world an understandable place. Why are some people criminals? Because of "bad blood", of course! Why can't we see beyond the horizon? Because the earth is flat!

In many respects individuals in primitive cultures are very secure. They have absolute answers to life's questions. Obviously, that is not the case for us. It seems the more we learn the more we realize we don't know. The experts disagree and ethical issues bombard us with increasing frequency. From Darwin to Hiroshima was nearly a century, from Hiroshima to the Pill was two decades, and from the Pill to recombinant DNA was only one. The "good old days" when life was simple and answers were absolute are gone forever, banished by the very science in which we have put so much trust..

Finally, the feeling that technology has gotten out of hand may simply be part of the broader realization that certain forces that will basically effect us are already loose in the world and there isn't much we can do to avert their consequences, at least in the short run. Let me illustrate what I mean.

In March of 1976 the estimated population of the earth reached four billion. We currently add the equivalent of a city the size of

Detroit to the planet's population each week. Barring a major catastrophy, there is practically no way to avoid a world population of $6\frac{1}{2}$ billion by the year 2000, with world population doubling every 34 years at present rates. Both Chinda and India will pass the one billion mark and Mexico will go from her present population of 55 million to 103 million.[5]

Shortages of basic raw materials will become a frequent occurrence. World demand for petroleum will exceed world supply sometime before the year 2000, most probably in the late 1980's, despite our late and meager attempts at conservation. Most of us in this room will live to see the sunset of the age of oil and natural gas. By the year 2000 the United States may have only one of the 13 key industrial commodities in plentiful domestic supply, namely phosphate. Contrast that to 1960 when we imported only four of these commodities, i.e., aluminum, manganese, nickle and tin.

Finally, the membership of the nuclear club will grow from its present 21 to an estimated 50 by the year 2000. This proliferation of nuclear capabilities will result from two factors: the need to find replacements for fossil fuels, and intense pressures from the manufacturers of nuclear power plants to make enough sales to recoupe their R&D investment. As the number of nations with nuclear capability increases, so will the possibility for accidental or planned nuclear confrontations.

In short, the technology that we led along like a puppy on a leash has now grown to full size and is chasing us around nipping at our heels, or at least that is how it seems. So I return to one of my major points, that is that the fit between science and technology and our other social values has deteriorated to a point where it is causing us increasing discomfort.

THE ENERGY SITUATION: A CASE IN POINT

In order to illustrate the relationship between science, technology, and social issues let me develop an example more fully. Since energy is both so much in the news and so important to the primary industry of this state I think it will serve my purposes well.

A brief look at the energy history of this country is a case study of the rapidity with which situations change in the modern world. As a nation we have about 5% of the planet's population but we consume 30% of its energy. In 1940 we derived 50% of our energy from coal. It is estimated that by 1980 70% will come from oil and natural ga[illegible] recently as 1960 we were an oil exporting nation, today about 50% of our oil is imported.[7] In 1973, when OPEC shut off the oil it affected less than 10% of our total consumption. Today OPEC oil accounts for nearly 30% of all we use. Until last year our energy consumption was increasing about 4% each year, or looked at another way, our appetite for energy doubles every 18 years. Thus at present rates by 1996, we will need twice the amount of oil that we need today. It seems obvious that we simply can't continue with "business as usual" in the energy area, but the questions then becomes, "what are our options?". I hope it is obvious by now that the question involves social as well as technological choices.

One choice that confronts us is that between centralization or decentralization in our energy systems. It is often said, for example, that we are near [illegible] hydro-electric capacity in this country because there are few major rivers left to dam up so that additional electricity can be generated, and that is certainly true if one thinks about facilities like those at Hoover Dam. But here is a perfect example of how our cultural orientation toward bigness makes us blind to some other possibilities. The Chinese have designed small electric generators that are practical when installed in very small dams, like those found all over this country. According to a recent U. S. Army Corps of Engineers survey there are 49,000 existing dams of one sort or another that could be -- but aren't -- used to generate electricity. That is just one step we could take toward decentralizing our energy system; passive solar systems on individual dwellings would be another. The idea is to decentralize the system so that changes in one area do not ripple into other areas.

Whichever direction we choose we must decide on the role of government in helping us get there, another social rather than scientific problem. Through its tax incentives and the allocation of research and development money the government can do much to help or hinder diversification. Because of previous investment patterns we have almost no choice but to use nuclear power to bridge the gap between the fossil fuel era and whatever is to follow. Had the research dollars been spread more evenly between solar, wind, nuclear, coal gasification, and geothermal we might not now be as locked in as we are on what I still consider a very dangerous power option.

