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U.S. Department
of Transportation



United States
Coast Guard

THE ROAD TO 2012:

Looking Towards the Next Two Decades



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"The Road to 2012" was prepared by the Arlington Institute for the U.S. Coast Guard's Strategic Planning Staff. It is a scan of the global environment in which the Coast Guard is likely to operate in the next 20 years. By design, it does not define or speculate on the Coast Guard's future or how it might relate to the future environment. Rather, it has wide application across government and private sectors. It emphasizes the critical roles that political, economic, societal, technological, and environmental driving forces have in shaping the future. It provides a seedbed of ideas to allow the crafting of plausible future scenarios for strategic planning purposes.

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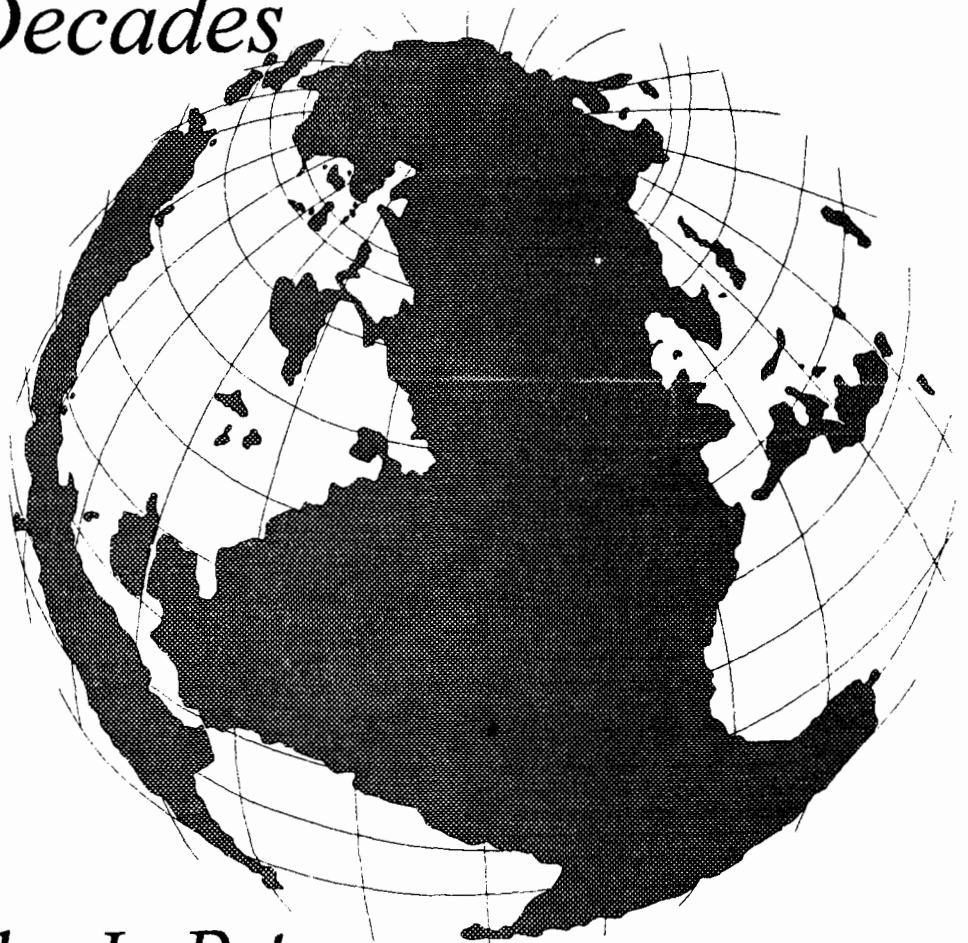
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THE ROAD TO 2012:

*Looking Toward The
Next Two Decades*



John L. Petersen

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For Diane, my best friend.



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Executive Summary

This report is probably not what you think it is. Although the possibility of a number of profoundly important potential events that are not commonly considered are raised . . . and a systematic look at the driving forces for all of the major segments of human existence is catalogued -- this is not a forecast of what will happen in the next two decades.

Rather, it is a tool -- a seedbed -- that will provide you, the reader, an example of an integrated framework from which you can develop your own models for thinking about the future. It is a mental device that will attempt to lead you down many paths, and in so doing, convince you forever that effective thinking about the future is impossible without casting a very wide net . . . and then the task becomes quite complex and fraught with uncertainties. Simple suggestions are simple-minded.

Painting Mental Images

Above all, this report will paint pictures in your mind about what might happen in the next twenty years -- mental images that are the key to thinking about the future. These images, or scenarios, are the most effective tool that has been found for pursuing this discipline. Only by overlaying all of the driving forces and trends -- in images so complex and dynamic that only the mental computer is powerful enough to effectively deal with them -- will you be able to begin to make sense of what might be on your horizon.

This exercise will be successful if you are convinced by this report that we are living in one of the most extraordinary periods of recorded history, and that the experience and tools that most of us have for dealing with incremental change will not work in this new context of explosive, exponential change. It is hoped that you come away impressed that in order to navigate the rapids ahead you will need to become proactive; and that simply dealing with events as they come along will guarantee failure -- in most every area of life. We all must learn how to think differently.

Systems-based Planning

This is a simple example of systems-based planning. It begins with an explanation of how, in the broadest terms, the system is defined: the fundamental nodes are *information accessibility, social values, and technology*. Everything else is subsidiary to and a derivative of these three driving forces. What we know, what we think about it, and what tools are available to us form the very underpinnings for everything else -- economy, politics, environment, energy, et. al.

Information, values and technology work together like the forces that make an airplane fly. The information engine provides the motive power without which nothing else happens. Technology functions like wings which generate lift and provide the advantage needed to overcome inertia and gravity. Our decisions, driven by our values, give direction to our lives, much like the rudder, elevator and ailerons which control the direction of flight.

In our airplane metaphor, economy, energy, environment and all of the other subsidiary system nodes are much like a banner being towed behind. Progress is either inhibited or aided depending upon the amount of drag it generates.

Mapping the Edges

Significant change always starts at the edge. The first indications don't pop up in the middle of the status quo, but are generated by people who think differently -- and are, therefore, not in the middle of the pack. In our search for the early indicators of change -- the seedlings of possible futures -- we must necessarily wander throughout the sector edges. This uncertain, unstable landscape always has many risks and hazards that must be

identified and avoided, but it is also home to the beginning of the future.

So, as we map the edges, and look for the initial glint of the precious stones we seek, do not be deterred by the rough exterior of some of what we find. Don't throw them out summarily; only the burnishing and polishing of time will yield the true nature of these trends, and for that we must be patient and observant.

This report looks at the major trends in social values, technology, economy, politics, energy, environment, health, population, transportation, and commercial space. Some of the major highlights include:

- Two overarching methodologies of looking at changing social values produce indications of how these values might shift in the next two decades. The emerging dominance of the *Boomer* generation about 1995, will significantly influence the tenor of the country. Boomers will cast off some of the liberal leanings of the past and embrace a commitment to virtue -- in all areas of life. They will be less accommodating, more conservative, frustrated with existing institutions, and ready to make changes.
- At the same time, a massive, a fundamental shift of values not seen since the enlightenment, and driven by the implications of *quantum mechanics* and consciousness research, will wash through a major segment of the world. The idea that individual consciousness has a direct affect on physical matter -- that consciousness is causal -- will threaten many of the intellectual underpinnings that have described reality for centuries. This holistic perspective will change the way people live, organizations operate and governments function.
- The centrality of the *microprocessor* in the exploding technology revolution also makes this era unique. The computer will enable the development and communication of more knowledge, faster, than can almost be imagined, and is spinning off profoundly important new scientific disciplines. Unlike past information technologies, the microprocessor is feeding itself -- each new generation of chip is used to make more capable chips.
- Perhaps the most important trend is the construction of a "nervous system" for the planet made up of satellite, and undersea and land fiber optic networks. Within a short

number of years, any place will be accessible from any other place in the world, and the global network will be connected directly to millions of huge databases.

- The key to life -- literally -- is being explored in *artificial-life* experiments which take place in the memory of computers. Autonomous, adaptive "living" computer code is being designed; and its implications will be far more profound than the discovery of nuclear weapons.
- *Chaos Theory* promises to open the door to understanding all of those things around us that are fundamentally unstable -- like the weather, and group and market behavior, and turbulence. It is a breakthrough on the scale of quantum theory.
- *Virtual Reality* will, within a year, begin to change every significant aspect of life: entertainment, work, learning, travel, communications. Using the power of a computer, an individual will be able to transport his or herself *virtually* to anyplace that can be simulated. Information will be moved instead of people.
- *Virtual Prototyping* is beginning to allow aircraft, ships and other devices that interact with fluids, to be designed and tested completely on computers, bypassing wind tunnels and other such expensive and time consuming processes.
- *Nanotechnology* may well make obsolete every manufacturing technique known to man by allowing items to be made by manipulating individual atoms into predetermined configurations that have been defined by computer-aided design programs. The first product should be available about 2002.
- *Biotechnology* is about changing organic life -- plants, animals and people -- by manipulating the genetic code that determines physical characteristics. The Human Genome Project will have mapped the whole of the human genetic structure within this century and opened up the possibility of anticipating diseases long before they manifest themselves as symptoms. Vegetables, animals, drugs and things like customized biological organisms (to eat ocean oil spills) are in the design process. A whole new set of ethics problems are associated with the ability to understand and reconfigure life that may upset many existing structures and institutions.

- *Computational Chemistry* is unlocking the secrets of how molecular structure in materials translates into physical characteristics and, in the process, revolutionizing *Materials Science*. We are close to being able to specify the characteristics required for a particular application (color, stiffness, strength, etc.) and then designing and producing a custom material that meets those needs.
- *Zero Point Energy* is that unlimited amount of energy that quantum mechanics has shown exists throughout the universe in the "ether." Generators are now operating that access this energy, making it likely that within the next decade new energy production methods will be available that take energy out of the "air" with no negative byproducts at all.
- *Holography* will mature within the next two decades to the point that full-size, full-color, three-dimensional images are likely to be transmitted over fiber optic networks and projected into a physical space, allowing people situated in different locations to "meet" with each other virtually.
- *Cyc* is a landmark project that is distilling the common-sense of human beings into a knowledgebase that will be available for use in personal computers within 2-4 years.
- A major problem with all of this exploding technology is trying to understand what it will do to us as human beings -- as it will certainly change us profoundly. Just as cars, airplanes and television have shaped how we now think and perceive reality, so will these emerging technologies . . . only in much greater ways.
- The industrialized world has been experiencing a major recession and only the U.S. appears about to come out of it anytime soon. This is a problem for the U.S. whose weak economy is struggling to resolve substantial problems associated with a growing trade deficit and an increasing national debt. If major reform of the U.S. system (health care costs, budget deficit, etc.) is not accomplished very soon, the existing problems and those brought upon by other emerging issues (increases in natural disasters, unfunded federal pension fund insurance, the shift to an information-based economy, etc.) could come together to deal a mortal blow to the U.S. economic system.
- China could become the major economic and political force of the next century if its economy continues to grow

at the present rate of about 10 percent a year. At that rate it will become the largest global economy in 2020.

- The international and domestic political situation is in a state of flux, with many countries waiting to see how the new period that replaces the Cold-War Era evolves. There are two major opposing trends -- integration and fragmentation -- that are gaining in strength and likely to produce problems in the future as extraordinary information technology quickens and shapes the political process.
- In the U.S. it is likely that there will be a restructuring of government and the political process, to attempt to adapt to the emerging information environment.
- Environmental pollution threatens the very future of humankind. The degeneration of the ozone layer is producing wholesale skin cancer in Australia, and blind animals and fish in Patagonia. At present rates of thinning, it will soon begin to affect the vitality of the ocean phytoplankton which provide 40-60 percent of the planet's oxygen and is the lowest link of the aquatic food chain, on which the majority of the humans in the Pacific Rim are dependent.
- It now appears that the global warming from increased greenhouse gases could be forcing the planet's system to find new ways to expel energy that cannot be radiated away, as has been the case in the past. Significant new increases in weather, earthquakes and volcanoes seems to be the likely result.
- The global AIDS epidemic may kill 110 million people in the next two decades; 50,000 per year will be dying in the U.S. by 1995. Whole countries in Africa and Asia are being ravaged by the scourge, destroying the merchant class of some societies. In the U.S., escalating health care costs mortally threaten the economic viability of the country.
- Extraordinary advances in medical- and biotechnology could significantly lengthen the average lives of humans. At the same time new ideas in medicine that revolve around holism are making their way into the mainstream.
- The global population is exploding and will soon be adding 97 million people to the planet each year. Most of this growth is in the poor areas of the world, exacerbating the have/have-not disparity. By the mid-90s, half of the

humans on the earth will be under the age of 20. The growing numbers of people are moving to urban centers, tragically overtaxing the infrastructures of those cities. These pressures will probably produce major problems of immigration as people abandon squalid conditions and move to those countries and regions that appear to offer hope.

- America is becoming more polyglot with important areas of the country being so much so, that "minority" already is not be a meaningful term. At the same time, there is a growing disparity between the country's rich and poor. This problem on a regional scale is producing concerns about the potential illegal immigration of millions of Mexicans and Central Americans to the U.S. in the coming years.
- The U.S. is particularly troubled by the increase in single-parent families which is producing a generation of children who do not learn, relate, or work as well as previous generations. Broader issues of the society's changing (or lack of) values is a growing national concern.
- Within the next two decades, new transportation modes that include magnetic levitation trains and supersonic air transports are likely to become reality. Zero-emission automobile legislation is moving the U.S. toward electric cars and the possibility of a hydrogen economy. Fuel-cells may become a major source of electrical energy production.
- Information technology is remaking the commercial shipping marketplace and may well result in an fully integrated, automatic, global system where the intermodal interface associated with moving products or commodities is seamlessly arranged by artificial intelligence and other information technologies.
- In the commercial space arena, it appears that the planet will be completely covered by satellite-based telephone and message capability before the end of the century. The Russians have entered the commercial launch marketplace and have driven launch prices very low. This may well encourage an expansion of the commercial use of space. At the same time, the commercial industry has lost regulation and cohesion and is exhibiting anarchic behavior.

- Remote sensing satellites are generating huge amounts of data on the environment, the operation of oceans, the use of lands etc. This will produce important new insights in how our earth works and what we are doing to it.
- The Global Positioning System satellite constellation is revolutionizing navigation and other forms of positioning. It is already enabling cars and aircraft with moving maps and will result in major changes in commercial shipping.

These trends are overlaid on each other and a small, representative set of cross cuts and potential wild card events are arrayed in the final chapter. A quick perusal of that section will provide a much better sense of the potential implications of the interaction of these trends than a summary here.

The appendix includes charts that show the relationships of the different trends to each other and a visual array of the crosscuts and wild cards. Also included is a list of references.



Final Observation

These are extraordinary times that will require brand new ways of thinking and new tools for making sense out of the change we are experiencing. There is a clear undercurrent emerging from the interaction of these trends that suggests that there is not much time available for us to identify these new ways of thinking and begin to implement the use of the new tools.



Introduction

"Waiting for a crisis to force us to act globally runs the risk of making us wait too long."

-- Isaac Asimov

Systems-based Analysis

Scanning the horizon for the most significant driving forces that are likely to affect the future two decades hence is a complex undertaking. Every significant problem or issue in our lives is now a systems problem. No longer can humans approach the future of any discipline thinking only of that discipline. Linear thinking must give way to systems based analysis -- trying to see the shapes and patterns that arise in the dynamics of a group of highly complex interdependent relationships. The global context is obviously a very complex system and trying to make sense of its evolution (or revolution) is similarly complicated.

This document is the report of such a scan and, in broad, relatively simple terms, the relationships of the emerging forces to each other and the evolving new reality. Others have suggested that the appropriate metaphor is that of a helicopter, hovering above the broad terrain, noting the intersections and confluence of

trends not obvious from ground level, and focusing in the directions in which they point.

In the end, the objective is to significantly broaden one's perspective -- to expand the options that are considered in making significant decisions.

The Principal Driving Forces and How They Interact

Three principal driving forces, acting together, provide the major direction for the broad collections of events that become the future: **social values, technology and information accessibility.**

Think of different technologies as being books on a shelf in a library, put there by technologists. Many different products and capabilities are available for use, but only certain technologies are ultimately embraced by society. Just as we select books in a library based upon our personal interests, so social values determine our interest and needs and just what technologies are taken down and used.

But information is the lifeblood of human systems. It is the fuel (or engine) that controls or modulates all other activity. It is the prerequisite for everything else. Throughout history, a growth in information -- usually enabled by certain technologies -- has always produced a similar increase in economic activity and a fundamental change in how humans see themselves. Information availability is the valve that meters the tempo of social activity: greater accessibility generates a faster metabolism.

Greater information availability also reduces surprises. There are few, if any real surprises, if by surprise is meant that there were no indicators before the fact suggesting that change was imminent. Increasingly, both in unanticipated natural and human events we find that the data was available before the fact but was not identified or analyzed correctly.

By information, here we really mean knowledge, which is a derivative of information. Information by itself (such as foreign and unfamiliar television images which are not understood except in the context of a local culture) can be disruptive and threatening.

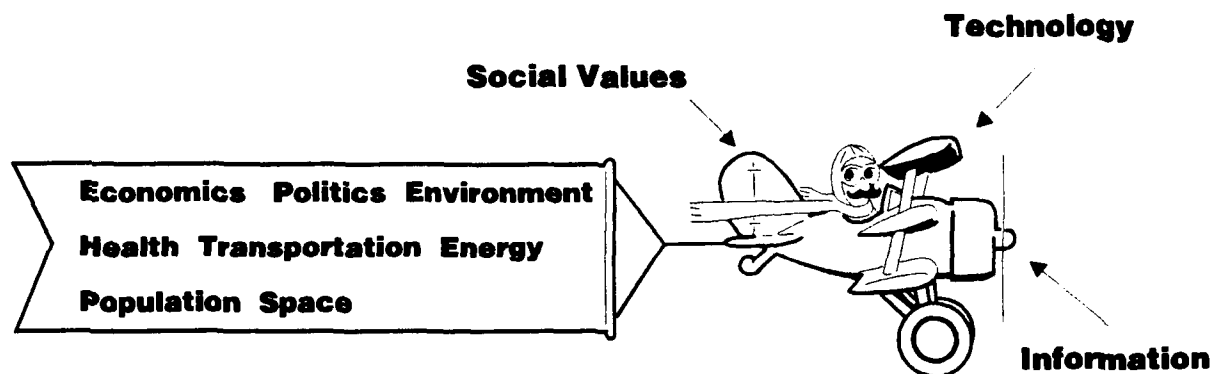
It is the expanded knowledge that attends broader information accessibility that engenders positive change.

There are also lesser forces that inhibit or advance the principal driving forces. The economy, politics, the natural environment, energy, health, and population density all influence the outcome, but (except in very unusual situations), are the byproduct of the nexus of society and technology as constrained or enabled by information.

Forces Function Like an Airplane

The relationship of these forces function much like those that allow an airplane to fly. In the same way that thrust, lift, drag and weight (or mass) interact on an airframe, so the constellation of forces in the larger environment converge to produce the future.

In an airplane, the thrust produced by the engine allows the wings to generate lift and the control surfaces to provide direction to the flight. In both airplanes and life there is a natural weight and drag that must be overcome in order to fly. The mass of the system tends to keep it grounded.



Without thrust, regardless of the condition of the rest of the plane, it will not fly. So it is with information accessibility, the controlling force. If information is not available there is no basis on which to act. When the engine runs, a plane is driven through the air and the wings generate lift. In our simplified model technology provides the "lift" that gets the system off the ground. The direction of flight to the future is then provided by social

values: the framework underlying the decisions and initiatives people make.

Economics, politics and the other aspects mentioned above provide the drag to our airplane metaphor in the form of a banner that is being towed. The banner can be lengthened or shortened, and therefore influence the speed at which the machine flies, but it is not a principal determinant of flight.

As we make our way through the coming analysis of driving forces it may be helpful to keep in mind this relationship and how the forces relate to each other, also remembering that none of them function independently.

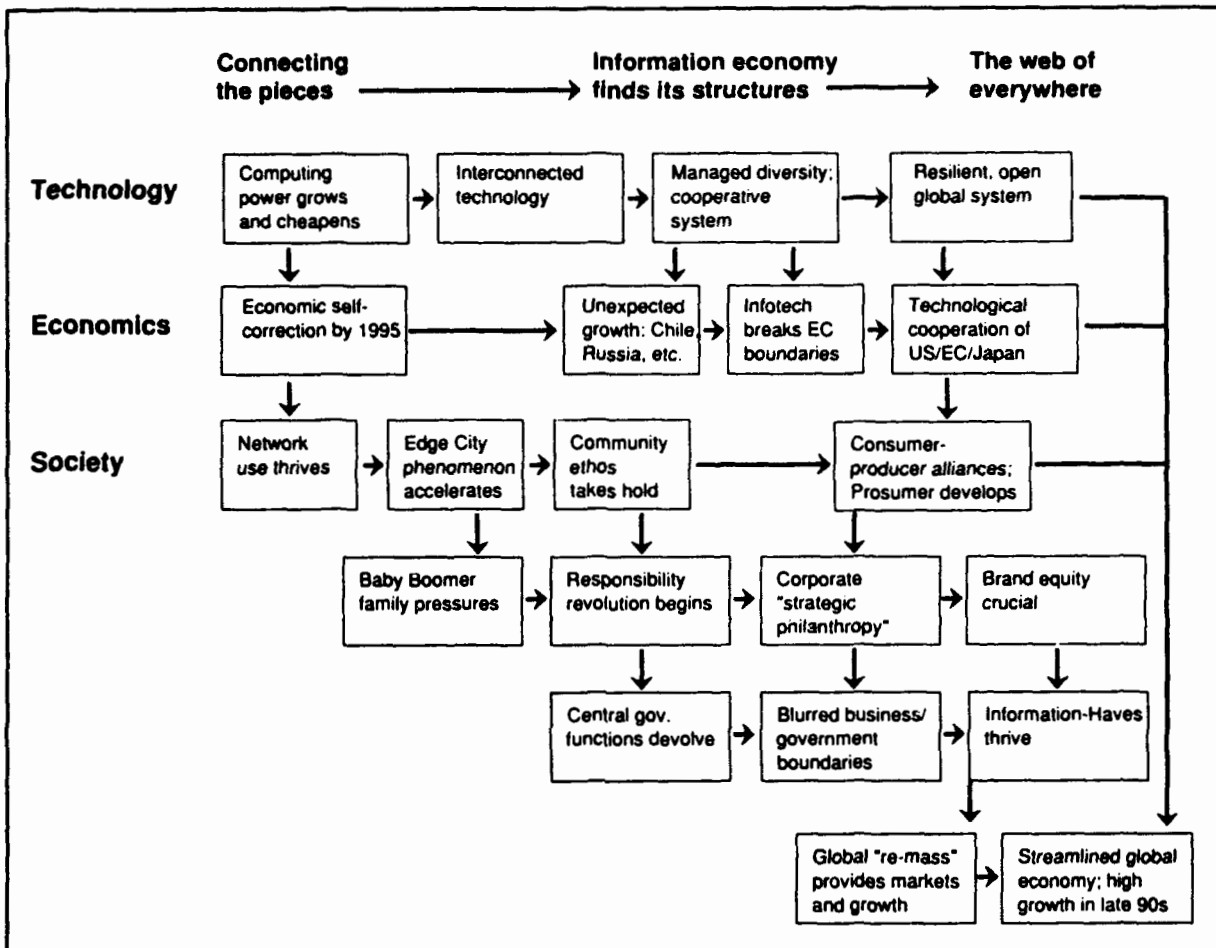
Three Images of the Future

As a framework on which to overlay the assessment of the various driving forces, consider four futures, or scenarios, that posit in broad terms the directions in which humankind might be headed. These scenarios, developed by the Global Business Network¹, identify three major economically-oriented paths [one of which has two variations] that would lead to dramatically different futures: *New Empires*, *Market World*, and *Global Incoherence*. The three scenarios vary primarily around the degree of cooperation that may be seen in the emerging new era. Scenarios with a bias toward economics are useful here because, as we have suggested, economics reflects changes in both social values and technology.

Market World: The web of everywhere

Market World, describes a largely cooperative globe, where major players respond in open and trusting ways and the innovative capacity of business is relatively unrestrained. Information is traded freely through an increasingly networked world. It is a world of "edge cities," which "evolves out of grassroots change from which emerge the most robust strategies, technologies and agreements -- creating a market-like system where the hard and fast lines that once existed between governments, economics, and communities start to blur."²

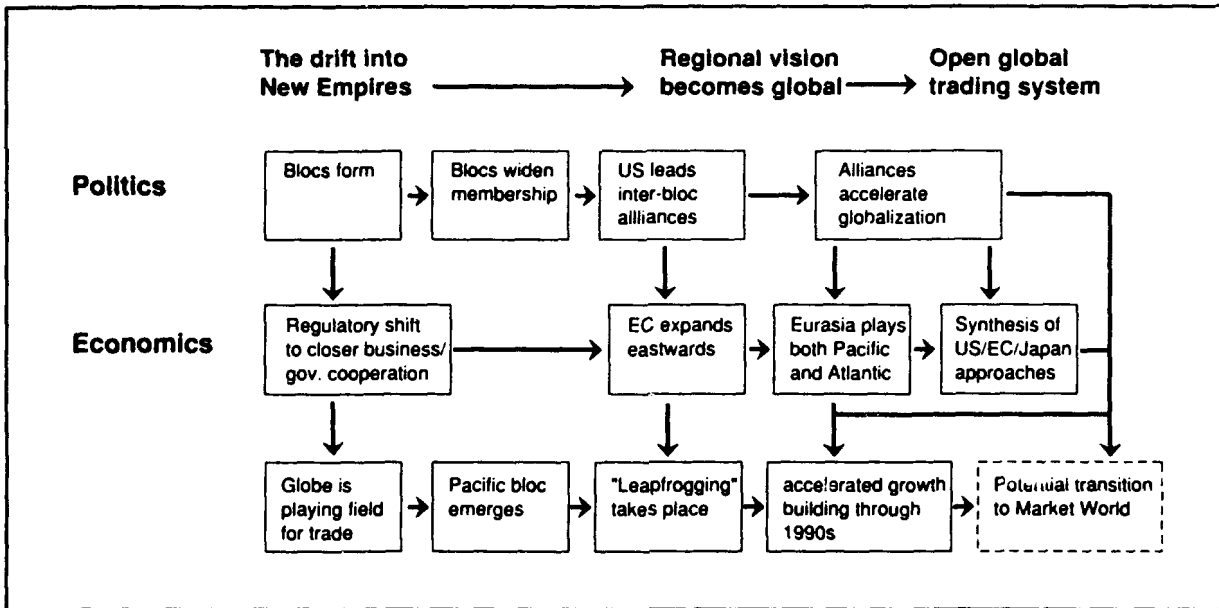
MARKET WORLD



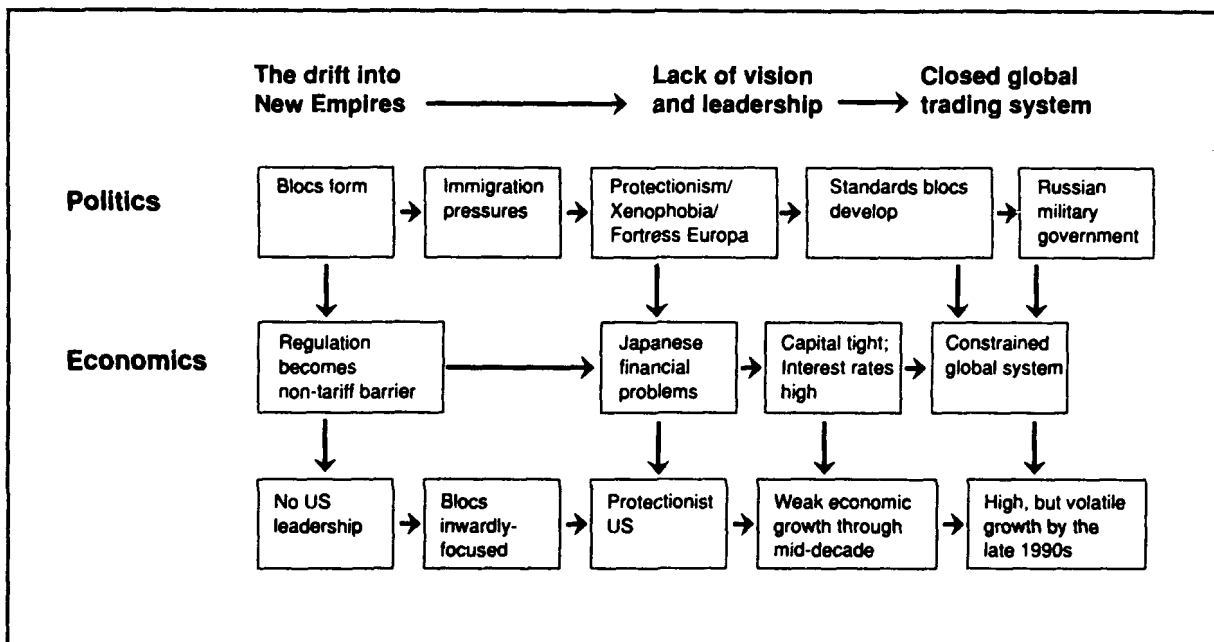
New Empires: A new scale of organization

In *New Empires*, there is less openness. Business and countries compete more stridently; possibly in closed, protectionist ways, or alternatively, in a largely free trade mode. It is the picture of "a regionalized world with the potential of moving in either of two directions: towards a competitive world of protectionist trade blocs in which inter-regional trade predominates, or towards a cooperative world of free trade blocs in which inter-bloc trade expands."³

FREE TRADE EMPIRES



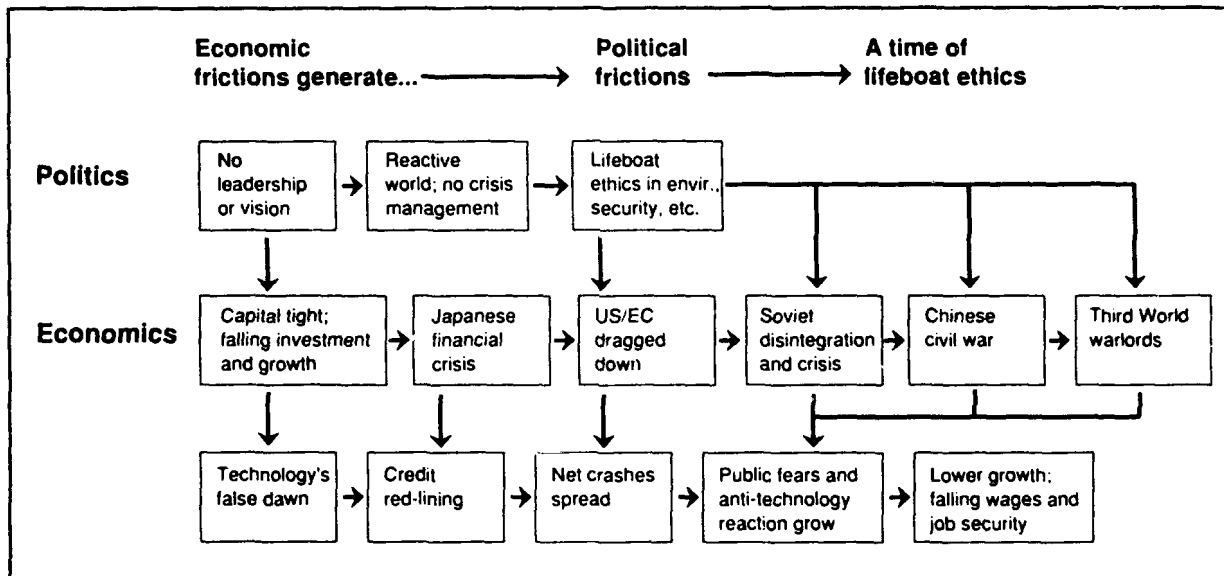
PROTECTIONIST EMPIRES



Global Incoherence: The warlords reign

In the *Global Incoherence* future, "the sum of all fears is realized." It is a "world adrift -- lacking leadership, lacking the motivating vision of the future than can propel societies forward. The weight of the past proves more powerful than the inspiration of any potential future. From individuals to institutions, this is a world that can only react to, rather than avoid, crisis . . ."⁴

GLOBAL INCOHERENCE LOGIC



"Which way the world economy will trend -- whether toward, *Market World*, *Global Incoherence*, or *New Empires* -- may not be evident till the mid '90s. There are forces toward all three active in the present. Activities that might move the world rapidly toward free markets are resisted by protectionism, both of trade and information flows. Likewise, attempts to restrict and regionalize market activities keep being subverted by the sheer resilient success of those markets, which often sift through attempted barriers and control hierarchies. If the collision of these forces grows worse rather than resolving one way or the other, then the deepening chaos of *Global Incoherence* emerges. The behavior of the economy would be fairly stable but medium growth in the *New*

Empires scenario. It would be more volatile but also higher growth in the *Market World* case. And the economy would be not only volatile but chaotic and low-growth in a world of *Global Incoherence*.⁵

These four futures span a spectrum of plausibility and are likely to include, in one form or another, the outline of the future that indeed evolves. They are a helpful basis from which to relate the trends and changes that are detailed later in this report. Throughout this assessment, ask yourself the question: in which direction -- toward which of these futures -- are these trends pushing us.



Notes:

¹Global Business Network, P. O. Box 8395, Emeryville, CA 94662

²*Search for Vision 2000: 1991 GBN Scenario Book* (Emeryville, CA: Global Business Network, 1991) p. 60

³*ibid.* p. 53

⁴*ibid.* p. 75

⁵*Decades of Restructuring: The 1989 GBN Scenario Book* (Emeryville, CA: Global Business Network, 1991) p. 14

Social Values

Two Approaches

As social values change so also does behavior. Human beings do things differently -- and the future becomes something different than the present and the past. A clear sense of possible changes in values, along with technology, would provide the framework for building a spectrum of images of plausible futures.

We have chosen two significant models for tracking social change, the Generation Model and the Paradigm Shift Model. Both are primarily focused on the developed world, for this is a study for an American agency and developed societies lead the world in change. But, because of this focus, one should not make the mistake of losing sight of the lesser-developed world and the problems resident there. Indeed, as we shall see, major problems confronting the U.S. in the coming decades will likely originate in the poorer part of the world and those regions will be major players in the future.

Nevertheless, how we in the developed world respond to events in the future will be a function of our social values and these two approaches are particularly illuminating.

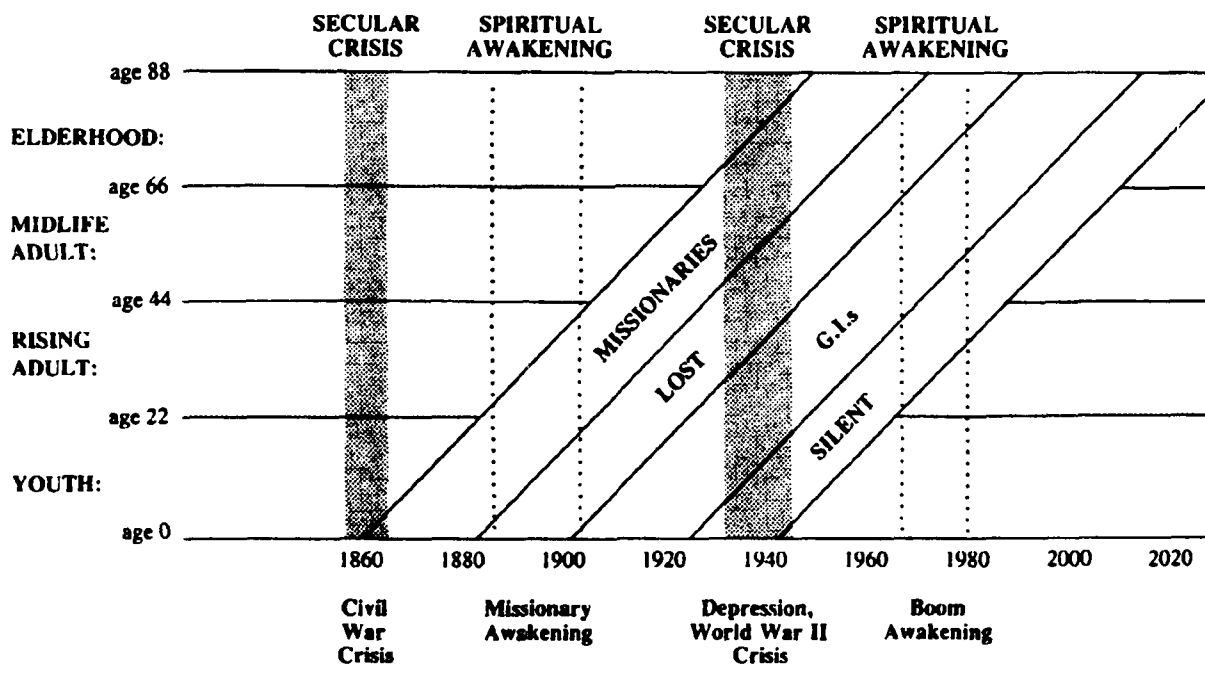
The Generational Model

William Strauss and Neil Howe, in their book *Generations*,⁶ "posit the history of America as a succession of generational biographies, beginning in 1584 and encompassing everyone through the children of today." They theorize that each generation belongs to one of four types, and these types repeat sequentially in a fixed pattern. "The vision of *Generations* allows [one] to plot a recurring cycle in American history -- a cycle of spiritual awakenings and secular crises -- from the founding colonials through the present day and on into the next millennium."⁷

Each generation, as a majoritarian social unit, has a special role in human history. Based on the peer personalities of today's generations as they age into new phases of life, this school of thought projects future national moods.

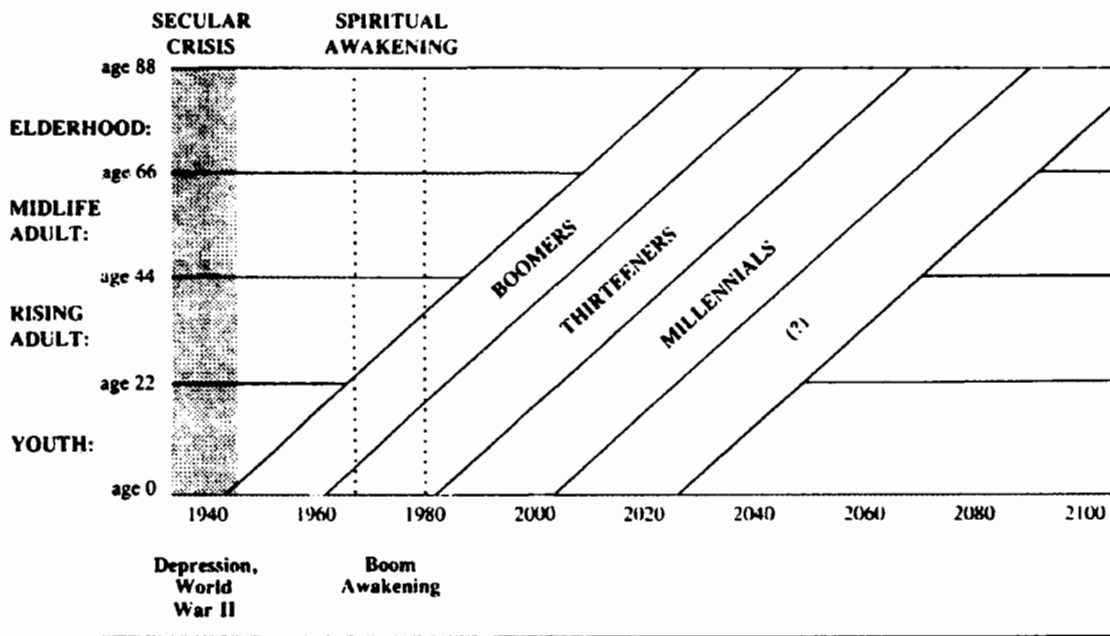
A basic assumption is that peers share the same "age- location" in history, and one's generation's collective mindset cannot help but

Great Power Cycle: Age Location in History



Source: *Generations*

Millennial Cycle: Age Location in History



Source: Generations

be influential -- whether it is embraced or a lifetime is spent battling against it. Douglas Coupland author of *Generation X* says, "Hippies were searching for something valuable. Benetton youth are looking for that same timeless essence but with a radically different sensibility. Generations really do exist. And it's a weird, almost solipsistic, conceit on the part of their parents to say, "Hey, we understand you kids completely."⁸

From the beginning, America has had a series of regular social cycles that moved between eras of Spiritual Awakening and Secular Crisis. After an Awakening, the country would enter a time that was largely Inner-driven. This inward orientation would lead to a period of Crisis, which would be followed by an Outer-driven era and then the cycle would repeat itself. Each of the eras has a unique set of characteristics.

Crisis Era - A grim preoccupation with outer-world peril grows to maximum intensity, as spiritual curiosity declines, wars are very likely, and they are fought with fury and efficacy, sex role distinctions widen, public and family order strengthen, and personal violence and substance abuse decline.

Social Moments in American History

	<u>Years from End of Crisis to End of Awakening</u>	<u>SPIRITUAL AWAKENING</u>	<u>Years from End of Awakening to End of Crisis</u>	<u>SECULAR CRISIS</u>
Pre-Colonial Period		(1517-1539)	49 years	(1580-1588)
		Reformation Awakening		Defeat of Spanish Armada
	52 years	(1621-1640)	52 years	(1675-1692)
Colonial Cycle		Puritan Awakening		Glorious Revolution
	51 years	(1734-1743)	46 years	(1773-1789)
Revolutionary Cycle		Great Awakening		American Revolution
	48 years	(1822-1837)	28 years	(1857-1865)
Civil War Cycle		Transcendental Awakening		Civil War
	38 years	(1886-1903)	42 years	(1932-1945)
Great Power Cycle		Missionary Awakening		Great Depression & World War II
	35 years	(1967-1980)		
Millennial Cycle		Boom Awakening		

Source: Generations

Outer-Driven Era - The sense of community reaches its cyclical peak, the ideals that triumphed in the Crisis era are secularized and institutionalized, the emphasis is on planning, doing, and building, wars tend to be unwanted echoes of the recent crisis.

Awakening Era - The focus on inner life grows, as secular interest in outer life declines, wars are unlikely, artistic culture is high, crime and substance abuse rise.

Inner-Directed Era - Confidence in established institutions sinks, satisfaction with personal and spiritual life is high, individualism flourishes, wars become more likely, open hostility emerges between risk-taking adventurers on one side and punitive moralizers on the other.

Paradigmatic Moods

Associated with each type of era is a paradigmatic, or typical, mood. The character of each of the four generation types is a product of its relationship to the other three.

The IDEALIST Lifecycle

Nurtured as children amid secular confidence and coming of age during an awakening, in a post-crisis era of mellowed Reactive elders, vigorous Civic midlifers, and conformist Adaptive rising adults, these generations travel a prophetic lifecycle, with their coming-of-age passion and their principled elder stewardship in times of crisis.

The REACTIVE Lifecycle

Nurtured as children during an awakening and coming of age amid spiritual confidence but secular uneasy, children to an era of still powerful Civic elders, torn Adaptive midlifers, and moralizing Idealist rising adults, these generations travel a picaresque lifecycle, tinged with pleasure-seeking and other high-risk behavior.

The CIVIC Lifecycle

Nurtured as children amid spiritual confidence and coming of age during a secular crisis, in a post-awakening era of sensitive Adaptive elders, values-oriented Idealist midlifers, and pleasure-seeking Reactive rising adults, these generations travel a heroic lifecycle, with a clear collective mission and high ambitions for cleaning up and rebuilding the outer world.

The ADAPTIVE Lifecycle

Nurtured as children during a crisis and coming of age amid secular confidence but spiritual uneasy, this cohort enters childhood surrounded by stern Idealist elders, pragmatic Reactive midlifers, and aggressive Civic rising adults, these generations travel a genteel lifecycle, with a cult of professional expertise and critical gestures of conscience and humanism.

Throughout the country's eighteen generations, the strands of four recurring peer personalities have been woven together, following each other in a fixed order. Each has been predominant for about 22 years and plays a direct role in defining the characteristics of the other three lifestyles.

Different Approaches to Life's Challenges

Depending upon where they were located on this social wave that moves between crisis and awakening -- where, during their lives they were confronted by these eras -- generations have taken on one of the four different *moods*. The result: significantly different approaches to the major aspects of life. See page 25.

The generational types also exhibit a predictable set of *personalities* at different times during their lifecycle. Some of these characteristics are shown in the chart on page 26.

Recent Generations

Strauss & Howe name a generation for the time in which the cohort is middle-aged and most influential. *Everyone who lives a normal lifespan experiences every constellational era once.*

Almost all persons alive today in the U.S. are members of one of the following generations:

G.I. elders, born 1901-24, age 66-89; (glorious, civics): firm believers in public harmony and cooperative social discipline, accustomed to being looked upon (and rewarded) as good, constructive, and deserving. A rationalist generation

SILENT midlifers, born 1925-42, age 48-65; (progressive, adaptive): Other-directed, more appreciative of the mind-sets, virtues, and flaws of those born before or behind them, no elected

Constellational Moods, by Era

	AWAKENING ERA	INNER- DRIVEN ERA	CRISIS ERA	OUTER- DRIVEN ERA
<i>(Aligned Constellation at End of Era)</i>				
ELDER:	Civics	Adaptive	Idealists	Reactives
MIDLIFE:	Adaptives	Idealists	Reactives	Civics
RISING:	Idealists	Reactives	Civics	Adaptives
YOUTH:	Reactives	Civics	Adaptives	Idealists
CYCLE CALENDAR:	Year 1-22	Year 23-44	Year 45-66	Year 67-88
NURTURE OF CHILDREN:	under-protective	tightening	over-protective	loosening
SEX ROLE DIVISIONS:	narrowing	narrowest point	widening	widest point
TOLERANCE FOR PERSONAL RISK:	rising	high	falling	low
INDIVIDUALISM VS. COMMUNITY:	rising individualism	maximum individualism	rising community	maximum community
WORLD VIEW:	rising complexity	maximum complexity	rising simplicity	maximum simplicity
BEHAVIOR TOWARD IDEALS:	discover	cultivate	champion	realize
BEHAVIOR TOWARD INSTITUTIONS:	attack	redefine	establish	build
SENSE OF GREATEST NEED:	fix inner world	do what feels right	fix outer world	do what works
VISION OF FUTURE:	euphoric	darkening	urgent	brightening

Source: Generations

President among this generation, they bring nonjudgmental fairness and open-mindedness to American society.

BOOMER rising adults, born 1943-60, age 30-47; (awakeners, idealist): An authentic generation, have a unique vision, a transcendent principle, a moral acuity more wondrous and extensive than anything, typically exert their most decisive influence on history late in life, have a capacity for great wisdom, terrible tragedy, and insufferable pomposity.

**Peer Personalities,
by Generational Type**

	<u>IDEALIST</u>	<u>REACTIVE</u>	<u>CIVIC</u>	<u>ADAPTIVE</u>
Lifecycle Type:	prophetic	picaresque	heroic	genteel
Parental Attachment in Youth:	strongest to mother	independent of both	strongest to father	obedient to both
Coming-of-Age Experience:	sanctifying	alienating	empowering	unfulfilling
Principal Focus, Coming-of-Age:	inner-world	whatever works best	outer-world	torn between inner & outer
How Perceived Coming-of-Age:	stormy	bad	good	placid
Preoccupation in Rising Adulthood:	reflecting	competing	building	ameliorating
Attitude Transition in Midlife:	detached to judgmental	risk-seeking to exhausted	energetic to hubristic	conformist to experimental
Preoccupation in Elderhood:	civilization	survival	community	family
How Perceived as Elders:	visionary, wise	lonely, caustic	busy, confident	sensitive, flexible
Style of Leadership:	righteous, austere	pragmatic, cautious	grand, expansive	process-fixated, pluralistic
God is . . .	truth	persuasion	power	love
How It Is Nurtured:	relaxing	underprotective	tightening	overprotective
How It Nurtures:	tightening	overprotective	relaxing	underprotective
Positive Attributes:	principled resolute creative	savvy perceptive practical	rational selfless competent	caring open-minded expert
Negative Attributes:	ruthless selfish arrogant	amoral pecuniary uncultured	overbold unreflective insensitive	indecisive guilt-ridden neurotic

Source: Generations

13er youths, born 1961-81, age 9-29; (lost generation, reactive): Named for the 13th American generation. Low expectation is a game this generation can play to its advantage: know the odds. An ill-timed lifecycle. A popular 13er put-down is "That's history," which means: that's irrelevant.

Millennial, 1982-?, are still unknown.

Endowment Efforts

Throughout its lifecycle, each generation's endowment efforts are concentrated in areas closely connected to its peer personality. The group either adds to the accumulated stock of **physical, natural, or human capital**, or adds to the ancestral legacy of **political, artistic, and spiritual capital**. As a generation matures, its endowment behavior becomes part of its peer personality -- part of its self-image and its image in the eyes of elders and juniors.

Dominant Generations

IDEALISTS	Principle, Religion, Education
CIVICS	Community, Technology, Affluence

Recessive Generations

REACTIVE	Liberty, Pragmatism, Survival
ADAPTIVE	Pluralism, Expertise, Social Justice

Each generation develops a lifelong endowment agenda pointing toward the endowment activity that society neglected or reversed during its youth. In each era, the most noticeable endowment neglect or reversal is likely to occur in the endowment activity associated with the generation currently passing beyond elderhood.

1990s: An Inner-Driven Era

The 1990s are an Inner-driven era where Idealist endowments of principle, religion and education are likely to rise. The Reactive endowments of liberty, pragmatism and survival may wane while the Civic characteristics of community, technology and affluence will become dormant. Adaptive endowments (pluralism, expertise and social justice) should peak and then fall later in the decade.

History suggests that a Crisis is due by 2020 -- about half way through the Millennial Cycle.

Boomer Leaders in an Inner-Driven Era (1991-2003)

To understand the principal influence of the next decade we must understand the dominant generation, Boomers, rising adults, born 1943-60, age 30-47 in 1990. They will be entering mid-life in an **Inner-Driven Era**, (1991-2003) and elderhood in a **Crisis Era**, (2004-2025). Boomers will always listen to 1960s music, debate the "lessons" of Vietnam, show a weakness for granola and mineral water, but even though none will return to 60s, all will be steered by their coming-of-age experiences.

Boomers will **assert their mid-life values**. They will subject their coming-of-age awakening -- what it did and did not accomplish -- to growing scrutiny and generate **stormy peer-on-peer invective** (following the script of every prior Idealist generation entering mid-life).

Boomer perfectionism will begin to express itself less in the realm of personal fulfillment than in the realm of social virtue.

Boomer politics will become more intensely values-laden. They will grow increasingly pompous, intolerant, uncompromising, snoopy, and exacting of others, as well as more dutiful, principled, and demanding of themselves.

The Boom's era of **political remission will end when the last G.I. President departs**. Bill Clinton's presidency is the signal for a new activism.

Notwithstanding their current reputation for personal selfishness, they will not mobilize around appeals to collective self-interest (tax, labor, trade, retirement issues), but look for lofty commitment on matters of principle. This will produce an attitude that will help to **revitalize a sense of national community**. The Communitarian movement may be the first indication of this thrust.

The Boomer **share of Congress and governorships** (now 21%) **will expand rapidly** in the middle 1990s and become a plurality following the 1994 or 1996 election. They will reach their lifetime peak share of national leadership around the year 2005, just as the Inner-Driven era is ending, 62 years after the birth of their first cohort.

Some of the promising Boomer politicians and presidential candidates will spring from outside the ranks of law, government, and

party politics. Ross Perot, though not of the Boomer generation may well be the harbinger for this movement. Their elite will maintain individual identities apart from institutions.

In Congress, resignations over matters of principle will become more common and throughout the top echelons of government and business, interest in philosophy, literature, and the arts will rise -- and interest in "how-to" manuals will fall.

Seeing new virtue in community, they may see advantage in taxes on consumption, regulation on speculative investment and pleasure-seeking leisure, and public intrusions into what others will consider matters of personal and business privacy. Similarly, an anti-drug and pro-environmental alliance may emerge as the nation's most potent lobby. In all aspects of civil life they will insist on enforcing a new sense of local community.

Boomers will **remain a hard sell for political and commercial marketers**, take less interest in flesh-and-blood candidates than in abstract issues. To reach them, aspiring politicians will have to demonstrate candor, simplicity, moral rectitude, serenity of soul, even a hint of detachment. They will seek high purpose in what they buy: quality over quantity, uniqueness over comfort, inner satisfaction over outer popularity.

Boomer manager-owners will try to **turn firms into agents of public and private virtue**. Focus on the "bottom line" will not just mean profits, but principles about what companies should mean to owners, employees, customers, and neighbors. Boomer executives will be prepared to accept a narrowed pay gap between themselves and their workers.

The culture war will develop between the Boomer and 13th by their pushing an austere and stripped-down version of their New Age morality into mainstream social life. Around the year 2000, Boomers will settle in as a more cerebral "older" generation, seeking the classic and the enduring over the faddishly popular. They will challenge sex, profanity, and violence in the media and get results and mount attacks on all forms of substance abuse.

The mid-life black elite will assert moral leadership in troubled neighborhoods, force younger people to build "character" and accept more responsibility for their own condition. Black Boomers may ultimately make their most enduring contributions in letters and cultural leadership.

Boomer women will have an explosion in public life, aging Boom women will widen sex role distinctions, and push women back toward the pedestal of family life.

Boomer judgmentalism will land heavily on the criminal justice system as well as in civil law. Society's leaders will find it easier to condemn individuals and harder to condemn "society," demanding both of others and themselves.

They have the capacity to **age elegantly**, in their own eyes and in the eyes of others, but if Boomers cling to a youth-fixated narcissism into their forties and fifties, America will be heading for trouble. The split between the New Age (modernist) and evangelical (traditionalist) camps should be watched carefully.

Crisis Era: (2004-2025)

Whether Boomer Leadership will end in **triumph or tragedy will hinge on their capacity to restrain** (or let others restrain) **their latent ruthlessness**. Faced with crisis, this generation of one-time draft resisters will not hesitate, as elder warrior-priests, to conscript young soldiers to fight and die for righteous purposes. Let us hope that old Boomers will look within themselves and find something richer than apocalypse.

The Paradigm Shift Model

Another model for looking at changes in social values has been developed by Kirk and Christine MacNulty, principals in the London-based strategic planning firm of Applied Futures, LTD.⁹ The MacNulty's believe that the Western World is in the middle of a profound social change in the very framework that is used to describe reality -- a paradigm shift -- the likes of which has not been seen for over 400 years. The last time this happened was when the world shifted from the Medieval era to the Industrial age. In this case they believe we are moving from the Scientific/Industrial period to a Social/Consciousness age.

Three Driving Forces for the New Paradigm

Where new scientific discoveries (by Newton, Copernicus, Galileo and others) in the 14th to 17th centuries (and spread by the printing press) fueled a fundamental shift in the most fundamental terms of how humans understood reality -- themselves and their organizations -- similarly, modern physics, analytical and developmental psychology, and interest and research into consciousness and perennial philosophy, are precipitating a basic overhaul of the general outlook of a growing segment of developed societies.

New Physics

The new ideas are anchored in quantum mechanics, and are now beginning to work their way into everyday life. They revolve around the powerful notion that consciousness is required to explain the existence of matter. No longer do leading physicists like David Bohm believe that reality exists outside of human involvement. *Consciousness is causal* -- a chair exists because it is observed -- someone is required in order for physical reality to exist.

Furthermore, the mathematics prove that matter can go both forward and backward in time, all reality is connected to everything else through instantaneous connections, matter can appear and disappear (many times very rapidly), and a given piece of matter can split into two pieces that are the same size and weight as the original one. Time does not flow in at a fixed rate and it is an integral part of space -- one does not exist without the other. These ideas make obsolete the Newtonian explanation of reality, which are the basis of Western beliefs.

Analytical and Developmental Psychology

Psychology, which came into being only during this century, also supports these ideas. Both Maslow and Jung suggested that people are more than their egos. Maslov included levels above those of self actualization in his hierarchy of needs. Jung posited that people develop from instinct to ego to self; self being the best personal and transpersonal aspects of the psyche.

It is this detached, transpersonal orientation that allows one to see the reality from outside of a narrow personal perspective. It is the

realization of the existence of something greater than mere physical life, for instance, that allows a person to offer his or her life in the place of another. In more mundane terms, this perspective allows a "systems" view that accepts personal loss or pain in order to accomplish a larger good.

Consciousness Research

As a response to these ideas, more and more major universities and research institutions are exploring the mind/body relationship and finding that the mind has ultimate control over the body. The discipline of psychoneuroimmunology has shown a causal relationship between physical health and mental attitude. Alternative medicine based on nonphysical forces is now being taught at Harvard Medical school and other similarly prestigious institutions.

The common concept that is arising from all of these areas is that consciousness is an integral part of the equation of reality -- consciousness is causal. Marvin Cetron and Owen Davies say we are redefining what it means to be a human being. ". . . we are beginning to distinguish between being human and being a person, between the body and the functioning individual who may -- or may not -- inhabit it. And the rights we once granted to all humans are now being limited only to persons."¹⁰

Three Major Value Groups

Research in most Western countries shows that basic social values are changing. These long term (5-20 years), deeply held beliefs are manifest in the medium term as attitudes and lifestyles, and in the short term as behavior. The change is tracked with regular surveys that monitor the beliefs of whole populations and how they segment themselves into major groupings based on values. The three major groups, Inner-Directed, Outer-Directed and Sustenance-Driven are subsections of Abraham Maslow's hierarchy of needs.

Inner-Directed people look largely within themselves for direction. They are not significantly influenced by the attitudes and actions of others. They march to their own drum and as a group produce first and nurture most of society's big new ideas and value shifts. They are innovators who maximize individual potential

and whose needs are primarily "growth needs." They enjoy recreational activities and are trend setters.

Outer-Directed individuals rely on external indicators for their own self worth. They are "climbing a social ladder" and need to be seen being successful. Their needs are "esteem needs" which are supplied by the "right" brands and the correct kind of friends, etc. They are the dynamos of society, providing much of the push for economic and national gain. Once an Inner-Directed idea begins to flourish in society (such as the interest in the environment) the Outer-Directed sense the change and align themselves in the new direction. They usually lag the Inner-Directed by 2 to 3 years.

The *Sustenance Driven* are inhibitors who are most concerned about holding on to what they've got (both possessions and institutions) and are very adverse to both risk and change. Theirs are deficiency and security needs. They follow the lead of the Outer-Directed.

At the present time, research in Europe and the U.S. shows that the Inner-Directed segment is growing significantly in all major Western countries. This is the group that is embracing the "consciousness is causal" perspective and beginning to see the world in holistic terms. The net effect is that a radical new understanding of reality is working its way into Western societies at an increasing pace.

As we shall see, an information technology explosion is spreading these ideas and their derivatives throughout the developed world.

Consciousness is Causal

As the Inner-Directed values increasingly establish a larger position in society, a new paradigm will evolve. It will be an era where, since a person can directly influence their reality, there will be decreasing tolerance for those who do not take the responsibility to do so. Those individuals, for instance, who are a burden on society because of poor health or a form of dependency (drugs, alcohol, etc.) may well find themselves without the traditional sympathy or support that they previously were accorded. No one can any longer blame "them," -- one's problems are not the fault of society or external circumstances.

There will a number of new fundamental new trends.

1. **Dependency will be overtaken by independence and interdependence.**
2. **Autonomy will subvert collectivism.**
3. **Socialism, already discredited, will increasingly give way to capitalism.**
4. **Materialism as a metaphysics will increasingly be overcome by the idea that consciousness is causal.**

A New Renaissance

This model argues for the blooming of a "super renaissance" that is many times more significant than the last one. Spread and enabled by a new generation of microprocessor-based information technology, the coming years could see major changes in every significant aspect of life. The very underpinnings of reality -- philosophy, theology, ethics, sociology, etc. -- will all be assaulted by this new set of ideas.

In his book, *The American Future*, Wm. Van Dusen Wishard writes:

We are well into a Quantum Age of uncertainty and unpredictability; that in the realm of quantum mechanics, "objective experiment" is a contradiction in terms; that the physical world may not consist of structures built out of independently existing (and unanalyzable) entities, but rather a web of relationships between elements whose meanings arise entirely from their link to the whole; that a "complete understanding" of reality lies outside the capabilities of rational thought, and must include subjective, intuitive insights; that consciousness/mind did not appear late in the evolutionary process, but were always here; that far from mind being housed in the brain, mind exists independently of the brain (and possibly independently of the body); and that subatomic particles may contain some form of consciousness enabling them to transmit knowledge faster than the speed of light, over distances measured by light-years.

The above assumptions form the greatest shift of scientific world-view since Galileo's work in the 17th century. Despite their startling implications, they evolved [in the Western world] during the past century. They still have to work their way through the philosophy,

knowledge structure, culture, education and general worldview of the rest of our society. But these new assumptions, asserting their authority, are causing the upheaval we are seeing in our society today.¹¹

Generation or Paradigm?

What we have here are two different perspectives of the same period of time. They are not mutually exclusive, and our opinion is that they both describe the coming era from two different -- and equally valid -- perspectives. In fact, perhaps the best model for exploring changes in social values is a synthetic one that includes both generational and paradigmatic components.

The generational approach is essentially a "short-wave" analysis: every 22 years a new generation comes on the scene with a set of predictable characteristics. The paradigm model is a "long-wave" perspective: the last shift of this kind was some 400 years ago. *It therefore seems to make sense to superimpose the two trends, and take as the major social value driving force a paradigm shift modulated by generational change.*

This also offsets intrinsic shortcomings of the generational model in that it represents an analysis of trends, a) during a period between paradigm shifts (i.e. no major value shifts), b) which does not reflect the insertion of a technology that even approaches the profundity of the current wave of information technology, and c) introduced fundamentally new concepts in science.

Major Trends

All other things being equal, the next two decades should see a number of new social trends driven by a constellation of value changes.

1. Two major groups, sustenance-driven traditionalists and inner-directed progressives, will be in open conflict for the mind of the society.
2. As a principal of operation and decision-making, wholism and interdependency will increase significantly.

3. Religious denominations and other conservative institutions will dig in deeply and defend their principles vigorously.
4. Conservative groups, in the face of rapid increases in threatening information, will hark to simpler, more familiar times.
5. Individuals will become increasingly autonomous, delinking themselves from institutions (which are naturally conservative).
6. There will be a growing intolerance for those who do not show personal responsibility, both in this country and abroad.
7. There will be major changes in the structure and function of government, business and education.
8. There will be much confusion by large numbers of people about the rapidly emerging new ideas. Many will find this destabilizing, producing an increase in compensating behavior.

Current Trends

A number of current social trends illuminate the underlying changes in values.

Social Fragmentation

High rates of change have historically produced a number of predictable reactions. Some groups, like the inner-directed, rapidly adapt, thriving on and precipitating change. Others, like sustenance-driven individuals, find change threatening and respond accordingly.

There appears to be a relationship between a high rate of change (which is driven by commensurate increases in information) and accessibility to the information. That is to say, if a person is confronted by significant external change, he or she tends to understand what it means and what is driving it, or they don't. If they don't understand (don't have access to information) the response

is often defensiveness and a reversion to comfortable, traditional, and understandable modes of operation.

This response is always toward conservatism -- a harkening back toward times and tools that have worked in the past rather than looking forward toward the future. A social group breaks into two subgroups: one progressive and one regressive . . . and a major ideological conflict ensues until the progressive ideas (promoted by the inner-directed) ultimately gain mainstream dominance (are embraced by the outer-directed). The new ideas then become conventional wisdom that is subject to attack by a new group of progressives.

Such a conflict is now in full bloom in the U.S. It played a major role in the recent presidential campaign, for example, with George Bush trying to appeal to conservative "family values," and Bill Clinton offering a new alternative to the status quo.

Tribalism

Tribalism, one of the most significant manifestations of this re-trenchment in the face of change, exhibits itself both domestically and globally.

In this country, the most obvious example is the fragmentation of the society into cultural subgroups. In the past, the idea of America was one of a melting pot -- "the creation of a brand-new national identity, carried forward by individuals who, in forsaking old loyalties and joining to make new lives, melted away ethnic differences."¹² But now, as the result of a variety of pressures, there is a major push by segments of our society to highlight minorities at the expense of the whole.

Arthur M. Schlesinger, Jr. summarized the trend well. "The hostility of one tribe for another is among the most instinctive human reactions. Yet, the history of our planet has been in great part the history of the mixing of peoples. Mass migrations have produced mass antagonisms from the beginning of time. Today, as the twentieth century draws to an end, a number of factors -- not just the evaporation of the cold war but, more profoundly, the development of swifter modes of communication and transport, the acceleration of population growth, the breakdown of traditional social structures, the flight from tyranny and from want, the dream of a better life somewhere else -- converge to drive people

as never before across national frontiers and thereby to make the mixing of peoples a major problem for the century that lies darkly ahead."¹³

The manifestation in the U.S. is not simply nationality or race. As Charles Sykes (presenting a classic Boomer critique) has suggested, "The increasing tendency of Americans to fragment themselves along the lines of race, sexual preference, gender, ethnicity and psychological infirmities may reflect their sense of the loss of more traditional communal ties -- family, church, community. But rather than defining themselves in terms of a shared culture, these new communities of grievance are animated by their shared conviction that they are victimized by "heightism," "lookism," "sizeism," or "toxic" parents.

Our victim culture is fueled in large measure by the desire to re-define inappropriate conduct as disease or 'addiction'."¹⁴

Minority groups want to study together, live in universities apart from the rest of the students, and, in some cases, rewrite the conventional view of history and change curricula to emphasize their particular view of the world. In Atlanta, for instance, the *Washington Post* reports that nearly all of the city's 109 schools and more than 80 percent of its teachers are using Afrocentric curricula in the upcoming school year. Third-grade children are taught math problems in the East African language of Ki-Swahili.¹⁵ In Washington suburban Montgomery County, a committee of Korean, Chinese and East Indian residents advise the school system on "what perceptions we want our kids to have about Asia" when a three-year world history sequence is overhauled.¹⁶

Other minority groups are also asserting themselves. In a major political fight in New York an angry schools chancellor Joseph A. Fernandez recently laid down an ultimatum to a Queens school board that had refused to adopt a plan to teach elementary school children to respect and appreciate gay people. [In the end Fernandez was fired as the result of an uproar by parents (boomers) against his policies.]

Global Fragmentation

Parallel issues dominate the international sections of our newspapers. The ethnic violence in the Balkans, the continuing conflicts and threats of war in the Middle East, the threatening religious

war in Northern India, and the Northern Ireland struggle are all examples of areas of relatively poor information accessibility populated by groups that are fixated on the past rather than the future.

Three anti-modern religions, Islamic fundamentalism, Maoism, and fanatic environmentalism (also known as deep ecology) also offer a harbor for those who find the pace and composition of change menacing. Islam was once the world's cultural and technical leader, but the new version is overwhelmingly anti-modern and anti-Western. It has great appeal to the underdeveloped world, and it may reconquer the entire Middle East from Morocco to Pakistan. Maoism has far fewer adherents, but Maoists are proactive killers and may succeed in taking over a faltering Latin American nation or two. Fanatic environmentalism has the greatest appeal to Western intellectuals.¹⁷ Alvin Toffler describes these eco-theologues as "wish[ing] to plunge society into pre-technological medievalism and asceticism. . . . [they] insist that there can be no technological relief, and that we are therefore destined to slide back into preindustrial poverty, a prospect they regard as a blessing rather than a curse."¹⁸

Uncertain Future

Where does this tribalism lead? Schlesinger points out that at some time in the past most ethnic groups, like the Irish, have attempted to influence curricula and literature in partisan ways but ultimately those efforts have died as the group became more completely integrated. Also, if the Generational Approach is to be believed, the Boomers will soon begin to dominate, and will increasingly depreciate these kinds of programs.

But neither of these historical perspectives considers the implications of information technology and what its effect will be on tribalism as information is more broadly and quickly communicated. Some have suggested, for instance, that television may play a major role in the integration of Europe, in that it more quickly exposes the different societies to each other.

On the other hand, the information overload and threats of the increasingly familiar unfamiliar may well generate additional stress and strengthen the resolve of subgroups to find stability within themselves.

Current Attitudes

All of these forces and trends are reflected in some of the current attitudes of the American people. Kimm and Paterson in their book, *The Day Americans Told the Truth*, identified some of them.

- Americans generally have a loss of faith in authority of government, the corporate sector, churches and education.
- On the whole, we believe less in others, trust less, and dislike our fellow citizens.
- We believe less in ourselves and the actions that we take with others and ourselves.
- There is much less belief in the traditional patriarchal family.
- We believe less in work as a calling. Work is something that is necessary and holds few other rewards. In the study, CEO's are extremely critical of other CEO's and this also applies to worker's view of other workers.
- The majority of those sampled believe that the United States in the future will be colder, meaner, greedier and more selfish than Americans in the past.

We have the highest illiteracy of industrialized countries, highest divorce rate, highest number of single parents, highest debt per household, highest crime rate, highest homicide rate with the highest expenditures on crime. We have one of the highest adult mortality rates, highest infant mortality rates, and yet the highest expenditure per capita for medical bills. We also now have the greatest economic disparity between the rich and the poor.

Newsweek magazine, writing about the changes we are confronting noted that, "Our new era lacks a name, but its central challenge is clear: to restore the American Dream, we must reconcile our ideals with today's economic realities. We need to rethink private and governmental responsibilities. Counting on prosperity as a panacea breed irresponsibility in government, Corporate America and even our personal lives. To some extent, things correct themselves. Tougher competition has forced many companies to improve. There's a renewed awareness of the irreplaceable importance of families in rearing children into self-reliant and

responsible citizens. But the one place where change can't occur automatically is government."¹⁹

New Structures for Dealing With the Change

We have suggested that the great changes we will experience in the next two decades will threaten the current paradigm at its most fundamental level. New models of organization, government and education are being actively explored by progressive thinkers.

Heterarchies -- Virtual Corporations

Business is reorganizing away from hierarchies to structures like heterarchies, where employees acquire a much broader stable of skills and use those abilities in differing roles, depending upon the job or project. One week they might be a team leader, at another time, a technician. Working groups are brought together on an ad hoc basis, by picking and choosing among the available pool of people -- always trying to put together the strongest team for that particular task.

Communitarians

At a more basic level -- perhaps responding to the pull set forth in the Generation model -- new groups are attempting to redefine the individual's relationship to society. A new collection of thinkers, both liberal and conservative, calling themselves Communitarians, are pointing to the need to curb the minting of rights and to balance existing ones with greater willingness to shoulder responsibilities and commitments to the common good. They emphasize the importance of community, the moral claims staked by shared needs and futures, as distinct from the claims of various subgroups and individuals.²⁰

Holistic Theories

Some Communitarians would resonate with holistic approaches that suggest that humans have direct links with all of the life around them, not only other people, but plants and animals as

well -- we all exist in a very large and complex interdependent system. As mentioned earlier, quantum mechanics supports this perspective. New generations of school children, indoctrinated from very early age with ecological principles implicitly take this view.

Evolving Definitions of Life

We have already mentioned the implications of the Paradigm model for redefining the definition of life: differentiating between human and person.



Notes:

⁶Strauss, William & Howe, Neil *Generations: The History of America's Future, 1584 to 2069* [New York: Quill/William Morrow, 1991]

⁷ibid. Cover notes.

⁸*U.S. News & World Report*, "Social Cycles," Aug. 17, 1992, p. 13

⁹Applied Futures, LTD; 2101 Crystal Plaza Arcade, Suite 223, Arlington, VA 22202

¹⁰Cetron, Marvin & Davies, Owen. *American Renaissance, Our Life at the Turn of the 21st Century*, [New York: St. Martins Press, 1989] p. 292-3

¹¹Wishard, Wm Van Dusen; *The American Future*, [Washington, DC: The Congressional Institute, Inc., 1992]

¹²Schlesinger, Jr., Arthur M., *The Disuniting of America - Reflections on a Multicultural Society*, [New York: W.W. Norton & Company, 1992] p. 13

¹³ibid. p. 10

¹⁴Sykes, Charles, J., *New York Times*, "I Hear America Wining," Nov. 2, 1992

¹⁵Cooper, Kenneth J., *The Washington Post*, "Broadening Horizons," Nov. 27, 1992 p. A1

¹⁶Duke, Lynne, *The Washington Post*, "African-Centered Curricula: Reclaiming History or Rewriting It?" Nov. 27, 1992 p. A1

¹⁷Carlson & Goldman, p. 23

¹⁸Toffler, Alvin, *PowerShift*, [New York: Bantam Books, 1990] p. 377-78

¹⁹*Newsweek*, "How our American Dream Unraveled," March 2, 1992, p. 32:

²⁰Etzioni, Amitai, *Wall Street Journal*, "A New Community of Thinkers. Both Liberal and Conservative," Oct. 8, 1991

Technology

The Age of the Microprocessor

At the same time that social values are undergoing extraordinary change, so technology, the other major driving force of the future, is transforming our lives and the outline of the horizon before our eyes . . . and at rates never thought possible. Profound implications -- some that we can't yet see or understand -- attend this explosion.

The rate of change is hard to comprehend. Consider that more scientists are alive now than the total who have lived and died since science first branched off from witchcraft and the magical arts.²¹ Eighty percent who have ever lived are alive today. And all of them are producing new discoveries at extraordinary rates.

The amount of information in the world is said to be doubling every eighteen months. In the last two decades, the update cycle for textbooks has shrunk from every five years to every one to three. There are some areas where the growth of information is so rapid that by the time the book is published, it is obsolete.²² There are now 25 accredited physician specialties and 56 subspecialties. Thirty-five of the subspecialties were recognized in just the past five years. Additionally, 123 self-appointed medical boards certify physicians in areas ranging from addiction treatment to circus medicine.²³

At the center of this maelstrom, functioning much as the printing press did soon after its invention, is the microprocessor. In the same way that Gutenberg's invention enabled the spread of information during the Renaissance and Enlightenment, so the microprocessor computer is exponentially expanding the human ability to collect, analyze, manipulate and communicate information.

Unlike the printing press, telephone or any previous information technology, though, the microprocessor is fueling its own revolution. Printing presses, for example, did not directly produce more capable printing presses, but each new generation of computer chips are used to make more capable computer chips, compounding the rate of change.

Where the printing press enabled the shift to the industrial age by greatly increasing the distribution of the ideas of Newton, Copernicus and others, the microprocessor will be responsible for moving the concepts of Bohr, Einstein and Heisenberg into the mainstream of society at a far more rapid rate. Where, even with books, information in the 17th century could take months, if not years to get widely communicated, now the news of new scientific discoveries can circle the globe hours, if not minutes, after the event.

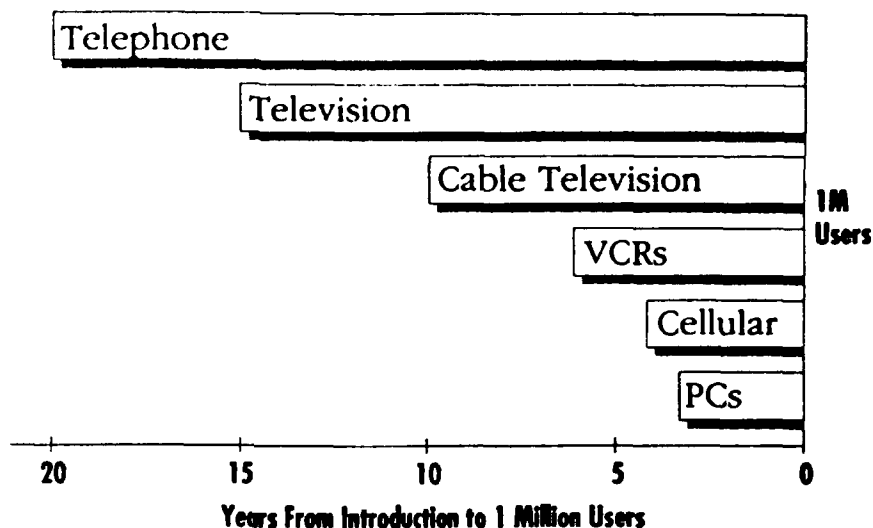
Exponential Increases in Proliferation and Capability

As we shall see, the microprocessor is making everything in the developed world move faster. The very metabolism of societies is being hyped by the exponential proliferation of devices that are becoming more capable at equally exponential rates. New disciplines and sciences are being explored that are only 8 or 10 years old -- because they became feasible only with the advent of the iterative capabilities of the desktop computer.

The growth is astounding. It took 100 years for the steam engine to make it to the marketplace. For the microprocessor it was 20 years.

Even compared to more recent inventions like television, the rate of penetration of personal computers has been extraordinary: a million users in only three years.

Penetration Rate of New Technologies



Source: RMI/Phillips Publishing

REGIS MCKENNA INC.

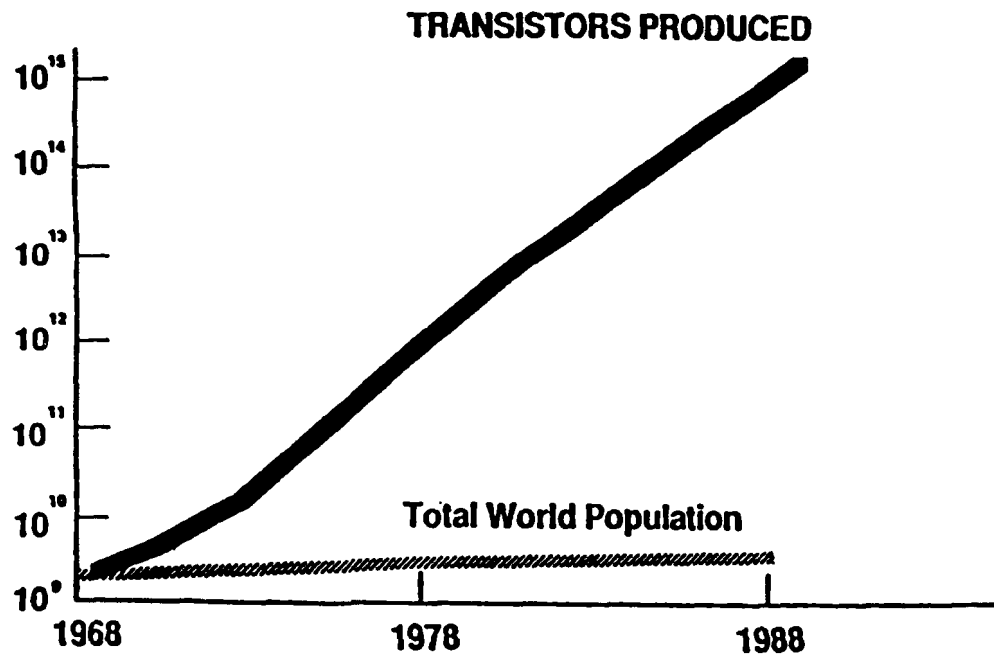
Personal computers have grown from almost nothing to over 60 million users in a decade.

The production of transistors, the most basic unit in the microprocessor, is exploding. It is estimated that over one million are produced each year for every person on the earth . . . and the rate is growing exponentially.

These transistors are being made smaller and smaller, so much so that recent industry estimates had somewhere between 100 million and 1 billion crowded onto a single finger nail-sized chip by the end of the decade. Since then, IBM's Thomas J. Watson Research Center claimed to have developed the world's smallest transistor, an experimental metal-oxide semiconductor field-effect device with nanometer (billionth of a meter) dimensions. IBM's transistor will permit memory chip fabrication in the realm of four gigabits (billion bits) and beyond.²⁴

As the density increases, the cost is coming down -- precipitously. Computing power is now increasing at a rate of 4000 times per decade for a given unit of cost.

TRANSISTORS PRODUCED PER YEAR



Source: DARPA

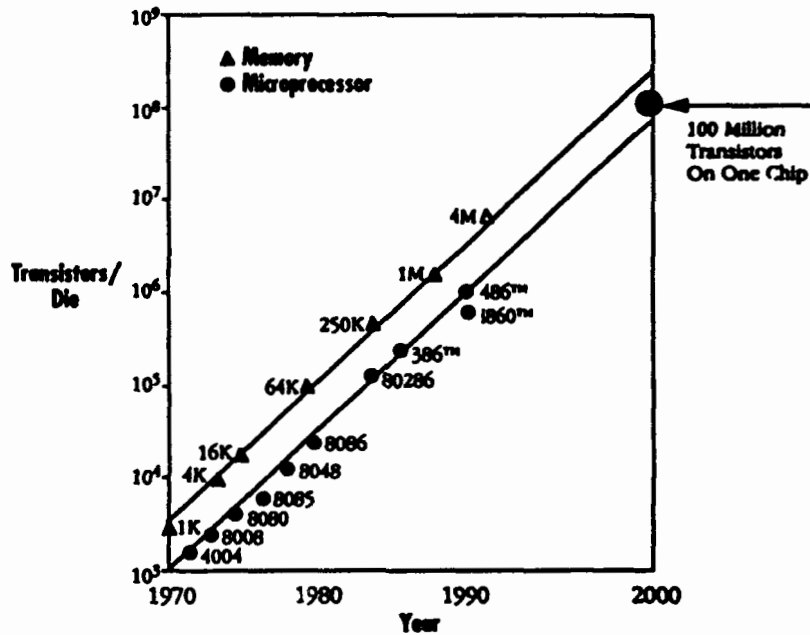
A PC bought in the year 2000 will be 4000 times more powerful than one purchased in 1990 for the same price. Projections in 1988 by Carnegie Mellon's artificial intelligence pioneer Hans Moravec suggested that single computers would bypass the raw computing capability of the human brain around 2010.²⁵ Others have suggested that it may be sooner than that.

New Developments

Tamarack Storage has shown a holographic memory device that quickly stores huge amounts of data three-dimensionally in its array of crystals by using two lasers so that they intersect at various angles within each crystal. The developers believe that the device could replace hard disk drives and may be able to store more than 10 gigabytes of data in a crystal smaller than a sugar cube.

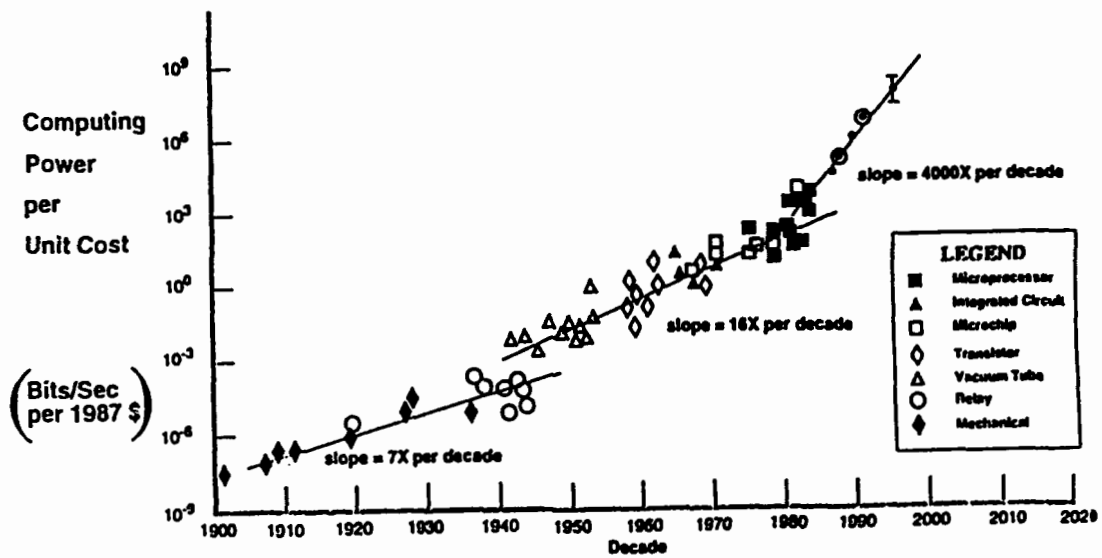
A year ago the San Francisco Chronicle reported on a major step toward building an artificial brain and other "intelligent" machines. Scientists at the California Institute of Technology and at the University of Oxford created a silicon chip that behaves much

Moore's Law



Source: California Management Review

PROCESSING POWER



Source: DARPA

like a human brain cell. The device which they call a "silicon neuron" and whose circuitry is explicitly modeled on the structure and internal workings of neurons in the cerebral cortex, is unlike conventional computers because instead of working digitally, it operates in the analog mode -- the same way a living brain works. Moreover, the device is so energy efficient that it uses only one ten-millionth as much power per operation as does a comparable digital chip. The feat -- along with the earlier development of a "silicon retina" that works so much like a real eye that it is even fooled by the same optical illusions that trick humans -- marks a significant advance in a field of computing that has long been overshadowed by digital machines.²⁶

Japanese researchers are working on optical integrated circuits that will be 1000 times faster than silicon chips. Some projections suggest that by the year 2000 they will be in the marketplace.

Extraordinary Applications

OMNI magazine reported last fall that home video games in eight years will have the equivalent power of the largest supercomputers made today. Single desktop machines at that time will have the capability of up to twenty current Crays. Nathan Myhrvold, planner for Microsoft said that ten years from now video Christmas cards will be sent with special effects rivaling those in *Terminator 2*. You will splice your kids' faces into TV shows.²⁷

Microprocessors are becoming a part of almost every aspect of life. Individual telephones have them. They are embedded in watches. They control washers, dryers and ovens. The automobile industry is the largest customer of microchip manufacturers. The Toyota Camry is reported to have 64 microprocessors in it, controlling all systems from individual valves, engine ignition and fuel mixture to the heating and air conditioning.

It is hard to imagine what the implications of this kind of growth and power might mean for we are really only at the beginning of this revolution. Computers are still primarily used only to do more effectively what has been done by other means in the past. When designers complete the transition into the new generation of devices that conceptually did not exist before the microchip, then huge new increases in productivity and capability will be upon us.

Communications Networks

One of the most profound and far-reaching trends that underpins the rest of the technology revolution is the rapid interconnection of individual computers. Some have suggested that it is the engine for economic growth in the 21st century. In a real sense, the world is being "wired-up" into global networks of millions of *personal machines connected to each other by fiber optic and satellite links*. These networks allow essentially instantaneous communication to anyone else on the net.

That interchange can include mail, documents, books, pictures and photographs, voice and music, video and television images and programs, and films. On large commercial networks like CompuServe, one can pay bills, shop at thousands of stores, make reservations and buy airplane tickets, monitor the stock market, and research large databases of newspapers, magazines, and encyclopedias, all from their home computer.

Huge databases located at universities, government agencies and research institutes are, in many cases, accessible to anyone at no cost. The largest of these networks, the Internet, includes over 1000 universities with databases of computer programs and other information.

This rush to connect computers is obviously not limited to researchers and academics. Whole countries are wiring every home, business and school in the nation. Japan expects to be completed by 2005. Turkey's system will move some remote locations from the Medieval age to the information age overnight.

In the U.S., the initial funding for the first of the networks that will be a national telecommunications backbone was assured by passage of the Gore bill in December 1991. The prototype is the National Research and Education Network (NREN) which today operates at 45 million bits per second.²⁸ One study estimates completion of a universal fiber network could boost U.S. annual productivity growth by 0.4 percent and add \$321 billion to the nation's wealth over the next 16 years.²⁹ The design for another section of this backbone, connecting 21 supercomputers together

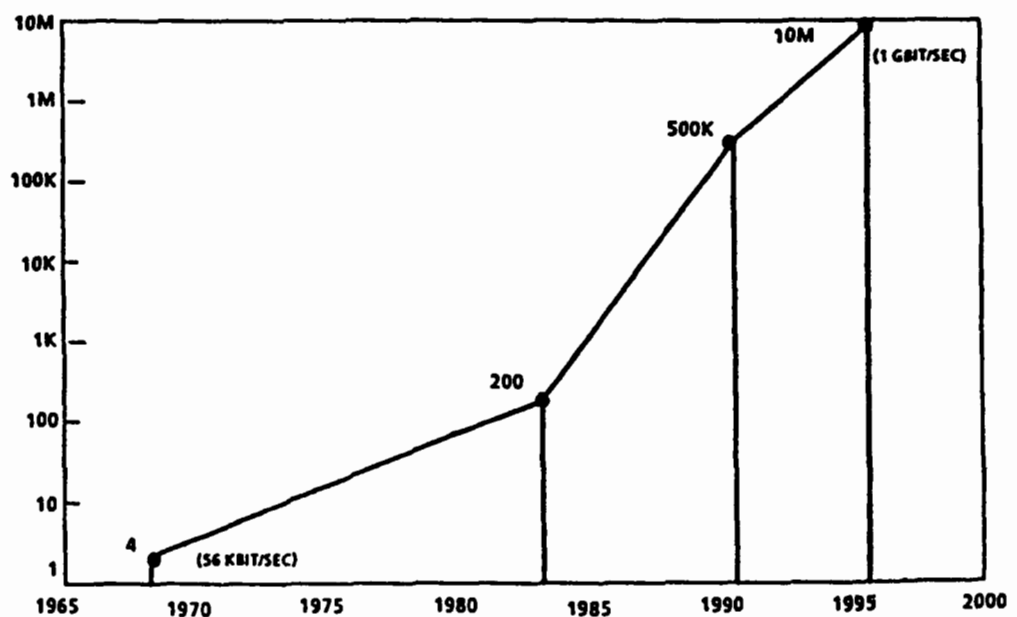
from San Diego to Cornell, was recently announced by the National Science Foundation.