Let's look at another really sticky social choice we face. How do we go about allocating a resource which is becoming increasingly scarce? Certainly one way is to let the price float and to let the market decide, i.e., those who can afford oil and natural gas can buy all they want as long as it lasts. But through a long period of regulating prices, the second of our options, we have kept energy at artifically low levels and thus have developed dependencies upon these fuels to a point where we can at best gradually deregulate prices. A third option is a combination of the first two; gradual deregulation of prices along with tax incentives and rebates for those who conserve and additional taxes on those who do not. Apparently we are about to choose this third option.

I realize that many of you may be getting tired of the many energy related examples, so I'll use only a couple of more before moving to a quite different area for a second illustration of how science and society are hooked into increasingly complex combinations. But let me finish my energy related examples. Do we conserve or produce? The utility companies project current usage patterns and conclude that we must move full speed ahead with new generating plants and pipelines if we are to meet anticipated demand at some future point in time. Now if demand does continue to increase at present rates, they are absolutely right, but there is another way to view this situation. We could set a per capita energy consumption goal for the year 2000 and then adjust life styles to meet those goals, which of course would be below those of simply projecting current trends into the future.[8] Any of you who are as old or older than I know that it is possible to live without air conditioning in our homes, offices and cars and yet in the air conditioning area alone it is estimated that last year we used more energy for that than was used in <u>total</u> in mainland China. The need for gasoline presents us with a similar choice. We could set out to reduce both the number of cars and the miles driven so as to need less gasoline. The flip side of that is to do what one of the senators from Indiana recently proposed which was to convert corn into a form of gasoline. I can't help but ask if that is a morally defensable use of some of the worlds richest farmland given the fact that world food reserves have fallen from over 100 days in 1960 to about 30 presently?[9]

Finally, let me ask you some personal questions as we leave the topic of energy. With major shortages an almost certainty over the next ten to fifteen years, what plans do you and your family have for coping with them? For example, have you thought about moving back closer to town, buying a solar heated home or at least having some back-up heating equipment for those times when gas, oil or electricity are not available? How about the notion of gradually replacing power operated this and thats with hand operated models? Paul Ehrlich, writing in a recent issue of SKEPTIC magazine suggests that as the energy problem becomes really severe and prolonged where we live may be an important consideration. Ehrlich predicts that one of the outcomes of frequent shortages will be social strains and that an increasing amount of pleasure in everyone's life is going to have to come from interpersonal relationships, and he says, "if the going gets rough you won't want to be among strangers" (p. 58). But enough, I promised to get off the energy examples, and I will.

THE AMERICAN FAMILY AND TECHNOLOGY

Up to this point I have been using energy to illustrate some of the social implications of science and technology. Let me now turn to the American family as a second example of how technology and social issues and concerns are inextricably linked.

Technology has made American family life among the most comfortable in the world. Our homes are marvels of labor saving devices. They are heated and cooled automatically, no more staying home to tend the furnace or carry ashes. Clothes and dishwashers are "automatic" and we are less than a generation away from using solar power to dry clothes, like my mother did. Freezers and refrigerators preserve food, stoves and micro-wave ovens cook it, garbage disposals grind it, and compactors mash it. When it is time to go to the store we jump into our cars with automatic starters, automatic chokes, and climate controlled eight speaker environments. In short, homemaking need no longer be a full time job, though it may still be some of the most trying work around. My point is that it is now possible for both adults in an American family to work outside the home and still rear a family and keep up a house. In fact, it is the desire to have more of these material goods that partly explains why the husband is the sole wage earner in only 13 out of 47 million American households.

But at the same time that technology was "freeing" the American family from the drudgery of earlier years it was also taking many of the traditional decisions away from it. Our food and water are full of chemicals we don't even understand and sometimes we don't even want. The media beams programs into our homes that we sometimes wish our children wouldn't watch. The devices that fill our homes have become so complicated that children see their parents having to resort to the service specialists when this or that breaks down. For example, during last winter's fuel shortage it was discovered that a surprising number of family's had no idea of how to re-light the pilot light on their gas furnaces. Schools use tests parents do not understand, summer camps are run by recreation specialists, and on and on. Many of the services once provided by the family are now provided by specialists outside the family who employ a complicated technology in their work.

With the things I have just described going on, what has been happening to the American family? As I have already indicated, in two-thirds of the two parent families, both work outside the home. Four out of ten children born in 1970 will spend part of their childhood in a one parent family, and this in a social context that still has rather traditional views regarding what families ought to look like. With the aid of technology parents are waiting longer to begin their families, and when they do have children they are having fewer of them. The price of rearing the children who are born is increasing dramatically, partly because our standards of what is necessary for children continually rises. Today's child wears braces, has regular medical checkups, takes vitamins, takes lessons for almost everything, has his own T.V.'s and stereos, often his own cars, and see college almost as a social "right".

Whether these developments have made the American family of the 1970's better or worse than those of earlier years is a matter of serious debate and many Sunday morning sermons. But in the context of this seminar, technology's impact on the American family has put that family into conflict with many traditional values. Let me illustrate what I mean by using a series of questions:

1. Who should decide what children learn, the parents or society? If it is the parents, how can they begin to exercise that control given the present technology of the mass media and the freedom of movement enjoyed by their children?

2. Is it the parent's responsibility to provide the traditional things for their children or has the parent's role become one of selecting the right specialists to provide those services?

3. Should parents have the right to terminate unwanted pregnancies or is the "right to life" more important?

4. Should the government continue through tax incentives to encourage families to have children, remain neutral, or actually institute a series of economic penalties?

Finally, let me leave the family by just alluding to a scientific development that may make everything I have just mentioned look like child's play. On March 31, 1978, IN HIS IMAGE -- THE CLONING OF A MAN by David Rorvik, was released. Rorvik's book, which has since been hotly disputed, claimed that an anonymous millionaire had a clone made of himself. Most scientists at my university, a leader in cloning research, believe that the cloning of humans is not yet possible, but that it may some day be. But even now frogs are being successfully cloned. I have a hunch that most of us will live to see the day when human clones are a scientific possibility. Can you imagine the social implications of such a breakthrough? Who will have the right to have a clone of him or herself made? How will the female's role change when there is no longer a need for her to bear children? What legal rights will clones have? How will traditional religious beliefs accommodate to such a development? Should the government promote the development of super humans through the cloning device? Well, I think you see what

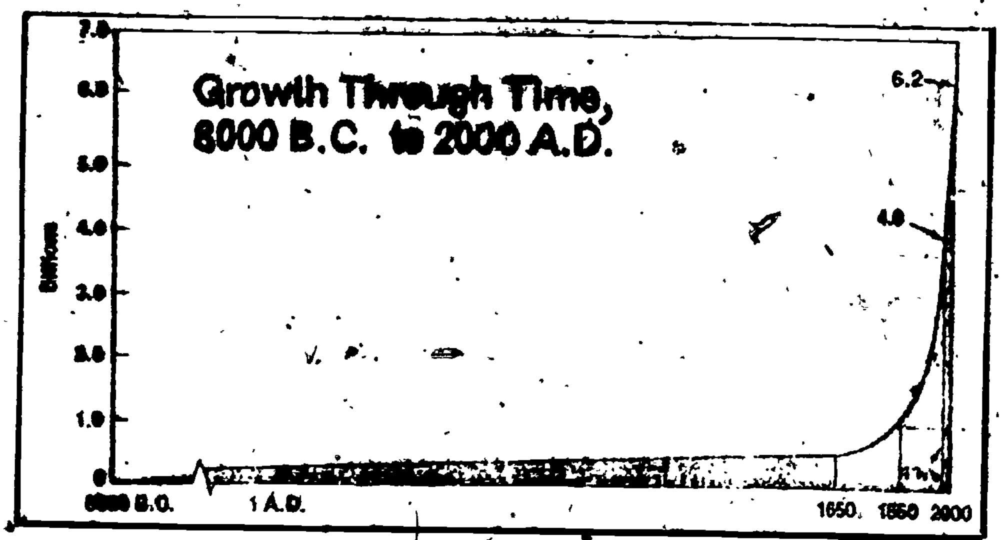
I mean about the social implications of such a scientific development.

In summary, let me say that if I could only have you remember one thing from all that I have said, it would be that things increasingly are never as simple as they seem. Science and technology have done marvelous things for us but we must always be looking for what Bob Hanvey has termed, the "hidden wiring." In the long run the social implications of scientific and technological changes may be the most difficult of all for us to cope with.