The Internet

The growth of the Internet is instructional. Started first by the Defense Department's Advanced Research Projects Agency this "network of networks" connected only four host computer systems in 1968. By 1983, there were 200 agencies, schools and corporate research labs interconnected. Between 1991 and 1995 it is estimated that the number of international host systems will increase from 500 thousand to 10 million. Transmissions of packets of information have swelled from 50 million a month in 1988 to more than 20 billion a month now.³⁰ Vinton Cerf, a codesigner of the Internet and now president of the nonprofit Internet Society, predicts there will be 100 million U.S. Internet users by the end of the decade.³¹

The Internet, which is quickly becoming commercialized, is growing at the rate of over 25% per month. At that rate (which cannot continue), every person in the world would be connected by 1995. In addition to network growth, the capability of the Internet is increasing because of higher transmission speeds (now gigabits per

INTERNET EVOLUTION - Computing Systems



Source: DARPA

minute), and the reach down to the grassroots (schools, small businesses, libraries, state and local government.)

Undersea Fiber Optic Cables

A fleet of almost three dozen cable-laying ships are laying under sea fiber optic cables about as fast as they can. AT&T's TAT-9 cable now in service under the Atlantic can handle 80,000 transmissions at one time and has the capacity to carry in one day what the first cable, installed in 1956, carried in 20 years. Two additional AT&T transatlantic cables are planned and a transpacific cable will soon increase this company's capacity to some 600,000 simultaneous calls when it begins service in 1995.

In total, by this means alone, there will be more than 1.1 million voice circuits between the United States and Europe by 1996 and 441,000 to Asia. (New techniques in data transmission that were widely deployed this year, like the so-called frame-relay format, will raise speeds of transmission nearly thirtyfold.)³²

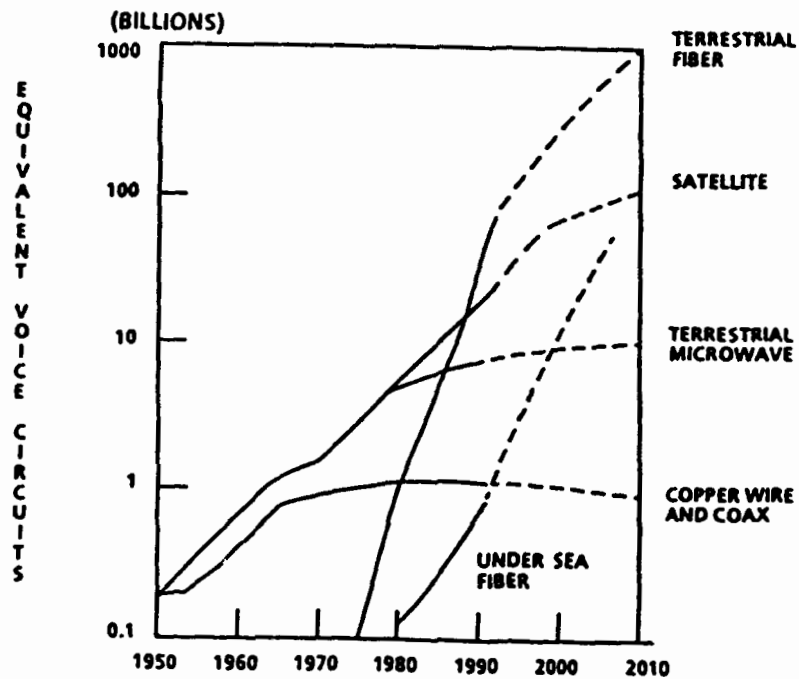
Satellite Systems

A number of new private global satellite constellations will also come on stream in the next five years. Large scale low-earth-orbit (LEO) systems -- like Motorola's 66 satellite Iridium system -- will provide telephone communications to and from any place on earth. [There is a section later in this report which focuses on commercial space.]

Ultimately this space-land-undersea network will be accessed by "Personal Information Appliances" which will include all of what we expect from televisions, radio, fax machines, computers, and probably some devices that haven't been thought of yet. One author believes that "By 2015 or so, our planet will be enshrouded in a delicate spiderweb of fiber-optic cable and circled by a galaxy of artificial communications satellites. Either network will be capable of transmitting symphony-quality sounds and video images of astounding clarity to wall-sized panels no thinner than picture frames, mounted in homes and exurban mini-office clusters."³³

The social and economic impact of this broadband networking will be profound. Guy Daniels, of *Telecommunications* magazine recently wrote, "Teleworking, or telepresence, has long been

GLOBAL TRANSMISSION CAPACITY



Source: DARPA

touted as the answer to traffic jams, the energy crisis, and increased productivity." He cited "potential savings to employers and employees alike, (in 1988, analysts at Arthur D. Little estimated that teleworking could save the U.S. economy \$23 billion per annum)."³⁴

Wireless Terminals

For business, in particular, the cost of wiring computers and peripherals into networks is a costly undertaking. It is particularly so when it must be redone every few years as the present technology becomes obsolete or the size or location of the company changes. There is therefore a growing trend toward wireless terminals -- computers and other devices that can interface with other machines via infrared or other electromagnetic signals (like common television remote controls). This allows computers to be moved easily and, as long as they remain in the vicinity, continue to function in a larger network.

The first generation of this capability is on the market now for desktop PCs. Some small palmtop units can trade files between themselves by just pointing them at each other. One columnist, after having tried out a palmtop machine told of writing nine E-mail messages on the plane between Boston and New York and releasing them into the air when she landed. "I think it could be the ultimate tool for mobile professionals. It could easily replace pagers and cellular phones."³⁵

This trend is significant, for as electronics shrink they become more portable, and the need to constantly connect and disconnect from a local area network is troublesome.

Cellular Networks

Cellular telephone and data networks are covering this country and have arrived at most major cities in the world. It will only be a short time before one can be in constant cellular contact in any significantly populated American area. Almost anything that can *function on a phone line* (computer, fax, etc.) can now access the cellular system and through that the larger global information network.

The cellular system is so advanced and spreading so rapidly (30 to 40 percent annually in the U.S.) that fiber optic advocates, who once thought that fiber systems would carry telephone traffic, now know that catching up and bypassing the advances that have been made by cellular operators are economically impossible.

Information and Knowledge Becoming Predominate

What this all means, is that we are **quickly moving toward the time when anyone can get any information to almost anyone else almost anytime**. We are also **increasingly moving information instead of people**. And we're doing it almost instantly.

Acting much like a body's nervous system, this global network will pulse with data and be the prime conduit for the capital commodity of the coming age: **information**. It will allow new ideas to sweep the globe and give extraordinary access to information to those who are connected. As Alvin Toffler suggests, the very concept of power is shifting *from being defined by money to being information-based*. This, by the way, is exacerbating one of

the major problems of the coming decades, the increasing disparity between the have and have-not nations. Toffler, referring to the effect that information technology will have on tempo of human activity, calls them the fast and slow societies.

Toffler and Japanese futurist Taichi Sakaiya speak of future economies being "knowledge-based". What they mean is that as information becomes more important in the relative success of an individual or group, the most significant resource then becomes the base of knowledge that has been acquired about the particular subject or project. No longer are natural resources, labor pools and the other traditional metrics of power and wealth as applicable as is the knowledge-base that can be drawn upon.

The global information network (which is far more refined in the U.S. than any other region), is the perfect tool that will allow the sophisticated knowledge worker to mine the databases and knowledgebases of a huge number of sources.

In an age defined by interdependency, this globe-girdling network will also facilitate the interchange of information between and among disciplines, something that has significantly held up the pace of discovery and enlightenment for most of history.

Computational Biology - Artificial Life

One technology with immense implications for the future that exists only because of the microprocessor is the discipline of computational biology and its principal derivative, artificial life (a-life). Briefly stated, a-life is the study of relatively simple computer algorithms that when turned loose in the memory of a computer, exhibit all of the characteristics of regular life. A single small organism (about 80 lines long) will self-replicate until there are many thousands living together. They self-examine themselves, destroy and consume other entities, creatively adapt to constantly changing situations, live off of other kinds of entities and generally act like they are alive. Common computer viruses are a simple form of a-life. As Steven Levy, author of *Artificial Life* summarizes:

It is something quite different from genetic engineering, which uses fully evolved wet life as its starting point. The scientists of a-life are devising the means by which actual living systems can be generated, evolved, and observed. Theirs is an effort to engineer the course of evolution and extend the range of living systems on planet earth and beyond.

From this grand experiment, a more profound understanding of life itself, an ability to use its mechanisms to perform our work and, perhaps, the discovery of powerful laws of nature that govern not only biological systems but also any series of complex nonlinear self-organizing interactions may ultimately arise.³⁶

Computer Code Adapts To Its Environment

The routines are autonomous, so once turned on, they continue to adapt to the environment automatically until destroyed. Since increasingly significant aspects of human existence are being defined in computer code, for researchers in this area, a-life appears to hold the answer to life itself, with all the potential opportunities and disasters that such knowledge would include. They talk about sending molecular-sized machines to someplace like the moon, where, on their own, the micromachines would replicate themselves and mine the surface for minerals, convert the minerals to metals, configure the metal into certain products . . . and then what? Since they are on their own and can adapt and evolve independently, science fiction-like scenarios quickly come to mind of "spores" of such things sending themselves off to other planets after they have ravaged the moon . . . and then to other planets. Or getting loose on earth and attacking humans and all other organic life.

Much More Powerful Than The Bomb

A leading scientist in the area says that understanding the powers of nature will be "very, very, very much more powerful than the discovery of the bomb, and it will have much wider consequences."³⁷ Another suggests, "By the middle of this century, mankind has acquired the power to extinguish life on earth. By the middle of the next century, he will be able to create it. Of the two it is hard to say which places the larger burden of responsibility on our shoulders."³⁸

How could the worst case scenario occur? "Farmer and Belin suggested a horrifying example of a potentially destructive use of a-life techniques -- 'military applications . . . from battlefield robots to satellite warfare.' Considering the pervasive government funding of a-life studies, . . . this seems almost an inevitability. Farmer contended that, if a-life came to realize its potential, those uses would destroy even those who sought to utilize it. 'Once self-reproducing war machines are in place, even if we should change our mind and establish a consensus, dismantling them may be impossible -- they may be literally out of our control.'³⁹

Artificial Intelligence

One area which has been under development for some time and promises significant benefits in the near future is artificial intelligence. AI is about designing computer programs that think for themselves -- that have an aspect of autonomous human logic.

Expert Systems

Expert systems, programs that mimic the decision-making process of an expert in a particular discipline, are the best known version of this set of computer applications. An expert system might be written to stand in for an insurance application analyst, for example. Just like the human expert, it would, step-by-step, go through the process of evaluating each of the processes that an analyst goes through to determine the quality of an application for insurance. Many thousands of expert systems have been written -- each for a specific task.

More generally, AI applications do things like monitoring the usage of long-distance telephone or credit card accounts for anomalous activity. If, for months or years, your telephone credit card bill has averaged \$50 a month and suddenly, a series of long duration, perhaps, international calls are made, and the usage of your card goes up to \$200 in a week, an AI program will probably spot the change immediately and flag a human to look into whether your card has been stolen or not. Similar programs operate big machines, monitor complex systems, and analyze things like stock market behavior.

Rule-Based

Most AI programs are rule-based -- the rules for each and every decision the program might make have been written in computer code and are part of the program. The problem with this approach is that the program knows nothing that it hasn't been told. If a particular rule, or situation hasn't been accurately anticipated and translated into computer code, the application will not respond correctly. A huge breakthrough in this area is on the horizon in the form of Cyc, a human commonsense knowledgebase that is presently under development. It is explained in detail later in this section.

Parallel Processing

Some of the shortcomings of rule-based systems have been sidestepped by parallel processing machines and their associated software. Parallel processors utilize many -- in some cases thousands -- of parallel-configured microprocessors which function, in very rough terms, like a human brain. Each processor is like a neuron, connected to many other neurons. Like a brain, parallel processing systems can *learn* -- determine new information on their own -- by analyzing inputs and making independent deductions about relative importance and significance.

Even though some of the most sophisticated computers around are massive parallel processors -- like the Thinking Machine -- conventional parallel processing too, has its basic shortcomings -- it cannot effectively deal with very complex problems with hundreds of inputs. A new parallel-processing-based approach to software, Holographic Neural Technology (which is also described later), appears able to circumvent many of these problems.

AI has great potential for automating many activities that are expensive, dangerous or time consuming. For years, great claims have been made for the future of AI that have not come to fruition, but it seems likely that with the combination of some of the new developments mentioned here along with significant advances in microprocessor power, the next two decades will see a significant expansion, both in quantity and quality, of artificial intelligence applications.

Complexity/Chaos Theory

Another new science that exists only because of the microprocessor is Complexity and its most famous derivative, Chaos Theory. Before the advent of the small computer, trying to determine the behavior of a very complex system after millions of iterations of change was essentially impossible to do. Even if large computers could even do it, it was usually too expensive an undertaking. Therefore, scientists assumed that dynamical systems exhibited two kinds of behavior: stable and unstable or chaotic. Chaotic behavior was opaque and seemingly completely random.

When scientists attempted to run some of these kinds of experiments of the new small, cheap computers that began to show up in the early 80s, they discovered that if they pulsed the systems enough times they could begin to see distinct patterns in this irregular, chaotic behavior. "Physiologists found a surprising order in the chaos that develops in the human heart, the prime cause of sudden, unexplained death. Ecologists explored the rise and fall of the gypsy moth populations. Economists dug out old stock price data and tried a new kind of analysis. The insights that emerged led directly into the natural world -- the shapes of clouds, the paths of lightning, the microscopic intertwining of blood vessels, the galactic clustering of stars."⁴⁰

A Major Breakthrough of the Twentieth Century

The most passionate advocates of chaos theory suggest that twentieth-century science will be remembered for just three things: relativity, quantum mechanics, and chaos. "Chaos, they contend, has become the century's third great revolution in the physical sciences. Like the first two revolutions, chaos cuts away at the tenets of Newton's physics. As one physicist put it: 'Relativity eliminated the Newtonian illusion of absolute space and time; quantum theory eliminated the Newtonian dream of a controllable measurement process; and chaos eliminates the Laplacian fantasy of deterministic predictability.' Of the three, the revolution in chaos applies to the universe we see and touch, to objects at human scale."⁴¹

The promise of chaos and the study of complexity is that we will soon begin to find explanations for enormous number of chaotic situations and images that surround us. Already Japanese theorists are trying to adapt chaos theory to business management. One could believe that there were applications of this discipline to the political sciences -- predicting why countries become unstable, or go to war, etc.

The new science of complexity was coined at the Santa Fe Institute in New Mexico where much of the most significant work on chaos has been done. Their researchers have looked into areas as diverse as stock market behavior (funded by a major American bank) and the activity of genetic and immune systems.

As was mentioned at the beginning of this report, every issue of any significance is essentially a problem in systems -- in most cases, a very complex dynamical system. All past attempts to model the economies of nations, the behavior of regions -- even the weather -- have all failed because of the inherent complexity and unpredictability of the systems. Chaos theory and the study of complexity offers hope that we may soon be able to push through what previously was thought to be an impenetrable wall of ignorance in these and many other areas.

Virtual Reality

Humans define reality by their senses. What they see, hear, feel, smell and taste, for most people, is the sum of their experience and the total input into the process of determining who they are, where they are and what the rest of outside reality is. In the same way that by saturating the sight and sound senses, a good movie can "transport" a viewer to a different place and time, so, though many times more effectively, modern computers can synthetically produce video, audio and kinesthetic inputs and in the aggregate, generate for the participating subject a "virtual reality."

Creates The Convincing Illusion of Being Somewhere Else

Howard Rheingold, author of *Virtual Reality* describes the process as being a "new technology that creates the illusion of being

immersed in an artificial world, or of being present in a remote location in the physical world. To enter virtual reality (VR), a person puts on a head-mounted display (HMD) that looks like a SCUBA mask. A pair of tiny television tubes, special optics and wide angle lenses, and a device that tracks the position of the user's head are mounted in the HMD so that when it is worn, the normal view of the outside world is completely blocked: in the place of the physical world is substituted a stereographic, three-dimensional computer graphics depiction of a 'world model' that exists in a computer. Besides being immersed in the artificial world, the person is able to navigate within that world, and to manipulate it using hands and fingers."⁴²

Revolutionizing Many Areas of Life

Virtual Reality is, of course, another profound technology that is based on the microprocessor and it is already beginning to revolutionize many areas of life. Doctors located in the U.S. have done operations on patients half way around the world using VR. In their "eyephones" they saw the world exactly as it was at the other location and picked up and used instruments by remote control.

Rheingold talks of "grabbing" and moving two molecules at one university installation. He could "feel" when the two otherwise invisible particles were bumped into each other and could see and feel the difference when he configured them in different ways.⁴³

The military has built a huge SimNet system that allows participants scattered around the world to simultaneously visit the same virtual battlefield in whatever type of airplane, tank or other equipment they use. Ships in the Pacific can have real-time radar displays that look like the "battlefield" located in North Carolina. Army tankers in trainers in Ft. Knox, Kentucky look out of their sights and see the same location -- only from each of their individual perspectives. Air Force pilots in California can "fly" missions in support of the other participants from their trainers at the same time.

The SimNet people have built a database of one of the major battles of Desert Storm and are able to replay that engagement varying almost every possible aspect: time of day, number of enemy tanks, location of enemy and friendly installations, view of the battlefield from any location in the area, etc., etc. Trainees can

rerun the battle trying different tactics and observing the change in results.

Virtual Reality's biggest short-term commercial potential lies in the entertainment area. Already VR arcade games are in the malls and Sega, a major electronic game manufacturer, has announced that they will introduce a home VR game in the summer of '93.

The Virtual Office

A practical example of how VR might be used is given by Steve Pruitt and Tom Barrett, writing in the book, *Cyberspace, First Steps*. They draw the mental picture of the Corporate Virtual Workspace (CVW) of the not distant future. "Austin" is a software engineer who, after getting up in the morning, goes to his study and dons his customized computer clothing. He logs in to the fiber optic network via his home reality engine and in doing so connects his Personal Virtual Workspace (PVW) with that of his employer's CVW.

"As he steps into the CVW, he enters a vast network of interconnected hallways in a bustling virtual corporation. He enters the CVW via his office, number 16 on the red hallway. . . . Even though Austin's PVW appears to his colleagues as just another office along the red hallway, he has organized *his* perception of it much differently. He perceives it as a control center at the confluence of several hallways. Upon entering his PVW, Austin can look out the window and down about 30 feet to view three hallways converging below him."⁴⁴

The red hallway contains offices and conference rooms for software engineers from all over the world who are currently involved in the CVW. The blue hallway is reserved for client offices (PVWs). The last, green, hallway supports a collection of resource centers. Vast collections of trade journals and technical publications are available in different resource centers that are organized around particular subject areas.

In much the same way that he would in a present day office building, Austin interfaces with his colleagues and clients by walking down the hall and entering offices, does research using huge knowledgebases, and tests his products -- all without leaving his study at home.

But in the end, VR holds the promise of revolutionizing business, education (for history, go back and walk through the world in ancient Roman times), travel (preview your trip by visiting there first virtually) and, even common conversations with relatives in a different state. In fact, VR is to the information age what the telephone was to the industrial age, believes Jaron Lanier, the premier spokesperson/philosopher of virtual reality.⁴⁵

The first phase of this trend is already in place -- telecommuting -- where knowledge workers work at home and stay in touch via E-mail, fax and telephone.

Again, in every VR case, the trend is to move information rather than people.

Virtual Prototyping

One of the major problems in designing vehicles, particularly high speed aircraft, is anticipating how the device will actually react with the external atmosphere when it is built. The amount of drag and stability that a vehicle ultimately exhibits are a function of a very complex interaction between the surface of the body and the air or water that it is driven through.

The equations that describe fluid flow (the so-called Navier-Stokes equations) are theoretically capable of exactly defining the flow down to the smallest turbulent eddy. The problem is that they are so complex -- perhaps even the most complex relationships in the case of hypersonic flight -- that it has been impossible in the past to produce more than general approximations by mathematical means. The accepted solution was to build scale models of the vehicle, put them in a wind tunnel or test tank, and then measure the forces on the model as air or water passes by.

This type of testing is representative of the basic approach human have had to take in many different areas. If the problem is too complex to model mathematically, go out and test a model and note the results. This is about to change.

The power of specialized computers is becoming so great that engineers will soon be able to directly model 80 percent of the fluid flow across a complex shape and approximate less than 20

percent of the energy contained in the very small eddy currents. This, in theory, would allow ships, aircraft, cars and trains (and anything else that flows through a fluid) to be completely designed with computers and not have to be physically tested. Shapes could be quickly adjusted to optimum and a wide variety of external conditions could be virtually simulated. This direct solution of turbulence would allow virtual prototyping -- a device could be built completely in a computer and its characteristics would almost exactly be known . . . before one piece of metal was cut or machined.

One wonders what the implications of this capability might be in other areas, such as social science or biology. Might we soon be able to anticipate the behavior of complex relationships that before were clearly left to fate?

Nanotechnology

Throughout history, most everything that has been manufactured by humans, was built from the top down: a larger piece of material (like a board of wood), was shaped, using tools, to something smaller. Regardless of the material, and except in some esoteric chemical processes, we have worked this way to make the items we make. This too is changing.

Molecular nanotechnology is the process of building things from the bottom up. Starting with individual atoms and using molecular-sized machines to put them together in predetermined configurations until you have what you want. Nanotechnology is a "revolution times a revolution" and will mean a thorough and inexpensive control of the structure of matter. As Eric Drexler, who coined the term says, "Twentieth-century technology is headed for the junk heap . . ."46

Applicable to Everything

This technology has profound applications everywhere -- energy, environment, communications, space development, construction and housing, food, population, defense, transportation, and health, to name a few initially obvious areas. "Molecular

manufacturing will be able to make almost anything with little labor, land, or maintenance, with high productivity, and with modest requirements for materials and energy. Its products will themselves be extremely productive, as energy producers, as materials collectors, and as manufacturing equipment. There has never been a technology with this combination of characteristics, so historical analogies must be used with care. Perhaps the best analogy is this: Molecular manufacturing will do for matter processing what the computer has [and will] do for information processing."⁴⁷

Nanomachines would be machines -- shafts, bearings, cams, articulated arms, pumps, etc., put together in combinations that function like small factories. The schematic diagram of some such machines is shown on page 65.

Drexler's computations suggest that a mature molecular manufacturing capability will be able to make products for about the cost of the raw materials alone. This doesn't take into account the front-end design cost, but in any case, things will be much cheaper.⁴⁸ Furthermore, things will be typically 80 times more durable and stronger, since they can be made of diamond as easily as any other material.

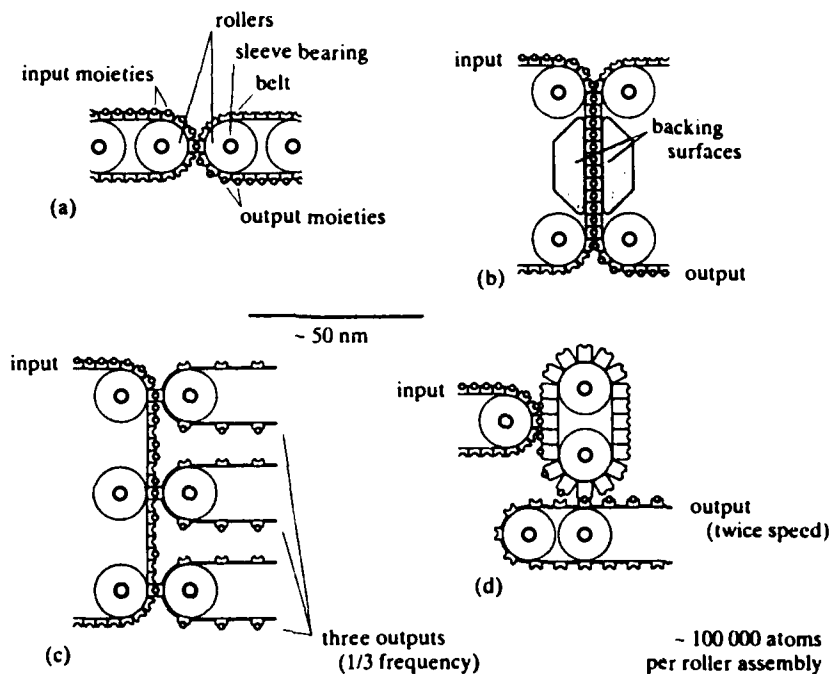
Applications

These characteristics, for example, suggest that solar cells can be made efficient, as cheap as newspaper, and as tough as asphalt -- tough enough to use for resurfacing roads, collecting energy without displacing any more grass and trees.

Medical Machines

Minuscule devices smaller than red blood cells could cruise the bloodstream searching for fat deposits and infectious organisms. When they found them they would destroy them. "Medical devices built on the scale of bacteria and viruses, and endowed with artificial intelligence from those tiny computers, could continuously monitor and repair the operation of every cell in the body."⁴⁹ Cells that "sagged" from their original configuration could be fixed -- thereby slowing aging.

Nanotechnology Machines (schematic diagrams)



Source: *Nanosystems*, K. Eric Drexler, John Wiley & Sons, 1992

Pocke: Supercomputers

Pocket supercomputers could become commonplace with nano-processors almost too small to see, yet having millions of times the computing capability of the largest supercomputer today. One estimate suggests that components of molecular size could make a single desktop computer of the future more powerful than all the computers in existence today combined.⁵⁰ If clusters of a few atoms could be the elements of an information code, every book, magazine, pamphlet, and newspaper ever printed, complete with graphics, could be stored in a volume the size of a credit card.⁵¹

Major increases in communications capacity could be had with data-cables that included "amplifiers, nanocomputers, switching nodes, and everything else needed, and were loaded with software that "knows" how to act to transmit data reliably."⁵²

Agriculture can become much more efficient as plants are grown in greenhouses, produced by molecular manufacturing.

Nanomachines could eliminate pests and automate the growing process.

In terms of transportation, underground tunnels for high speed trains could be bored cheaply and lined with very durable materials. They could probably be made less expensively than roads. Energy would be much cheaper and not fossil-based.

Information is Power

Molecular nanotechnology would quickly define power, as Alvin Toffler suggested, in information terms, and individuals would have the ability to have extraordinary influence on humankind -- with no resource other than a computer and the knowledge of how to use it effectively. In one Drexler scenario, Singapore becomes a global military power because two smart researchers with computers and nanomanufacturing capability designed a nanomachine that threatened everyone else.

The first usable products from molecular manufacturing should be available by 2002, followed quickly by further rapid development. In addition to all of the obvious advantages of being able to manufacture things like televisions inexpensively, in time molecular nanotechnology could eliminate the world's problems of food, energy, environmental pollution, and waste.

Biotechnology

Biotechnology, using technology to manipulate and take advantage of the genetic structure of plants, animals and humans, is making great strides. Many companies in the U.S., Europe and Japan are producing products in the areas of health care/pharmaceuticals, agriculture, chemicals, energy, and bioremediation. Biotech is very broad. It includes fish farming, forestry, production of enzymes for laundry detergents, genetic engineering of bacteria to clean up oil spills, kill insect larvae or produce insulin. Biogeneticists are working on better food and animals. It is therefore difficult to construct generalizations about the discipline.⁵³

There are two broad segments of biotechnology: genetic engineering and environmental engineering. Stanford's Richard Carlson

and Bruce Goldman say that genetic engineering will lead to improved crop yields, ultra-efficient manufacturing processes, and thorough toxic-waste clean-up. It will unlock the secrets of whole ranges of diseases, including cancer, diabetes, arthritis, and multiple sclerosis.⁵⁴

Health Care

Most present biotech products are primarily in the health care area. A report on the biotech industry in 1992 suggested that: "Never have so many revolutionary therapies come into the marketplace in so short a time. More products were approved in 1991 than in any of the previous eight years. More potential products are awaiting approval than at any time in the industry's history."⁵⁵ Already there are some three dozen genetically-engineered pharmaceuticals on the market designed for treating everything from leukemia, diabetes, hepatitis and hemophilia to AIDS. Still a couple of years away in pre-clinical stages of development are start-ups focused on neurobiologicals, treatments for Alzheimer's disease, Parkinson's disease, brain and spinal injuries, migraine headaches, schizophrenia, and anxiety.⁵⁶

Some of the advances in this area are a direct result of developments in computer technology. Computer modeling allows scientists to design specific molecules to interact with cellular receptors to block or enhance the desired cellular activity. Increasingly sophisticated computer models of human and animal systems coupled with the mapping of the human genome are also hastening the day when animals will not be used in testing for these new chemicals.

Agriculture

Research in this sector ranges from pharmaceuticals *for* plants to manufacturing pharmaceuticals *from* plants. A number of genetically engineered seed stocks have been developed for corn and sunflowers that offer much better resistance to pests and disease and produce products with enhanced natural characteristics. The first gene-spliced tomato may be in supermarket shelves in 1993. Calgene Fresh, Inc. has designed a tomato that resists softening and will have an extended shelf life as well. If the federal government approves, much tastier store tomatoes will find their

way into American salads. Other firms in the U.S. and Europe are also working on other gene-spliced tomato varieties.⁵⁷

Other companies have manufactured tomatoes that will grow in one-half salt water. Carlson & Goldman catalog the huge industrial potential for biologically altered organisms:

Genetically engineered microorganisms already concentrate ore and clean up toxic-waste spills. Many chemical processes today involve high temperatures, high pressures, imperfect catalysts, and toxic by-products -- ⁵⁸and are, therefore, energy-inefficient and hazardous. For thousands of years, "yeasts of burden" have been put to work in the brewing and baking industries. Thirty years from now, noiseless assembly lines of yeast or bacterial cultures -- each batch genetically altered to contain a particular ultra-efficient enzyme catalyzing one step of a chemical process -- will produce bulk chemicals of exquisite purity; additional genetically engineered microorganisms will gobble up any toxic wastes produced. Scientists will design new enzymes by computer, then build them from scratch in the laboratory and insert them into microbes that will do their bidding.

At Louisiana State University, biochemists are working on engineering potatoes, rice and cassava that will have the protein value of meat. A company in New Jersey uses genetic selection to grow naturally occurring strains of popcorn that have their own butter-like flavor. At Cornell University scientists are breeding apples that will not brown when cut up and exposed to air. The Japanese have developed a seedless watermelon. Pest- and frost-resistant fertilizers are on the market. Genetically engineered seeds for alfalfa plants that have more protein, require less fertilizer, and grow faster were tested in 1989.⁵⁹

In January 1988, on a farm in Wheelock, Texas, seven genetically identical purebred calves were produced from man-made embryos. In theory, thousands of identical animals could be produced through cloning.

Genetically altered cows in England are presently being used to produce drugs in their milk, thereby replacing whole pharmaceuticals factories. And the cows give birth to calves that also produce the desired medicines. Sheep produce a blood-clotting chemical used for hemophilia in their milk. Mice have produced a blood clot-dissolving substance that is used for human heart attacks. The same chemical is being derived from a herd of altered

goats. As few as 300 goats could provide the world's requirements for this medicine.⁶⁰

Ag-bio firm, ESA Agenetics, is using plant tissue culture to develop a commercial production capability for taxol, a scarce compound derived from the Pacific yew tree, which shows promise as a treatment for ovarian cancer.⁶¹ Technology columnist Michael Schrage believes that the \$20 billion global market in conventional chemical pesticides needs rethinking. "Ecologists, entomologists and agribusiness folks are growing more enthusiastic about the potential of biopesticides -- targeted technologies designed around biological principles, as opposed to the traditional chemical weapons of mass destruction."⁶²

Human Genome Project

The most famous biotechnology project is the \$3 billion, 15-year global attempt to map the human genome -- the entire human genetic code. The objective is to determine the location, identification and function of each of the 50,000 to 100,000 genes that go into making a human being. Rapid progress is being made and, in addition to those in the U.S., major efforts are under way in Europe, Japan and the former Soviet Union.

Researchers will concentrate first on specific areas that they believe are responsible for diseases like cystic fibrosis, muscular dystrophy, Huntington's disease, Alzheimer's disease and manic depressive disease. With such genetic libraries available, the greatest initial impact will be on the detection, diagnosis, screening, and genetic counseling rather than on therapy.⁶³

Principal Benefits

Biotechnology brings with it a host of benefits. Perhaps the most significant will be the greater understanding of the role of genes in illness -- and, in time the ability to compensate for them. There will be a great increase in the number of recognized disorders. Biotech includes the most fruitful areas of research for understanding the nervous system -- molecular neurobiology. Huge health benefits have also attended classical genetic methods, with the production of the organism that produce penicillin, for example, increasing more than 100 times in the past several decades.⁶⁴

It is interesting to note that biotech may have some unanticipated social and economic benefits. Some plants like tobacco, for example, which currently have a rather negative reputation, are ideal vehicles for gene-splicing and the production of valuable pharmaceuticals. If crops like tobacco (and coca) suddenly became more valuable as breeding stock for medicines than for smoking it could dramatically change both the economic and geopolitical realities for significant regions of the world.

As was suggested earlier, some of the world's major environmental problems are already being attacked using genetically altered bacteria.

Ethical Issues

As with other emerging technologies, there are legitimate concerns about this "messing with nature." Critics have developed rather frightening (though others say, far-fetched) scenarios about new gene-altered organisms running amuck. There seem to be two major areas of concern: **understanding and controlling the research** that is being done, and **dealing equitably with the knowledge** that is produced.

Controlling Research

There are potential problems associated with the control and direction of biotechnology research. The root problem say critics like Michael Fox is not so much with the technology itself as with our worldview. "I am not in principle opposed to biotechnology. However, I am opposed to those who seek to use it only for profit regardless of ethical, social, environmental, and animal-welfare concerns."⁶⁵ In reaction to the news about the gene-spliced tomatoes that are planned for supermarkets this year, Greg Goldin points out that the tomato's selling point is its improved taste, a byproduct of biotechnology being used to fix a human-created problem. Store-bought tomatoes are tasteless because they are harvested green to allow growers to ship the vegetables across the country without spoiling. "Presumably, the tomato will taste better because they will stay on the vine approximately three to five days longer than a conventional tomato," Goldin writes. But why should people in the Midwest and East depend on huge tomato farms in California and Mexico in the first place, when the crop can be grown locally by smaller growers? It is our

industrialized system of farming that needs to be changed, not the genetic blueprints of our food, argues Goldin.⁶⁶

Concern by Technologists

Others have questions as well. A British survey recently reported in *New Scientist* (Aug. 29, 1992) found that environmentally concerned technologists are even more suspicious of biotechnology applications than the general public. The *New York Times* reported that more than 1,000 of America's most respected chefs have promised not to serve genetically altered foods in their restaurants and called on the FDA to strictly regulate the foods. There have been problems in the industry. In at least one case 31 people died and 1,500 contracted a potentially fatal blood disease after ingesting a genetically engineered batch of L-tryptophan, a dietary supplement.

Genetic code changes naturally, though slowly, in nature. Scientists point out that these are often genetic anomalies and so the distinction between natural and unnatural is not clear.⁶⁷ There also appears to be a natural limit on how far things can be altered. Experts say that radically different varieties are impossible.⁶⁸ So far, the major concerns about runaway organisms have been unfounded, and there is already a very rapidly growing collection of products in the marketplace to evaluate.

Dealing With the New Knowledge

The problems are tough in this area. With knowledge comes power and biotech is about to generate an explosion of knowledge about human beings. Very soon, we will be able, with screening, to tell before the fact who, in their youth, are likely to get Alzheimer's disease in their elderly years. We will be able to know who is carrying rogue genes that would probably cause major damaging diseases in their children, if they have them. We will know if abnormal behavior comes from stress, psychology or genes.

There is a subtle, but important change in perception that is about to occur. Science will begin to relate mental differences and health problems with molecular differences in brain and genetic abnormalities. No longer will it be the random hand of fate that deals some a bad hand of personal cards, but it will be the result

of "who they are." When the realization that there is a direct linkage between this genetic code and the characteristics a person exhibits becomes commonly known, knowledge about a person's particular code becomes extraordinarily powerful.

In general terms, think of I.Q. and how people relate to each other based on their perception of intelligence. Might a person's personal genetic map take on a similar role as an arbiter of value? Then, there are the issues of employers and insurers.

Perhaps, as Theodore Friedmann suggests, there is little conceptually new here -- the same issues exist with medical information. But the magnitude of the problem and its potential for abuse is much greater. As he says:

We shall come to understand which genes are responsible for defects in the development and metabolism, tumor development, aging, neuropsychiatric disorders, and many other illnesses. As a result, we shall be capable of undertaking screening and detection programs for many disorders, which often lack effective therapy. We shall also be able to use genetic tests to identify individuals for medio-legal and forensic purposes. These applications raise troublesome questions, however, regarding the involuntary application of predictive genetic techniques in other areas, such as employment and medical or life insurance settings, where the rights of individuals, employers, and insurance companies will inevitably clash.⁹⁹

Genetic Information Should Be Kept Confidential!

Some therefore argue that personal genetic information should be kept confidential. Nevertheless, a recent survey indicated that the majority of Americans believe that personal genetic information should be publicly available.

Ultimately, of course, there are the *Brave New World* considerations about whether we (governments?) should "engineer" humans to not only eliminate disease, but also enhance other characteristics (big, dumb guys for laborers, etc.) But those days appear to be more than two decades distant.

Arthur L. Caplan, director of the University of Minnesota's Center for Biomedical Ethics, was recently quoted, saying, "Just the Human Genome Project alone is the Full Employment Act for

bioethicists."⁷⁰ Those bioethicists and many new ones that will follow them will have their plate full for years ahead.

Computational Chemistry/Materials Science

"Computational Chemists are on the verge of being able to create, on demand, materials that have specific properties, whether of flexibility, durability or the ability to turn an alluring shade of lavender when the late-afternoon light strikes them at a certain angle."

-- Paulina Borsook

Paulina Borsook, writing in the *Whole Earth Review*, said, "Dirac, one of the fathers of quantum mechanics, said in 1929 that 'The underlying physical laws necessary . . . for a large part of physics and the whole of chemistry are completely known, and the difficulty is only that the exact applications of laws lead to equations much too complicated to be solvable.' No chemist has had the time or the means to perform the calculations, so no chemical engineer has been able to use the solutions to build new materials. It is turning out that advances in computer hardware and software may prove Dirac wrong: supercomputers and new ways to use them may finally be able to solve the equations that explain and describe the material universe."⁷¹

Along with nanotechnology, computational chemistry is fundamentally changing the relationship of humans to materials. Throughout history designers have built things with materials that were available. While new materials, like plastics certainly were invented over time, those new compositions were often, if not always, the result of trial and error and broad experimentation. Sometimes, even mistakes yielded unintended materials with practical value.

As Borsook said, computers are changing all of that. We are approaching the time when the designer of a bridge, for example, may compute the characteristics of the structural material required to meet her needs (flexibility, abrasion resistance, color, strength) and then order the mill to manufacture the material in the configurations she desires. That is different than now, where

one looks up the characteristics of the materials that are available, a certain type of steel, for example, and computes how much of it (thickness, etc.) is required to handle the loads that are anticipated.

Computational chemists are beginning to be able to do the calculations that explain the most basic properties of materials and then should be able to translate that information into practical use. "In theory," Borsook says, "it is possible to apply the equations to understand precisely how it is that a piece of wood is brown and hard. Once that mathematical solution is understood, it should be a matter of engineering to create other substances that are equally brown and hard." The computers that are required for this breakthrough are very large, but with the rate that computing power is increasing, this capability should soon become more common.

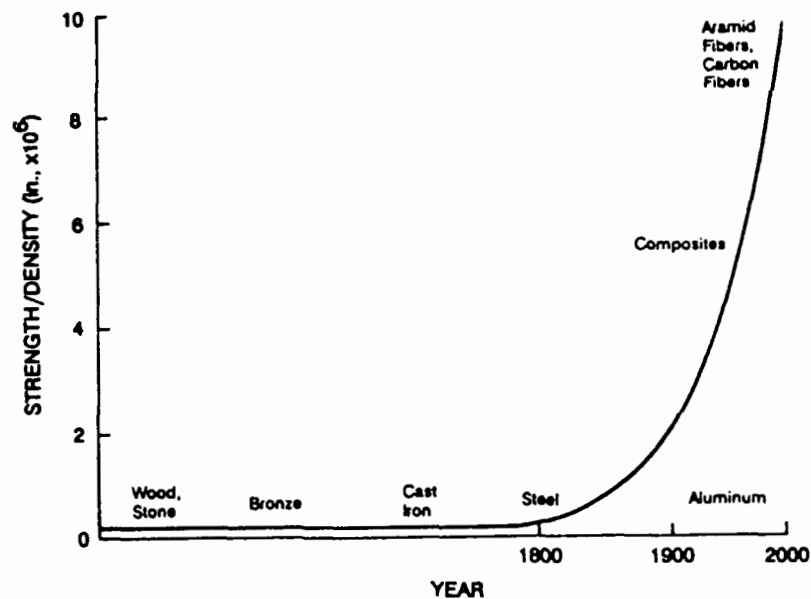
Recent Progress

Progress in materials design is greatly advancing both in conventional materials science terms and in molecular design. Richard Carlson and Bruce Goldman summarize some of the progress:

- *Catalysts* accelerate chemical reactions. Almost all the major catalysts were discovered by accident; we did not know why they worked. Now we design them. A catalyst that could efficiently make methanol from natural gas would revolutionize the energy sector.
- *Alloys* are combinations of metallic compounds. Alloys lighter than aluminum and stronger than steel are under development.
- *Plastics* are hydrocarbon materials; some of the best new plastics are derived from wood, not oil.
- *Composites* such as wood are the key to the superiority of biological materials. New artificial composites outclass all other materials in strength per pound.
- *Ceramics* were the first human-created materials (pottery), products of an art that changed very little for thousands of years. A moldable ceramic that could safely substitute for steel in automobile engines would double fuel efficiency. We are now designing ceramics that are perfect electrical conductors. Commercial microelectronics devices

Progress in Materials Strength-to-density Ratio

Shows a 50-fold increase compared to primitive materials



Reprinted with permission from *Materials Science and Engineering for the 1990s*, 1989, Courtesy of the National Academy Press, Washington, DC.

employing ceramic superconductors are just beginning to show up. A University of Houston team has devised a continuous process for fashioning rods of ceramic superconducting material -- a step toward the production of practical superconducting electric-power cables and electromagnets.⁷²

One of the advantages of these new materials is that they will last longer. Because of increased use of ceramics and plastics, one estimate has the average life of cars increasing from 10 years to 20 years by the year 2000.

Jerome Glenn has written that 40 percent of all engineering research in the 1980s was in materials science. "New materials are being developed, such as metal that dissolves in water, alloys of metal and plastic, and materials that seem invisible (clear like glass but will not reflect light from the surface like glass). Other new materials will include those that form with light, such as methyl methacrylate. When this plastic powder is sprayed in an area that has lasers shot through, it will form small plastic filaments to make a three-dimensional object. The object will dissolve by altering the light wave pattern and form a new shape. Improved materials will be forged by containerless melting, called 'acoustic levitation,' which is created by 160-decibel sound waves.

The waves suspend materials in furnaces for cleaner melting to produce improved fiber optics and lenses.¹⁷³

Molecular design (as one branch of computational science is called) is already considered to have strategic importance. The Office of Naval Research is bringing together chemists, physicists, engineers, and computer scientists to consider techniques for mastering the material universe at levels never before possible.

Emerging Technologies - New Science

There are a number scientific endeavors that appear close to breakthroughs. With the amount of effort that is being given to each -- and with the advances being made in computational capability -- it is not farfetched to believe that we will see significant development within the next two decades. In each case, the implications would make major changes to the way we live.

Room temperature superconductivity

A great amount of work is being done in the area of superconductivity -- the phenomena that allows materials to transmit electricity without any resistance. Since it was first discovered in 1911, superconductivity was thought to exist only at temperatures very close to absolute zero. In 1986, working with entirely new classes of materials researchers developed a material with a superconducting transition temperature of 39 Kelvin. Rapid progress increased the temperature to 125 K within two years. With the amount of time and resources being given to this area it is quite likely that important breakthroughs will occur in the coming years.

Since scientists do not understand why some materials superconduct, the technique for experimentation in this area is to try as many combinations of materials as possible, hoping to hit on the one that generates encouraging results. Advances in computational chemistry could well be responsible for the quick discovery of a substance that shows no energy loss at room temperatures.

This would ultimately make a profound difference in the energy requirements of the world since a significant amount of generated

electricity is lost to heat because of the resistance in copper, the most commonly used conductor. Highly-efficient superconducting wire, lighting and motors would decrease the need for powerplants, many of which contribute to the atmospheric pollution problems that the globe is now experiencing.

Cold Fusion

Room-temperature fusion research, effectively dismissed by the American scientific community, is alive and well in Japan and India. Cold fusion is the process that researchers believe takes place when an electric current is sent into palladium and platinum electrodes that are immersed in a jar of heavy water, rich in deuterium. The experimental results sometimes suggest that lots of energy is released in the process. If it is true, it could lead to the development of a virtually unlimited supply of inexpensive energy.

The idea was largely depreciated, especially in the U.S., when the experiments of Drs. Pons and Fleischmann, who claimed to have discovered cold fusion, could not be replicated by other researchers. But Japanese scientists, intrigued with the concept invited Pons and Fleischmann to Japan to discuss their work in 1989. Since then Japanese experimenters have apparently replicated Pons and Fleischmann's findings, producing up to 70 percent more energy in heat than was put into the system in electricity.

The *Wall Street Journal* reported that 5 to 6 labs in the U.S., India and Japan had conducted experiments that produced as much as 3 to 4 times more excess heat than the input power although researchers are questioning whether it is "cold fusion" they are seeing, or another phenomena.

Twenty or so university groups are pursuing cold fusion in Japan, mostly on a financial shoestrings. But now, Japan's Ministry of International Trade and Industry (MITI) has decided to fund some of the research. If this new effort produces more concrete results it could open a whole new avenue of potential future energy sources and would shift the focus of a good deal of energy research.

Zero Point Energy / Condensed Charge Technology

Zero Point Energy

The mathematical equations that describe quantum electrodynamics predict that there is a huge amount of energy that is ambient in the space -- the ether -- that surrounds us and all of the universe. It is very hard to measure this energy and thus establish its reality. We are much like fish in an ocean. How, if you're surrounded by water do you measure the existence of the water? It is generally only possible if a reference is available outside of the body of water from which to measure the difference between there and the surrounding environment. Such is the case with zero-point energy fluctuations (ZPF), the field of electromagnetic energy that exists in the "vacuum" of the universe along with the creation and annihilation of virtual particle-pairs (e.g. electron-positron).

Formally, the energy density associated with the vacuum electromagnetic ZPF background is considered to be infinite.⁷⁴ Although there is some question of what comprises this energy field, "there is, however, no question but that the ZPF fields lead to real, measurable physical consequences. One example is the very real Casimir force, an experimentally verified ZPF-induced attractive quantum force between closely-spaced metal or dielectric plates. An elegant analysis by Milonni et al., at Los Alamos National Laboratory shows that the Casimir force is due to radiation pressure from the background electromagnetic zero-point energy which has become unbalanced due to the presence of the plates, and which results in the plates being pushed together."⁷⁵

Particle physicists believe that this energy field is the residual energy that was not converted into the all of the mass that is presently in the universe.⁷⁶

Quite a few researchers -- although most are not in the mainstream of science -- are working on the problem of "mining" this vacuum energy for practical use. There are programs in the U.S., the former Soviet Union and other countries that are exploring the use of a cold, dense, charged plasma that takes advantage of the Casimir force to produce excess energy.⁷⁷ Other proposals for extracting vacuum energy have been made as well.⁷⁸ Although this research is at relatively early stages of work, already

at least two people have patents on generators that purport to operate on these principles.

It seems reasonable to believe that significant progress might be made in this area in the next two decades. If so, it could open up a source of unlimited, clean energy available anywhere in the universe.

Condensed Charge Technology

The Casimir effect is also used in condensed charge technology (CCT) to produce small, tightly bound, dense clusters of electronic charge of enormous power relative to their small size.

The underlying phenomena are ubiquitous: man-made natural spark/arcs of almost any kind, for example lightning, or even the familiar blue "pop" one gets from static buildup (e.g., when one walks across a carpet on a dry day and then touches a metal object). In its uncontrolled state, such "spark," large and small, is destructive and disruptive, and so scientists and engineers have traditionally labored to eliminate it completely from all electronic systems. Thus, the most important point about CCT -- and that which distinguishes it from any other electronics technology -- is that we have discovered a way(s) to integrate spark, or more accurately micro-arc discharges, into, not out of a system, thereby taking advantage of the many beneficial properties inherent to the phenomena. We make it, control it and use it on command.⁷⁹

The developers of CCT, which for a number of applications could be in the prototype stage within 1 to 2 years, say it could enable:

- 60-90+ GHz "plastic" radar, e.g., for automobile/aviation applications
- Tiny, throwaway X-ray devices (medical, and possibly some kind(s) of lithography, inspection, etc.)
- Super quick computers and switching devices
- Extremely high frequency communications
- Small, stand-alone energy conversion/storage devices
- Deep space propulsion
- Very high resolution, full color flat panel displays of far broader consequence than just HDTV

Holography

Although to date it has primarily been used for novel and small security applications (like credit cards), holography shows the possibility of significant further development in the next two decades. The real breakthrough will come when full-color, three-dimensional projection becomes possible. Rather large scale (about 2 foot square) flat holograms in full-color are now displayed at MIT's media lab. Media Lab leaders believe that holographic color projection might be ten years away.

If holographic information can be digitized and therefore transmitted (assuming adequate bandwidth) to remote locations, a whole new era will open. "Picturephones" may project the person on the other end of the line into the middle of your room. Conference calls would take on a new meaning in this context and could well threaten the growth and function of airlines and other transportation.

Robotics

Although robotics have a well established position in Japanese industry, it has not, so far, turned out to be what many prognosticators thought it would. Business in the U.S. and Europe have not embraced industrial robots at nearly the rate of the Japanese, and other, more consumer-oriented versions are very much in the development phase. Even so, industry sources believe that robots making clothes will be commonplace by the turn of the century.

This general trend is likely to change -- perhaps dramatically in the next two decades. Robots are, in one sense, collections of other more basic technologies: sensors, controlling and analysis software, pattern recognition capabilities, etc. Most all of these other technologies will make significant strides in capability, size, power requirements and other design characteristics and the synergy of the combination of these other advances should accrue to directly to robotics.

Holographic Neural Technology

Parallel processing neural networks, when exposed repeatedly to a given signal or pattern (image, sound, shape), can "learn" that

input. They will retain the essence of the stimulus well enough to be able to recognize, with high rates of accuracy, the original pattern - and to some extent, variations of the pattern -- when subsequently exposed to it. Almost all present neural network systems are based on Artificial Neural System (ANS) methods. ANS methods employ multiple neurons, often arrayed in configurations found in human nervous systems. Although they have made very significant contributions in the areas of signal processing, forecasting, and pattern recognition, because of the intrinsic bounds of the ANS architecture, such systems reach their limit of effectiveness with problems that have more than about 300 inputs or components. Above that level, the combinatorial implications result in a "brick wall" where effectiveness is reduced to very low levels.

This is problematical because most issues of major significance involve many more than 300 components. Enter Holographic Neural Technology (HNet) - a dramatic new approach to neural networks that effectively eliminates the brick wall and increases the productivity of neural net systems by orders of magnitude.

Computer software is almost exclusively written in real numbers (0,1,2,3). HNet is written in complex numbers (real and imaginary). The basic equations are variations of those that describe holographic principles, as well as of those from quantum theory. This approach allows information to be superimposed or enfolded by convolution of complex vectors. Very large numbers of associations (patterns) can be overlaid onto a single neuron cell. Unlike ANS methodology which may require many thousands of learning cycles to reach a level of effectiveness, HNet systems reportedly require only one to three (at the most) passes to map the desired information. Projects that take a hour and a half to run on a very large conventional neural array can be completed within 1/40 of a second using HNet.

HNet capability increases with an increase in the number of inputs to the neuron cell, and a single cell can accommodate 64K stimulus inputs.

Consider the application of this technology to voice recognition as an example. Any given word can be vocalized in a wide number of tones and inflections, over different durations. HNet is capable of explicitly mapping virtually an unlimited variety of vocal intonations onto the same storage set and differentiate between this

class and a very large set of alternate word class structures. This suggests a capability for voice recognition systems operating at a complexity far beyond that currently achievable. There is a distinct opportunity to create real-time speaker-independent and continuous voice recognition systems. Very few neurons (4 to 6 cells) are required to accurately identify spoken words from a large vocabulary after only a single exposure to each word. Large training sets may be employed to allow the system to recognize virtually any form or utterance of the word.

HNet is a pattern recognition system. Many, many things in life are patterns of one type or another. Most of what we see, think and analyze are combinations of generally understood components arrayed in different configurations. Behavior is defined in patterns. Different cultures behave in varying patterns. Trends are patterns.

With the development of this enabling technology, the possibilities seem immense.

CYC

Computers do not have common sense. Unless it has been explicitly told in advance, a software program does not know, for example, that when a closet door is opened, the Pacific Ocean will not be lapping over the threshold. It also does not easily know how people think and how governments and interest groups might react to given situations. Where system relationships are relatively well understood and predictable it has worked rather well. But when a domain of interest begins to include those areas dominated by human decisions, values and interests, then the software comes up short - it does not have common sense. This huge corpus of information that most of us take for granted, has heretofore been assumed to be an eternal roadblock to ever having causal systems intelligent enough that they could tackle some of the major problems that mankind routinely faces. It now appears that obstruction may be about to be removed.

In the early 80's, the Microelectronics and Computing Corporation (MCC) a consortium of American computer companies banded together to attempt to build a sixth generation computer. One of their major projects, centered in their artificial intelligence

lab, became an attempt to overcome this common sense problem with symbolic processing.

Writing Down All Common Sense

Headed by Dr. Douglas Lenat and called CYC, this undertaking is, simply stated, a heroic attempt to identify the component parts of the common understanding of human beings and enter them, rule by rule, into a knowledge base. As Lenat puts it:

Perhaps the hardest truth to face, one that AI has been trying to wriggle out of for 34 years, is that there is probably no elegant, effortless way to obtain this immense knowledge base. Rather, the bulk of the effort must (at least initially) be manual entry of assertion after assertion.

Half a decade ago, we introduced (Lenat, Prakash, and Shepherd 1986) our research plans for Cyc, a decade-long, two person-century effort we had recently begun at MCC to manually construct such a knowledge base.

The details of their work is interesting:

The bulk of the effort is currently devoted to identifying, formalizing, and entering microtheories of various topics (such as shopping, containers, emotions, etc.) We follow a process that begins with a statement, in English, of the microtheory. On the way to our goal, an axiomatization of the microtheory, we identify and make precise those Cyc concepts necessary to state the knowledge in axiomatic form. To test that adequately stories that deal with the topic are represented in Cyc; we then pose questions that any reader ought to be able to answer after having read the story.

. . . The aim is that one day Cyc ought to contain enough common-sense knowledge to support natural language understanding capabilities that enable it to read through and assimilate any encyclopedia article, that is, to be able to answer the sorts of questions that you and I could after having just read any article, questions that neither you nor I nor Cyc could be expected to answer beforehand.⁸⁰

Will Assimilate Information On Its Own

Doug Lenat and his friends are building the basis for HAL, the computer in the movie 2001 - and they are succeeding. They

expect, in the next couple of years to have entered enough basic information into Cyc that it can begin to assimilate information on its own. On-line texts will be piped into the system and the role of humans in the project would, "transition from the brain surgeons to tutors, answering Cyc's questions about the difficult sentences and passages." The system would learn information as fast as it could be fed to it.

Will Be Packaged With PCs

All of the MCC corporations that are participants in the Cyc project are individually designing applications that will use Cyc's abilities. Lenat believes that because Apple Corporation is involved, it is likely that by 1995 Apple Computers will come bundled with a CD-ROM Cyc disk that represents the common sense of a human. One company, Digital Equipment, is building a Cyc-based application whose job it is to ask questions about a potential Digital customer and come up with the right size computer requirements for them. This would involve an internal Cyc intellectual process that given that the basic business unit in a hotel is a room and at a car rental agency a car, would be able to use relatively deep understanding of what goes on at each place to decide that for a hospital, which is a new potential customer, the right business unit is a Bed, not Room.

Cyc is obviously important. It should be able to mimic human from different cultures, responding as they might from varying philosophical and religious bases. It is far enough along that its inventors/keepers believe that by 1994 it should be able to deal concurrently and in real-time in a very dynamic, technical and conceptual situations with many humans - and probably better them in the process.

Bioelectronic Devices

Jerome Glenn has reported that according to Dr. Williams Dobbelle of the Institute for Artificial Organs in New York City, "by the turn of the century, every major organ except the brain and central nervous system will have artificial replacements."⁸¹ The Japanese government believes these advances will come a little later: between 2000 and 2010.

A strategic component of this trend is the nerve chip, which is being developed by scientists at Stanford University Medical Center with support from the Veterans Administration. It is an electronic interface for individual nerve cells to communicate with a computer. This human-machine linkage will be used to program and control artificial hands, regenerate damaged nerves and enhance human capability in many other ways.⁸²

If artificial eyes convert video to nerve signals, won't it be possible to use the same technique to superimpose computer generated information in front of one's field of view?

New Science

There is a small but growing group of researchers who are looking into interesting areas that are on the fringes of conventional scientific knowledge. This area, called new science, or frontier science, is unstructured, generally discounted by the current "experts," and very broad.

These thinkers are, for instance, leading the attempt to bring the implications of quantum theory into practical use and, if anything, are generally characterized by their very openmindedness. In Paradigm Shift terms, "new scientists" tend to be inner-directed people, clearly marching to their own drums outside of the mainstream. This characteristic alone, makes them worth noting, for many of the new ideas in science in the next 20 years are likely to come from their midst.

Although many ideas and areas of study are undertaken under this banner, three major ones merit mention. These are also the major areas of study of the Center for Frontier Sciences located at Temple University in Philadelphia⁸³ from which these descriptions are taken.

Consciousness Research

This area involves inquiry on the nature of mind and its role in the physical and biological realms. In humans, different states of consciousness, beliefs, emotions, and intentions have been shown to play active roles in bodily functions. Research on multiple personality disorders (MPD) indicates that the patient's physiology shifts measurably with each personality. These include changes in allergy profiles, disease states, visual acuity, and EEG,

to name a few. MPD research implies that the body/mind is a fundamental indivisible unit.

Remote perception, or the capability to ascertain information non-locally has been demonstrated. Psychosomatic medicine and psychoneuroimmunology both show a distinct role of mind in health and disease. Biofeedback, hypnosis, the placebo effect, and autogenic training indicate that profound effects upon physiology can be elicited by subtle mental shifts.

Dozens of studies have shown that prayers and meditations of widely separated individuals correlate with a significant improvement of the health and well-being of others. Numerous investigations in consciousness research suggest an inseparability of mind and body and a participatory role for mind interacting with matter that transcends the limitations of ordinary space-time.

Bioelectromagnetics

This newly emerging area of study targets natural and artificial electromagnetic fields (EMFs) and their relation to life and health. Recent evidence shows a much greater sensitivity of life forms, especially developing ones, to low level nonionizing EMFs than had been predicted from classical physics. Both positive and negative biological effects of such EMFs, ranging from extremely low frequency to the radio and microwave regions, have been documented for many different life forms. Effects range from those at the molecular and cellular levels to tissue, organ, systemic, and behavioral changes.

There is a related area of research indicating that EMFs generated within organisms, observed as coherent biophoton emissions in the visible spectrum, are ubiquitous to life and may serve as bioinformational signals governing life processes.

Moreover, the well known phenomenon of dowsing may also be related to EMF effects. Research on dowsing suggests that the biological response in the form of a spontaneous twitch of a muscle observed as a jerk of a rod held in the hand as one is moving over a geological gradient is due to variations in extremely low intensity geophysical fields.

The increasing evidence from the wide range of research in bioelectromagnetics suggests an intimacy of life with field interactions that are unbounded. It challenges the conventional discrete,

biomolecular view of life in which living functions may be solely reduced to a complexity of biochemistry within the organism. Possibly living systems may even be regarded as fundamentally electromagnetic in their nature.

Complementary Medicine

This area focuses on the medical diagnostics and therapies that are modalities of subtle intervention. Some of these, such as acupuncture, homeopathy and infinitesimal drug doses, and healer interventions are older systems of medicine that remain largely incomprehensible in terms of the conventional biomedical model. Others such as electro-acupuncture and various other electromagnetic interventions are relatively new.

Collectively all of these have also been referred to as "energy medicine" or "soft medicine." Electro-acupuncture devices and other instruments that probe subtle parameters such as skin electrical conductivity are growing in usage. There is a steadily growing body of recent research documenting the biological effects of extremely high dilutions and homeopathic preparations. Therapeutic touch, now used in hospitals worldwide, has been widely documented.

Evidence is mounting from many different avenues of research in complementary medicine that living systems are highly nonlinear and that subtle interventions in the form of very small stimuli can lead to significant beneficial effects without side effects. Such effects are unanticipated by the conventional biomedical model.



The paradigm-challenging facts cited here, considered individually, may seem relatively insignificant compared to the large body of conventional mainstream science. However, taken collectively, they seem to fit together somewhat like pieces of a puzzle and are beginning to give shape to the rudiments of a new scientific world view.

Interactions

The above trends, as profound and interesting as they are, are by themselves only half of the story. When one considers what might happen when different technology disciplines intersect, often a synergy can be seen that spurs on development in all fields and produces synthetic products that are much more powerful than a single technology might produce. Here are just a few possible combinations:

A-life, Molecular Design & Nanotechnology

Consider, for example, the interaction between artificial life, computational chemistry and nanotechnology. One can easily see the three of these disciplines becoming married together at the point where molecular design determines the molecular characteristics required for a particular device or organism, nanotechnology provides the design of the nanomachine needed to configure the structure, and artificial life brings the control software routines that allow the nano-assemblers to operate autonomously.

This, of course, is the breeding ground for both the best and worst case scenarios having to do with nanotechnology and a-life.

Advanced Pattern Recognition & Shrinking Electronics

Early versions of pattern recognition of the kind that will become refined with holographic neural technology are already making themselves known. There are reports that by 1995, automatic translation of text messages sent on overseas telephone lines will be common. An American would send data in English and would receive the Japanese response to the message English. Similarly, the Japanese speaker would send and receive in Japanese. This capability will surely expand, in time, to include voice communications.

Soon after that, industry observers believe that electronics will become small enough, and pattern recognition effective enough, that people may carry a card deck-sized unit (in a shirt pocket, perhaps) that, through an ear plug, would provide automatic

translation of voices in the vicinity. These translation devices could have a profound effect on geopolitics and social attitudes.

The major problem with getting along with those from other cultures is that one doesn't understand them -- literally. When an American goes to Japan, the foremost restriction on communication (and therefore understanding and relationship) is the foreign language. When one can openly communicate with others, immediately a much greater amount of knowledge and understanding becomes likely.

Technology of this kind would begin to eliminate one of the major barriers to integration and cooperation. It is hard to overestimate what the significance of this might be.

Virtual Reality & Computational Science

The day may soon come when molecular designers manipulate molecules by "reaching out and grabbing them" by using virtual reality equipment. Combinations could be tried and then easily reconfigured at will.

Virtual Reality & Global Networks

This is the *Neuromancer* combination. In his book by that title, William Gibson told of a world where information thieves "jacked-in" to "cyberspace" and found themselves virtually navigating throughout the communication networks of the globe. Different databases "looked" differently. Security systems appeared as such. Large visual avenues connected the various peripherals. It was like flying down the middle of the street and looking out at different businesses, schools and government agencies -- only it was their information systems instead of their buildings.

This is not too far-fetched. People are already working on pieces of what might ultimately be this capability.

Artificial Life, CYC & The Internet

One of the most interesting ideas cruising around the Internet is that of "knowbots," or knowledge-robots. These software entities would be designed to operate like a very sophisticated research assistant. One would tell his or her knowbot what information

they were looking for and then send it off into cyberspace. The knowbot would be intelligent, and have CYC-supplied common sense -- it would learn and make decisions as it navigated from database to database trying to find both the basic requested information, and making excursions to chase down sources mentioned in footnotes, etc. After its foray, a completed digest would be deposited back at one's doorstep.

One wonders what might result from the merger of knowbots and a-life. What if knowbots were really autonomous? What if they developed a mind/interests of their own? What if one decided that it was interested in power or money?

Advanced Pattern Recognition and Computers

One of the most intriguing coming capabilities of powerful pattern recognition software is word recognition. As mentioned, already large machines are being readied to do translation. The more common use will be to interface with computers and ultimately other "appliances."

The *Wall Street Journal* reports that IBM has been working to develop a voice-activated computer for more than 20 years and has now begun to sell their first product. It has a vocabulary of only 20,000 words and sells for about \$10,000. Other manufacturers have systems in use with vocabularies of up to 50,000 words. The new Lexus has a car phone that can be activated by voice. Just tell it which of the preset numbers to dial and it does it automatically.

It seems clear that with advanced pattern recognition capability we will soon be able to easily and fully communicate verbally with common computers. Close behind that should be voice recognition systems for homes to control heat, lighting, etc., and then other appliances. Most anything that requires a manual input of settings is a candidate for vocal control.

Communications Networks, Condensed Charge Technology, CYC

When CYC brings common sense to computer systems, those capabilities will very soon find themselves in America's living rooms. Televisions (or "personal information appliances," as they will probably become), will become intelligent and interactive, learning individual preferences and adjusting to different

viewers. This kind of capability coupled with large, (4 ft. x 4 ft.) quarter-inch thick, flat screen monitors will give viewers a "window" into cyberspace. An extraordinary selection of topics will be available spanning the areas of entertainment, education, shopping, business and communication. The trends are already in place: five-hundred channel television will be in homes this year, hang-on-the-wall gas-plasma color monitors are available in Japan now.

Intelligent Cars

Three new technologies are being brought together for the car of the future, with some expected to be ready in five years. The *New York Times* recently summarized some developments.⁸⁴

- *Vision enhancement* - An infrared camera near the rearview mirror would allow the driver to "see" in the dark or through fog or snow. A heads-up display, similar to those used in tanks and warplanes, is being developed to allow the image to appear on the windshield in front of the driver.
- *Autonomous Cruise Control* - Using a radar signal reflected off the car in front, a computer calculates the time distance, based on speed, between the two cars and adjusts the throttle and the brakes to maintain a specified margin.
- *Collision Avoidance* - Using a combination of sensors, radar and video cameras, an on-board computer will determine key aspects of the car's environment. For example, it would warn the driver of traffic over three lanes or obstacles or if it senses that the car is going off the road. In the future it may have the capacity to adjust the steering of the vehicle.

Business Systems

A good place to see where the rest of the world will be in 5 or 10 years is to look at the leading edge today. In business technology integration, USAA, the giant insurance company that services military officers and their families is at the forefront. *Fortune* recently summarized their operation.⁸⁵

USAA's system employees scan all incoming mail that contains more than a check into their computer network -- nearly 14

million pieces a year. When a customer buys insurance on jewelry, say, which takes effect 24 hours after the postmark on the appraisal mailed to USAA, he can telephone a service rep and get an instant answer to the question, "Did my appraisal come, and can my wife wear her necklace to the theater tonight?"

By next year, when a customer calls to say he has had an accident, the system will digitize and store his phone call and scan the photos and the reports from doctors, lawyers, and appraisers that he send in. Even further out, the company is working with IBM to develop a multimedia system that in a lawsuit, for example, will allow a USAA employee to hold a conference call with a lawyer in Miami and a doctor in Fort Lauderdale in which all participants can hear the recording of the original telephone accident report and view on their screens documents, X-rays of injuries, and color videos of damage to the car.

What is Technology doing to us? What are we becoming?

There is a big question that needs to be considered when thinking about the magnitude and rate of change of technology that we are experiencing: what is this technology doing to us? What are we becoming? Technology does not just change the way we do things. One of its major byproducts is that it changes the way those who use it see and understand themselves, and the world in which they live. There is a philosophy that comes bundled with a technology and when one is embraced, the other is there as well.

Television: The Most Powerful Mind Tool

One need only consider how cars, telephones, television and airplanes have changed our perspectives of ourselves, our relationships to others around us, and our understanding of the world, to know that this is true. Recently, the Canadian Innu Indian tribe, which had been moved in 1967 against their will to an isolated island, was successful in getting the government to move them back to the mainland where they could resume their traditional caribou hunting. All adults in the tribe were unemployed and their living conditions were so poor that 25 people committed

suicide last year, out of a total population of about 500. It was television that mobilized them, by allowing them to see how their lives compared with those who were better off. They then made a video tape of their Third World situation, highlighting Innu youth sniffing gasoline and talking about suicide, and gave it to the Canadian Broadcasting Corporation. The outpour from Canadian viewers to the scenes was enough to force the government to agree to move them back to the mainland. Television made them aware of their condition and television made others aware of it.

In India, Star TV, the new Asian satellite television programming service has only been in service since September, 1992. Already, it has been cited as the chief inspiration for major changes in Indian culture, such as fashion and popular music, and has increased the demand for brand name products. It has engendered vigorous new calls to liberate the Indian economy from once-dominant state control. The window on the West, (MTV, BBC, American sitcoms, soap operas, etc.) that it opened to viewers from Burma to Beijing is providing a bewildering taste of commercials and unfiltered news. "Santa Barbara" is the highest rated show on Indian television. Tom Hunter, vice president for international programming at MTV said, "India is the most enthusiastic audience we have."⁸⁶

As Van Wishard has observed, "Television is the most effective instrument ever invented for influencing the minds of masses of people. (It took 40 years for *Gone With The Wind* to sell 21 million copies. But, in one night, 55 million people watched the movie version.) As *The Wall Street Journal* noted, 'TV has become more significant than any other single factor in shaping the way most of us view our world . . . more than religion or politics.'⁸⁷

Some argue that television may become the most important force for globalization and may be the major driver that integrates Europe culturally and linguistically.

But now, we are entering a super renaissance -- a time when we are changing life, creating life, linking people together much closer and faster, changing the meaning of reality, time, space, and location. We are about to design and manipulate matter and are on the edge of tapping the greatest energy source in the universe. What will this all mean to us as human beings? These are important -- perhaps the most important -- questions that we

should be thinking about this new age of information and technology.

Technology Trends and Driving Forces

- **Speed** - everything is going faster, so *speed is the metric that is increasingly being used to measure value.*
- **Trend toward light** - light is the fastest communications medium with the greatest capacity to carry information. *There is a clear trend toward utilizing light and optics in information technology.*
- **Information**, in the form of knowledge, is what allows speed. *Information is the capital commodity of the future.*
- **Going to digital** - *information in all forms is being converted into digital forms so that it all can be transmitted through the same cables, fibers, frequencies and equipment.*
- **Global connectivity** - *everything is being connected to everything else. In time, almost every home, office, school and government agency in the developed world will be connected to each other in a huge information system by way of every computer and telephone.*
- **Global accessibility** - *there will be no place on the surface of the earth where one can't access the whole network*
- **Moving Information instead of people** - *information technology is making it more advantageous -- in almost every situation -- to move information rather than people.*
- **Power migrating toward individuals** - *individual people will increasingly be able to access, analyze and manipulate information (the source of wealth and power) without the need for larger organizations like corporations and governments.*
- **Systems** - *all things of importance are becoming to be understood to be systems; in most cases highly complex, dynamical sets of sometimes widely dispersed components. In science, particularly, there is a move toward the integration of disciplines. In manufacturing: concurrent engineering.*

- **Organic models** - *large systems increasingly are seen to mirror and behave like organic models.*
- **Increasing complexity** - *man-made systems are becoming more complex, faster.*
- **Increasing vulnerability** - *the more complex a system becomes the more likely the chance of system failure. There are unknown secondary effects and particularly vulnerable nodes.*
- **Qualitative becoming more important than quantitative** - *Software, intuition, speed, and quality are areas pregnant with opportunity.*
- **New structures and organizations** - *all structures and organizations (business, government, education) will reconfigure to adapt to the faster, more interconnected world and the more powerful and enabled individual.*
- **New info-criminals** - *There will be a significant increase in information crime, more viruses, and a growing international information criminal element.*
- **Unpredictability** -- *technology is a huge effort with lots of people in an extremely complex context where there are fundamental changes in the underlying principles. It is almost certain that a goodly number of very significant things will happen that are unanticipated.*
- **Punctuated change** - *there are enough reality exploding nascent technologies in development that it is likely that one or more of them will come to fruition soon and send shock waves throughout the global system.*
- **Isolated perspective** - *most of the population of the world will not participate in this revolution. The implications of that could be profound.*



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Economics

To understand the major pressures that are likely to shape the economic arena for the coming years, we should begin with a summary of the present situation.

Global Recession

Europe

High interest rates and uncertainty over the future of economic unity have virtually all of Europe in a recession. There is a political crisis of confidence in Europe. While consumer confidence rose steeply in the U.S. following the November '92, political elections, the Bundesbank is keeping interest rates high to dampen inflation caused by Chancellor Helmut Kohl's refusal to raise taxes to finance Germany's reunification. Its policy also has driven up interest rates across Europe, and the resulting downturn undermined support for one European currency, in place of today's system in which Germany calls the monetary tune for all.

After a series of exchange rate crises that have forced Britain, Italy, Spain, and half a dozen other countries to cut their currencies loose from the mark since mid-September '92, EC plans have been

substantially undermined. This has sent confidence plunging and layoffs soaring across Europe.

The growth rate in Western Germany in 1992, its worst in a decade, was only 0.8 percent, having contracted slightly in the fourth quarter. *The New York Times* reported that Horst Kohler, state secretary in the German finance ministry, said in a speech that growth prospects for 1993 were worse than were expected as recently as last summer. "I do not exclude the possibility of negative growth rates on average in 1993," he said.⁸⁸ A three percent drop in Germany's industrial output is forecast for next year and the picture in Spain, France Italy and Sweden is not much better. American international firms such as IBM, Caterpillar, and Ford are feeling the pinch already. Ford's auto sales in Britain, last year were down over 30 percent. The company announced the elimination of over 5000 European jobs last December.

German interest rates are still at an all time high. The initiative for other EC nations to peg their currencies to the German mark through the ecu weighted bundle of currencies mechanism, resulted in abnormally high interest rates in Great Britain, Italy and France. This high rate directly contributed to major recessions in those latter three countries. These recessions reduced the demand for U.S. goods in those countries, reducing the magnitude of the U.S. trade surplus with the EC countries.

Finally the house of cards collapsed in October when Britain officially de-linked their currency from the ecu, followed by wild gyrations in several other member nations. In one instance, the official overnight interest rate in Sweden rose to over 100 percent, all in an attempt to support the Swedish kroner and its linkage to the ecu. Following delinkage, the British pound dropped almost 20 percent of its value within 48 hours. The Bush administration chose not to intervene in the international currency markets, preferring that the EC nations sort out their own untidy house. This situation is still extremely volatile, and will become more so as the EC becomes more of an economic reality after the first of 1993.

Japan

In Japan, the a sustained and extraordinary fall in equity prices has exposed many weaknesses in its financial structures reported *The Economist*, recently. The financial character of the recent bad

news is self-evident. With hindsight, the stockmarket's peak of 1989 can confidently be deemed a "bubble." The bubble has not burst, just suffered a slow puncture. Because Japanese banks have relied heavily on the unrealized gains from their holdings of equities, regarding them as capital, the fall has left them perilously weak. As the banks have come under closer scrutiny, imprudent lending, outlandish practices and corruption on an alarming scale have come to light. These are textbook consequences of ill-managed financial restructuring, *The Economist* said, and textbook precursors of full-scale crisis.⁸⁹

There no longer is any question that Japan's recession, until recently considered a victimless slowdown, is biting deeper than anyone imagined. And it looks as though it will not slacken any time soon. Indeed, some economists believe that Japan will continue to slide into an economic trough even after the United States begins to bounce back. "The prospects are severe," said Hirofumi Adachi, chief economist at Yamaichi Research Institute. He projected flagging consumer spending and thin corporate investment in plants and materials that may continue another year. With the economy growing at an annual rate of about 1.5 percent and corporations reporting big profit declines, others are unwilling to be even that specific.⁹⁰

This first Japanese economic downturn in the last twenty years has not encouraged increasing imports from the U.S.. Within the last year the Japanese stock market has lost over 40 percent of its equity value. Commercial real estate is down over 60 percent in many urban areas and probably will continue to fall further until the Japanese speculative real estate bubble of the 1980's is worked out.

Japan looks foreword to very slow growth as it works off a heavy debt burden and sharp drops in real-estate prices. After a decade in which there was a worker shortage, now Japan finds itself with a worker surplus. Major corporations are, for the first time laying off employees, a practice unheard of in Japan's postwar history.

China

China may be the world's most significant economic force in the next century. World Bank officials predict China will be the third largest economy by the turn of the century and the largest by

2020. Those projections are partly a function of China's vast population, but also reflect an economic growth rate that has averaged 8 percent since 1985. In 1992, the country's economy grew 12 percent. The Chinese government plans for growth rates to average 10 percent through the end of the decade. China's trade surplus with the United States is second only to that of Japan.

Canada & Mexico

Canada, the U.S.'s largest trading partner, can't escape the recession in which it has been mired since 1990. Though things may get better in the short run, it probably won't be a dramatic improvement. The Bank of Canada dropped its key lending rate by more than 1/2 of a percentage point in the 1st week of December, 1992.

Some economists predict a sharp rebound of the Canadian economy in 1993, predicated upon a strong increase in the U.S. economy and approval of the North American Free Trade Agreement (NAFTA). However, a huge budget deficit stands in its way despite relatively very high taxes.

What about the impact of the North American Free Trade Agreement? Intra-regional trade in NAFTA comprise more than 40 percent of total export volume among the U.S., Canada and Mexico. This is up from about 33 percent in 1980.⁹¹ However, this is well below the level of intra-regional trade among European nations which account for more than 66 percent of the total amount of European trade. Although 69 percent of Mexico's exports go to the U.S., it has recently benefited from a surge in foreign direct investment. Many Japanese, Chinese, British and Korean companies have initiated joint ventures which anticipate penetration into the North American Free Trade zone.

Since 1980, trade between the U.S. and Canada doubled from \$84 billion to \$165 billion. Trade between the U.S. and Mexico grew 60 percent from \$25 billion to \$40 billion during the same period. One must keep in perspective the relative differences among the three countries: the Canadian economy in terms of output is only about 10 percent as large as the U.S. economy. The Mexican economy, by the same standards, is only about 5 percent of the size of the U.S. economy. The Canadian economy is very sensitive

to the U.S. economic health. A one percent drop in U.S. output is typically reflected by a 4 percent drop in Canadian output.⁹²

The United States

The U.S. recession appears to be over, with a 4.7 percent GNP growth recorded in February of '93. But, in the past three years the Federal Reserve cut the Fed funds rate 22 times, lowering it from 9 1/4 percent to 3 percent, yet economic conditions worsened: real per capita gross domestic product -- incomes -- in 1993, is lower, more people are unemployed and the rate of business failures has risen to the highest level since the Great Depression.⁹³

The National Debt Burden

The U.S. was the world's greatest lender. In the 1980s we became the world's greatest debtor. While the interest rate was kept at synthetically high levels during the 1980's, the U.S. achieved a free ride because foreign investors financed the U.S. debt. Debt service by 1992 had risen to 20 percent of the annual U.S. budget. However, one very important aspect had changed. The debt now absorbs U.S. investors' capital, not foreign capital. As a matter of fact, by 1992, foreign investors no longer carried the U.S. debt because our interest rates were too low relative to real rates of return available from other nations, such as Germany.

Servicing the accumulated debt created by ever-increasing budget deficits required over two-thirds of all funds which would have otherwise been available to the U.S. private investment sector in 1992.

This increasing debt-service resulted in a capital shortage both here and abroad. Why abroad? As former East Germany absorbed enormous amounts of capital and German and French investors poured capital into the new nations formerly under Soviet domination. A serious capital shortage drove up global interest rates and precipitated a worldwide recession which tottered on the brink of a world wide depression.

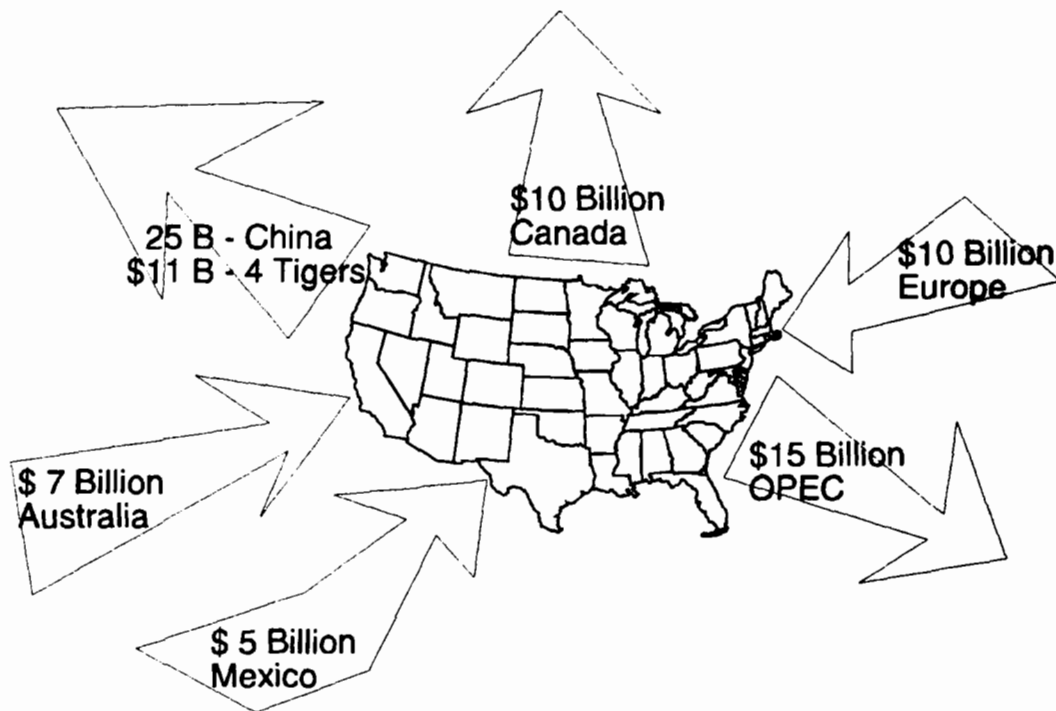
Increasing Trade Deficit

U.S. export gains are rising much slower than the increase in our imports from other countries. The U.S. trade deficit jumped to

\$26.5 billion in the three months ending September 30, 1992. This was the highest level since 1990.

Currently, the U.S. has a regional trade deficit with Pacific Rim countries and trade surplus with Europe. By trade deficit, we mean that the U.S. is buying about 12 billion dollars more merchandise than it is selling. A trade surplus is just the opposite: we are selling about \$2 billion dollars more than we are buying.

If the EC trade surplus stops (because of a continuing recession there and a decrease in demand for U.S. products), but the Pacific Rim deficit remains or grows (because China, for one, fuels its rapidly increasing growth with exports to the U.S.), the net trade deficit in the U.S. rises as a function of reduced EC trade and increased Pacific trade.



Net Merchandise Trade - Bi-lateral
U.S. - 1992 Major Trading Partners - Projections

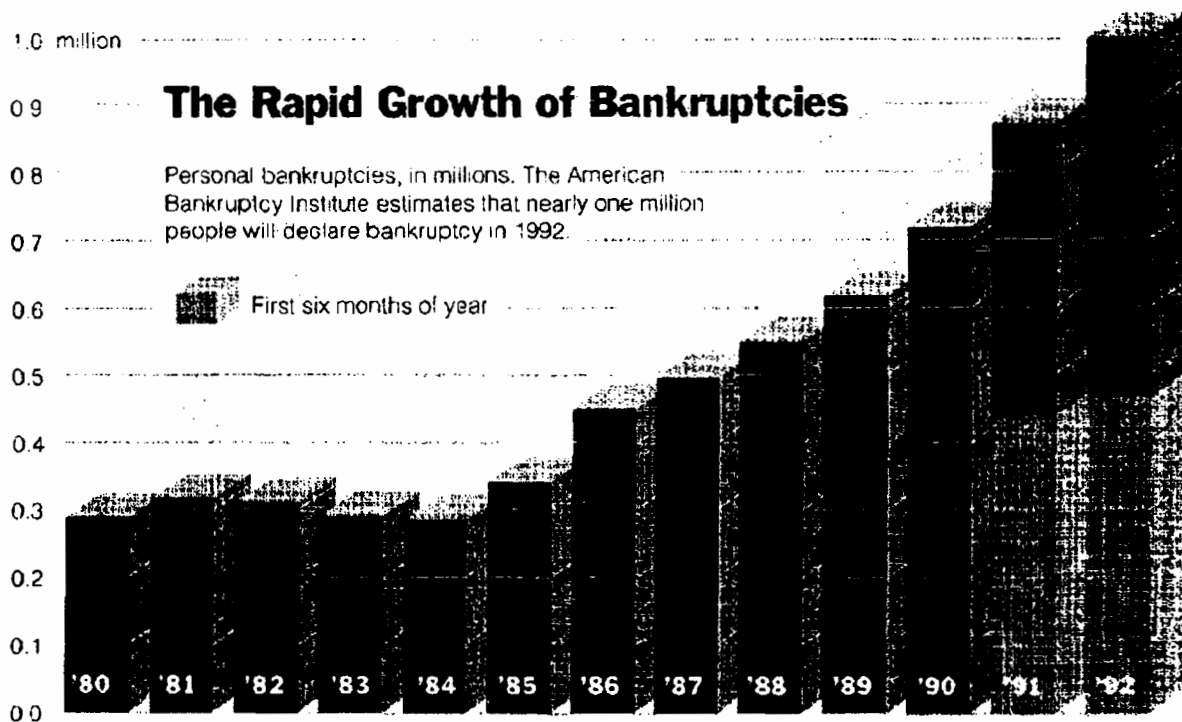
Source: Department of Commerce - Dec. 1992

The interesting point is that the perceived culprit will be the Pacific Rim countries, particularly Japan, Korea, Taiwan, Singapore,

Malaysia, and China. Their percent contribution to the U.S. trade deficit will increase disproportionately as U.S.-Pacific Rim trade increases in relative magnitude to U.S.-European trade. The fact of the matter is that few South East Asian nations are running an overall trade surplus. They rely upon running a trade surplus with the United States in order to pay for large oil imports. Unfortunately, that money goes to oil exporting nations, not the U.S.

Weakened Social and Economic Infrastructure

The country's lack of economic vitality manifests itself, of course, in grassroots social ways. In 1970, only 20 percent of full-time working Americans 18-24 years old could not earn a wage higher than the poverty level. By 1992, this had deteriorated so that 40 percent of those workers in this category could not earn above a poverty level wage, according to economist Lester Thurow. Said another way, in 1955, the minimum wage was equal to 105% of the poverty level. In 1992 it was 55% of it. *There appears to be no long term dynamics to reverse this trend. The sociological pain, increased crime and urban violence that are the byproducts are inevitable in the America entering the 21st century.*



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As the recession has persisted, the number of people filing for bankruptcy protection has reached record levels. For the year ended June 30, '92, there were 972,490 filings, a 10.5 percent increase over the previous 12 months period.⁹⁴ Even the recent economic upturn has not produced a similar, and usual, increase in jobs.