SUMMARY

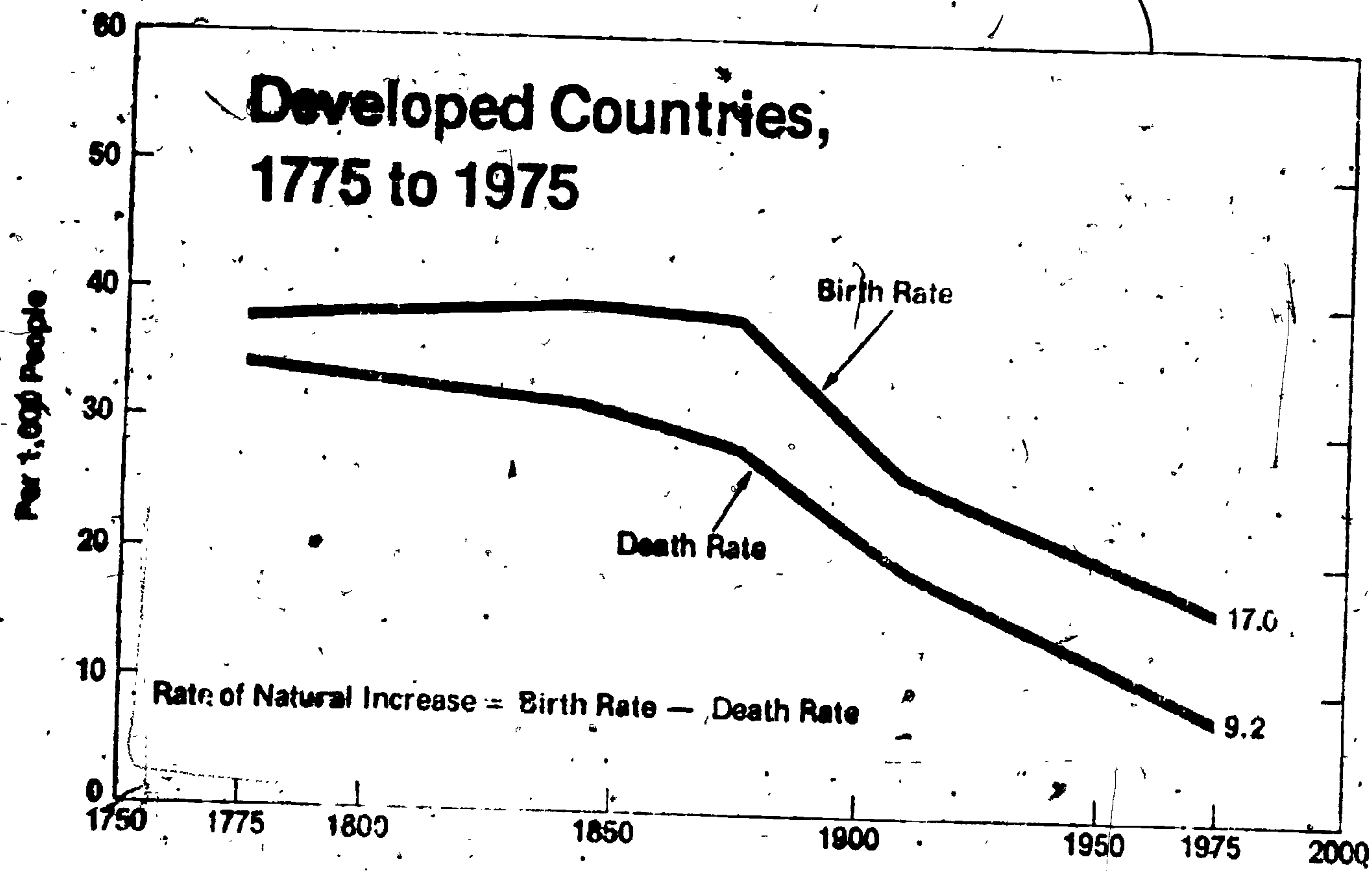
Science and technology are neither bad nor good, they just are! If at times technology seems to have gotten out of control, perhaps it is because the social setting in which we employ it has changed. Certainly one of the most basic changes is our ever growing interdependence. Almost by definition this means that a change in one part of the society causes changes in other parts of the society, often in unexpected ways. As the pace of change seems to continually accelerate the gap between what is possible with our technology and what our social values will support seems to widen. We must not become so preoccupied with science and technology that we ignore their social consequences for in the long-run those may be the most difficult problems of all to solve.

#1



World Birth and Death Rates
(Estimated)

#2



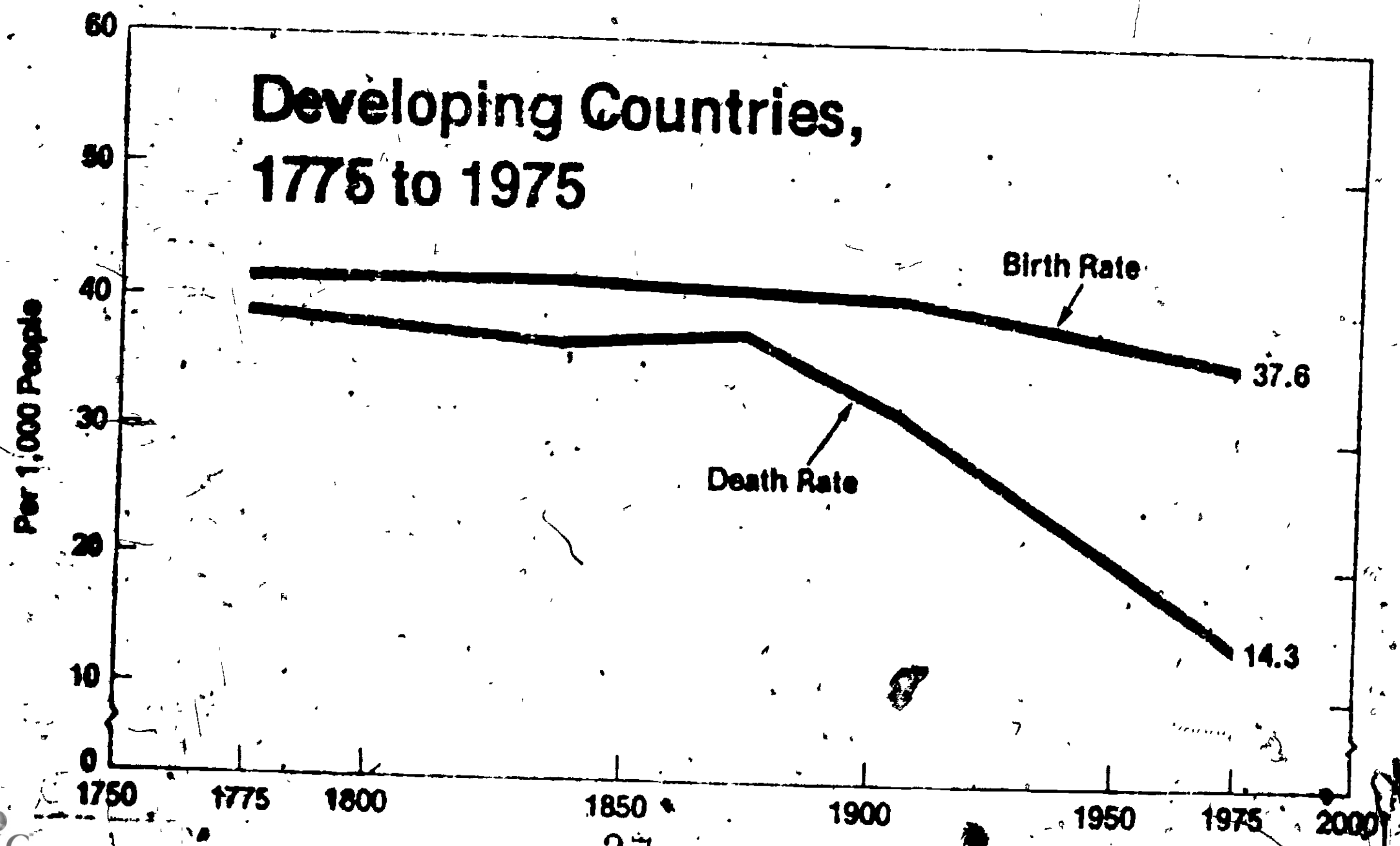
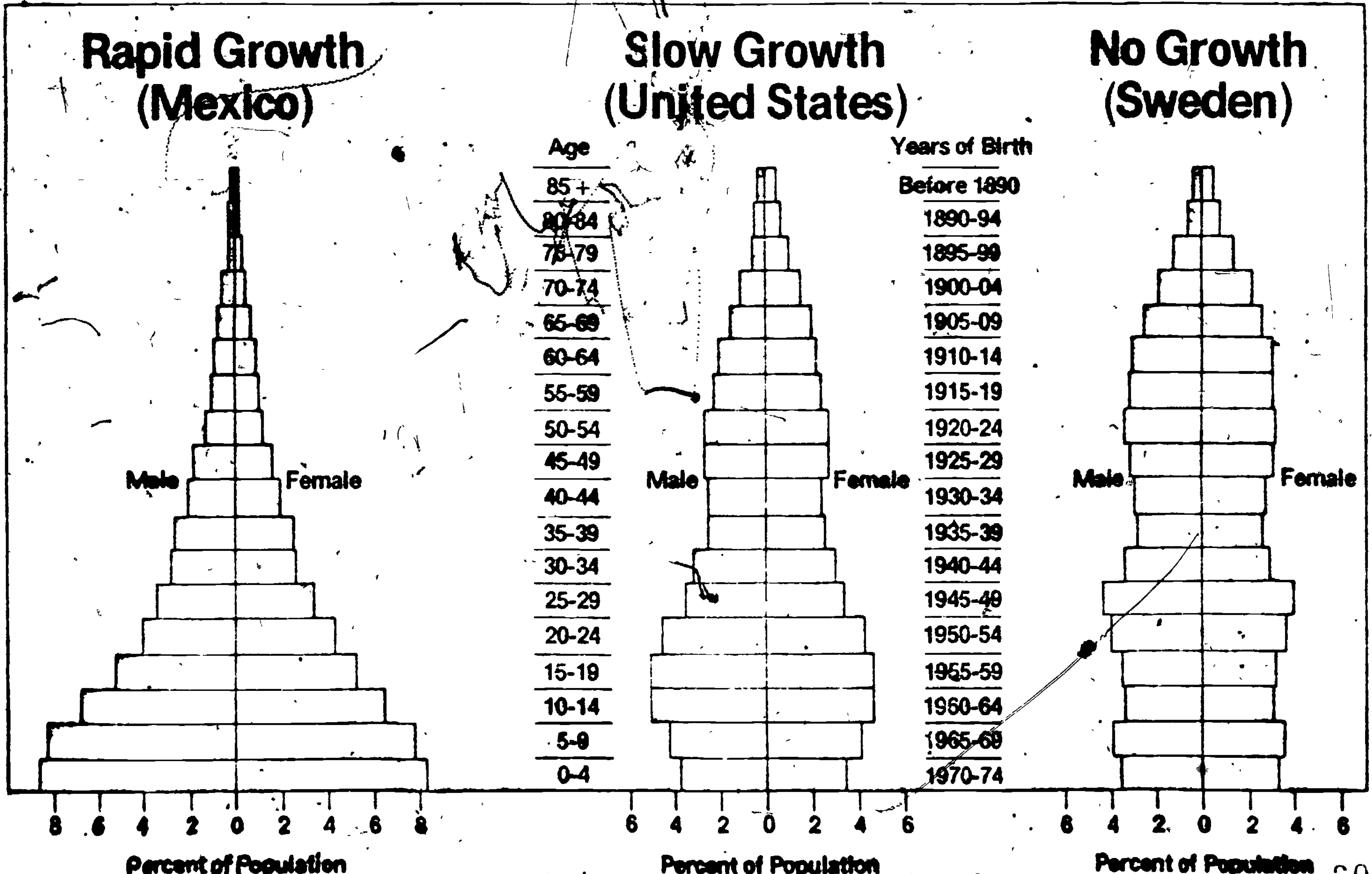