Banks Threatened

Both banks and insurance companies are weaker than they have been; banks because of the economy, and insurance companies because of a substantial increase in casualty losses.

The New York Times recently reported that FDIC regulators expected up to 125 possible bank failures in 1993. About 85 banks failed in '92.⁹⁵ California banks face serious problems because of continued weak real-estate markets and a stubborn regional recession. Federal regulators, banking analysts and officials of small and large banks agree that there may be as many as 30 fewer banks in California in 1993 as a result of the current problems. A bank's health mirrors the economy the bank serves. Most economists here say that California's economic slump has not bottomed out and that it may grow worse before the earliest projected recovery, in 1995.⁹⁶

James Dale Davidson, co-author of *The Great Reckoning* recently said, "The U. S. government has become so heavily indebted that it can't keep the banks afloat much longer. Today, 62 cents out of every dollar that's paid in *personal* [emphasis added] income tax to Washington goes just to pay interest on the national debt. If you keep compounding that, you reach a point of no return, where the government is unable to continue absorbing more and more liabilities."⁹⁷

Despite Bush administration assurances to the contrary, the savings and loan bailout could not be quickly cleaned up. Recent estimates indicate about a \$300B clean-up bill to the American taxpayer if it is handled smartly. Otherwise, the bill will be much greater.

Insurance Companies Weakened

Earthquakes, riots and hurricanes have together contributed to the largest losses in recent history for the insurance industry. *Best's Review*, characterizing a recent industry meeting, said that

the shadow of hurricane Andrew and the rest of 1992's record series of catastrophes also loomed over the proceedings in Boston, and representatives of the reinsurance business were in demand. There was a pervasive sense that the worst news is yet to come on Andrew's impact, but tentative hope that the hurricane losses might prompt the long-awaited turn in the property/casualty underwriting cycle. The one certainty, repeated often by reinsurance executives, was that capacity in their industry would tighten and that catastrophe covers would become more expensive, if available at all.

A month later, A. M Best Co. said the insurance industry's losses on hurricane Andrew will be \$13.4 billion, or 25 percent more than the American Insurance Services Group, which serves as the industry's official scorekeeper, estimated [in October.]⁹⁸ Allstate Insurance Company alone increased its estimated losses from hurricane Andrew by more than 40 percent to \$2.5 billion in December 1992.

A Weak Global System in Recession

The world economy will grow far more sluggishly next year than was predicted just a few months ago, economists say, because of a surprisingly deep slump in Europe and Japan. Since September 7, 1992, it has become clear that the German economy teeters on the edge of a damaging and lengthy recession, and Japan's growth remains surprisingly anemic. "Americans have not yet absorbed the dramatic drop in German economic output this year: Germany is now limping along at 1 percent growth. Japan for the past three months has grown only at 1.1 percent on an annual basis. Current U.S. growth is about 1.5 percent."⁹⁹ The overseas slump, the economists say, could mean the difference between respectable growth in the United States next year, with unemployment falling substantially, and another lackluster year with the jobless rate hovering above 7 percent.

The Washington-based Institute for International Economics says the global slump may reduce American exports by \$20 billion in 1993 and cause employment to grow by 400,000 fewer jobs than previously predicted. When growth falters abroad, foreign businesses buy fewer American-made goods.¹⁰⁰

William Rees-Mogg, former editor of *The Times of London* sees the trend in deeper, more fundamental terms. "A world economic crisis is a type of world revolution. It destroys old structures, economic and political. The Soviet Union, with its rigid inability to adapt, was the first to fall before the full force of the storm now blowing through the international financial system. . . . Such a crisis destroys well meaning politicians and promotes men of power . . . It destroys respect for government, as people discover that their leaders cannot control such events."¹⁰¹ Rees-Mogg noted that nothing less than the credibility of governance is at stake in this spreading economic crunch.

"Are we entering a full-blown world economic crisis?" asks columnist Jim Hoagland. "Will the politicians in power in the world's industrial democracies pay the price not only in diminished credibility but also in being thrown from office?"

Trade Balance and National Debt: The New American Squeeze

Trade Balance

All other things being equal, the pool of funds that is available to business, government, education, and individuals for investment in our economy rises and falls with our balance of trade and the interest rates charged by the Federal Reserve Bank. Money that comes into the country in return for American sales abroad is available to be spent -- invested in this country. When we buy foreign goods, we send money out of the country and decrease the amount that is available in the pool for investment here.

If we send out more than we take in, the difference must be made up in some way in order to maintain an adequate pool for reinvestment by local businesses and organizations. A government can print more money, thereby decreasing the total value of the money (producing inflation), or it can raise interest rates, thereby increasing the incentive for foreign traders and investors to move their money into the U.S. for the higher return. We have mostly used the latter approach to deal with our imbalances when other

forces like currency exchange rates have not been playing a major role in the mix.

U.S. Exports to EC: Decrease

The opportunity for the greatest change in U.S. trade exists between ourselves and both Europe and Japan. As mentioned, most economists predict a growth in the British economy of only between 1-2 percent next year and even worse numbers for Germany. If Europe's slump gets much worse, and as of the startup of the EC this year, it will become much harder for the U.S. to make inroads into European markets, not so much because of European protectionism, but because of plunging demand.¹⁰²

Consider the stability of our trade surplus with the EC. What will be our long term impact due to the European Community now that much of its external trade has become internalized? As long as the European economy remains soft, the likelihood of an increase in our surplus with the EC is remote and the possibility of a drop in our exports grows.

China's Rapidly Growing Exports to U.S.

At the same time, China presents a rather dicey, but opposite, trade problem for the U.S. Explosive growth in the PRC is being largely enabled by exports to the U.S. China was one of the world's fastest-growing economies in 1992, with real GDP growth that averaged almost 9 percent a year for a decade, a rate that doubles the size of the economy every eight years. If China meets its goal of 10 percent a year for the rest of the century it will be six times larger in 2000 than it was in 1978. That would equal the performance turned in by Japan and Taiwan in the 23 years after 1950. But China's growth would have come in a country not of 20 or even 120 million people, but in one that is home to more than a fifth of humankind.¹⁰³

If this happens, it would substantially increase our trade deficit, for much of China's growth is the result of skyrocketing exports to the U.S. In the last two years, Chinese exports to the U.S. have tripled. At the present rate of increase China will bypass Japan in 1995 as the country with which we have the largest trade deficit (while Japan pretty much maintains its levels of U.S. exports).

There are powerful political reasons that argue that we should let this happen: allowing capitalism within their own country to be the force that erodes away the authoritarian nature of China's government. The alternative, of course, is some kind of protectionism, with its attendant set of problems.

Former President Richard Nixon, argues strongly against protectionist measures: "More than ever, trade is the key to prosperity. The recession of 1931 became the Great Depression of 1932 after the Smoot-Hawley tariffs contributed to the collapse of world markets. Since trade accounts for 25 percent of U.S. GNP today, a trade war would trigger a depression that would make the present downturn look like a minor blip."¹⁰⁴

It appears that the Clinton administration has embraced what could become a "get tough" trade policy. Recently a 100% tariff was put on steel imports from Japan, Germany, Brazil and five other nations. The Administration has also indicated that they will similarly respond to perceived inequities from Europe. In essence, the President has said that the nation's commercial rivals won't get unless they give. This isn't exactly a confrontational stance, but it could turn the trade failures of 1992 into serious trade frictions next year at a time when the global economy is in its worst shape in more than a decade. Rising trade barriers could well damn the current GATT deliberations and may accelerate the onset of a depressionary cycle.

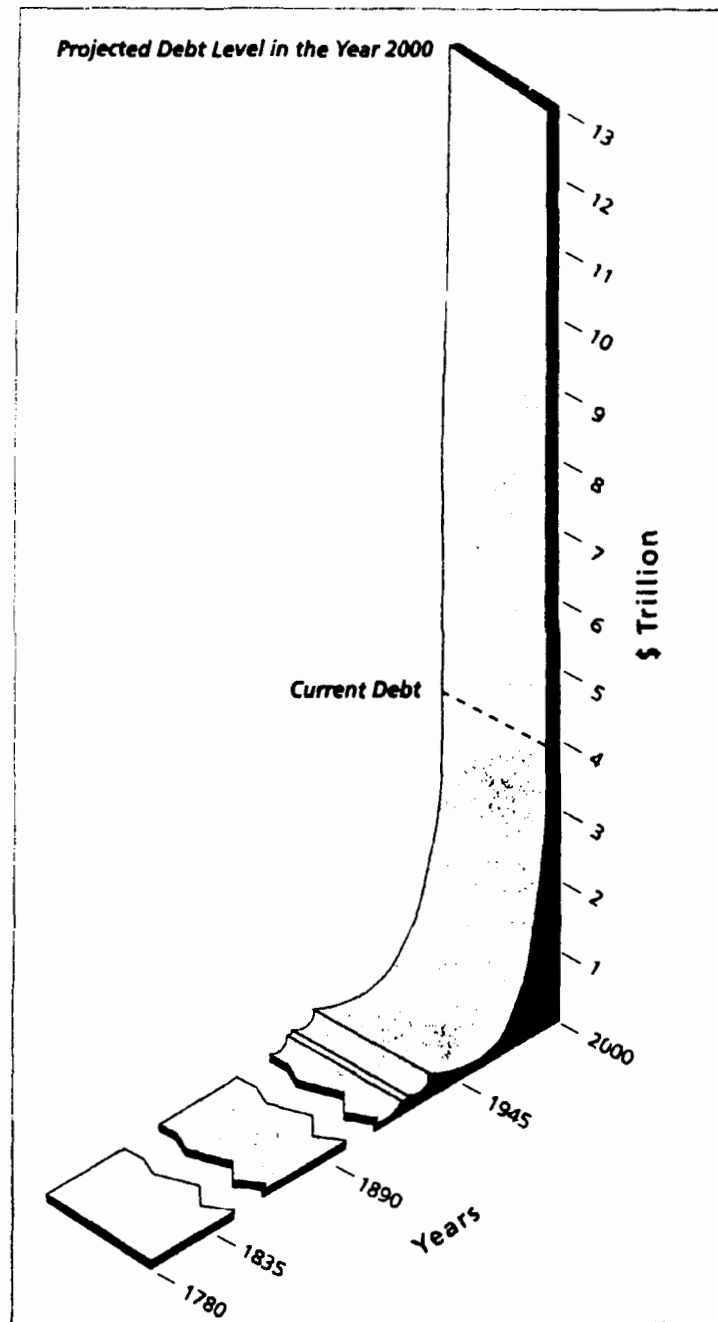
The National Debt - an anchor to recovery

The nation's total debt from consumers, business and government more than doubled in the last 10 years to \$11.3 trillion. But in a development that defies postwar credit history, the economy has been unable in this recovery cycle to "reliquefy," or pay down debt and position itself for fresh spending.

Corporate debt remains equal to nearly 38 percent of gross domestic product, the highest level in at least 25 years. And interest payments, though they have fallen from their 1990 peak, still consume almost 25 percent of corporate cash flow, compared with about 20 percent 10 years ago.

Corporate debt service costs might have fallen even further if business weren't paying a huge price for the federal government's staggering budget deficit, almost \$400 billion last year (when

U.S. Government Debt



source: Based on DRI/Grace Commission Projections

everything is counted). These troubling numbers have kept long-term interest rates hovering between 7 and 8 percent, or an unusual four percentage points above the inflation rate. Washington's deficit is expected to remain at uncomfortable levels in the near future, and this means that real long-term interest rates could very well stay at historic highs despite the fragile economy.

"Debt is the major impediment to a robust recovery," says economist and money manager Henry Kaufman. "There is simply no precedent for this in our postwar experience."¹⁰⁵

Manipulating Interest Rates Will Become Decreasingly Effective

But the problem is worse than just being a hindrance to recovery. The size of the federal debt is such that interest payments alone in 1992 accounted for 20 percent of the total federal budget.¹⁰⁶ Fifty-two percent goes to entitlement programs and the balance of 30 percent is spent on funding the whole of government operations (defense, commerce, state, etc.)¹⁰⁷ The 20 percent is based on a current interest rate of 5 percent -- which is what is being charged for the 3 to 3 1/2 year notes with which the debt is being financed. (The average maturity of the federal debt is 3-5 years.)

If, in an attempt to control inflation or increase foreign capital flow into the country, if the Fed were to increase average interest rates so that the 3-year notes yield, say, 10 percent, the deficit debt service could similarly double to an amount equal to 36 percent of the present budget, leaving only 12 percent available for all of the rest of government -- half of the previous amount; an untenable position. Therefore, for the first time, there is an effective interest rate ceiling above which the Fed cannot practically go; for in doing so, it systematically eliminates the funding of government -- or forces the monetizing of the difference, therefore increasing inflation.

An alternative scenario envisions the increase in interest rates to a "global" competitive level where the increased debt service is met by foreign capital, predominately financing an accelerating U.S. federal deficit. This is essentially what President Reagan did during the 1980s. Once this nation passes the point where debt service equals federal annual revenues and increases of debt service are met only by increased foreign borrowing, we have reached a point of no return. Hyperinflation will soon follow, destroying

almost all savings -- particularly those of insurance annuities and elderly people on fixed incomes.

As the budget deficit increases, particularly if the economy doesn't rebound strongly, the effective interest ceiling will decrease, making less and less "control" available to the Fed for regulating the economy.

Economist Paul Krugman, writing in 1990, said:

The Federal Reserve is currently in a strong position, based upon its perceived success. Yet there is in that position a basic vulnerability of which the Fed is all too well aware.

The problem is that the United States has two major economic worries -- the trade deficit *and* inflation -- while the Federal Reserve has just one policy instrument: control over money and credit. The textbooks tell us that monetary policy needs to be supplemented with fiscal policy to achieve macroeconomic goals. Translated, that means that you can't count on having both acceptable inflation and acceptable trade performance unless you are willing to do something about your budget deficit as well as your money supply. With the Federal deficit trapped in political amber, however, the Federal Reserve bears the entire burden of stabilizing the economy.

So far, the Fed has been both lucky and skillful in reconciling these goals. It has kept inflation under control, and the trade deficit has remained tolerable. But there is lurking danger that growing pressures to do something about the trade deficit will undermine the commitment to keeping inflation down. There is continuing political pressure on the Federal Reserve to adopt "soft money" policies that would keep interest rates and the dollar low, even at the risk of inflation. Should the Fed give in to these pressures, the end result could easily be an inflationary resurgence -- squandering the gains won at such enormous cost.

This is not academic speculation. The recent experience of Britain shows that a seemingly stable monetary situation can unravel with sickening speed.¹⁰⁸

The Ominous Implications of the Federal Debt

Grace Commission cochairman Harry Figgie argues that if present trends continue, the federal government's accumulated debt will have reached approximately \$6.56 trillion by 1995.¹⁰⁹ That's

roughly nine times the amount the government will collect in personal and corporate income taxes in that year.

Depending on what President Clinton and Congress decide in 1993, Figge believes the growth rate of the federal budget deficit may well accelerate. From nearly \$400 billion in 1992, the Grace commission estimated the deficit will climb to \$640 billion in 1993, to \$730 billion in 1994, reaching \$850 billion in 1995. If this scenario plays out, interest payments are projected to exceed the amount of money the government collects in personal income taxes by 1995. In that year, interest on the debt alone will reach 103% of all personal incomes taxes collected.

In 1964, the national debt was \$316 billion. Interest on the debt was \$10.7 billion, or 14.8 percent of all personal and corporate income taxes collected that year. By 1988, the national debt had climbed to \$2.6 trillion and interest to \$214.2 billion. Interest payments took 43 percent of all government income tax revenues that year.¹¹⁰ In 1992, interest charges on the national debt came to \$293 billion. Paying that amount alone took nearly 52% of personal and corporate income taxes. By 1995, when the national debt will have reached \$6.56 trillion, the interest charge alone (assuming interest rates don't rise) -- some \$619 billion -- will amount to 85% of all income taxes, *more* than the government collects in taxes from individuals.

In 1991, interest on the national debt was the largest single item in the federal budget. In that year, the U.S. government spent more on interest than on the combined expenses of the departments of Agriculture, Education, Energy, Housing and Urban Development, Interior, Justice, Labor, State, Transportation, and Veterans' Affairs.

In 1982, America's debt stood at 36% of Gross Domestic Product. By the end of 1992, the debt reached 70% of GDP. The debt is growing three times faster than the size of the U.S. economy. At this rate, by 1996, the U.S. federal debt will total more than the entire industrial output of the United States.

The Next Two Decades

A Depression?

Economist Shlomo Maital, reviewing books by James Dale Davidson and Lord William Rees-Mogg, Jacques Attali, and Lester Thurow mentions that the last decade of this century and the approach of the new millennium are the confluence of two types of cycles.¹¹¹ One is the 500-year cycle noted by Davidson and Rees-Mogg: "The end of each century divisible by five has witnessed a major transition in Western civilization." The second type of cycle is the so-called 60-year Kondratieff Cycle, named after the Russian economist who first discovered it. Three depressions have occurred in the past two centuries -- in 1814-49, 1873-96, and 1930-39 -- roughly 60 years apart. The fourth depression is now due, say the cycle's proponents. The prime signal, instability in financial markets, they say has been broadcasting loud and clear, with the collapses of U.S. stock prices in 1987 and again, in 1990, and the 49 percent drop in the Nikkei Dow Index that same year, a drop far sharper than the one experienced by Wall Street in 1929.

The big winners of the next millennium could be Europe and Asia, Maital reports. In 10 years, Attali predicts, half of all world trade will occur in the Pacific Rim, whose member countries will achieve an aggregate gross national product equal to that of Europe or the United States. Access to the U.S. market is absolutely critical to the near term accelerated growth of Pacific Rim countries.

In 15 years, Attali says, new high-speed ships will make every Asian port only a day apart. Europe, too, may be a winner, but only if it is able to bring to fruition its dream of a huge, efficient single market and only if the Soviet Union's and Eastern Europe's struggling economies do not collapse, sending millions migrating toward the West.

The big losers, according to all four authors, will be Latin America, Africa, India, and China [As noted earlier, there is a strong counter-argument for China flourishing]. These regions, the authors agree, will be locked out of the major trading blocs, left

without capital, skill, or technology. Africa's future is particularly bleak: Attali writes that "it will be the only region on the whole planet that is entirely excluded from abundance."

China, and particularly India, must cope with tremendous societal, economic and ethnic/religious transition strains. By 2035, assuming current population dynamics, India will surpass China as the most populated nation on earth. China's GDP per capita will increase during the next 20-30 years while India's will decrease, reflecting the dynamics of China's zero population growth.

Options: Dependent Upon International Political Initiative

The Economist, talking about the possibility of a global depression said, "The best way to reduce the risk of such a calamity is to forestall those preconditions. That is the job of financial regulation -- a state of affairs which is not exactly encouraging."

They continue, "A renewed drive toward more tightly regulated domestic markets may be attempted. (Some recent changes in American banking rules, for instance, seem to echo earlier direct controls of interest rates, and all that.) But this approach is likely to fail for exactly the same reason that domestic deregulation came about: financial markets have knitted themselves together, and it will take more than the wit of regulators to separate them. If one country tries to regulate more tightly by itself, it might find that it has delivered its financial industry into the hands of foreign competition.

What then are the hopes for international regulation? This is undoubtedly the right way forward, but the difficulties are immense."¹¹²

It has been almost 50 years since the Bretton Woods agreement sought to stabilize the free world's currency rates through a formal market mechanism. The world has changed vastly since those days. Some have called for a Bretton Woods II, given the reality of the new economic security relationships.

Other Trends

Within the macro trends cataloged above there are a number of other issues and currents that have long-term significance.

Pension Fund Overhang

Fewer Pension Plans

There is potential pension crisis brewing in the U.S. On one hand, fewer and fewer workers are provided a pension plan by their employers. Workers actually covered by pension plans peaked at 48.3 percent in 1979 and fell to 43.2 percent in 1988.¹¹³ Most of those not covered work for small businesses. The compliance costs for administering a traditional defined-benefit plan nearly tripled from 1981 to 1991 because of 10 major changes that Congress made to the Employee Retirement Income Security Act in that period.

More Defined-Contribution Plans

Of those employers who do provide a plan, more and more employers are moving from a *defined-benefit* plan that guarantees retirees a certain payment, generally based on years of service and level of compensation, to a *defined-contribution* plan which do not guarantee a specific pension. Defined-contribution plans have a great appeal for small companies because they are less complex and roughly half as expensive to administer than defined-benefit plans. The U.S. Department of Labor reported that workers covered under defined-contribution plans more than doubled from 1980 to 1987 to 13.4 million.¹¹⁴ In 1991, some 11,900 defined-contribution plans were initiated; only 370 defined-benefit plans.¹¹⁵

Not Funding All Liabilities

Furthermore, corporations are increasingly not funding all of their pension liabilities -- leaving the federal government with the growing obligation. The Pension Benefit Guarantee Corporation, a government agency, protects the retirement income of nearly

40 million participants in about 100,000 private pension plans. It does so by insuring private pension beneficiaries against the loss of promised benefits if a pension plan that has insufficient resources to make good on its promises is terminated. Pension benefit payments currently insured by the PBGC are more than \$800 billion.¹¹⁶ The PBGC insures benefits promised by defined-benefit plans, but *does not insure* defined-contribution plans.

For a number of reasons, a corporation may end up not funding all of their obligation under their plan. A sudden drop in the stock market can cause a plan that was fully funded last year to be significantly underfunded this year. If a company gets in financial trouble, the IRS can give it a waiver that relieves it of the obligation to either completely or partially fund its plan. In these situations, the PBGC insures the unfunded difference so that the employee knows that his or her pension will be paid at retirement. Congressional leaders charge that cash-strapped companies frequently make pension promises that far exceed the money they set aside to cover them, knowing that if the company doesn't survive, federal insurance will cushion the fall.

At the present time, the U.S. government has a \$94 billion unfunded liability, \$10 to \$13 billion of which are plans of financially troubled companies. While it has sufficient cash to continue paying benefits, the pension insurance fund has billions of dollars less than it will need to meet escalating long-term obligations to retirees, according to the General Accounting Office. Rep. J. J. Pickle (D-Tex.) feels that unless Congress acts now, these problems would worsen and "become the next savings and loan bailout."

If the government's exposure in the commercial area is this great, one wonders what the unfunded pension liabilities are for federal workers, retirees and the military.

Weak Insurance Companies

An additional 4 million retirees receive pension benefits through annuities that have been purchased by their employers from insurance companies. But, according to the GAO, 170 life insurance companies failed between 1975 and 1990. Forty percent of the failures occurred during 1989 and 1990. Since then California-based Executive Life Insurance Co. has been placed in

conservatorship. This is the largest U.S. insurance company failure in history.

If the stock market were to drop significantly, the continued sluggish economy produces more business failures, more insurance companies fail, and/or the PBGC be inadequately funded to assume the unfunded corporate pension overhang, then the U.S. pension system could be in for a big blow.

The U.S. Educational Problem

As the Information Age matures it will be increasingly clear that knowledgeworkers are the most important capital asset of any country. In order to compete effectively in world trade we must learn how to invest in human capital.

How do we manage human capital? Our society largely does not understand how, for it is a systems problem and not one of just a single program or area of concern. The principal aspects though, are education and health (dealt with in a later section of this report).

An Education System That Is Old And In Disarray

The United States has the best public education system in the world for the top 15% of our students; the bottom 25% is a disaster. Our schools, particularly in urban areas, are sending out graduates who are ill-equipped for our information-based economy, let alone, in many cases, life. In the increasingly competitive global marketplace of the future, the uneducated are a severe drain on our future. If we do not provide as much information as possible to our people, we will find ourselves responding to those societies that have. Information is the key commodity.

The U.S. needs a revolution in education, and it almost certainly is in the making. The question is whether big change will come fast enough. Americans are more and more frustrated with the shortcomings of our system. Business and the military spend many billions of dollars teaching entry-level workers the basics that they didn't learn in school. Manual-labor jobs are decreasing and the growth in opportunities are in industries requiring more intellectual content. Our inner cities are a wasteland, moving

young people farther and farther away from the economic mainstream of the country.

But, among other things, a new chain of private schools is being developed by Christopher Whittle, and software designers are exploring dramatic new models of learning based on images and interaction. Organization and structural change that is making its way through the business community, will, in time certainly invade education. Again, one hopes in time.

Finding Educated Workers Elsewhere

The transnational nature of business and the hyperfluidity of information assures that the business community will find the knowledgeworkers they require -- wherever they can find them. Highly educated people in other countries (at lower costs) are a real incentive to employers. For example, third-party offshore computer programming services to U.S. firms totaled \$250 million in 1991, and the business is growing at an estimated 50 percent a year, according to International Data Corp.

By one estimate, India's computer science departments churn out 20,000 English-speaking graduates a year. What's more, India's programmers are increasingly schooled in the hot languages of the 1990s, C and C++, because their universities can't always afford the mainframes needed to run older languages such as COBOL.¹¹⁷

U.S. high-tech companies are hiring Russian programmers in Moscow to develop routines for commercial applications and similar services are being sourced in Ireland and some south east Asian countries.

New Models

As the increasingly interdependent world searches for better ways to decrease the economic swings that bedevil it, at least one new idea has surfaced as a new way to understand economics. Jonathon Rauch, writing about government reform in the *National Journal* touched on it. "The dramatic initiatives and experiments of the New Deal and the Great Society have created their own

bureaucracies and constituencies, which now strangle efforts to attune the government to the realities of the present day. Entitlements alone account for three-quarters of all federal domestic spending, but they are engraved in government stone.

Governments ought to work like a capitalist economy, Rauch says, or a *biological* system -- evolution through trial and error.¹¹⁸

It's not just government that needs to be reconsidered, it's the underpinning theory that we use to describe the behavior of economic systems. Federal Reserve Chairman Alan Greenspan recently called the U.S. economy a "different animal," because it was not acting like it always has in the past. As we enter this new era that is changing in so many ways, we should be looking for new models that better describe this extraordinarily complex system upon which we are all dependent.

Bionomics

Rauch's idea of a biologically operating economic system may well have been drawn from the work of Michael Rothschild, author of *Bionomics*. Reacting against the mechanistic imagery and structure of classical economics, he has developed a new model for explaining the operation of the economic system which parallels that of the biological world. Instead of the "economy as machine" model, bionomics argues that a market economy works remarkably like an evolving ecosystem -- a naturally occurring, spontaneous, evolutionary phenomenon. Just as biology studies the evolution of genes, organisms, and the ecosystem, bionomics studies the evolution of technologies, organizations, and the economy.

From the bionomic perspective, the global market economy of the information age looks like a "capitalist rain forest," populated by vast numbers of highly specialized organizations instead of highly specialized organisms. Companies compete for survival within their industries just as creatures compete for survival within their species. The more intelligent, adaptable, and responsive the organization, the better its chances of surviving in today's fast-evolving economic environment.¹¹⁹

Many observers are assailing traditional economics as its practitioners increasingly fail to explain the behavior of the world's economy. Clearly, a new model -- like Bioeconomics -- is needed.



Notes:

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- ⁸⁹"World Economy Survey," *The Economist*, "September 19, 1992 p. 41
- ⁹⁰"Japan's recession biting deeper than expected," *Omaha World-Herald*, Dec. 3, 1992: .
- ⁹¹The Conference Board, 1992
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- ⁹³Dalio, Ray; "Depression, Not Recession," *Barron's*, October 12, 1992, p. 17
- ⁹⁴Rankin, Deborah M.; "When a Bankruptcy Is the Best Way Out." *The New York Times*, November 7, 1992, p. 33:
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- ¹⁰³The Economist - The World in 1993
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- ¹⁰⁶Figgie, Harry E. Jr.; *Bankruptcy 1995*, [New York: Little Brown & Company: 1992] p. 70
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- ¹⁰⁸Krugman, Paul; *The Age of Diminished Expectations - U.S. Economic Policy in the 1990s*, [New York: Riverside, 1990] p. 85
- ¹⁰⁹Summary of: Figgie, Harry E., *Bankruptcy 1995: The Coming Collapse of America and How to Stop It*, [Boston: Little, Brown & Co., 1992], by Wm. Van Dusen Wishard, WorldTrends Research, Reston, VA
- ¹¹⁰Figgie
- ¹¹¹Maital, Shlomo; "Future Winners . . ." *Across The Board*, December 1991, p. 7. A review of *The Great Reckoning: How the World Will Change in the Depression of the 1990s* (Summit Books) by James Dale Davidson and Lord William Rees-Mogg, *Millennium: Winners and Losers in the Coming World Order* (Random House) by Jacques Attali, and *Head to Head: The Coming Economic Battle Between Japan, Europe, and America* (William Morrow) by Lester Thurow.
- ¹¹²"World Economy Survey." *The Economist*, "September 19, 1992 p. 47
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¹¹⁴"The Pension Headache." *HR Magazine*, January 1992

¹¹⁵"Trojan Horses." *FW*, October 27, 1992, p. 32

¹¹⁶"Understanding the Risk to Pension Benefits," *Personnel Journal*, January 1992

¹¹⁷"Programming Ships Out To Cheaper Climates," *Corporate Computing*, September 1992, p. 21

¹¹⁸Rauch, Jonathan, "Demosclerosis," *National Journal*, Sept. 5, 1992,

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Politics

Remember, democracy never lasts long. It soon wastes, exhausts, murders itself. There never was a democracy yet that did not commit suicide. It is in vain to say that democracy is less vain, less proud, less selfish, less ambitious, or less avaricious than aristocracy or monarchy. It is not true, in fact, and nowhere appears in history. Those passions are the same in all men, under all forms of simple government, and, when unchecked, produce the same effects of fraud, violence, and cruelty. . . .

— John Quincy Adams

International

There are two forces in tension in the political world today: one encouraging cooperation and commonalty and the other attempting to highlight the differences between groups. These **integrationist** and **fragmentationist** forces, as Samuel Huntington has called them,¹²⁰ manifest themselves in isolated places within most societies, but each has its central locus on different ends of the economic spectrum.

Integrationists

In general, integrationists cluster in the developed world and the fragmentationist message is more warmly received in lesser developed regions. In light of the trends we have seen so far in this report, it seems that there is good reason for this.

On one hand, there is a clear pressure from the growth of information technology to increase the interdependence of nations and groups. Economies blend with each other, ideas move across boundry-less borders and people soon see that they are wedded to others in this world and cannot go it alone. In fact, they learn that there is a significant synergy and economy to working with other foreign governments, businesses and academics.

As the power and proliferation of information technology explodes it is likely that this trend will increase as well.

Fragmentationists

But not everyone in the world is participating equally in the information revolution. Most of the world's residents, in fact, are not aware of the extraordinary trends and capabilities that have been chronicled earlier in this report. They see (mainly through television) the effects of the underlying technology and education and find it threatening. Throughout history, the natural reaction to significant, unfamiliar change has been to search for stability by defending comfortable, well-known ideas and structures, and in so doing, discriminating one's own group from the larger society. It is the standard reaction to a lack of information accessibility -- an inability to participate in the change.

We will use this polarity as the organizing structure for understanding the major political trends of the coming years.

Integrationist Trends

A movement toward integration can be seen in each of these political trends that are centered in the developed(ing) world.

Democratization

There have been twenty-some countries who have given up their attempts to make communism work in the last dozen years. This has been the third wave of democratization in the world since 1974.

De-ideology

De-ideology -- A number of countries that became disillusioned with ideological communism have lost interest in ideology of any kind. China's Deng characterized that country's new orientation as "Chinese socialism" rather than call their quest capitalism or socialism.

Diffusion of Power

Political power is diffusing away from strong national organizations. Consider that:

- European countries are both deepening their military and political unity and widening its scope.
- The USSR has been transformed from a tight centrally-controlled structure into a loose and voluntary confederation.
- Beijing has loosened its central control enough that capitalism is flourishing; so much so that it may well be the most significant threat to the continuation of the communist government.
- Regional security accommodations are replacing previous superpower-dominated relationships.
- Corporations are becoming larger, non-national and more efficient. Alvin Toffler raised the idea that as governments and inter-government organizations become less responsive to business needs, it is likely the *transnational firms will end-run governments and demand direct participation in global institutions*. "It is not too hard to imagine," he wrote, "a Global Council of Global Corporations arising to speak for these new-style firms and to provide a collective counterbalance to nation-state power."¹²¹ Already groups of corporations are taking over

some of the traditional roles of government. In northern India, for instance, tea growers are raising an 8,000-member private army to protect their interests.¹²²

- Information technology is moving the world, step-by-step, toward a time when *individual people will have less and less need for many of the services supplied by the government* because they will have the capability (and power) to operate independently. Already it is predicted that most libraries, as we know them, will begin to close soon into the century because computer owners will be able to access the information directly and more conveniently.
- As technology evolves, *both small groups and individuals will increasingly obtain the power to threaten established governments.* Nanotechnology and artificial life, for instance, may both ultimately empower individuals with the ability to menace whole nations, if not all of life itself. A virus, designed by a youth, can shut down whole industry segments and public service suppliers.

Multilateralism

There is an "even-ing-out" taking place in the relative positions of major international political players and as a result of that, and growing interdependency, leaders are far more reluctant to go-it-alone in responding to major problems.

New concept of broadened political community

Nations are beginning to take on democratic accountability for problems that transcend national boundaries. In both Iraq and Somalia, for example, many nations came together and jointly developed and contributed to a plan of action.

New conceptualization of world security

A new concept of national security is emerging, and at its center is the idea of interdependence. It is becoming clear that one must start with global or regional security in order to begin to understand what is required for national security.

- The concept of sovereignty is changing and the notion of political community is becoming broadened.

- New, untraditional threats, like the global environment and the proliferation of weapons of mass destruction must be considered.
- The need to become proactive rather than just reactive is becoming understood.
- New systems of cooperation are replacing the hegemonic models of the past.

Global Institutional Solutions

Some have talked about global solutions to transnational problems by using institutional innovations such as the creation of an International Investment Trust to recycle surpluses, a World Central Bank, an international debt facility, and a global environmental protection agency.

An oligarchical coordination, in which the US, Japan, and Germany are the major political influences in the world could well evolve -- particularly as the result of a major catalytic event and continent-centered trading and security blocs are, of course, being formed.

Demilitarization

The multilateral trends are evolving what might become a new collective security order. Wars will be primarily small and regional, and stem from local antagonisms and the ambitions of Third World rulers. Peace will be restored by the joint effort of the entire world community, as in the Gulf War.

One indication of this trend is that developed countries are dramatically decreasing their military forces and defense budgets.

Fragmentationist Trends

In the lesser developed regions, a set of opposing pressures are at work.

Weapons Proliferation

Conventional Weapons

Both conventional and unconventional weapons are rapidly proliferating throughout the third world. Conventional arms exports are the major hard currency source for Russia and other Eastern European countries and they are therefore eager to sell as much as they can. The Russian Minister for Economic Relations recently reported that they push such sales vigorously but only for cash -- no more credit to Third World states. The major Russian purchasers of Russian arms are India, China, and Iran. Russian weapons plants have more than 200 combat aircraft and 1,000 modern tanks for immediate sale.

The United States is, of course, the major arms merchant to the world and U.S. companies are actively looking for foreign buyers to replace the shrinking domestic defense market. Germany recently changed its long-standing policy against certain arms exports for similar reasons.

Russia is willing to sell their front-line weapons to most anyone who has the cash to buy. They recently inked a deal with Iran for two additional diesel submarines. The result is that Third World armies are equipped with some of the most sophisticated armament in the world -- supplied by the US and Russia. That is bothersome at face value because of the potential destructiveness, but is particularly problematic in light of the fact that American forces may someday face those weapons.

Weapons of Mass Destruction

Of more concern are nuclear, biological and chemical weapons. In the past, major military powers developed these capabilities expressly so that they would *not* have to use them. Now, countries (and perhaps, groups) are acquiring these weapons with the objective of using them.

The CIA reports that tactical nuclear warheads are being sold by officials in some of the former Soviet republics to middle-eastern groups. Iran has reportedly closed a deal to buy nucs from Kazakhstan. Iran also made a trip in September, 1992, to China and took along a team of nuclear technicians whom he left behind in

Beijing. Germany has had over 100 cases last year of attempts to smuggle radioactive materials out of Romania and the former Soviet Union.

Then Congressman Les Aspin's 1992 analysis of the security threat to the U.S. during the coming years determined that our number one concern should be terrorists with nuclear weapons.

The most ominous of this class of devices is biological weapons. A thimbleful of agent, disbursed effectively by the wind, could kill most all of the inhabitants of a city like New York. There are no common antidotes for this threat. Saddam Hussein was working on biological agents as, it has been rumored, have other third-world leaders.

U.S. intelligence analysts estimate that the number of countries with ballistic missiles capable of delivering a nuclear, biological or chemical weapon over many hundreds of miles will double or triple by the end of the century. Almost all countries will be within reach of someone with this capability.

Islamic revival

A worldwide Islamic revival threatens to put conservative fundamentalists in the leadership of an increasing number of governments. A negative reaction to the great change in the developed world, this trend has as its main tenets:

- Increased emphasis upon viewing Islam as an all encompassing way of life
- The goal of a global Muslim community
- Heightened fundamentalism in values, ideals, and political solutions
- Organized movements mobilizing Islamic political power

A worldwide crisis of national identity

We are living through a time of transition -- from the cold-war era to something yet to be defined. One of the major characteristics of this time will be realignment -- in all areas of life. Politically, many relationships will shift. Organizationally, new models will be designed. And, since everything is in flux, old conventions that helped contain animosities and apprehensions have

vanished. Also, new concerns, influenced by technological and other forces have been freshly generated.

New Relationships

This fluidity has generated a worldwide crisis of national identity. Comfortable, familiar relationships have given way to searches for new relationships.

For the U.S., the "new world order" has not yet materialized, and we have yet to decide what particular role we might play in the framework that ultimately evolves. As mentioned earlier, we are being rapidly driven down an unknown path by new concepts in science, powerful new technologies and a geopolitical situation undergoing rapid change.

Canada is struggling with serious national identity problems. Whether they will still be a country in ten years with their familiar provinces, is now actively debated. The former Soviet Union, of course, is doing its best to transition to something new without an expansion of their already corrosive inter-republic and civil wars.

Capitalism and democracy have widened the gap between Czechs and Slovaks so that they recently split Czechoslovakia into two countries.

The savagery in Yugoslavia has saturated the press. Serbian "ethnic cleansing" is rewriting traditional national identities while in Germany, Neo-Nazi groups are trying to reestablish their identity.

The Role of Television

It is important, briefly, at least, to mention the profound implications of television for promoting both integrationist and fragmentation trends.

In the last few years, with the advent of television repeater satellites, television has become a global communication device; moving images of peoples lives, behavior and fashions

instantaneously between and among most all nations and most cultures.

This window on the rest of the world (primarily the Western world), is having a profound effect in promoting integration (some think it will speed the integration of Europe) and fragmentation (the reactions of Fundamentalist Muslims to the West is a byproduct of TV images). Although it is hard to anticipate just what role this technology will play in future global politics, it is clear that we have entered a new era where images and sounds from far and strange cultures will increasingly find themselves inserted into our lives -- wherever we live.

Russia

Two major countries, Russia and China, are real political wild-cards that will be dealt with here in more detail. Both of them are in positions where their futures, depending upon what happens, could have a profound political influence on the rest of the world.

The former Soviet Union is in trouble. Big trouble. In broad terms, during a period when the developed world was embracing information technology as fast as it was produced, the USSR chose to try to continue to control information accessibility. While other societies were decentralizing, they maintained a tight, centrally-controlled economy. Businesses in the West and Japan were linking with each other at extraordinary rates, but not with the Soviets. Western nations refused to allow them to buy personal computers and other equipment that was freely available in other countries.

The net effect: the developed world, enabled by information technology, began to move away from countries like the USSR at accelerating rates. The tempo of development outside of Russia has become so much greater than theirs, that it is as if they are still deep in a hole, trying to get out, while the West is already a half mile away, running faster and faster away every day. One wonders if it is possible in the next two decades for Russia to even begin to catch up. They will make significant progress, but

not as much as the others with whom they will compete politically and economically.

Some recent reports are illustrative of the problems they have.

"A U.S. business man in Moscow told me that the worst words in the world for him are **instability and uncertainty**," said the University of Chicago's Marvin Zonis recently. "Both are present in Russia. In fact, there is instability and uncertainty about virtually every aspect of life in Russia -- the political, economic, legal, monetary and fiscal systems are either unknown or poorly established. As a result, many US businesses are shying away from substantial investment."¹²³

In a report of October 19, 1992, Zonis cataloged the problems. Illness and disease are sweeping Russia as its economy, water, medical, and public health infrastructures collapse. Pharmaceutical plants are shutting down. Water supplies are increasingly unhygienic with Moscow and Kiev joining St. Petersburg as unsafe. (The Russian government recently reported that 40 percent of all Russian hospitals do not have any running water while another 12 percent have no hot water.) Hospitals have run out of medicines, disinfectants, and soaps and infections are rampant. (When President Yeltsin's mother was hospitalized in Ekaterinburg, he flew her medicines from Moscow since none were locally available.) Illnesses, long thought to have been stamped out, have reappeared, in some cases in epic proportions. The birth rate has plummeted, the population is shrinking, and life expectancy has decreased.

In search of new sales, Russia dispatched recently its first military sales mission to the United Arab Emirates. Western governments fear new international arms races spurred by Russia's desperate search for hard currency earnings.¹²⁴

The Situation Is Getting Worse

The Jamestown Foundation reported similar trends in the political realm.

In short, the situation in Russia is very bad, and getting worse. We may have won the cold war, but as of today we're losing the peace.

In the best-case scenario, Russia and the other CIS republics will evolve into peaceful free enterprise democracies, contributing their

wealth of human and natural resources to the betterment of the planet, and posing no threat to the world community.

In the worst-case scenario, Russia and the other CIS republics will disintegrate into chaos, and civil and interrepublic war, Yugoslavia on a horrific scale, but with the deadly difference which the possession of nuclear weapons makes -- the potential for nuclear and ecological disaster.

The trend is in the wrong direction. The tide is now running in favor of autocracy and statism. The mood of the populace is ugly, and the political ramifications are dire. The statist and the "red brown coalition" are gaining strength daily. Yeltsin, in moves ominously reminiscent of Gorbachev, is attempting to appease them by retreating from his previous positions. Hardliners are moving into his cabinet. Reformers are leaving. Gaidar is gone. The reformist bloc in parliament is waning, as various factions and parties leave to join the growing statist bloc.¹²⁵

Time magazine recently characterized Russia as, "... undergoing the most severe economic hardships since World War II. State orders for unwanted factory goods have dried up, shrinking Russia's gross domestic product as much as 23 percent this year. The number of jobless workers has surged from 59,000 in January to 905,000 today. An estimated one-third of the population now lives below the poverty line. Russian economists expect inflation to hit a monthly annualized rate of 2,200 percent by the end of the year, further eroding faith in the ruble and threatening to scuttle reform."¹²⁶

The economic squeeze is taking a serious social toll. According to Russia's Interior Ministry, there were 32 percent more murders and attempted murders during the first nine months of 1992 than in the same period of 1991, 60 percent more armed robberies and 51 percent more burglaries in homes.¹²⁷

These problems and changes have opened the door to elements that did not exist under the Communist control. In St. Petersburg and in every other big city in Russia, the mob rules. Gangsters are moving in on business, government and the daily lives of the long-suffering population. Ministry of Interior investigators count almost 3,000 gangs across the country. With the help of well-armed "bulls," they extort millions of dollars and operate rackets from prostitution and drugs to the illegal export of billions of

dollars' worth of Russian raw materials. In St. Petersburg, one top investigator estimates that 70 percent of the police are corrupt.¹²⁸

A new, ultra-conservative political organization, Pamyat, is gaining adherents. Two years ago it claimed thirty branches around the Soviet Union, 20,000 members in Moscow alone. It is reported to have strong links to both the military and KGB, as well as support from middle-level officialdom. Pamyat is facing criminal prosecution for spreading hate and resembles the Black Hundreds movement, which organized pogroms under the Tsar at the turn of the century. Some of their membership call for a restoration of the Tsarist monarchy, linked to religious orthodoxy.¹²⁹

"Before *perestroika*, there were some ideals," says officer Sergei Selivonov, an expert in juvenile delinquency, "Now, these have been destroyed. People no longer know what to believe in."¹³⁰

But amid all of this darkness, hope still shines. One of Russia's premier sociologists and experts on public opinion, Leonid Keselman, says: "I don't see a power strong enough to change the people's desire for a better society." His surveys which are published in 15 newspapers and broadcast nationwide, indicate that most Russian citizens agree with him. Despite the deepening economic crisis in Russia, Keselman remains an optimist.¹³¹

China

China is a wildcard because it is so big and it is moving so fast. Its economy is booming, and the present rate of growth and development could be multiplied with a shift in governmental priorities, a very plausible possibility.