Table #1 The Amount of Time Required to Double the Population in Selected Areas[8]

Area	Growth Rate	Time Required to Double Population
Europe	.7%	99 years
North America	.8%	87 years
USSR	1.0%	69 years
Asia	2.3%	30 years
Africa	2.5%	28 years
Latin America	2.8%	25 years
World	2.0%	34 years

Age-Sex Population Pyramids: Rapid, Slow, and No Growth Models



#5

SAMPLE RESULTS IF 25 PER 1,000 BIRTH RATE RECOMMENDATIONS ARE FOLLOWED

	PRESENT POP.	BY 2015
INDIA	600 MILL.	1 BILLION
MEXICO	55 MILL.	103 MILL.
BANGLADESH	77 MILL.	127 MILL.

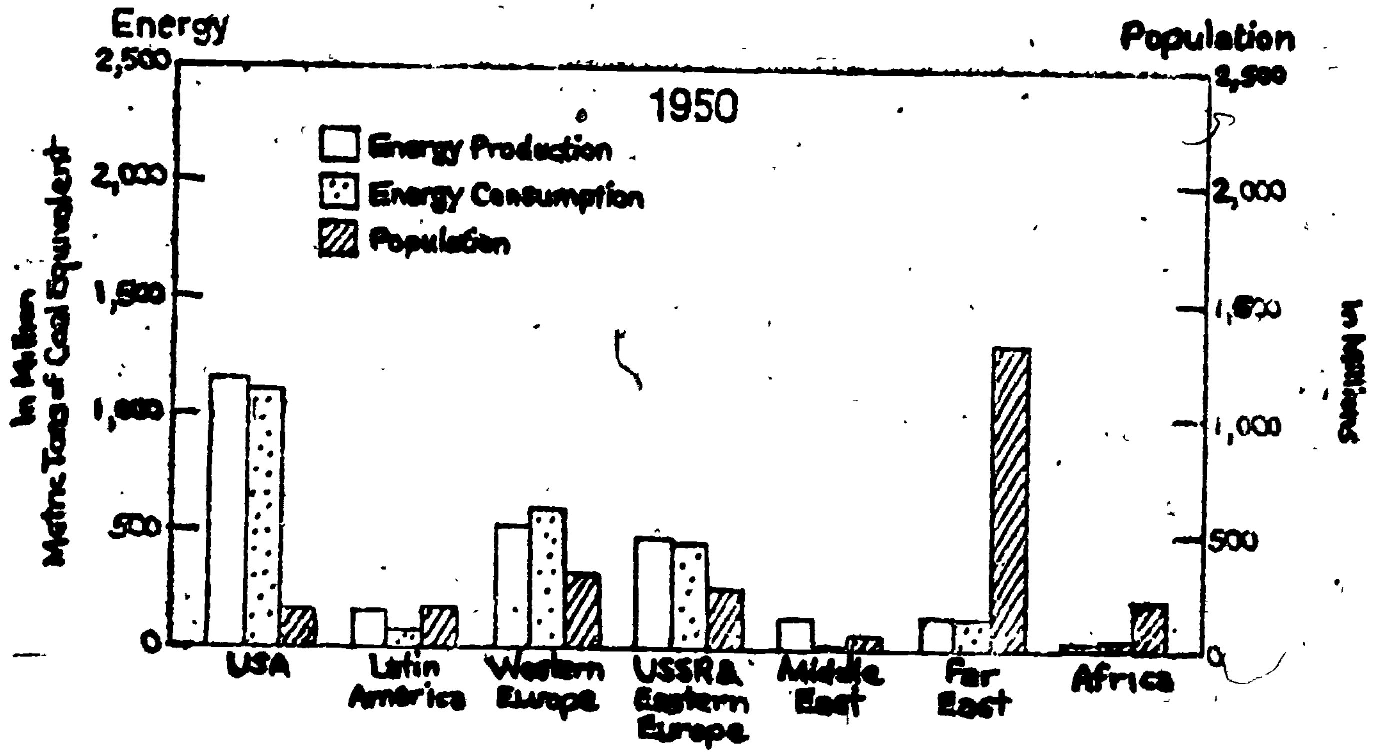
B-15. World Energy Consumption, by Types of Energy, 1960, 1970, 1980, and 1990 (quadrillion Btus[a] and percentages)