Inc. magazine characterized China in these terms:

The 1980s may have witnessed Japan's global reach, but the 1990s belong to China. The Chinese are reshaping the world in everything from technology to manufacturing to finance.

Overseas Chinese -- who account for the vast majority of foreign investment in China -- already have transformed the mainland's

southern coastal provinces of Guandong and Fukien, the ancestral homes of most Chinese abroad, into arguably the world's most rapidly growing economic region. Capitalists from Hong Kong employ more than 2 million workers in Guandong alone. With economic growth there averaging better than 12% annually in the 1980s, exports more than tripled. Per capita output reached as high as four times the national average.

Besides absorbing roughly half of China's foreign investment, Guandong, with more than 70 million people, also has developed its own network of small private companies, which has helped reduce the share of the economy run by central planning to a mere 15%. Here local officials increasingly place greater emphasis on cultivating their overseas capitalist brethren than on pleasing their masters in faraway Beijing.

This slow process of economic integration with their capitalist cousins over time may do more damage to the Communists than the democracy movement itself could do. In the '80s, China saw, in addition to its emergence as an economic power, the precipitous decline of its socialist structures, as the state-owned share of industry nationwide dropped from more than four-fifths of industrial production to barely half. In 1990, non-state-owned factories accounted for 70% of all industrial growth; the output from factories involving foreign investors, mostly Chinese émigrés, grew at nearly 20 times the rate for government-owned plants.

The increasing personal contact between mainlanders and their diaspora brethren could prove equally corrosive to the Communist order. With more than 300,000 Taiwanese alone visiting the mainland every year, more and more mainlanders have become aware of the enormous strides made by Chinese who live in places like Taiwan or North America, whose governments generations of mainlanders have been brought up to revile.

If willing to capitalize upon their global experience, the Chinese, with their enormous human resources, historic flexibility, and entrepreneurial skills, have the potential to develop a worldwide presence not seen since the hegemony of the British.¹³²

The U. S.

The imperatives of domestic renewal

America is facing some very serious economic problems that are growing at an exponential rate. *During the next decade the major political concern of the country will be to get the domestic situation -- economic and otherwise -- under control.*

There will be a shifting balance between America's global commitment and our domestic needs, resulting in a necessary decrease of U.S. regional security responsibilities.

New forms of government

Within the next decade events will make it obvious that our present structure of federal government, in both the executive and legislative segments cannot effectively respond to the pace and composition of change. The structure of both business and education is rapidly changing to adapt to the new, information-rich environment. It is inevitable that government will as well -- though, as usual, they will be the last to adjust.

Electronic Town Meetings

The legislative side will have to link themselves more effectively with their constituents. Although Ross Perot's "electronic town meeting" will not probably be the ultimate form, the underlying idea -- that the people will be more directly connected to the representative process by information technology -- is correct.

Restructured Agencies

The executive branch will also have to move information more quickly, push decision-making to lower levels, cut out many layers of redundancy, and organize around different concepts if they are to remain effectively engaged. With the other major institutions in our society moving so much more rapidly and working so much more efficiently, government faces the very real risk of becoming even more reactive than it is, and ultimately finding

itself under the "control" of external events and institutions. Major failures of the system may be required to generate the pressure needed to make these kinds of changes, but they are inevitable.

A new form of intergovernmental cooperation

Effective organizations are responding to information technology by rapidly pushing decision-making to as low a level as possible. There will be a pressure to do the same in government, with the federal sector granting the states control over matters previously maintained at the federal level.

If for no other reason than that centralized government control will increasingly become unable to be responsive to the needs and problems of the country, the federal government will unload more and more of their responsibilities onto the states.

Similar decentralization trends are apparent in education, organized religion and in the "edge cities" that are surrounding our major urban areas.

General Trends

The interaction of social, technological, and economic trends will produce some dramatic new political realities in the coming twenty years.

- *Government, as it is presently structured is becoming increasingly less effective. As the changes of the next two decades descend upon us, it will become even more unresponsive and lose even more of the ability to influence the economic and political environment*
- *The American government will be less able to deal with major shocks to the system, like natural disasters. Except for the participation of the military, federal government agencies will be shown incapable of dealing with events that require them the most.*
- *Business will take an increasingly aggressive role in influencing U.S. government policy. Business is much more sensitive to environmental changes and has built-in incentives to*

respond and adapt. In times like this, they have much more to lose than government and will respond accordingly.

- *The American people are demanding fundamental change in government. They know that government is increasingly not working, and the appearance of their most vocal representative, Ross Perot (a businessman) is a harbinger of the future. If Bill Clinton is not able to get government to be responsive to the country's most pressing problems the people will become much more strident in 1996.*
- *The Boomer reaction will be a third party. The 13er generation sees the problem in far more fundamental terms and talks increasingly about a violent revolution being the only way to dislodge the deep tentacles of self-interest that characterize the present system .*
- *People will be increasingly informed and therefore powerful. Information technology will make available to them far more information than they have had in the past and they will demand more response from government at every level.*
- *Private corporations will play an increasing role on the world stage. Many have grown to be larger in terms of annual sales than most countries budgets. They are much more informed and sophisticated than governments and can act much faster.*
- *The mega-firms are non-national and will respond in that way. Large corporations are not international or transnational, they are non-national and will increasingly see economics and politics without a particularly national flavor.*
- *War as prosecuted by the U.S. and other developed nations will be increasingly oriented toward information war and information-rich approaches with an emphasis on very low exposure for friendly troops. Individual military groups will become more functionally specialized. They will be put together in "modular" ad hoc, groupings based on the mission of the moment. The military will become much more flexible, agile and adaptable.*
- *The American government will be reorganized -- there will have a new internal structure and method of functioning and a new interface with the American people. The external interface will have a high information technology*

quotient. People will be able to access government more easily at different levels. As fiber optic networks and other information infrastructure becomes more ubiquitous, computer bulletin boards or other such message moving mechanisms will become very important.

- *The press will become stronger and more influential.* They are a business, can react faster than government, will have more advanced capabilities to access and analyze information. They will increasingly interpret and "shape" government (even more than they do now), because they control the configuration of the flow of information between the government and the people.
- *Local politics will quickly embrace infotech links with the people.* Already many cities and towns (Arlington, Virginia, for example) have computer bulletin boards for accessing services, and conferences for debating issues.



Notes:

¹²⁰Huntington, Samuel P.; *The Third Wave - Democratization In The Late 20th Century*. [Norman, OK: Univ. of Oklahoma Press, 1991]

¹²¹Toffler, Alvin; *PowerShift* p. 463

¹²²Hazarika, Sanjoy; "Tea Growers Plan Own Army in North India," *The New York Times*, Nov. 4, 1992, p. A15

¹²³"Report on a Trip to Moscow," *International Update*, [Chicago: Marvin Zonis and Associates, Oct. 6, 1992]

¹²⁴ibid. Oct. 19, 1992 "Disease in Russia"

¹²⁵Russia - Status Report," *Activities Update*, [Washington, DC: The Jamestown Foundation, Nov. 19, 1992]

¹²⁶"The New Russia/Economy - Why It Still Doesn't Work." *TIME*, Dec. 7, 1992, p. 60

¹²⁷"The Wreck of Russia." *U.S. News & World Report*, December 7, 1992, p. 40

¹²⁸"Russia's Goodfellas: The Mafia on the Neva," *Newsweek*, Oct. 12, 1992, p. 50: :

¹²⁹Toffler, Alvin: p. 386

¹³⁰"The Wreck of Russia," p. 45

¹³¹"Leonid Keselman, Sociologist, knows what Russians are thinking," *Newsweek*, Oct. 12, 1992, p. 69

¹³²Kotkin, Joel: "China, Inc.," *Inc.*, December 1992, p. 114

Environment

"For better or worse, the nineties will be a decisive decade for the planet and its inhabitants." -- Lester Brown

As we examine the state of our world's environment and think about the future, we find that we may be in the process of committing ecological suicide. According to a 22-nation poll by the Gallup organization, environmental damage, once dismissed as a concern of the rich, is now widely recognized as a threat to human health. Protecting the environment has joined problems of economic livelihood, crime and violence as major concerns around the world.¹³³

In this chapter we will attempt to put those concerns into a logical context using the following framework:

- **Intractable long-range problems**
 - Global warming
 - Ozone depletion
 - Loss of coastal wetlands
 - Loss of rainforests
- **Solvable, but politically difficult, issues**
 - Acid rain
 - Loss of habitat

- Problems with drinking water
- **Overlooked major issues**
 - Desertification
 - Changing weather patterns
 - Understand the Oceans
- **Important but lesser issues**
 - Toxic wastes
 - Garbage
 - Lower atmosphere ozone
- **Solutions and Strategies**

Intractable long-range problems

For the most part, problems in this category are problems with a global scope which will require global intervention, problems which are poorly understood or problems which involve our favorite addictions (like cars, political power, money, or seaside resorts).

The Atmosphere: Ozone Depletion

The "atmosphere problem" has two related but different aspects:

- Upper atmosphere ozone shields the earth from ultraviolet radiation and is being depleted, and
- Increases in carbon dioxide and other "greenhouse gasses" which keep heat from radiating back into space.

Upper Atmosphere Ozone

At the simplest level, life survives on earth because it is shielded from the sun's deadly ultraviolet light by the ozone layer, located 30 miles above the planet's surface. Ozone is an unstable molecule consisting of three oxygen atoms, which absorbs ultraviolet light. Ultraviolet light that penetrates the ozone layer is enough to cause sunburn, cataracts, and skin cancer. Major ecological disruptions would follow a rather small additional decrease in the

ozone layer. Land animals would experience a plague of ultraviolet-induced cancers. Life would survive, but not without a period of mass species extinctions similar to the one that destroyed the dinosaurs.¹³⁴

That extinction, though would start in the oceans. Already, in some regions of the world, more than 7 to 8 percent of the ozone layer has been destroyed. At an estimated 11 to 12 percent of ozone depletion the plankton in the oceans begin to die. Phytoplankton is the base of the oceanic food chain and supplier of 40 to 50 percent of the planet's oxygen. In addition to atmospheric oxygen, the plankton generate the free oxygen in the ocean that is necessary for fish to live.¹³⁵ As they died, so would the fish that are dependent upon them. Since 70 percent of the food protein eaten by humans living on the Pacific Rim come from the sea, it is obvious that even in its early stages, this is a potential catastrophe of the first order.

Ozone is depleted primarily by the human use of chlorofluorocarbon (CFC) substances. Part of the problem is that the causal CFCs do not affect their dirty deed until years after they have been released in the lower atmosphere. Even if the use of these chemicals was completely stopped today, it would be most of a decade before the damage from yesterday's releases was done. Therefore, it appears we are due for significant degradation of the ozone level over quite a few years before any near-term change in behavior begins to take effect.

Holes Are Enlarging

Thinning has been greatest near the geographic poles, but the "holes" in this protective layer are enlarging and expanding into the mid-latitudes. People in Patagonia, for example, have been advised by the Argentine Health Ministry to stay indoors as much as possible during September and October. Hunters now report finding blind rabbits; fisherman catch blind salmon.

In Queensland, in northeastern Australia, more than 75 percent of citizens who have reached the age of 65 have some form of skin cancer, and children are required by law to wear large hats and neck scarves to and from school to protect against ultraviolet radiation.

This may seem far removed from problems in the United States but the protective ozone shield in heavily populated latitudes of the northern hemisphere is thinning twice as fast as scientists thought just a few years ago. And scientists have recorded higher levels of ozone-depleting chlorine over northern New England and Canada than they have ever recorded over Antarctica or anywhere else.

Greenhouse Warming

The second atmospheric issue is the problem of global warming. It is probably the least understood and perhaps the most intractable and potentially the most disturbing of the environmental climate problems.

A report published in late 1990 by the Intergovernmental Panel on Climate Change (IPCC) warned that global warming could soon force temperatures higher than they have been in hundreds of thousands of years. The report, prepared by 170 scientists from all over the world, concluded that if the world's economies follow a "business as usual" scenario, increases in carbon dioxide and other trace gasses in the atmosphere will cause the earth's average temperature to rise by about 5 degrees Fahrenheit before the end of the century.¹³⁶

When most of us see a quote like the one above we don't now how to interpret it. To understand it better, we should ask:

- What is it?
- Is it happening?
- What are the consequences?

What is it?

The greenhouse effect refers to the way the greenhouse gasses (CO₂, chlorofluorocarbons, methane, and nitrogen oxides) trap heat from the surface of the earth by preventing it from radiating back into space -- just as closing the windows heats the interior of a car on a sunny winter day. Without the greenhouse effect the average temperature of the planet would be below freezing.

Is it happening?

Evidence is beginning to accumulate that:

- The earth's surface was warmer in 1990 than in any year since recordkeeping began in the mid-nineteenth century;
- Six of the seven warmest years on record have occurred since 1980.
- Atmospheric levels of heat-trapping carbon dioxide are now 26 percent higher than the preindustrial concentration, and continue to climb.

What are the consequences?

Initially a warming climate may not seem like a problem. It would make climate in New England like the climate of New Jersey and it would extend the growing season for the Scandinavian countries and Russia. However, there are some associated issues.

First is the rise in sea level. As the temperature rises, more of the polar ice could melt, raising the level of the sea. Scientists predict different increases from a few inches to as much as 50 feet depending on the model used. The University of Maine at Orono's George Denton and Terry Hughs suggest that if temperatures rise sufficiently to melt off the Ross ice shelf, much of the west Antarctic ice sheet (which is grounded below sea level) may break off from its moorings, become unstable, and raise the sea level as much as 6 meters (approximately 18 feet) -- considerably more than would be predicted on the basis of temperature alone. The loss of the reflective properties of the ice sheet would raise temperatures even more which, in turn would melt more ice, thus starting a positive feedback condition.¹³⁷

According to Harold Borns, glaciologist and scientist with the West Antarctic Initiative on Ice Sheet Stability, research during the 1992 field season may indicate that the West Antarctic ice sheet may already be becoming unstable as isolated streams of ice are moving with great speed through the ice sheet.

Yet another issue is the stability of climate during times of change. From research into other times of climate change, like the "Little Ice Age," scientists at the University of Maine's

Quaternary Studies Institute have suggested that although average temperature may rise, the rise may not be smooth. In one year the growing season may be longer than the mean annual growing season only to be followed by a year in which it may be considerably shorter. This climatic instability would be a major problem for large scale agriculture which relies on regular growing length. (e.g., we can breed a plant to accommodate cold or heat but not for both.)

Global System Changes

In addition, the lack of reflectivity identified by Denton and Hughs raises another major issue - the earth may be unable to continue to dissipate energy as effectively as it has in the past. Physicist Adam Trombly and other scientists now believe that heat and other energy reflected and generated by the planet have in the past been rather easily transmitted away from the surface through the layer of atmosphere that surrounds it. With increasing greenhouse gases reducing the ability of the earth to radiate energy, a number of other phenomena are taking over to allow the escape of this energy. Increased hurricanes, earthquakes and volcanoes, they believe, could well be devices that are providing new paths for release now that the efficiency of conventional radiation paths is decreasing.¹³⁸

The rising level of wind speeds that have been accompanying some recent major weather events are believed by Trombly and others to be a direct result of this insulative factor which has increased the slope of the gradient between high and low pressure atmospheric systems.

The most important problem associated with the greenhouse effect is that we don't know how to proceed and we may not have time to do what is needed. Scientific research based on observed trends and their complex interactions is slow. By the time we have sufficient evidence to be sure about our observations, it may be far too late to do anything about it.

Loss of coastal wetlands

The intractability of this problem is due to the combined effects of global warming, political pressure, and real estate development. Coastal wetlands are a productive and dynamic environment,

critical to both ocean life and waterfowl. When sea levels are constant, wetlands extend themselves by capturing silt. They grow on one side, extending out into the water and retreat on the other, as marsh slowly becomes dry land. If sea levels rise, the process reverses; marsh is lost to the sea, but reclaimed from once-dry land. Rivers bring fresh water, silt, and replenish the barrier beaches that protect the marshes. Beaches are unstable land forms of sand changed constantly by the action of wind and waves. They guard the Atlantic and Gulf Coasts and are flooded several times a century.

Now we have both dammed the rivers, cutting the flow of silt and sand, and heated the atmosphere to raise the sea level. The result has been accelerated flooding and loss of both barrier beaches and coastal marshes. The U.S. is already losing 30,000 acres of coastal marsh per year in Louisiana alone.

A sensible policy would be to abandon the barrier-beaches to the sea as water levels rise and to let them recreate themselves inland. Money should be spent on resettlement and issues of greater environmental priority. Fighting the sea is hopeless and impossibly expensive. The current federal flood insurance guarantee program alone would suffer losses of hundreds of billions of dollars to sea-level rise. This is one of many examples where economics and the environment are allied against traditional politics.¹³⁹

Loss of rainforests

A more urgent problem which owes its intractability to its global nature and to the poverty and politics of the third world is the loss of rainforests. The United Nations Food and Agriculture Organization report of September, 1991, showed the world's tropical forests are being cut down at a rate 40 percent faster today than they were 10 years ago. In 1990 approximately 42 million acres of tropical forest were cleared, an area about the size of Washington state; more than an acre every second -- much of it cleared and burned by poor people desperate for land and food. Forest loss:

- Contributes to greenhouse warming,
- Eliminates the cleansing of the atmosphere,
- Threatens wildlife,

- Creates new semi-deserts, and
- Increases large-scale flooding.

As we saw, tree burning accounts for about 30 percent of world-wide total CO₂ emissions. Brazil, whose annual rainforest losses run to between 12.5 million and 20.5 million acres, released as much carbon into the atmosphere by burning trees as the United States did burning fossil fuels.

The problem is poverty and politics. Governments of Latin America and Indonesia are faced with overpopulation and political turmoil in the cities and are using their rainforest frontiers as an escape valve. These policies produce short term economic benefits from logging (timber is one of the few raw materials that has risen in price) and immediate (and generally, unsustainable) increases in agricultural output.

Forest destruction is being financed, directly or indirectly, by loans from the World Bank as well as private U.S. and European lenders. Happily, U.S. political pressure is already reducing World Bank loans for environmentally destructive projects. However, even with these efforts, significant further loss of rainforest is inevitable.¹⁴⁰

Solvable, but politically difficult, issues

Acid rain

Rainfall is naturally acidic but its acidity is increased by the burning of fuel containing sulfur (mostly from coal), which produces sulfur dioxide, or by high-temperature combustion (car and truck exhaust), which creates nitrogen oxides. Acid rain primarily affects lakes and trees. In lakes it kills off algae, the bottom of the aquatic food chain. This results in the death of fish, many invertebrates, and fish eaters, such as loons. Affected lakes are crystal clear and sterile. Acidic mists are also killing high-altitude coniferous forests in both the U.S. and Europe.

The obstacles to reducing acid rain have been political. High-sulphur coal interests in the East and economically weak

Midwest, and the automobile industry oppose strict sulfur standards. Existing regulations require few controls on old (pre-1975) power plants, even while requiring new power plants (not just those causing the damage) to install expensive control technology. Thus dirtier, older plants are kept in operation well past the time when they would ordinarily have been retired.¹⁴¹

Loss of habitat

Resource and Species Depletion

In addition to the problems of loss of marshes and coastal wetlands, clear cutting and burning of rainforests and desertification mentioned above, we are losing a wide variety of life primarily through destruction of habitat. Biologist E.O. Wilson estimates that people have recently begun to extinguish lesser creatures at a pace of 10,000 times the typical natural rate. A minimum of 140 plant and animal species are condemned to extinction each day. The value of many of these species are already known. What is less known, and should be reason for serious concern, is the role -- and benefits -- that many of these disappearing creatures play in the larger environmental system within which we live.

For example:

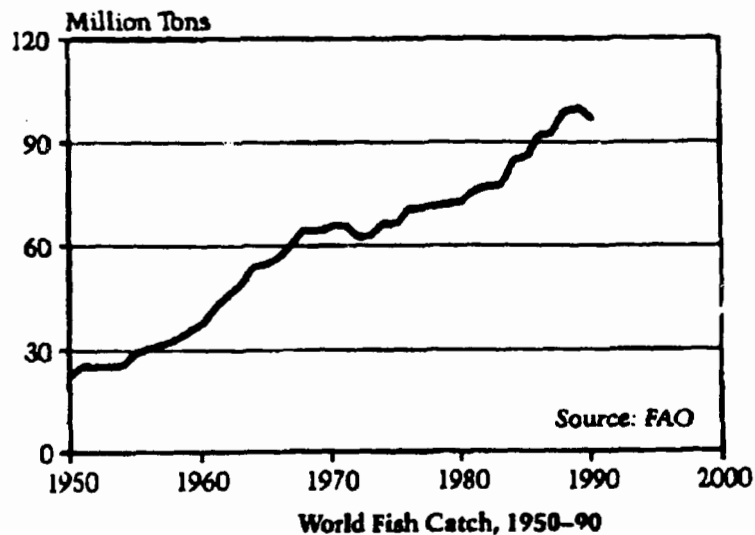
- A rain forest viper venom is important to the manufacture of the preferred prescription drug for high blood pressure, capoten.¹⁴²
- Waterfowl populations in the United States, have dropped by 30 percent since 1970. Songbirds are suffering sharp declines or local extinctions, and mallard and pintail duck populations are down 50 percent since the 1950s.
- The White House Council on Environmental Quality estimates that 30 percent of the continent's freshwater fish are threatened with extinction.
- In the southeast, fish and shellfish catches have dropped 42 percent since 1982.¹⁴³
- "Tuna are doomed," explains one fisherman, quoted in the *Wall Street Journal*. "They're too valuable to live."

The Rape of the Oceans

The case of commercial ocean fishing is illustrative of this trend. Jessica Matthews, writing in *The Washington Post* wrote that fifteen years ago, foreign high technology fish factories (ships that catch and process on board) were working off our coasts destroying our fisheries. The United States declared a 200-mile limit of national jurisdiction to hold off foreign fleets.

Encouraged by the government and the 200 mile limit, U.S. fishermen invested in high technology: bigger ships equipped with sonar and electronic fish finders, electric harpoons, and spotter planes for giant tuna. This started an addictive cycle: the more technology the fishermen bought the more fish they had to catch, the more fish they caught the less fish there were, which in turn increases the reliance on high technology.

World Fish Catch Falls



Source: Vital Signs, WorldWatch Inst.

Since the beginning of the 200 mile limit, U.S. fish stocks have declined. In the Atlantic, nine of twelve of the valuable ground fish stocks are decimated. The haddock catch is reduced to a fifth of what it was. Cod, flounder, tuna, Atlantic salmon and swordfish stocks are depleted. Oyster and clam catches are both down by half. Where fishermen once brought back 50,000 pounds of fish from a three-day trip, now the best outfitted and most expensive

boats work twice as long to bring back less than half as much. This has cost New England 14,000 jobs.¹⁴⁴

Added to these problems is the loss of the aforementioned coastal wetlands where many fish spawn. Without marshes there will be no way to replenish fishing stock. Seventy-seven percent of the commercial fish catch harvested by U.S. fishermen is from species that depend upon estuarine wetlands for survival. In the Gulf of Mexico and the southeast Atlantic, 98 percent of the commercial fish catch depends upon estuaries.

Fish populations in estuaries such as the Chesapeake Bay are at an "all-time low," and The White House Council on Environmental Quality estimates that 30 percent of the continent's freshwater fish are threatened with extinction. In the southeast, fish and shellfish catches have dropped 42 percent since 1982.¹⁴⁵

Woods Hole Oceanographic Institute scientists predict that the response to this trend will be growing near-term legislation of fishing stock in order to sustain these natural resources. Already the New England Fishery Management Council is considering drastic conservation measures that would essentially cut the catches in half over the next five to seven years in order to give the stocks a chance to rebuild.

But since the problem is a product of a number of issues, not just overfishing, it is questionable whether, in the near term, aquatic populations can be effectively replenished.

Some endangered species we can, and have, taken steps to save. But there is a problem with looking at species loss on a case by case basis. We may win the battle and lose the war. Most species loss is due to habitat destruction. If we exhaust our energy in saving a few species and fail to halt the destruction of the oceans, coastal wetlands, deforestation and the climate changes which follow in its wake, we and all species, will suffer the consequences. We need to take the problem of species loss as an indicator of the global problems of habitat and climate change and attack it at that level.

Problems With Drinking Water

Of the total water on earth, 97 percent is seawater, 2 percent is locked in icecaps and glaciers, and a large portion of the

remaining 1 percent lies too far underground to exploit. Of what remains, human populations, from the slums of South America to the overburdened farms of China, are outstripping the limited stock of fresh water throughout the third world .

In the past, we have been distracted by issues of security and economics; now the ecological crises which have been ignored may threaten as strongly as any enemy. For example:

- Water could be the first resource that puts a limit on human population and economic growth. According to the United Nations, 40,000 children die every day, many of them the victims of the water crisis.¹⁴⁶
- Countries are prepared to go to war over oil, but in the near future, water could be the catalyst for armed conflict.

Rain is the primary source of fresh water, and when there is a reduction of precipitation it often results in serious droughts. Eighty arid and semi-arid countries with 40 percent of the world's population find themselves in this situation. Although global circulation models generally predict that precipitation will gradually increase between 4-12 percent if carbon levels in the atmosphere double (12-36 percent in higher latitudes),¹⁴⁷ clean water for drinking has, nevertheless, always been a problem in many, mostly poor, parts of the world. For the first time, though, the pressure of civilization is draining and polluting major sources of fresh water in many new locations, some of which include the industrialized world.

Sandra Postal of the WorldWatch Institute summarized the situation in her book, *Last Oasis: Facing Water Scarcity*:

There is a large unmet demand for household water. Nearly one out of every three people in the developing world -- some 1.2 billion people in all -- do not have access to a safe and reliable supply for their daily needs. Often they resort to shallow wells or stagnant pools that are easily contaminated with human and animal waste. As a result, waterborne diseases account for an estimated 80 percent of all illnesses in developing countries. And women and children walk several kilometers each day just to collect enough water for drinking, cooking, and cleaning.

[Considering rainwater,] nine out of 14 countries in the Middle East already face water-scarce conditions, making it the most concentrated region of water scarcity in the world. [This forces reliance on

desalination of sea water and the mining of transnational aquifers, which is often unsustainable. Transnational rivers also then become a drinking water supply source, with all of their historical problems of controversy and violent conflict. Populations in six of [these countries] are projected to double within 25 years, and so a rapid tightening of supplies is inevitable. With virtually all Middle East rivers being shared by several nations, tensions over water rights are a potent political force throughout the region, and could ignite during this decade.

The arid kingdom of Saudi Arabia represents one of the most egregious cases of unsustainable water use in the world today. They pump 75 percent of their water needs from fossil groundwater. A major push by the Saudi government to raise food self-sufficiency largely explains the escalation in groundwater pumping.

As in Saudi Arabia, the Libyans are linking their economic fate to a nonrenewable water supply. Engineers project that the wells will run dry within 40-60 years.

In and around Beijing, water tables have been dropping 1-2 meters a year, and a third of its wells have reportedly gone dry. All told, some 100 Chinese cities and towns, mostly in the northern and coastal regions, have suffered shortages in recent years.¹⁴⁸

This North China Plain area includes 200 million people and will have 6 percent less water than needed by 2000. The daily shortfall in Beijing alone will be 66 percent of their current consumption. The Chinese government is aware of these figures and has planned a massive project to divert the waters of the Yangtze River near Shanghai, a total distance of 1,190 km overland to compensate for increased water needs.¹⁴⁹

Time magazine continued the litany of problem areas:

At least 8,000 Indian villages have no local water supply at all. Their residents must hike long distances to the nearest well or river.

In Russia, the mismanagement of land around the Aral Sea has cut it off from its sources of water, causing the volume of the once giant lake to shrink by two-thirds in 30 years. Now storms of salt and pesticides swirl up from the receding shoreline, contaminating the land and afflicting millions of Usbeks with gastritis, typhoid and throat cancer. In the Western U.S., four years of drought left municipalities and agricultural interests tussling over

diminishing water stocks. In Mexico, as many as 30 million people do not have safe drinking water.

In the West the most troubled dry spot is Mexico, where a government report asserts that "water will be a limiting factor for the country's future development." The demands of Mexico City's 20 million people are causing the level of their main aquifer to drop as much as 3.4 meters (11 ft.) annually.

Mohammed El-Ashry of the World Resources Institute estimates that around the world 65 percent to 70 percent of the water people use is lost to evaporation, leaks and other inefficiencies.¹⁵⁰ Additionally, in the developing world, over 95 percent of the urban sewage is discharged directly into surface waters without treatment, increasing the likelihood that what water there is, is polluted.¹⁵¹

The scarcity of fresh water for agriculture makes famines more likely every year. Because of the dependence of many countries on U.S. food exports, a two-year drought in the U.S. breadbasket could rapidly lead to a global food calamity.

The Middle East Situation is Critical

Decades of overpumping have caused seawater to invade Israel's coastal aquifer, a key freshwater source. Some 20 percent of the aquifer is now contaminated by salts or by nitrates from urban and agricultural pollution, and water officials predict that a fifth of the coastal wells may need to be closed over the next few years. This degradation of the coastal aquifer greatly deepens Israeli dependence on the reserve underlying the West Bank.

Competition for water is especially fierce between Israel and Jordan, which must share the Jordan River basin. Many towns in Jordan receive water only two times a week, and the country must double its supply within 20 years just to keep up with population growth.

Israel is far from secure, despite its formidable conservation technologies. An expected 750,000 Palestinians in the Gaza Strip face what Zemah Ishai, Israel's water commissioner, calls a "catastrophe" because of overpumping and contamination of groundwater.

Egypt, in particular, faces hard times. The country's population of 55 million is growing by 1 million every nine months. Already, the people must import 65 percent of their food and the situation could grow far worse. The flow of the Nile, Egypt's only major water supply, will be reduced in coming years as upstream neighbors Ethiopia and Sudan divert more of the river's waters. Egypt's only practical course is to brake population growth and reduce the enormous amount of water wasted through inefficient irrigation techniques.

A War Over Water?

In the near future, water could be the catalyst for armed conflict. Israel and Jordan, Egypt and Ethiopia, and India and Bangladesh are but a few of the neighboring nations at odds over rivers and lakes.

Thomas Naff, Middle East water analyst at the University of Pennsylvania has said, "It is water, in the final analysis, that will determine the future of the Occupied Territories, and by extension, the issue of conflict or peace in the region."

A recent piece in *The New Republic* summarized the problems facing Israel and its neighbors.

Almost one-third of Israel's fresh water (130 billion gallons per year) is derived from aquifers in what Israel calls Judea and Samaria, and what the Arabs call the West Bank. Israel cannot survive, especially with the prospect of increased immigration and the natural population increase of both Jews and Arabs, without retaining access to this water or replacing it from some other source. That is the real security problem.

Even with the water from the West Bank, Israel's water consumption exceeds natural replacement. Therefore the water table is constantly lowering, and the salinity of coastal wells is increasing. Many wells have become useless for drinking water and irrigation. Shortages of fresh water in Gaza are chronic, and Jordan faces an ever greater water crisis because of its growing population and an influx of refugees from Kuwait.

From the time of Israel's independence, water has been the source of conflicts between Lebanon, Israel, Jordan, and Syria. The only real source of new fresh water in the region is desalinated sea water, and

the desalting of any significant volume of water requires an enormous amount of power.¹⁵²

History shows that environmental destruction can have far-reaching consequences. The salinization of irrigated land led to the fall of Mesopotamia and Babylon, and perhaps even the Mayan civilization of Central America. Similar pressures are at work today. Sandra Postel of Worldwatch Institute estimates that 60 million hectares (nearly 150 million acres) of irrigated land worldwide have been damaged by salt buildup.

U.S. Water Problems

The linked global problem of water, deforestation, climate change, and desertification is a serious problem in much of the world. However, in the United States the water shortage is the result of bad economic policy rather than a serious environmental problem. In the American West water shortages exist because it is underpriced. Generally city dwellers pay over \$100 per acre foot (enough water for the average family for a year). Farmers may pay as little as \$10 dollars per acre foot (less than the cost of storing and delivering their water).¹⁵³

Nevertheless, the Global Tomorrow Coalition, projects the per capita water availability will drop by 50 percent between 1975 and 2000. During the early part of that period, consumption in the U.S. went from 89 billion gallons per day in 1980 to more than 100 billion in 1988.¹⁵⁴

Significant Groundwater Issues

Much of the country is dependent on groundwater for its agricultural, industrial, and drinking water supplies, but major U.S. groundwater supplies are being unsustainably "mined." Groundwater is being removed faster than it is replenished in 35 states, including the rapidly growing states of California, Arizona, and Florida. In Florida, as coastal aquifers are drawn down, ocean saltwater is increasingly seeping into freshwater supplies, rendering those aquifers unfit for use. Meanwhile, the aquifers of the high plains are being depleted so fast that farming communities from Nebraska through Texas are facing the prospect of not having enough water to continue farming operations.¹⁵⁵

The Ogallala aquifer, is a vast reservoir from which Nebraska, Kansas, and parts of Colorado, New Mexico, Oklahoma, and Texas draw most of their water. Since the end of World War II, irrigation systems pumping water up from the Ogallala have turned the Dust Bowl of the 1930's into a farming center that grows much of the nation's corn, wheat, sorghum, and cotton - crops worth much more than \$20 billion a year in all. Thirty years ago, reported futurist Marvin Cetron, the Ogallala contained roughly as much water as Lake Huron. But far more water is drained from the aquifer every year than rainfall restores, and today the supply is drying up. In parts of Texas, New Mexico, and even Kansas, the water table has dropped more than one hundred feet since the mid-1950's.

Farmers in the region are already working to cut back their water consumption. Some have stopped growing corn, which requires a huge supply of water, and turned their fields over to cotton, wheat, and sorghum, which do not. Many have turned to water conserving irrigation methods and graded their fields billiard table flat, so that desperately needed water does not run off. But in the end, these techniques can only slow the depletion of the Ogallala, not stop it. By 2000, many Great Plains farmers will have had to go back to dry-land farming, working harder to eke out smaller crops. If the present trend continues, by 2020, the six states that depend on the Ogallala will have lost more than 5 million acres of irrigated farmland, an area the size of Massachusetts.¹⁵⁶

Major Policy Shift in California

The problem is not just with groundwater sources. California gets most of its water for drinking and agriculture from snow melt from the Sierra Nevada mountains. As greatly increased numbers of people have moved into the Southern California region and the area experienced a four-year drought, the water supply system has become overtaxed and begun to drain the Northern California lakes and rivers that supplied the Los Angeles area. As tension between the urban and rural interests built, new legislation and policies were enacted that fundamentally changed the historical relationship of Californians and water.

The New York Times saw a new age dawning in the American West. Under inexorable urban, political and environmental

pressures, it reported, water -- the lifeblood of this arid region -- has slowly begun to flow away from farms and ranches and toward the big cities. The Omnibus Water Act explicitly encourages farmers to sell their water to the cities and would reserve large amounts of water to repair environmental damage in California. The act substantially raises rates paid by farmers, imposing a three-tier system to encourage water conservation, and the end the practice of renewing water contracts for 40 years at fixed rates.¹⁵⁷

Overlooked major issues

Desertification

Related to the destruction of rainforest is the often overlooked problem of desertification. It is mankind's oldest and least publicized environmental problem. It is a significant problem because of its seriousness:

- More of the world's productivity has been destroyed by deforestation, overgrazing, irrigation, and plowing fragile soils than by all other forms of pollution combined,
- It is due to a combination of complex causes - ecological, economic, demographic, and political, and
- It is a slow process which takes place over decades as salts poison the soil, wind blows it away, and erosion cuts the land.

Human activities have disrupted the natural systems that maintain water supplies. Vegetation traps water, reducing runoff and replenishing ground water supplies. Deforestation can reduce the amount of rainfall: usually as much as half the moisture settles on trees and quickly evaporates into the sky, to precipitate again in a continuous cycle. Throughout the world, tree cutting has led to floods, mud slides, soil erosion during the rainy seasons, and water shortages during dry periods.

Trees and Shrubs Produce Rain

In dryer regions, shrubs help maintain rainfall. Once ground cover is stripped, the land hardens and evaporates less moisture into the air. At the same time, the naked soil reflects more sunlight, triggering atmospheric circulation processes that reduce rainfall by drawing dryer air into the area. The result of these processes is desertification, a gradual conversion of forests in to marginal land and marginal land into wasteland. This is taking place at an unprecedented rate as the world becomes overpopulated and poverty stricken people clear land for homes, farms and fuel.

Rapidly Changing Weather Patterns

The issues addressed thus far add up to an increasing likelihood of climatic instability. According to the Stockholm Environmental Institute's Irving Mintzer:

Global warming due to the greenhouse effect will have many important consequences for natural ecosystems and for human societies . . . many scientists now believe that, if current trends continue, one of the important potential impacts of rapid global warming is a further increase in the frequency, duration, and severity of extreme weather events. If such changes occur, most of the negative impacts will be felt in developing countries.¹⁵⁸

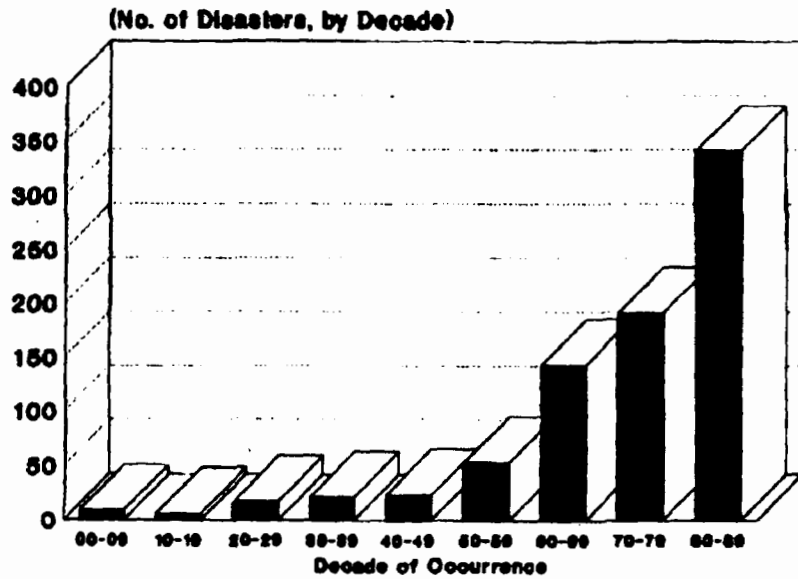
As the charts on the next page from Mintzer's World Bank report show quite graphically, the incidents of major weather events has been growing exponentially since the beginning of the century.

Other sources suggest that flooding will increase in frequency and magnitude in the coming years. Frequency will increase because of human development: rapid population growth, deforestation, unsuitable farming on steep slopes, etc. When these activities diminish the soil's ability to hold rain fall or snow melt, run-off occurs much more suddenly, resulting in floods.¹⁵⁹

A number of the issues raised in this report have a direct relationship to climatic stability and highlight the systemic nature of the problem.

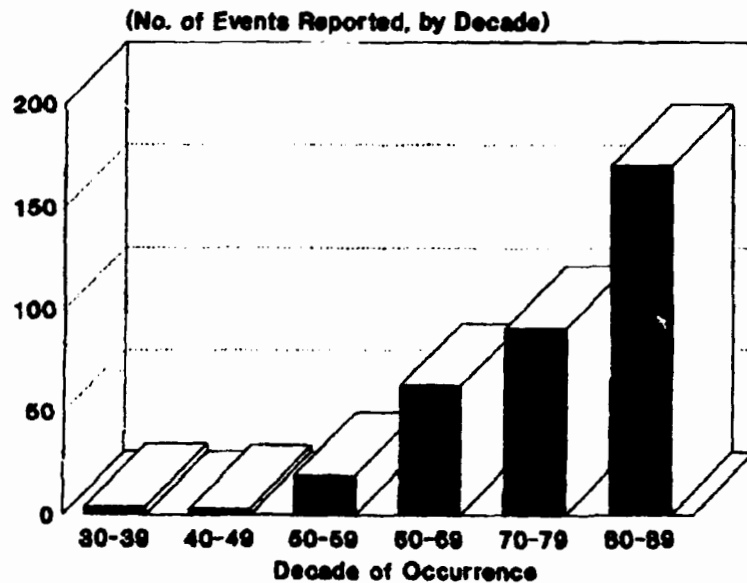
- Loss of rainforests removes the means of cleaning the atmosphere of greenhouse gases.

REPORTED WEATHER DISASTERS Events with more than 20 deaths, 1900-89



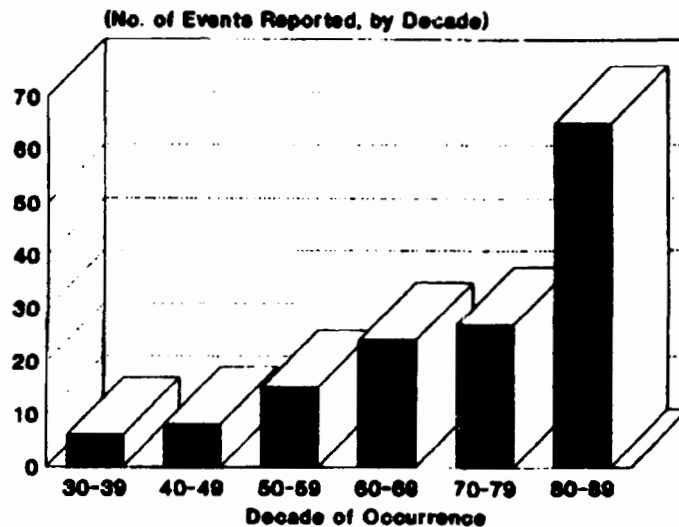
Source: US AID/OFDA

REPORTED WEATHER DISASTERS: Floods Events with more than 20 deaths, 1930-89



Source: US AID/OFDA

REPORTED WEATHER DISASTERS: Typhoons Events with more than 20 deaths, 1930-89



Source: US AID/OFDA

- Tree burning and exhaust fumes add to greenhouse gases.
- Greenhouse gases and a loss of upper atmosphere ozone may cause global climate change.
- Times of climate change are likely to be times of major differences in temperatures and growing season lengths on a year to year basis.
- Loss of wetlands, rainforests, and desertification all lead to loss of recycled moisture.
- Atmospheric moisture moderates climate. Humid climates have warmer winters and cooler summers.
- Loss of moisture contributes to water shortages which contributes to loss of moisture in a negative feedback loop.

The combination of these effects may have devastating effects on world weather patterns. The following examples may be harbingers of things to come. Already the patterns are the subject of attention of an increasing number of researchers.

More Hurricanes

The *San Francisco Chronicle* last year asked the question: Was Andrew a freak -- or a preview of things to come? Many scientists say recent storms prove that global warming is changing the world's climate. Why have the past three years seen both Hurricane Andrew, and Hurricane Hugo, which smacked into South Carolina in 1989 and was rated a 4 on the 5-point scale measuring storm intensity?

And what about Gilbert, which ravaged Jamaica and Mexico's Yucatan Peninsula in 1988 and was rated a 5? It might be a harbinger. One predicted consequence of the greenhouse effect is that we will have more severe storms. If the climatologists' computer models are right, a hurricane that would otherwise have rated a 3, would be whipped up to an Andrew-size 5. "[We could see] a 50 percent increase in the destructive potential" of the most powerful tropical storms, says meteorologist Kerry Emanuel of the Massachusetts Institute of Technology.

Bob Sheets, who directs the National Hurricane Center of the U.S. Weather Service in Coral Gables, Florida was reported to have said that some meteorologists contend that global warming could set off atmospheric changes producing far more powerful storms, packing winds up to 225 miles per hour. "We've been in a real lull in hurricane activity," he said "The indications are we are going to return to more hurricane activity within the next decade -- maybe next year, maybe the year after."¹⁶⁰

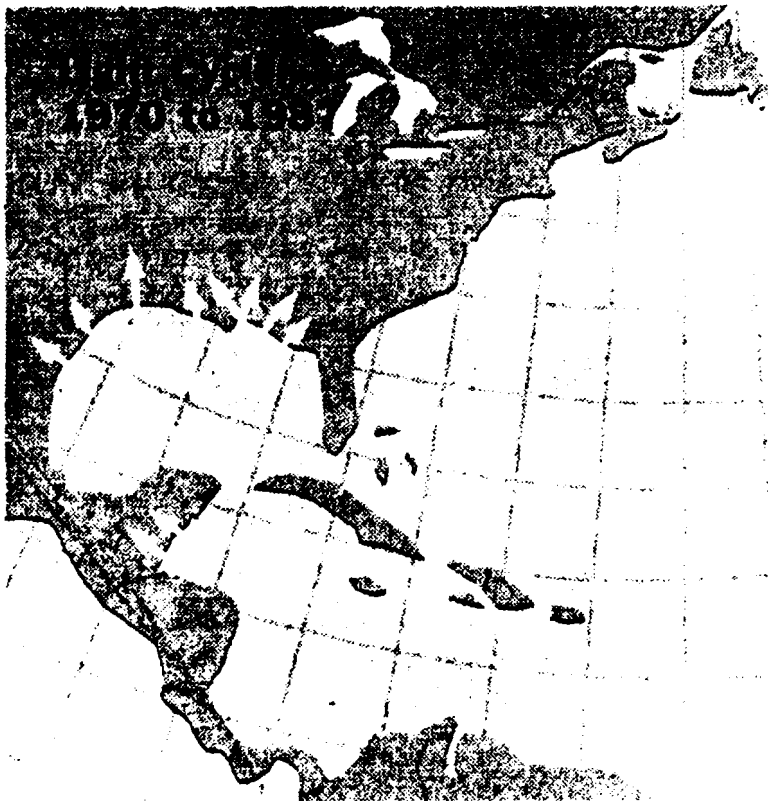
William M. Gray of Colorado State University, links the frequency of severe hurricanes in the United States to the amount of rain in the western Sahel region of Africa, just below the Sahara. *The New York Times* reported that he believes an extended drought is likely to end there within the next few years, concluding the long lull in major hurricane activity here. Between 1947 through 1969, a rainy period in the Sahel, 13 hurricanes with winds of more than 110 miles an hour struck the East Coast. From 1970 through 1987, a dry period, only one such storm hit.¹⁶¹ This is not only distressing for the safety of coastal communities but it is also expensive. Gray thinks that the U.S. will be hit by six major storms in '93, up from four in '92. He predicted the '92 activity precisely.

At a recent industry conference, James Gustafson, executive vice president of General Reinsurance Corp., was cautious in his



White arrows trace the paths of the most severe hurricanes (wind speeds of more than 110 miles per hour).

This 23-year period had lots of rainfall in West Africa, which some experts feel is what sets up the weather patterns that can turn into hurricanes.



West Africa had little rainfall in this period.

predictions but said the hurricane Andrew taught important lessons and raised disturbing questions for the future. He noted that all of the industry's 10 worst catastrophe losses have occurred since 1988, and that even adjusting for inflation, their severity and frequency have increased dramatically in recent years. While claiming no expertise in climatology, Mr. Gustafson said insurers need to consider the possibility that more violent and frequent storms are here to stay.¹⁶²

Newsweek mentioned that structures such as homes and sea walls are built to withstand storms of a certain severity. If they are battered by stronger winds, they are simply going to be destroyed. And if insurers write their actuarial tables based on a Hugo or an Andrew occurring only once a century, they may be seriously underestimating the odds on disaster.¹⁶³

Natural Disasters Have Climbed Steadily

Others have noted that the toll inflicted by hurricanes, floods, earthquakes and other "acts of God" has climbed steadily for more than 20 years. "At any moment, we could be hit with an event causing thousands of deaths and economic damages as high as \$100 billion -- unless we are better prepared," said Stephen Rattien, who oversees disaster research at National Academy of Sciences. That event -- a major quake on the Hayward Fault east of San Francisco, for instance -- would produce casualties at levels usually associated with Third World disasters. It could overwhelm the insurance industry, topple banks and send shock waves through the economy.¹⁶⁴

The infrastructure supplying water to Southern California is most vulnerable. The Los Angeles/San Diego area gets roughly half of its water from a single canal system, the California Aqueduct, which carries water from the Sacramento River Delta 800 km (500 miles) south to Los Angeles. Mark Reisner, author of *Cadillac Desert*, an examination of Western water, notes that the delta is sinking by as much as 7.6 cm (3 in.) a year, leaving the area, much of it already below sea level, ever more vulnerable to sea water intrusion. A major earthquake on the nearby Hayward fault could destroy the levees that protect this crucial water supply. "It's a fragile, fragile system," says Reisner, "ludicrously so since 19 million people depend on it."¹⁶⁵

Understanding the Behavior of the Ocean

Oceans play a significant factor in determining weather. So vast is the world ocean that one of its regions, the Pacific Ocean, is 25 percent larger than all of the land surface of the world combined.¹⁶⁶ The ocean is an important (perhaps the most important) component in the global weather system. When considering the earth as a system, this huge mass of water clearly plays a major role in the transfer of energy across and through the surface of the planet.

For most of history humankind has understood little about the operation of the ocean, but now, giant steps are being taken that, within the next two decades, will open up many of the secrets of how the ocean functions and what its contribution to weather and other phenomena really are.

The information that is being gathered on the sea comes from a number of sources. Remote sensing satellites launched in 1992 carry radars to measure ocean currents, waves, wind stress and ice cover. Undersea data on salinity, plankton, temperature, and currents is being gathered by ships systematically towing instruments repeatedly over large expanses of ocean. One of the interesting, though not surprising, perhaps, things that have been learned through these techniques is that there are a huge number of undersea storms swirling around deep in the seas of the southern hemisphere.

New computer analysis capability is allowing researchers to begin to model the behavior of the oceans, although present capacity does not begin to show a comprehensive picture. In order to gather the additional information needed for a more complete understanding of the system, two new programs are being implemented. A new generation of unmanned robots are being designed that, by 1998, will autonomously cruise the oceans to gather data. Hundreds of these robots will be deployed at less than one-tenth the cost of doing it by ship and will survey the ocean, from the bottom to the surface, contributing data to a master model of the whole system.

For the shallow water areas, the Army Corps of Engineers has been developing a system called SHOALS (Scanning Hydrographic Operational Airborne LIDAR Survey). This surveyor

allows a helicopter to sweep an area with a laser system and collect bathymetric ocean bottom information from a large number of floating "pellets" that give it a horizontal accuracy of less than 20 feet and a vertical accuracy of less than one foot. The position of each sensor is established by using GPS.

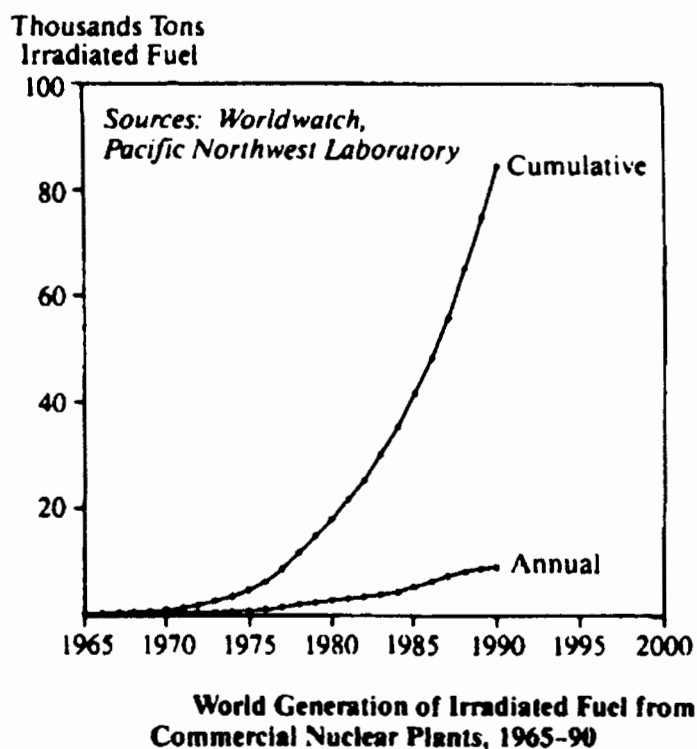
The combination of all of these sources should soon make it possible to design an operational system for monitoring the global ocean in much the same way the atmospheric weather is monitored now. This Global Ocean Observing System could be working by 2015.

Important, but Lesser Issues

Toxic Waste

Garbage and toxic waste may not be as intractable as some of the problems we have examined but it is expensive and it contributes to the global problem of environmental degradation and climate change. Our oceans, soils, and atmosphere are remarkable systems; they have amazing buffering qualities. We can pour seemingly endless quantities of stuff into them and the natural buffers will return the systems to normal. However, it is likely that these are threshold systems. A threshold system implies that the system as a whole has at least two stable states. Up to a certain point it seems to remain unchanged regardless of what is done to it and then, suddenly, a very small additional change knocks the system into another stable state.

Consider, for example, that the global industrial system is steadily growing larger in comparison with the natural environment. The volume of human-generated outputs are reaching damaging levels regardless of whether or not they are traditional pollutants. The industrial flows of nitrogen and sulfur are equivalent to or greater than the natural flows; for metals such as lead, cadmium, zinc, arsenic, mercury, nickel, and vanadium, industrial flows are as much as double natural flows, and for lead, 18 times greater.¹⁶⁷



U.S. Military a Major Polluter

Industry is not the only villain. *TIME* magazine gave an example of both the scope of work and the cost:

Officials have identified 10,924 hazardous hot spots at 1,877 U. S. military installations. At a time of shrinking defense budgets, environmental cleanup is the fastest growing category of military expenditure -- up 18%, from \$2.9 billion last year to \$3.4 billion in new 1993 funding. The task is so overwhelming that accurate cost projections are almost impossible to make. Some analysts put the figure at \$20 billion over the next 30 years, not including overseas bases or the nuclear facilities run by the Department of Energy. [The Department of Energy alone may have to spend as much as \$300 billion, to clean up toxic materials at forty-five of its facilities.] The Pentagon's inspector general has said the cleanup bill might go as high as \$120 billion -- about what America spent on the Apollo space program in today's dollars.¹⁶⁸

Thus the secondary "story" on radioactive waste is the cost of the clean up. Another \$1.8 billion per year will go to fund programs designed to prevent further contamination.

But the good news is that it can be done. We have managed to make some progress. In 1982, American factories were turning out some 77 billion pounds of toxic waste every year. Since then the amount going into landfills has been cut by 65 percent. By 2000, we should be detoxifying 90 percent of our waste which will bring us equal to industrialized West Germany today. This is not enough - today Holland and Denmark destroy or recycle all their toxic waste.¹⁶⁹

Radioactive waste

Chemical, industrial, and toxic waste can be recycled. But, 50 years after the beginning of the atomic age, we still don't have a long term plan for the disposition of more than fifteen thousand metric tons of spent nuclear fuel from the nation's 106 operating nuclear power plants, which will have grown to nearly 50 thousand tons by the year 2000. The material is no longer useful; yet it will remain dangerously radioactive for the next ten thousand years.

The facts are riveting:

- Civilian nuclear power has produced roughly 95 percent of the radioactivity emanating from waste in the world.
- In 1990, the world's 424 commercial nuclear reactors created some 9,500 tons of irradiated fuel, bringing the total accumulation of used fuel to 84,000 tons -- twice as much as in 1985.
- The United States houses a quarter of this, with a radioactivity of more than 20 billion curies.¹⁷⁰ [The bombs dropped on Hiroshima and Nagasaki released an estimated 1 million curies.]¹⁷¹
- Within eight years, the global figure could pass 190,000 tons. The cumulative output of irradiated fuel from nuclear plants is now 20 times what it was in 1970.¹⁷²
- Total waste generation from all the nuclear reactors now operating or under construction worldwide will exceed 450,000 tons before the plants have all closed down in the middle of the next century, projects the U.N. International Atomic Energy Agency (IAEA).¹⁷³

Attempts to effectively deal with this growing waste have been failures. At best, short-term storage is waiting for long-term answers; at worst, there are many unmitigated disasters.

Long-Term Storage

All the countries using nuclear power are pursuing geologic burial as the solution to their waste, yet by their own timelines most programs have fallen way behind schedule. In 1975, the United States planned on having a high-level waste burial site operating by 1985. The date was moved to 1989, then to 1998, 2003, and now 2010 -- a goal that still appears unrealistic.¹⁷⁴

Germany, France and Japan have similar problems.

The current U.S. plan is elaborate and very expensive. It is to bury seventy thousand tons of spent fuel rods one thousand feet below ground level and about one thousand feet above the water table, in a six-mile-long ridge of geologically stable ground in southern Nevada. If all goes according to plan, the first facility will be built and ready for the first radwaste in 2003. The dump will be full, by 2030.¹⁷⁵

But there is a problem -- many problems, in fact. The site, Yucca Mountain, is crisscrossed with more than 30 seismic faults; it is believed that an earthquake could dramatically raise the water table. If water came in contact with the buried waste "the resulting steam explosions could burst open the containers and rapidly spread their radioactive contents. 'You flood that thing and you could blow the top off the mountain. At the very least, the radioactive material would go into the groundwater and spread to Death Valley, where there are hot spring all over the place,' says University of Colorado geophysicist Charles Archambeau."¹⁷⁶

And so, scientists and policymakers continue to look for ways to effectively deal with this most growing issue.

The worst U.S. pollution has taken place at processing and weapons manufacturing plants. The problems at sites in Washington, South Carolina and Colorado are illustrative:

Hanford Plant, Hanford, WA

High-level liquid and semisolid wastes containing radiation and chemicals are stored in 177 [underground] tanks. Some 66 of 149 older tanks have been found leakers or potential leakers. [ed.: Many

have been found empty.] Potentially explosive hydrogen gas generated in some tanks is a major concern. Two hundred square miles of groundwater are contaminated. DOE admitted in 1990 that airborne releases of iodine 131 from Hanford in the 1940s were large enough to cause health risks to nearby residents.¹⁷⁷

Some of Hanford's problems come from dumping highly radioactive liquids into unlined trenches or pits. Some of the leaking waste has ended up in the Columbia River, contaminating shellfish hundreds of kilometers away in the Pacific Ocean.

Savannah River, Aiken, South Carolina

Aging production reactors were shut down in 1988 for safety reasons. DOE is pumping industrial solvents out of an aquifer beneath the site. Ten of 51 large steel tanks containing high level nuclear wastes have developed leaks. Tank and transfer pipe leaks have contaminated thousands of cubic feet of soil. Groundwater is contaminated with tritium, and potentially cancer-causing industrial solvents have seeped into the Tuscaloosa Aquifer.¹⁷⁸

Rocky Flats, suburbs of Denver, Colorado

Contaminated groundwater from Rocky Flats may affect drinking water supplies in the Denver suburbs. A series of accidents, spills, and fires at the facility, beginning in the 1950s, has contaminated the area with plutonium and other hazardous elements.¹⁷⁹

Russia and Eastern Europe

In most places toxic and radioactive waste is an "important, but lesser issue," but not in the former Soviet Union and Eastern Europe. There, it is a problem of the highest order. The pictures painted by *The New York Times*, *Time Magazine* and Murray Feshbach and Alfred Friendly, Jr. in their book, *Ecocide in the USSR*, is the same: inadequate policies implemented poorly. This is a natural consequence of an informationally closed society that manifests itself on two levels; the government, or policy level, and the level of the individual. On the policy level, the leaders of the USSR had to prove the superiority of the communist state. It was mandated that all sectors of society (including science) serve the needs of production and that there be no bad news: a policy which had pernicious consequences.

- The state was the major manufacturer and could use and waste resources without paying economic or ecological costs.
- There were no checks from other sectors of the society.
- Early warning signs were regarded as bad news and thus covered up.

Now, with the end of the cold war, we are seeing a horror story of ecological contamination and destruction.



CONTAMINATION

1 Chernobyl: Reactor meltdown in 1986 released heavy isotopes of plutonium and uranium, contaminating a large area around it. There are 19 similar reactors still in operation.

2 Chelyabinsk: A tank containing waste from a nuclear-weapons plant exploded in 1957. Nearby **Techa River** is severely contaminated.

3 Barents Sea: Off Norway, a submarine sank with its reactor and nuclear-armed torpedoes on board

4 Novaya Zemlya: Nuclear test and dump site. Up to 17,000 bbl. of solid radioactive waste was dropped into

the waters offshore and into the **Kara Sea** between 1964 and 1990. Nearly 165,000 cubic meters of liquid waste was dumped into the **Barents Sea** between 1961 and 1990, and at least eight submarine reactors, some with fuel, and three reactors from an ice breaker were sunk off **Novaya Zemlya**

5 Semipalatinsk: Nuclear testing area. More than 125 atmospheric explosions were set off before 1962, and some 300 underground tests have been carried out since

6 Ob and Yenisei rivers: Contaminated by waste from nuclear-weapons plants

7 Petropavlovsk, Sea of Okhotsk and Vladivostok: Radioactive waste has been dumped in these areas by the Pacific Fleet

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- The Chernobyl meltdown released heavy isotopes of plutonium and uranium in 1986 - there are 19 similar reactors still running in the former Soviet Union.
- Chelyabinsk - the Techa river is contaminated by the explosion of a tank containing radioactive waste from a weapons plant in 1957.
- Barents Sea - where a nuclear submarine, complete with reactor and torpedoes, sunk and where nearly 165,000 cubic meters of liquid waste was dumped between 1961 and 1990.
- Novaya Zemlya - A nuclear dump containing up to 17,000 barrels of solid radioactive waste, at least 8 submarine reactors, and three reactors from an ice breaker were dumped between 1964 and 1990.
- Weapons builders sent nuclear waste into Lake Karachav which has become "the most polluted spot on the planet." It is so radioactive that even today standing at its shore for an hour would be lethal.¹⁸⁰
- 616 radioactive sites have been discovered inside Moscow since 1982.
- Seventy percent of Chernobyl's radioactive fallout remains in Byelorussia. Half of its territory was covered with fallout. About 20 percent of the farming land has been withdrawn from production and more than 40 percent of the forests have been contaminated.

The problems are not just with radioactive materials.

- In Byelorussia, 92 million cubic meters of liquid manure from 261 meat producing complexes are discharged into the republic's rivers and lakes each year. Ecological degradation is expected to increase threefold by 1995. Of the 214 biological water treatment installations, 149 (70 percent) are either out of order or were never put into operation. The total chemical pollution and the complete failure of underground sources for drinking water is expected in 10 years.
- Air pollution levels in every major industrial city exceed former Soviet norms, sometimes by a factor of 50.

Environmental movement in Russia is very strong

The only good sign in this bleak picture is that the Russian people have become ecologically active. There are strong bases of popular concern. A spring 1990 poll in Moscow and its suburbs found 98 percent of those questioned more worried about pollution than about rising crime, the threat of AIDS, international conflict or even the reality of food and consumer goods shortages.

The U.S. Garbage Problem

Against the problem in the former Soviet Union, the garbage problem in the United States seems small in comparison. All we need to do is to stop waste and to start recycling, and yet the very magnitude of the problem makes clean-up difficult. A short list from Cetron and Davies' *American Renaissance* gives a feel for the problem. Every year we throw away:

- 16 billion disposable diapers,
- 2 billion razors and razor blades,
- 220 million tires,
- More glass and aluminum than existed in the entire world prior to World War II, and
- 160 million tons of garbage; twice as much per person than any other industrialized nation.

And then, of course, there is sewage. According to Scripps Institution of Oceanography's Scott Jenkins, "Almost every city has grown faster than its sewer system has grown, and so almost every city is in the situation where the sewer system is overburdened." Boston's sewage system, currently in the process of an expensive overhaul and modernization has pumps so old that they will be exhibited in the Smithsonian.¹⁸¹

Lower Atmosphere Ozone

Another atmospheric pollution issue is the increase in low altitude ozone. The action of ultra violet light initiates chemical reactions between hydrocarbons and nitrogen oxides to produce ozone smog. The thinning of the upper atmosphere layer means

there is more ultra violet light, therefore there is more smog. This smog presents a clear health hazard.

The problem in some of the major cities in the world is severe. There is an often cited story about a flight of sparrows making their way across Mexico City who all died -- fell out of the air, one-by-one -- because of the toxicity of the atmosphere. The pollution of urban air costs many billions in dollars in compensatory health care (to say nothing about the personal suffering), and causes significant erosion and damage to buildings and other structures.

Lester Brown mentioned a UCLA study that reports that in the Los Angeles Basin, there are now thousands and thousands of children who by the age of ten have permanently impaired respiratory systems.¹⁸²

But smog is increasingly a problem in less populated areas as well. In the tropics, the intense radiation of the sun quickens the production of ozone and can make pollution more dangerous than in cooler regions.

A vast pool of alarming ozone and smog is concentrating over fires raging across fields and grassland of Brazil and the savannas of southern Africa that is comparable to the pollution over industrial regions in Europe, Asia and the United States.

During the burning season, a thick pall of smog, produced by vegetation fires and aggravated by other exhaust, hangs over central Brazil and large parts of South Africa. Doctors in both areas, report that at this time of the year, people suffer many more respiratory problems than at other times. For example, according to a *New York Times* report in October of 1992, in an area just north of Brasilia, almost every pollution monitoring instrument went off scale. Air conditions at 11,000 feet were approaching a Stage 2 smog alert in Los Angeles. In a Stage 2 alert, on a three-stage scale, children and the elderly are advised to stay indoors.¹⁸³ On the ground it must have almost literally been deadly.

What is happening? What might happen?

A short list of news stories suggest that the individual problems with our environment may be reacting with a negative synergy that could result in a global catastrophe. A series of perplexing but ominous indicators are cropping up around the world. Are they "miner's canaries," warnings to us that something very serious is afoot?

- The beds of sea grass, vital nurseries for many marine species, are getting smaller in many coastal areas. The cycles of algae plagues, which kill much sea life, are becoming more intense.
- In Greek waters, biologists are seeking the reason why sea sponges are dying on a large scale. In France, scientists have puzzled over an affliction that has caused sea urchins to lose their spikes.
- A virus killed 18,000 seals in the North Sea in 1988, while yet another strain caused a major epidemic among dolphins in the Western Mediterranean in 1990. "Now we have it in the Eastern Mediterranean," said Seamus Kennedy of the British Government Veterinary Sciences Laboratories in Belfast. "We have gone back over the literature for more than a hundred years and we found nothing like it, no other cluster of virulent epidemics like we have now."¹⁸⁴
- All around the world, species of frogs and toads who have existed for 200 million years are simultaneously dying without any indication why. "Frogs are in essence a messenger," says David B. Wake, director of the Museum of Vertebrate Zoology at the University of California. "This is about biodiversity and disintegration, the destruction of our total environment."¹⁸⁵
- Every fall millions of redish-brown and black Monarch butterflies move southward across the United States to Mexico, where they spend the winter. But this year some of the normally crowded migration routes are nearly empty. There is a 90 percent decline of the creatures in the eastern U.S.

Researchers say the decline could be the result of the devastating winter last year at the butterflies' roosting sites in the mountains of Mexico. It is estimated that as many as 80 percent of the monarchs died there. Much of the mortality comes from wood harvesting in and around the areas where the butterflies roost. Not only are the roosting trees themselves being cut, but the surrounding firs are being taken, exposing the butterflies to excessive wind and cold.¹⁸⁶

- The North Atlantic has become much rougher over the last 30 years scientists say, and surprisingly, gustier winds are not to blame. Average waves were about 30 percent higher in the mid-1980's than during the earlier 1960's. Recent studies indicate that waves were nearly 50 higher at the end of the 80s than 30 years ago. The cause is puzzling. Wind affects waves, but average wind speeds in the North Atlantic have been flat. Dr. Neil Hogben, a consultant to British Maritime Technology Ltd., suggest that it is the result of disturbances in the ocean generated from much farther away.¹⁸⁷

Looking at the entire garbage and toxic waste problem prompts the question, how long until we so saturate the ecosystem that it will cease to absorb and be knocked over the threshold into some other stable state, one which it may be impossible for us to recover?

Talking about the possibility of a shift to a different state is not just academic speculation. Recent research on ice core conductivity data from the cap ice in Greenland shows that in the past the earth experienced climate shifts of a year or two between dusty, glacial conditions and warmer weather. Climate experts now must strive to explain the causes of such abrupt climate changes. The new finding raises questions about whether global warming from greenhouse gas pollution could soon knock the climate into a new pattern. "The lesson to me would be that the atmospheric system clearly has inherent instabilities, and it can clearly change in extremely short times. It ought to add just one more note of caution to proceed slowly," says Gifford Miller, a geologist with the University of Colorado at Boulder.¹⁸⁸

Solutions and Strategies

Throughout this report we have talked about the linkage between ecological, social, economic, and political problems. We have mentioned the difficulty in dealing with problems which are global in scope. And, finally we have outlined the systemic problems of thresholds, positive feedback, and system instability. These issues argue for the need to see the world and our role in it in a much different way. As Sandra Postel has suggested, **eliminating these threats to our future requires a fundamental restructuring of many elements of society** -- a shift from fossil fuels to efficient, solar-based energy systems, new transportation networks and city designs that lessen automobile use, redistribution of land and wealth, equality between the sexes in all cultures, and a rapid transition to smaller families. It demands reduced consumption of resources by the rich to make room for higher living standards for the poor. And with current nation's concept of economic growth at the root of so much of the earth's ecological deterioration, it calls for a rethinking of our basic values and vision of progress.¹⁸⁹

In the same report Lester Brown said, **"Put simply, the global economy is rigged against both poverty alleviation and environmental protection.** Treating the earth's ecological ills as separate from issues of debt, trade, inequality, and consumption is like trying to treat heart disease without addressing a patient's obesity and high-cholesterol diet: there is no chance of lasting success."¹⁹⁰

But, we may well ask, is this possible? Can we do anything to halt the destruction of our environment? There are small items of encouragement. Chemist James Crivello a professor at Rensselaer Polytechnic Institute is developing a way to make plastics that are as tough and versatile as those produced today, but are ecologically friendly. The secret, he says, is manufacturing plastics from plant oils, rather than petroleum.

In another example, a Swiss agronomist, working by himself in Kenya, created a successfully operating ecosystem on some of the most difficult terrain imaginable, abandoned limestone quarries. Starting with nothing but fossil coral rubble, he began his reconstruction by looking for an appropriate tree. He knew the species had to withstand heat, drought, sun, and wind and be able to

provide its own nourishment from out of the atmosphere. He found six trees that would thrive, the best being the casuarina tree. After planting many of them, and as they became established, he introduced millipedes to help to turn the tree litter into soil. Insects were required to pollinate the trees and other plants. A fish farming operation was started in some of the quarry ponds and that drew birds -- now 130 species in all. Slowly building, step by step, he worked until today there is a fully functioning mixed-use forest. Rain water has returned and other trees have been planted. People are now employed to tend and extend the forest, with wages that are paid with money from forest products. There is even a lake with a hippopotamus and fish.

We need to make intelligent policy decisions about how we use resources: whether or not we want to defend our coastlines against the rise of sea level, and how we want think about water in the U.S., but more than all of this we have to take care of our atmosphere. And this is apt to be the most difficult of all because it involves global cooperation.

Implications for the Future

World population is growing by 92 million people annually, roughly equal to adding another Mexico each year; of this total, 88 million are being added in the developing world. To many in the third world, the vision of the wealthiest nations asking them to conserve their forests seems incredibly imperialist. To motivate them, we will have to make it worth their while. And that means that we may have to consume less energy, have less of the world's wealth, and help others to conserve their environments in spite of the grinding poverty in which they live. This will necessitate thinking beyond our borders and our generation, as well as investing in resources.

There appears to be two paths that humankind can take relative to the most serious problems of the spoiling of our environment. Absent any extraordinary reason to do otherwise, it seems likely that there will be a relatively slow increase in awareness of the seriousness of the problem by a growing number of people. The profound changes that are needed to seriously offset the growing

trends will nevertheless be perceived to be expensive, and hard to accomplish by enough powerful people that progress and change will be evolutionary -- and therefore ineffective in holding back the ultimate disaster.

On the other hand, the possibility exists that some very significant event will capture the attention of a large portion of the earth's population and leadership and convince them that a serious change in direction is required to maintain the system that supports human life on the earth. A clear change in the earth's weather patterns, or a rapid increase in natural disasters might be enough to provide a shift in direction.

The key to dealing with this problem lies in a fundamental change of perspective. Then Senator Al Gore characterized this mindset well:

I have come to believe that we must take bold and unequivocal action: we must make the rescue of the environment the central organizing principle for civilization. Whether we realize it or not, we are now engaged in an epic battle to right the balance of our earth, and the tide of this battle will turn only when the majority of people in the world become sufficiently aroused by a shared sense of urgent danger to join an all-out effort.¹⁹¹

We must become proactive, and not wait until it is too late.



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Energy

The world's energy issues revolve around *energy dependency* and *pollution*. For countries like the U.S. and Japan, who are highly dependent upon other nations for fossil fuels, one eye must always be kept on the accessibility to energy sources and the time when these traditional resources are likely to run out. At the same time, the environmental pollution produced by these fuels has become a serious global problem. Developed countries are scrambling to find alternatives and legislating incentives to spur research into new, cleaner sources.

Lesser developed countries find themselves squeezed between the need to use increasing amounts of energy to fuel economic development, and the pressures (often primarily from large, foreign countries) to find different energy sources than the dirty ones used in the development of the major countries. The developed countries are, in effect, saying: don't do it like we did it -- but we don't have any alternative ideas yet about how to do it differently.

These pressures have produced a constellation of developments that offer hope for long-term, at least, solutions to the world's energy problems, but short term dependency on conventional energy sources will continue.

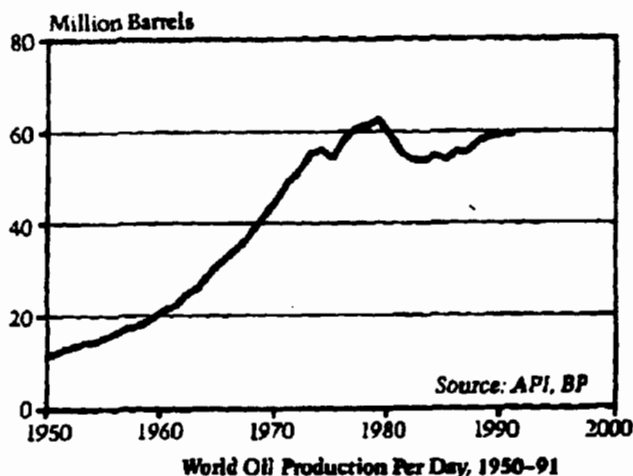
Conventional Sources

The Department of Energy believes that U.S. energy demand should grow slowly over the next two decades as a result of energy conservation measures and advances in energy-efficient technology. That "official" projection translates into an annual growth rate of 0.9 percent to 1.4 percent, "far below the overall economic growth rate."¹⁹² Nevertheless, if current policies and energy-use trends continue until 2030, national energy consumption will rise 41 percent.¹⁹³ Absent any new legislation or other action to curb them, carbon emissions are expected to grow by 0.7% to 1.3% annually over the same time frame -- and increase of 58 percent.

A look at projections for use of common sources of energy will suggest that this "official" scenario is quite possible. But we will also see that absent any revolutionary technology, energy use, particularly in the U.S., could decrease substantially with a new set of energy policies.

Oil

Oil analyst, A. W. Jessup, believes that *world oil demand will reach 72 MMB/D [million barrels per day] by 1996, an increase of nearly 6 MMB/D over 1991. Oil will continue to supply 40 percent of world*



Source: Vital Signs Used by permission.

energy through this period, and its share may not be reduced for the rest of the decade.

East Asia will account for the largest share of the demand increase over this period, a little over 35 percent. Another major contributor to oil demand growth will be the United States, which will be consuming about 1 MMB/D more in 1997 than in 1990. Because of declining domestic production, U.S. imports will increase nearly twice that amount or by 1.7 to 2 MMB/D.¹⁹⁴

There are plenty of oil reserves to meet the conventionally assumed growth in demand well into the next century -- about one trillion barrels of proved and probable reserves. Seventy-seven percent is located in OPEC, 65 percent in the Gulf.

Every barrel of increased oil consumption will be a barrel for OPEC to supply, principally by its Gulf members. U.S. production will fall, driven by the advent of exclusionary zones that prohibit future domestic prospecting and there are real questions about the ability of the former Soviet producers' ability to reorganize and overcome problems of low morale, shortages of oil field supplies, and lack of investment.

If demand increases as assumed, OPEC production expansion plans will just cover it, but since there will be little worldwide spare producing capacity, pressures for an increase in real oil prices could begin as early as 1995.

Within five years, the Gulf producers will have solidified their roles as the No. 1 oil powers. Other producers will be at maximum sustainable capacity or beginning to decline. Only the Gulf producers will have scope for expansion, and only Saudi Arabia will have almost unlimited capacity to expand to meet the steadily growing world demand. Saudi Arabia will become the swing producer; how fast it expands production will determine how well oil supply and demand will be balanced, and the pressure on prices. Without Saudi expansion beyond its present 10 MMB/D sustainable goal, prices will be under severe upward pressure by 1997.¹⁹⁵

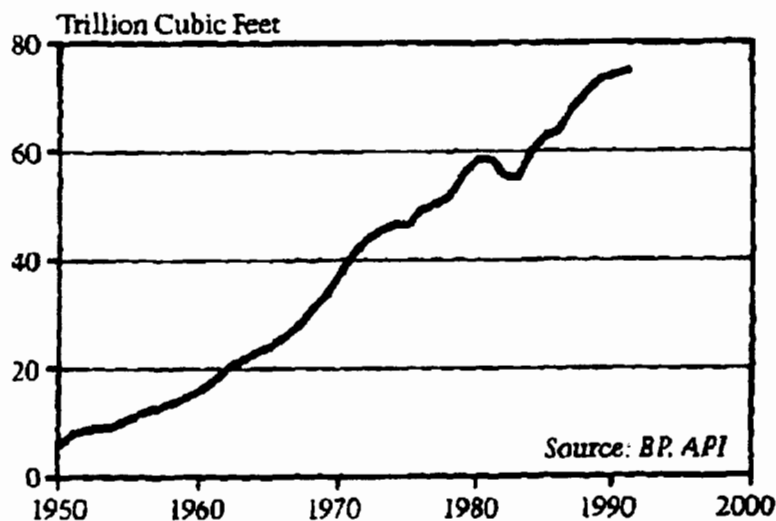


Presently, the global economic slump has driven demand and prices down to uncomfortable (for the producers) lows. The above anticipated growth in demand will only come with a decent, and relatively quick, recovery in the global recession.

Russia has been the largest oil producer at about 9 MMB/D, and the liquid is its largest export, responsible for \$13 billion in 1992. But Siberian oil field equipment is in bad shape, morale of workers is very low and the industry is in trouble. Production dropped to 7.9 MMB/D in 1992 and is moving down. The income generated by oil exports is the principle source for funding of the economic reforms advanced by Boris Yeltsin, yet all indications are that decreasing production will bring the country to the place -- perhaps by 1994 -- that it will not be able to supply its own needs, let alone sell to others. "If Russia fails to turn around the energy industry, the reform effort will fail," says David C. Roche, a senior economist at Morgan Stanley.¹⁹⁶

Natural Gas

The DOE believes that the U.S. has 167 trillion cubic feet of proven reserves of natural gas -- gas in existing wells that can be extracted economically with available technology. But a new report by the National Petroleum Council, supported by the oil industry, suggests that the actual amount of U.S. gas is far higher. They estimate that some 1,200 trillion cubic feet of gas in the U.S. is economically recoverable. Virtually all U.S. gas reserves have been produced as a counterpart of oil exploration.¹⁹⁷ The United States has been producing about 20 trillion cubic feet of natural gas per year for the past twenty-five years.



World Natural Gas Production, 1950-91

Source: *Vital Signs* Used by permission.

There are a number of good reasons why the demand for natural gas may well increase in the coming years. Natural gas produces only half of the carbon emissions associated with coal, so growing environmental concerns will encourage more of its use. If fuel cell-powered electric cars become successful, natural gas will be the likely feed stock that is converted to the hydrogen that fuels the cell. This would greatly increase the demand in the first decade of the new century.

In an attempt to wean themselves from dependency on mideast oil, Japan has shifted its electric production to natural gas and nuclear power. A consortium of Japanese companies plans to build a \$20 billion undersea pipeline network that would link eastern Siberia with Japan and most of the rest of the Far East, including South Korea and the Philippines.

Coal

In the U.S., coal is plentiful, cheap, and dirty. It is a major fuel for electric power plants and a major source of greenhouse gases and acid rain. But because of its price, it is a barrier to the use of other fuels.

The Christian Science Monitor reported that in 1959, electric utilities accounted for 44 percent of the coal consumed in this country. Their share in 1991 was 96 percent.¹⁹⁸ Coal's growing importance in the U.S. energy mix can be measured in a number of ways they reported:

- Since 1984 coal has been the largest source of domestic energy production, passing 33 percent in 1990. (Because of energy imports, coal accounts for only 23 percent of domestic consumption.)
- Coal production last year reached a record 23 quads, with the excess going to exports that earned \$3 billion.
- Fifty-six percent of electrical generation comes from coal -- almost three times more than nuclear, over five times more than natural gas or hydroelectric, and 16 times more than oil.
- The U.S. has the world's largest coal reserves -- 25 percent of the total. Ninety percent of the nation's store of fossil fuels is coal. The U.S. has 6,000 quads of recoverable reserves, 10,500 quads of reserves potentially mineable

with existing technology, and identified deposits of 89,000 quads.

Additional demand for coal will come from new power plants and replacement of old ones. By 2000, more than 25 percent of generating capacity will be 50 years old or more and ready to retire. And electricity generation, which accounted for 36 percent of total energy consumption in 1990, could rise to 45 percent by 2010. A midrange projection in the national energy strategy puts U.S. coal consumption up another 65 percent by 2010.

The problem with coal is the sulfur dioxide and nitrogen oxide emissions it gives off when burned. The government and industry are looking for new methods to decrease these emissions. The Department of Energy launched a \$5 billion program in 1986 to develop highly efficient "clean coal" technology for new plants.

Thirty projects have been funded so far. One, a "pressurized fluidized bed combustion" combustion system, captures more than 90 percent of coal's sulfur emissions.

China is also providing the electricity that powers its explosive economic growth with their plentiful, but polluting coal.

Until some of the new energy production technology becomes mature and competitive, coal will continue to be a major source of fuel in the world.

New Production Requirements

The regular escalation of energy requirements assumed in the National Energy Strategy would necessitate by 2030:¹⁹⁹

- *Commercial Electricity* -- 260 new coal and nuclear plants
- *Industrial and Other Electricity* -- 200 coal and nuclear plants
- *Residential Electricity* -- 140 new coal and nuclear plants

America's dependence upon foreign sources of energy would continue to grow, roughly doubling over the period.

New Advances in Existing Methods

Work has progressed with a number of conventional and emerging technologies that, in terms of cost and cleanliness, is quite encouraging.

Nuclear Power

The need for new power sources has produced several new nuclear-based electricity generation concepts that largely eliminate the problems of the earlier designs. They are either on the drawing boards or now being tested.

These models rely for safety not on "active" measures such as the automatic closing of a valve or an operator's turning a wheel in the event of an emergency, but on "passive" features such as gravity and convection. Even in worst-case scenarios, instead of melting down, the reactors simply run down like a car out of gas. One model not only runs on uranium 238 -- an isotope 100 times more plentiful than the uranium 235 today's reactors use -- but actually eats radioactive waste; specifically, it consumes those long-lived by-products that we're now looking for ways to store underground for 10,000 years or more, and its own wastes decompose within a more workable time frame of hundreds of years.

The new reactors are small and standardized; thus they can be factory-built and subjected to rigorous quality control, then shipped to their destinations in trucks for on-site assembly. Reduced public concern about safety will speed up the licensing process, which will make the new models competitive with conventional fossil fuel plants.²⁰⁰

Although new designs that produce no waste seem appealing, there is a real question whether nuclear will come back on its own. Public sentiment is against it. The problems of waste are immense and increasing. Existing old plants in Eastern Europe may well fail in the coming years. It appears that the future of nuclear power generation will depend upon external events, which will either doom it forever or breathe new life into it.

Solar-based Approaches

Significant progress has been made in the development of both photovoltaics and wind-generated power.

Photovoltaics

Science reported in 1989 that the cost of photovoltaic power generation has shrunk by a factor of 40 in the last decade, bringing it close to competing with other sources of electricity.²⁰¹ It seems likely that advances in solar cells will be such that within the next few years it will become economical to generate a significant amount of residential power through this pollution-free source. Home owners could supplement their power company-purchased electricity with roof-mounted cellular arrays.

If nanotechnology develops anything like it appears that it might, one could be manufacturing photovoltaic cells in twenty years at very, very low costs. Eric Drexler's vision of streets paved with photovoltaics begin to give one an idea where some of these new developments might take us.

Wind Power

We have entered a new era for making electricity from the wind. New technology has made windmills -- known as windturbines -- competitive with fossil fuels in the cost of producing electricity. Windmills, are, of course, pollution-free, and now, with advances in aerodynamics and microelectronics, significant portions of the world have been opened up to the production of clean electricity.

New computer technology now allows much smoother air flow over the blades and maintains the frequency of the alternating current output, resulting in much higher levels of efficiency.²⁰²

Renewable Sources

Renewable energy sources, including hydropower, biomass and waste-to-energy technologies, along with wind, geothermal, and solar thermal facilities are becoming increasingly viable. J. Michael Davis, Assistant Secretary of Energy argued that, "Collectively [renewables] offer a diverse and virtually inexhaustible resource . . . It is substantially less harmful to the environment . . .

It can contribute significantly to our economic and energy security."²⁰³ Davis said that the size of the resource is orders of magnitude larger than foreseeable demand.

Presently renewables supply just 8 percent of the U.S. demand (13 percent of U.S. electrical consumption.) But a recent study by five national laboratories concludes that even without any change in policy, this portion will double over the next 40 years because of accelerating technological and economic trends. By doubling or tripling federal research and development efforts (spending another \$3 billion over the next two decades) the contribution of renewable energy sources would nearly quadruple, the government white paper predicts.

New technologies, like the energy-efficient windows coated with low-emissivity glazing that keep heat in that were that are mentioned later in this chapter, have saved \$3 billion worth of energy since they were introduced in 1981. Amory Lovins, energy consultant to many utilities, says that from the initial "oil shock" in 1973 through the 1980s, more "new" energy was obtained through efficiency than all other sources of supply -- seven times as much. "New technologies, most of the best less than a year old, can save twice as much electricity as five years ago, at a third of the cost," says Lovins.

Efficiency

A major source of new energy lies in the efficient use of power. As the economy grows and the need for electricity increases, there are two responses that the country can take: build more generating capacity, or increase the efficiency of new construction and the huge, presently installed consumption base, thereby decreasing the need for energy. There are clear advantages to taking the efficiency route.