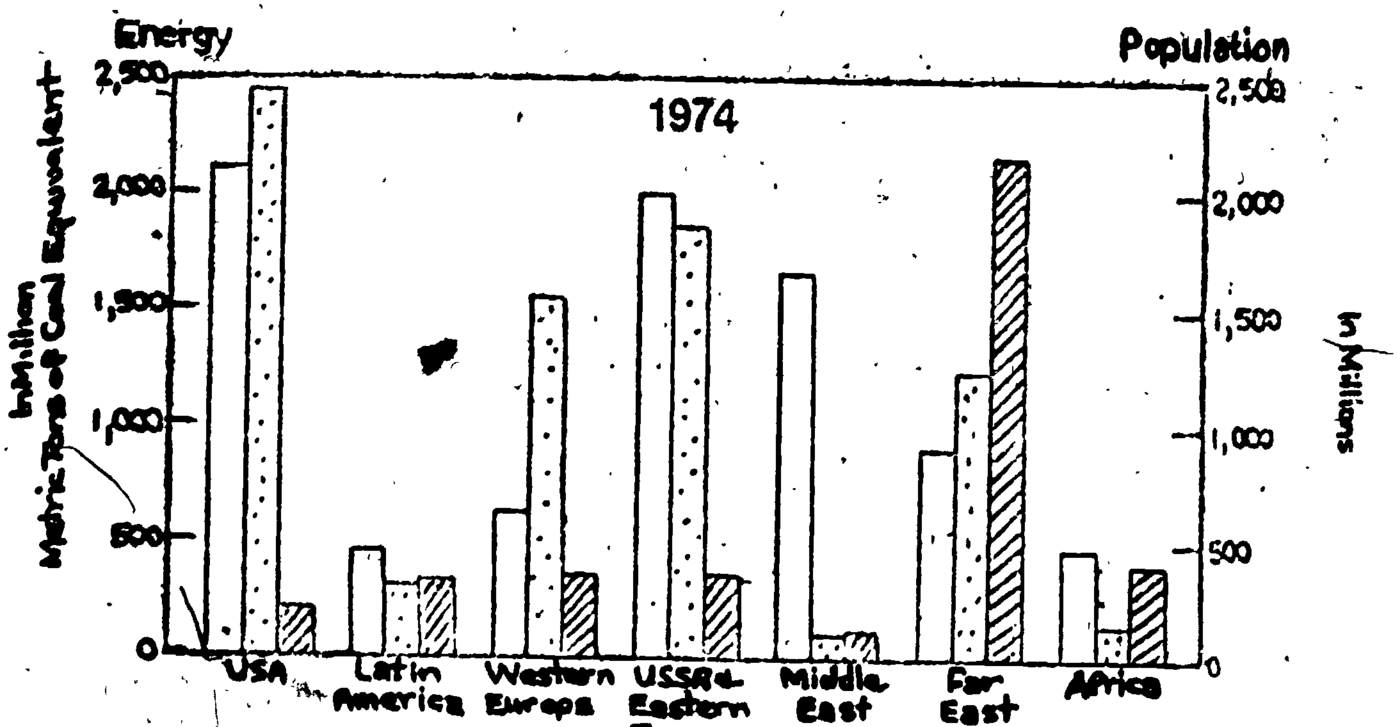
	1960		1970		1980		1990	
	quad. Btus	percentages	quad. Btus	percentages	quad. Btus	percentages	quad. Btus	percentages
Coal	61.5	46.7	66.8	30.8	79.2	26.7	92.0	22.1
Petroleum	45.3	34.4	96.9	44.7	132.3	44.7	165.0	39.6
Natural Gas	18.0	13.7	40.6	18.7	56.8	19.2	77.1	18.5
Hydropower and Geothermal	6.9	5.2	11.8	5.4	15.4	5.2	18.8	4.5
Nuclear	-	-	0.8	0.4	12.6	4.3	63.6	15.3
Total	131.7	100.0	216.9	100.0	296.3	100.0	416.5	100.0

[a]British thermal unit. One quadrillion Btus is equivalent to 500,000 barrels of petroleum per day for a year; 40 million tons of bituminous coal; 1 trillion cubic feet of natural gas; or 100 billion kilowatt hours.

SOURCE: Based on U.S. Department of the Interior, Energy Perspectives: A Presentation of Major Energy and Energy Related Data (Washington, D.C.: U.S. Government Printing Office, February 1976), p.8.

World Energy Production Consumption, and Population, 1950 and 1974





#8

PER CAPITA ENERY USE

U. S.	11,897 UNITS	US : "X"
INDIA	192 UNITS	62 TIMES
BRAZIL	625 UNITS	19 TIMES
MEXICO	1,173 UNITS	10 TIMES
NIGERIA	63 UNITS	188 TIMES

Table #3 Indicators of World Food Security 1961-1976 (million metric tons and days)[10]

	Reserve Stocks of Grain[a]	Grain Equivalent of Idled U.S. Cropland (million metric tons)	Total Reserves	Reserves as Days of Annual Grain Consumption
1961	163	68	231	105
1962	176	81	257	105
1963	149	70	219	95
1964	153	70	223	87
1965	147	71	218	91
1966	151	78	229	84
1967	115	51	166	59
1968	144	61	205	71
1969	159	73	232	85
1970	188	71	259	89
1971	168	41	209	71
1972	130	78	208	69
1973	148	24	172	55
1974	108	0	108	33
1975[b]	111	0	111	35
1976[b]	100	0	100	31

[a]Based on carry-over stocks of grain at beginning of crop year in individual countries for year shown. Stock levels now include reserve stocks of importing as well as of exporting countries, and thus are slightly higher than previous published estimates.

[b]Preliminary estimates.