New Technologies

It is possible, with new energy-saving technologies, some only a year or two old, to save as much as 75 to 80 percent of the electricity used in a typical office building. These techniques produce the same office environment for much less cost. As a matter of fact, the new technology usually pays for itself in savings over a usual period of one to six years. Other benefits of this approach

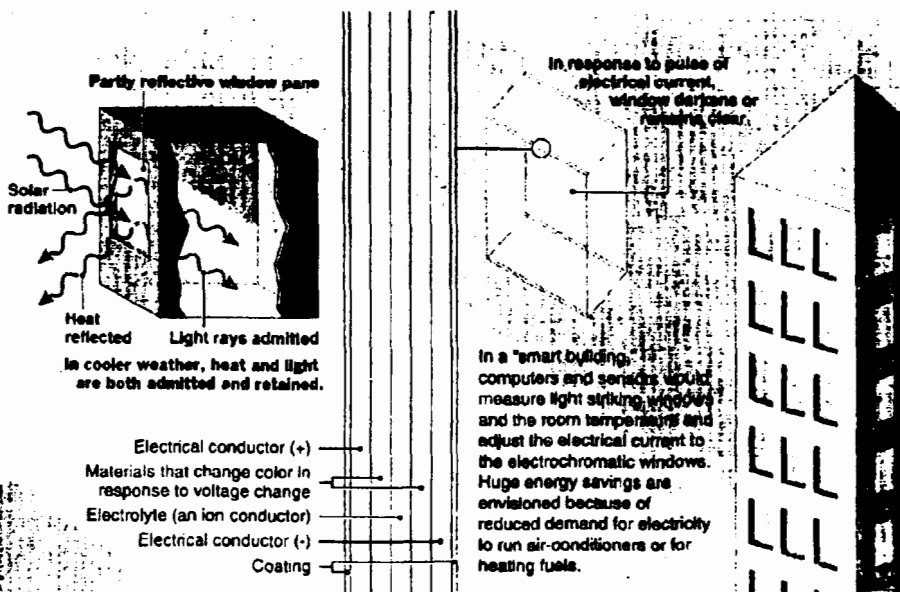
are manifold: less requirements from a powerplant that produces pollution; less capital expenditure for increased capacity (the money can be used elsewhere in the economy), less fuel required, etc.

Modern "superwindows" can now insulate as well as 8 to 12 sheets of glass and let in three-fifths of the visible light but only 2 percent of the infrared (heat rays).

Pulling Down Electrical Shades

An electrochromic window uses an electric current to react to heat and light conditions. It allows sunlight to be absorbed and captured in cold weather and reflected in hot weather. The window is composed of seven very thin layers. Five of the layers act the same as the anode, cathode, electrolyte and metal electrodes in a battery. When the electrical state changes, the color of an insertion material changes, controlling the amount of radiation going into or out of the window.

Source: National Renewable Energy Laboratory; Electro-Optics Technology Center



Similar savings can be had by replacing motors (which use half of all U.S. electricity) with new efficient ones, buying energy efficient office equipment and downsizing heating, ventilating and air conditioning systems to compensate for savings in other areas.

Behavior Change

Enormous differences in the requirement for energy can be made when people change their minds about how they use it. After the oil embargo in 1973, Americans became much more efficient; increasing insulation, caulking, weather stripping, etc. The U.S. automobile fleet also increased its efficiency by five miles per gallon. During 1977-85, the U.S. steadily and routinely saved oil four-fifths faster than it needed to do in order to keep up with both economic growth and declining domestic oil output. This five-

percent-per-year increase in national oil productivity cut total oil imports in half.²⁰⁴

The California Energy Commission estimates that cost-effective investments could reduce total U.S. electricity demand by 40-75 percent while improving the quality of life through cleaner air and lower energy costs. Computers are a case in point. More energy efficient machines could decrease U.S. commercial energy consumption by as much as 10 percent. Rocky Mountain Institute's Amory Lovins asserts that about six percent of all the electricity used for commercial purposes in the country goes to power our 30 to 35 million computers and attached peripherals. A roughly equal amount of power is consumed by the heating and air-conditioning systems in office buildings that deal with the heat that the office automation equipment gives off.²⁰⁵ Laptop computers eliminate most of both of these requirements, and when flat panel wall displays are available that can be driven by a laptop, there will be no need for the power-hungry machines that we are all accustomed to.

"Nationwide installation of just one fixture -- low-flow showerheads that conserve hot water," said WorldWatch, Vice President Sandra Postel, "would save as much energy as oil drilling in Alaska's Arctic National Wildlife Refuge would be expected to produce, and at a far lower economic and environmental cost."²⁰⁶

International Solutions

Efficient use of energy can also make a huge difference in developing countries. The People's Republic of China recently decided it was time people had refrigerators, and built more than 100 refrigerator factories. The fraction of Beijing households owning a refrigerator rose from a few percent to more than sixty percent during 1981-86. Unfortunately, however, through mere inattention, an inefficient refrigerator design had been chosen -- thereby committing China to billions of dollars' worth of electric capacity to serve those refrigerators.²⁰⁷

A partial solution to the problem of growing energy requirements in developing countries is energy-efficient design; not only of individual appliances and factories, but whole electrical systems.

Possible Technology Breakthroughs

There are two or three technologies that are in a stage of development such that they could, within the next two decades, have profound, overnight implications on the world's use and production of energy.

Room-temperature Superconductivity

If room temperature superconductivity, the ability of a material to conduct electrical current without any resistance, were discovered it would make almost all electrical equipment and power distribution systems obsolete. It would usher in a whole new generation of products that were not possible before (like magnetic levitation trains without a need for cryogenic cooling), and would greatly enhance the efficiency of computers (since there would be much less heat losses in microprocessors).

The need for electricity would, over time, plummet, as the internal inefficiencies of electrical equipment approached zero. Room-temperature superconductivity would be a boon to the Third World, helping them to get around the waste and inefficiency that characterized the development of the world's more advanced countries.

Zero Point Energy

Taking energy out of the electromagnetic fluctuations in a vacuum seems too good to be true. But already, at least two zero point energy generation experiments have reportedly been operating successfully in this country and research programs are underway in Japan and Germany, as well. One approach, in Austin, Texas is protected by international patents and has been discussed with a wide variety of government and corporate representatives. The present experiment is generating two times the energy that is put into it. The inventors hope to have a working model within two years that needs no input and can be used as the basis for full-scale engineering. Within a decade they believe that it will be the most widespread type of energy generation.

This technology is, of course, revolutionary, and would change the whole equation of global energy. It would immediately depreciate the value of petroleum and therefore, the world's emphasis on the Middle East. It would reverberate throughout the economies of the world, dealing a significant blow to oil companies, shipping lines, etc.

The significance of this discovery should attract extraordinary interest and effort once it becomes established as credible. That kind of reaction should result, very quickly, in practical products. It would seem reasonable to assume that by 2012 a major industrial segment will be built around this technology. Perhaps an analogy would be to think of the progress that has been made in computer technology in the past twenty years and project that kind of effort out for the next two decades for zero point energy generation.

Cold Fusion

As mentioned in the technology section, cold fusion, or what ever the reaction is, continues to produce enough success to have the interest of segments of the scientific communities in Japan, India and the U. S. One of the inventors of a successful zero point generator believes that the "cold fusion" phenomena may well be a manifestation of zero point energy. In any case, it does appear that something of interest is here, although at very early stages of development.

If, in the next few years, cold fusionists come to believe that what they are seeing has to do with zero point energy, it could be a real push for the whole ZPE endeavor.

Energy Policy

Although the idea, that as our economy grows we will need to consume more energy sounds reasonable, it is fallacious. It is wrong because we waste so much energy and have incentives in place that encourage wasteful behavior. If government (and personal) policies were put in place that changed the attitude of energy users to one that valued energy efficiency, huge differences in

consumption would result. Engineers would design equipment with power consumption in mind. Architects would have it at the top of their list of building priorities. Automobile and engine designers would approach their jobs from a far different perspective. Consumers would search for the most efficient electrical appliances and lighting equipment.

It would be a revolution that would clean up the atmosphere and produce as much as \$2.3 trillion in net savings for the United States over the next 40 years -- money that could be invested in other, more productive areas.

A Different Way Of Seeing Things

A change toward an effective energy policy aimed at stabilizing the degradation of the climate would take into account every area of energy usage. Recently, a group of organizations interested in building a strong economy and clean environment produced a landmark report, *America's Energy Choices*, that deals with the policy aspects of energy, sector by sector. We have used their findings here for this is one of the best examples of systems-based planning that we have encountered.²⁰⁸

Buildings

A tremendous potential for cost-effective energy savings would result from the use of more than 60 types of conservation technologies and measures currently available, ranging from more efficient lighting, windows, and appliances in existing residences to more efficient heating, ventilating, and air conditioning systems in new commercial buildings.

Industry

Large contributions to energy supply can be had from cogeneration, solar and geothermal resources.

Transportation

Energy efficiency can be increased by improving vehicle technology by shifting to more efficient transportation modes, by changing land-use patterns, and by implementing measures that reduce wasteful travel (such as single-occupant commuting). At the

same time, emissions of CO₂ and other pollutants can be reduced by improving efficiency and switching to less polluting fuels.

Much of the energy for personal transportation could be supplied by electricity and by biofuels such as methanol, ethanol, and hydrogen. Biofuels could be produced from wastes or energy crops, such as short-rotation trees and grasses, that would be grown on a large scale and converted to fuel using thermochemical and biochemical processes now under development.

Electricity Supply

Near-term conventional and advanced fossil technologies and electric-generating facilities that use renewable resources, and the penetration of more advanced coal technology (fuel cells and magnetohydrodynamic facilities) could be coupled with advanced renewable energy technologies to produce significant savings.

New Energy Policies

The policies that put in place the above changes must be comprehensive, fair, enlightened and they must:

- Harness market forces
- Make efficiency the standard
- Invest in the future

These three basic approaches can be expanded into a series of policies:

Harnessing market forces

- Promote least-cost planning. Eliminate regulatory incentives for increased energy sales, require all utilities to develop least-cost plans that allow supply-side and demand-side measurers to compete on an equal footing, and ensure that least-cost investments are the most profitable investments for the utility.
- Establish a production tax credit for renewable energy supplies. To help correct for the different tax treatment of fuel expenses versus capital investment (which biases energy choices away from capital-intensive fossil technologies), and to help the renewable energy industries

expand their levels of production so as to achieve significant economies of scale, the federal government should establish and expand production tax credits for renewable energy supply.

- Use market incentives to promote efficient technologies. Charge fees on inefficient technologies or rebates for efficient ones. When both are combined, the practice is known as "feebates."
- Shift some of the tax burden from income to pollution. To reflect the environmental and national security costs of various energy sources, the government could assess fees on fossil fuel consumption, with part or all of the revenues used to reduce income or other taxes.

Making efficiency the standard

- Increase automobile fuel-economy standards to cut U.S. oil dependence. Raise the fuel economy of new cars from 28 mpg to 46 mpg during the next 10 years, while maintaining vehicle size, performance, and safety.
- Set building and equipment efficiency standards to minimize lifecycle costs. Standards should be set, and gradually raised over time, in such areas as new construction, existing building retrofits, appliances, lamps, and motors. The federal government should update and strengthen the national model energy code, require states and localities to meet or exceed this code, and require that federally financed or subsidized buildings also meet it.
- Require effective energy management at federal government facilities. Conservative estimates show that the federal government can save more than \$850 million per year in its own buildings by making cost-effective efficiency improvements. Federal, state and local governments should invest in such efficiency measures, as well as cost-effective renewable energy production.

Investing in the future

- Give energy-efficiency and renewables their fair share of federal R&D dollars. Federal R&D efforts should shift away from the current, heavy emphasis on nuclear energy

and fossil fuels, and more priority should be given to energy efficiency and renewable energy R&D.

- Develop an integrated transportation network to increase access and cut congestion. The policies include the market-based measures discussed above to ensure that automobile users pay the full costs of driving, and encompass zoning changes that would discourage sprawl and encourage in-fill development in cities, towns, and surrounding suburbs; high-occupancy-vehicle lanes and ridesharing programs that would increase passenger occupancy in personal vehicles; and substantial increases in funding for rail- and bus-transit projects.
- Expand education, training, and certification programs in energy-efficient and renewable energy design and construction. Expand support for educational programs that increase the number of qualified designers of national energy programs, conservation program managers at utilities, inspectors of construction sites for compliance with energy-efficient building codes, and other such professions.

Summary

There appears to be an imminent convergence of attitude shifts and to radically change the global energy landscape within the next two decades. However it works out, fossil fuels will decrease in importance -- perhaps dramatically. There is a clear trend toward, clean, renewable -- if not unlimited -- sources. One only hopes that they come fast enough to effectively allay the major problems that our present energy systems and policies have produced.



Notes:

¹⁹²1993 Annual Energy Outlook, U.S. Department of Energy, 1992

¹⁹³ibid.

¹⁹⁴These calculations are extrapolated from the U.S. Energy Information Administration's 1992 Annual Energy Outlook.

¹⁹⁵Taken from *Geopolitics of Energy -- Supplement*, Conant and Associates, Ltd., Washington, DC, April 1, 1992

¹⁹⁶"Drilling for a miracle," *U.S. News & World Report*, December 7, 1992

¹⁹⁷*International Update*, Marvin Zonis and Associates, Inc., Chicago, January 18, 1993

¹⁹⁸In 'Saudi Arabia of Coal,' Use Rising Despite Clean-Air Laws," *Powering the U.S. into the 21st Century*, The Christian Science Monitor Reprint

¹⁹⁹*America's Energy Choices, Investing In A Strong Economy And A Clean Environment*, Alliance to Save Energy, American Council for an Energy-Efficient Economy, Natural Resources Defense Council, Union of Concerned Scientists

²⁰⁰Carlson, Richard & Goldman, Bruce: *2020 Visions - Long View of a Changing World*, [Stanford, CA: Stanford Alumni Association, 1991] p. 97

²⁰¹Hubbard, H. M.: "Photovoltaics Today and Tomorrow," *Science*, April 21, 1989

²⁰²"A new era for windmill power." *The New York Times*, Sept. 8, 1992

²⁰³"Renewables and Conservation Are Finding a Place in the Sun," *Powering the US into the 21st Century*, The Christian Science Monitor Reprint

²⁰⁴Lovins, Amory B.; *Energy, People, and Industrialization*, [Snowmass, CO: Rocky Mountain Institute, 1989] p. 3

²⁰⁵"Do computers and Networking pollute the environment?" *Network Computing*, August 1992: p. 18

²⁰⁶Brown, Lester et. al ; *State of the World 1992*, [Washington, DC: WorldWatch Institute, 1992]

²⁰⁷Lovins. p. 18

²⁰⁸*America's Energy Choices, Investing In A Strong Economy And A Clean Environment*, Alliance to Save Energy, American Council for an Energy-Efficient Economy, Natural Resources Defense Council, Union of Concerned Scientists

Population

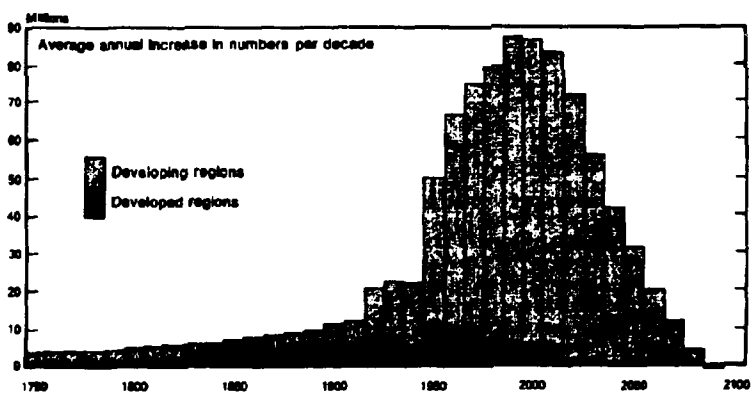
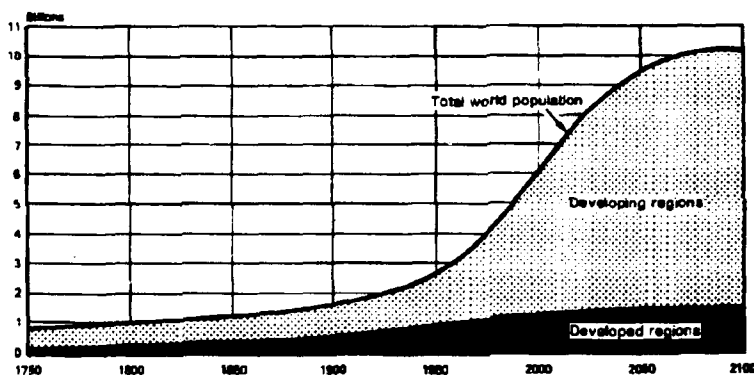
A Global Issue

An Historic Explosion²⁰⁹

Human demographic history has reached an important turning point. World population passed the 5 billion mark during 1987 and is growing by about 1.7 percent a year -- the difference between global birth and death rates. After accelerating for more than two centuries, the annual rate of world population growth is slowing; today's rate of 1.7 percent is down from a peak of about 2.04 percent in the late 1960s and is expected to continue to decline, to between 1.4 and 1.5 percent in 2000 and zero toward the end of the 21st century, according to the United Nations. For most of the past and also for most of future human history, world population increase was and will be limited, both relatively and absolutely.

Annual increases in the absolute size of world population have also been growing for more than two centuries and, since the end of World War II, have reached numbers that are enormous by historical standards. Currently, some 90 million people are added to the world's population each year. In the ten years from 1975 to 1985, world population grew by about 760 million, a number equal to the estimated total world population in 1750. Even

though the annual growth rate of world population is now declining, the numbers added each year are likely to increase for at least another decade, because the size of the base population to which this growth rate applies has become so large. According to the latest, 1988, medium variant assessments of the United Nations, numbers added to world population will average 94 million a year from 1990 to 1995 and reach a peak of 97 million a year, on average, between 1995 and 2000. In the year 2000, world population is projected to be 6.25 billion. After that, annual numbers added will be increasingly smaller until world population eventually stabilizes. The U.N.'s most recent long-range medium projection, prepared in 1980, puts this in the last decade of the 21st century at a total of about 10.2 billion.



Source: Population Reference Bureau

Focused in Africa, Asia and Latin America

Of the projected 3.4 billion addition to world population between 1985 and 2025, 3.1 billion, or 93 percent, occurs in Africa, Asia,

and Latin America, increasing their share of global numbers to 83 percent, and reducing that of North America, Europe, the former U.S.S.R., Japan, and Oceania from 24 percent in 1985 to just 17 percent in 2025. The largest absolute increase, 1.7 billion, is projected for Asia, again reflecting its large population base.

All other things being equal, about 2035, India will pass China as the world's most populous nation. By the same year, the population of Brazil and Argentina combines will almost equal that of the U.S.

World Population Shifts (between 1950-2025)

Percent of World Population

	1950	2025
Africa	8.8%	18.8%
Asia	54.7%	57.8%
Europe	15.6%	6%
North & Central America	8.7%	7%
South America	4.4%	5.8%
United States	6%	3.5%

Source: World Bank 1993

But Asia's percentage growth in the 40-year projections, 63 percent, is below the overall average, 70 percent. Thus Asia's share of total world population drops from 56 to 54 percent. All other things being equal, by about 2035, India will pass China as the world's most populous nation.

Relative growth in Africa and Latin America is projected to top the world average by a large margin. Africa is projected to add 1.1 billion people, reaching 1.6 billion in 2025, triple the 555 million of 1985. By 2035, the population of Brazil plus Argentina will be almost equal to that of the United States -- whose population density would increase by about 20 percent. Latin America's projected gain is 374 million, to 779 million in 2025, close to double 1985's

405 million. The worst case developing countries are doubling at a rate of 20-30 years.

Specific Examples of Population Growth²¹⁰

	Population - millions			
	1950	1990	1995	2025
AFRICA	222	642	747	1597
Somalia	2.4	7.5	8.4	18.7
Zaire	12.2	35.6	41.8	99.4
Egypt	20.3	52.4	58.4	90.4
Nigeria				
NORTH & CENTRAL AMERICA	220	427	453	596
United States	152	249	258	300
Mexico	28	88.6	98	150
Canada				
SOUTH AMERICA	111.6	297	326	494
Brazil	53.4	150	165	245
Argentina	17.1	32.3	34.2	45.5
ASIA	1337	3117	3413	4912
Bangladesh	41.8	115.6	132.2	234.9
India	357	853	946	1442
China	554	1139	1222	1512
Japan	83.6	123.4	125.9	127.5
EUROPE	392	498	504	515
France	41.8	51.6	57.1	60.3
Italy	47.1	51.6	57.1	52.9
U.K.	50.6	57.2	57.8	59.6
Germany	68.4	77.6	77.3	70.9
Spain	28	39	40	42
WORLD	2516	5292	5770	8504

Source: World Bank, *World Resources 1992-1993*

Jacques-Yves Cousteau has put it in personal terms, "During my lifetime -- 82 years only -- the world population has more than tripled. If nothing drastic is done, in another 80 years, 2070, the population will triple again, reaching the absurd figure of 16 billion human beings. Every six months, the equivalent of France (50 million) is added. Every 10 years, there is a new China born in the poorest regions of our Earth." Cousteau allows that the real number may end up being closer to 12 billion, but he has made his point.

A word of caution is needed about both the magnitudes and regional distribution of population in projections to 2025. Because of its currently high birth rates and declining death rates, Africa has the *demographic* potential to grow as projected, rivaling the growth of Asia and Latin America over the last three decades. But there is no guarantee that Africa has the political, social, and economic base to support such increases.

Most Growth in Poor Areas of the World

The problem with population growths of this kind is that the brunt of the explosion is in countries that don't have an effective infrastructure to deal with it. This inverse relationship results in the most pressure being concentrated in the places most susceptible to failure. In some parts of the world there are too many people in relationship to available local resources such as potable water and arable land. The problem is also that in other places, too many resources are consumed too fast by too few.

Environmental Implications

A world population of this size is a problem primarily for environmental and food reasons. Urban consumption is much different in energy and transportation than in rural situations. Providing new infrastructure and products for development (at least as it has been done in the past), produces large amounts of land, water and air pollution. Increased energy production and physical infrastructure development required to support burgeoning populations combined with traditional industrial process waste have become such a problem that a new concept of national development that is more environmentally benign is required. Perhaps some of the emerging technologies will offer

dramatically different approaches to development in the near future.

Population growth is not the sole culprit in environmental degradation; there are other factors, including poor land management, poverty and inappropriate technologies.

Feeding the Multitudes

Barring any technological breakthroughs, the gap between population growth and food production will widen. Efforts are underway to protect soil, conserve water and restore the productivity of degraded land. "But doing everything feasible on the food side of the food/population equation is not enough," warns Lester Brown.

To put the population/food equation in simple perspective, an estimated 24 billion tons of topsoil wash or blow off the land each year. Thus, every year, the world's farmers must try to feed 93 million more people with 24 billion fewer tons of topsoil.

"Reduction of fertility in and of itself will not cause hungry poor nations to become rich," the final report of the 71st American Assembly on International Population Policy concluded, "but it can provide time and relieve pressure on societies to direct resources toward satisfying the minimum needs of a rapidly growing economically dependent populations."

The Global Teenager

The rate of population growth has been so great that the major proportion of the globe's denizens for the next two decades will be poor young people. By sometime in the mid-1990s, over half the humans on earth will be under the age of 20 and their plight will be worse than those of today. In a report on the "global teenager," the *Whole Earth Review* summarized the situation.

The natural condition of youth is to hope and aspire, to find a worthy task and master it, to locate oneself in a community and give one's best to advance it. To have faith, once again, and in this way to strengthen an identity. But how can faith, especially the new and often frail faith of the young, withstand the iron hammer of the economy, reducing whole nations to rubble or forging others into pavilions of luxury?

The young are signed up for the most intensive course, a crash course. Just coming on the labor market, heads stuffed with images of affluence, they find out quickly enough their value to society. They are the most unemployed class in the world, also the worst paid and least protected. They are offered the most boring, filthy, dangerous and demeaning jobs available. In the language of one of those UN reports: "The key words in the experience of young people in the coming decade are going to be: 'scarcity,' 'unemployment,' 'underemployment,' 'ill-employment,' 'anxiety,' 'defensiveness,' 'pragmatism,' and even 'substance' and 'survival' itself."²¹⁰

Later in the same issue, Kevin Kelly observed that adding to the tempest of this storm is the curious phenomenon called "high adolescent density," the observation that when the number of youth in a society overshadows the number of mature adults, younger people have no role model except peers. "Call it the *Lord of the Flies* syndrome. Anything can happen, and whatever does happen forms the psychological basis for the rest of that generation's life. In the long run, the most important thing about global teenagers is that, like the baby boom in America, their character will be the main event of world culture long after they outgrow pimples."²¹¹

Growing Urban Centers

As the world population doubles, urban population triples as people move to cities looking for work and food.²¹²

The New York Times recently used Latin America as an example of what is happening across the world in areas of high growth:

Despite grinding poverty, Peruvians seeking a better life have been fleeing the countryside for Lima at the rate of more than a thousand a day and building settlements that seem like an endless expanse of small straw huts brushed constantly by a gritty wind next to a noisy highway.

Latin America is the most urbanized part of the underdeveloped world. In 1950, only 42 percent of Latin Americans were city dwellers; today almost 73 percent live in cities, according to the United Nations. This compares with 34 percent in Africa and 33 percent in Asia.

The trend has created megacities throughout the continent: Buenos Aires, with 12 million out of 32 million Argentines; Santiago, with 5 million out of 13 million Chileans; Lima, with 7 million out of 22 million Peruvians, and Mexico City, the world's largest city, with more than 20 million of the country's 90 million people.

In many countries, the equation is similar: the major city attracts one-quarter to one-third of the country's population, with many living in squalid slums or shantytowns encircling the affluent inner city. Experts say that by the year 2010, Rio de Janeiro and Sao Paulo will be one continuous megalopolis 350 miles long with almost 40 million people.²¹³

The relationships between the developed world and lesser developed countries can be seen in the population densities of major cities. New York, for example, has a density of 5,000 people per square mile; in Tokyo it is 22,000 per square mile. On the other hand, in Bombay, 150,000 souls are crowded into the average square mile.

The Poor Will Know That They Are Poor

The Population Reference Bureau's Barbara Torrey has suggested that one reason urbanization is important is because CNN will hit these people. Unlike any time in the past, when transnational communications were concentrated between certain developed countries and were, almost exclusively audio, with the advent of satellite repeaters and networks like CNN, in the last decade, live images from the developed world are now beamed around the world and available for reception most everywhere.

A story is told by a Coast Guard commander of riding in a dug-out canoe to a small jungle village in the Philippines that had no land access only to find, perched on a stand in the middle of the collection of thatched huts, a communal television, connected to a satellite dish. Each night the villagers gathered around to watch MTV, beamed from the U.S.²¹⁴ In cities, instead of a few people being exposed to TV, almost everyone will be.

What this means is that for the first time in history, the poor are beginning to understand how relatively poor they are compared to the rich nations. They see, in detail, how the rest of the world lives and feel the increasing disenfranchisement. The "ideas" of the industrial world will also accompany the quality of life

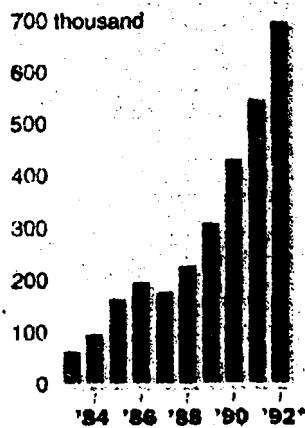
images -- and will threaten the familiar and comfortable concepts that have been the basis for life for those who have been isolated.

Immigration Pressures

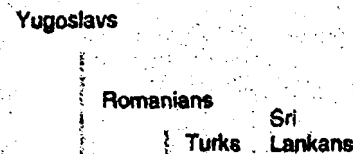
As people are increasingly crowded into a places with limited capabilities to support them, they will increasingly move, not only within their country but to other countries. Therefore, in light of the huge increases in population that the world will experience in the next two decades, international migration is likely to be one of the major challenges to the world economic system in the 1990s. Bailey Morris, writing in *Economic Insights*, suggests that not since the turn of the century, the last great migration period from 1900-1910, have so many people been on the move. "According to recent estimates, more than 80 million people currently live outside their country of citizenship. For the first time in memory, all of the major OECD countries are net immigration nations, a trend that is expected to continue through the decade. Thus, the great migrations of the 1990s promise to be an international issue equal in importance to the environment, trade and the search for sustained global growth"²¹⁶

Seeking Refuge In Western Europe

Total number of asylum-seekers arriving in Western European countries.



Leading groups of asylum-seekers



*Estimate

Source: Inter-Governmental Consultations on Asylum, Refugee and Migration Policies in Europe, North America and Australia

Both Europe and the U.S. have concerns about significant increases in immigration. The Western Europeans are watching Eastern Europe, Turkey and North Africa. The major U.S. threat is from Mexico and Central America.

Two of the biggest problems in regulating immigration, Morris says, are its close links to issues of national sovereignty and the desire of most governments to sweep the problem under the rug. Official reactions, therefore, are often in response to crisis: half-starved Haitians in fishing boats off the coast of Florida; Albanian refugees in Italy; Pakistanis and other "guest workers" who are stranded in post-Gulf War Middle Eastern countries.

A Lack of Long-term Government Planning and Policy

Morris believes that the lack of long-term planning and policy coordination rests in large part on the belief of governments that they can turn immigration on and off like a faucet, which will not be the case in the coming decades if the policies of the past are any indication of future decisions. "Demand-pull immigration has given way to dramatic supply-push."

Philip L. Martin, writing in the same issue said that industrial countries often discuss immigration in crisis terms because they are being overrun by migrant workers, the same group that they used to recruit. Until rather recently, all of the industrial countries needed workers from outside of their country to do the (usually) low-paying jobs in their economy, and developed immigration policies with incentives for such groups. In the 50s and 60s the U.S. and Western Europe recruited migrant workers to fill what were believed to be short-term labor gaps.

The world's labor force is projected to increase by almost 800 million by 2010, and 93 percent of these additional workers are expected to be in developing countries. It is this demography that is at the root of fears that the industrial world will be swamped by migrant workers seeking jobs and higher wages. The number of legal and illegal migrant workers, today some 25 to 30 million, has been rising despite some government interventions. There are an additional 16 million refugees waiting in countries like Thailand until they can find other places to go, and about 2 million immigrants are admitted legally, half of them into the United States.

During the 1980s, the United States received about 9 million immigrants, including 3 million Mexicans. Projections indicate that the U.S. can expect 4 to 5 million legal and illegal Mexican immigrants to arrive in the 1990s.

The switch from demand-pull recruitment to supply-push migration is now evident everywhere, and helps to explain the scramble to find trade and aid strategies that encourage potential migrants to stay at home.²¹⁶

But the solution does not lie in traditional trade and aid approaches; industrial countries will have to make structural adjustments of their economies and labor markets to reduce the demand-pull factors that attract migrant workers. Martin, who is a professor at the University of California-Davis, suggests that there are three things that hold the key for the industrial countries gaining control of this problem:

1. Acknowledge that there is no simple or single cure for the immigration dilemma; not a new development program, not a new immigration category, and not a new type of regional economic block.
2. Look harder internally for the reasons why immigrants come; demand-pull is as much a factor as supply-push in determining immigration patterns.
3. Recognize the critical links: immigration patterns and policies promise to join trade and finance as major forces in the international economic system.

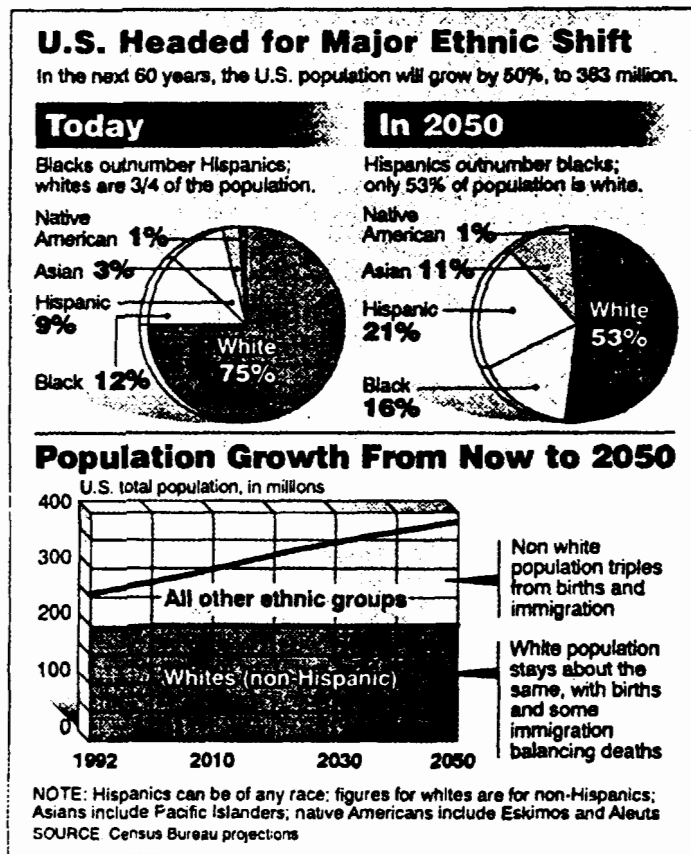
U.S. Undergoing Significant Change

Because of the much greater population increases in other areas of the world, the U.S., although it will grow, is relatively becoming a smaller piece of a growing pie. An increase in births among American women coupled with massive immigration will add more people to the nation's population over the 1990s than any time since the baby-boom decade of the 1950s, says the Census Bureau. Overall the American population is expected to grow by about 50 percent from its current level of 255 million by the middle of the next century.²¹⁷ The population density will, of course, increase -- up about 20% by 2025.

Greater Ethnic Diversity

Most of the growth will be from minority groups, and in both the short- and long-run, America will become a much more polyglot nation. New population projections also underscore the nation's rapidly changing ethnic profile: by the middle of the next century, virtually half of the population will be made up of blacks, Hispanics, Asians and American Indians, and our current terminology of "majority" and "minority" will become meaningless.

The Census Bureau projects that the number of Hispanics will



Knight-Ridder/Tribune Graphics Network

KNIGHT-RIDDER TRIBUNE

surpass blacks in two to three decades. And by the middle of the next century, Hispanics will nearly quadruple to 81 million, or more than a fifth of the population.²¹⁹

Demographer Peter Morrison projects that by the year 2000, today's politically salient minority groups -- blacks, Hispanics, and Asians -- will make up a slightly larger share of the total U.S. population than they do today. Blacks will increase from 12.3

percent of the population in 1989 to 13.1 percent in the year 2000; Hispanics, currently 8 percent, will grow to 9.4 percent. Other races, primarily Asians, will increase from 3.4 percent to 4.3 percent.²¹⁹

Local and Regional Clustering

Far more important than these national shares, Morrison suggests, are the distinctive regional and local patterns of population distribution. Hispanics and Asians are highly clustered in a few regions of the country. In 1989, 73 percent of all Hispanics lived in just California, Texas, New York, and Florida; in 1980, 49 percent of all Asian-Americans lived in just California and Hawaii.²²⁰ In California, for example, one of every four cities above 50,000 in population has no racial or ethnic majority of any kind.

Minorities are clustering in regional areas, upsetting historical racial mixtures. Already, one in four Californians is Latino; nearly 4 million Latinos live in Los Angeles County alone. Counting illegals, they make up almost half the population. Two million more live in the neighboring counties of Orange, San Diego, Riverside and San Bernardino. These figures will quickly grow. By the year 2010 southern California will have become a Latino subcontinent -- demographically, culturally and economically distinct from the rest of America.²²¹

Morrison argues that the traditional notion of the "melting pot" no longer holds; "its ingredients have separated into a complex racial and ethnic mosaic in which groups of people cling to their separate identities." He points out that in the 1990 census upwards of 250,000 unique entries were reported in addition to the conventional 16 categories of "White," "Black," "Chinese," and the like.²²²

A Growing Disparity Between the Rich and the Poor

During the last decade, more of America's wealth has become controlled by a smaller number of people. This trend was not just in the white community but was also reflected in black families. The percentage of black families making more than \$90,000 more than doubled from 1967 to 1990, according to new Census Bureau figures. At the same time, the proportion of black families at the lowest income level grew by 50 percent. In 1990, more than one

black family in nine earned less than \$5,000 a year. The widening gulf has meant a marked decrease in the proportion of black families in the middle-income ranges.

"The deepening of poverty, which affects whites and Hispanics as well, is particularly true among a substantial segment of the black community, and is cause for real concern," Robert S. Greenstein, the Center on Budget and Policy Priorities is reported to have said.²²³ Mr. Greenstein and other economists and sociologists said they expect the trends to continue, particularly in a sluggish economy. "The real question," said Chris Winship, a professor of sociology at Northwestern University, "is whether the government is going to ask the increasingly wealthy to support the increasingly poor."

An Aging Population

Although less than 13 percent of the nation's population is presently 65 or older, that segment will rise to about 20 percent by 2025 and the number of elderly will have doubled. The main effect of the aging of the population will be felt during a short period of intensive change that will commence in the year 2011, when the first members of the baby-boom generation will reach age 65.

Population aging will affect the lives of both the elderly and the nonelderly. Social Security taxes will rise, and more of the federal budget will flow to the elderly. The most palpable effects will be felt locally and within families, as chronic health problems and limitations on the routine activities of daily living increase the need for long-term care.²²⁴

Immigration Worries

All indicators point to a migrant intake system near overload. New legal and illegal immigration to the United States has surpassed one million annually. Some 2.5 million are on waiting lists abroad for visas. A recent study by the Census Bureau found that there are 20 million immediate relatives of American citizens and resident aliens living abroad potentially eligible for entry with an immigration preference. A 1989 *Los Angeles Times* poll in Mexico found that 4.7 million Mexicans -- about 7 percent of the total

MIGRATION TO THE U.S. BY DECADES

	1951-1960	1961-1970	1971-1980	1981-1990
Humanitarian Immigration	482,371	212,843	539,447	1,606,389
Total Immigration*	4,515,479	5,321,877	8,993,314	9,871,059
Humanitarian as a % of Total Immigration	10.9%	4.0%	7.7%	16.3%

SOURCE: Immigration and Naturalization Service

* Total Immigration for 1951-1970 includes an estimated 200,000 illegal entrants each year, while Total Immigration for 1971-1990 includes an estimated 250,000 illegal entrants each year (except 1981 and 1982 since illegal entrants from that period were later legalized by IRCA and counted in total immigration figures for 1988 and 1990).

Graphic: Zero Population Growth

population of 67 million -- intended to emigrate to the United States.

Worldwide demand for settlement in the United States is expected to continue surging in the 1990s. The growth of the working age population of the Third World will accelerate; the expanded numbers of earlier immigrants now in the U.S. will strive to bring in family and friends by any available admissions channel; and political and social unrest will most likely continue to trouble much of Africa, Latin America, the Middle East, Eastern Europe and the former Soviet Union. Admissions under refugee and other humanitarian provisions, which are unlimited by law, could become a much more important source of new settlers during the present decade, adding as many as two and a half million to three million newcomers.

A Changing Attitude

The New York Times made reference to political conservatives having been repeatedly unsuccessful in recent history in pushing through any measures restricting the legal flow of immigrants. Nonetheless, in the last year and a half, in political campaign rhetoric, magazine articles and legislative proposals, the tenor of public conversation about immigration has changed, with emphasis shifting from romantic rhapsodies about the melting pot to anxiety attacks about the dwindling resources of an economically strapped nation.

In California, the Sierra Club, concerned that immigrants are causing a population explosion harmful to the environment, joined forces with three groups that favor immigration restriction to create the Coalition to Stabilize Population. And in Congress, a proposed Constitutional amendment that would deny citizenship to American-born children of illegal immigrants was sponsored by 12 Republicans and two Democrats who are civil rights advocates.

It became particularly trendy in California for politicians to blame the state's economic woes on immigrants, and especially on illegal ones. With Gov. Pete Wilson, a Republican, claiming that immigrants were bankrupting the state by using more in services than they pay in taxes, Los Angeles, San Diego and Orange counties all commissioned studies to determine just how much new and illegal immigrants cost taxpayers.

The New Jersey Legislature eliminated public assistance benefits to illegal immigrants and appears to be moving swiftly to deny them the right to a driver's license. In New York's suburban Suffolk County, the welcome of more generous times has given way to such negativity that when a principal in Elmont, N.Y., reported two of his students, the children of illegal immigrants, to immigration authorities, he was applauded by his local school board.²²⁵

The Changing American Family

One of the most far-reaching aspects of American demographic change is the alteration of the American family. The family is the institution that most fundamentally shapes and nurtures personal values. Children historically have gained their sense of self worth and positioned themselves in the larger society through the implicit and explicit teachings of their parents and extended family. This social unit has always provided the basic equipment -- the stability -- that allowed our citizens to deal more or less effectively with the major changes in our country's history.

No more. The family, as it has traditionally been understood, is changing fast in both structure and function. The result is sobering, especially as we enter the era that will include the most acute and threatening change in our history.

A Rise in Single Parenthood

The problem starts at birth. Demographer Peter Morrison suggests that one reason why children's families are changing is that more of the women having children are not married.

- Nationwide, in 1988 unmarried women bore one million children, or 26 percent of all births that year, the highest proportion ever.
- In black and Hispanic families the rates of single-parent families are almost 63 percent and 30 percent, respectively; among white women, 18 percent.²²⁶
- In the past 30 years, the divorce rate has tripled.²²⁷
- Of every 100 children born today only 41 will reach the age of 18 living continuously with both parents.²²⁸
- Among children who were born in 1980, as many as two of every three white children and 19 of every 20 black children will live in single-parent families at some time in their youth.²²⁹

The traditional family with married couples living with their own children has become a distinct minority. In New York City, for example, they constitute only one in six households and declined from 19.2 percent of all households in 1980 to less than 17 percent in the 1990 census.²³⁰

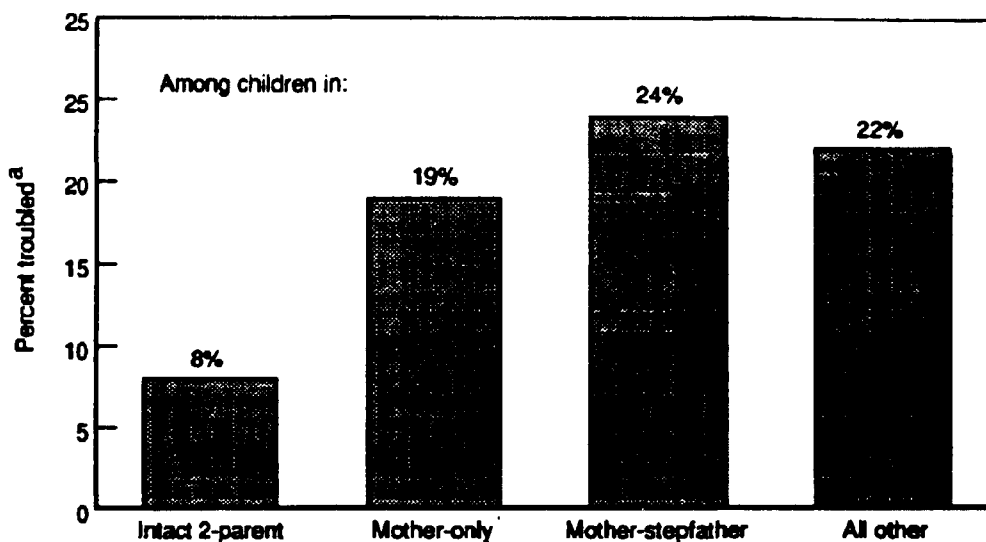
If these trends continue, by 2000:

- More than two of every three children under age 6 will have a mother who is employed outside the home
- Fewer than three of every ten adolescents will have lived in a continuously intact family through all 18 years of their youth.²³¹

Instability and Disfunctionality in Single-Parent Homes

This instability and lack of both mother and father figures in our children's lives is producing problems, at best, and disfunctionality, at worst. The 1988 National Health Interview Survey of Child Health, for example, found that "young people from single-parent families or stepfamilies were two to three times more likely to

have had emotional or behavioral problems than those who had both of their biological parents present in the home."²³³



SOURCE: National Center for Health Statistics, 1990

^aChildren 3-17 ever with emotional or behavioral problem lasting 3+ months or needing treatment

Prevalence of psychologically troubled children, by type of family

Peter Morrison: RAND Corp.

Children from broken homes have more trouble in school and with learning, getting along with other people, getting and keeping a job and maintaining relationships in marriages. In what has been labeled the "new morbidity of childhood," an increase has been noted in developmental delays, learning difficulties, and emotional and behavioral problems. The prevalence of emotional and behavioral problems, for example, varies from 8 percent among children in intact two-parent families to 19-24 percent among children in nonintact ones.²³⁴

As David Popenoe of Rutgers University has said, "... in three decades of work as a social scientist, I know of few other bodies of data in which the weight of evidence is so decisively on one side of the issue: on the whole, for children, two-parent families are preferable to single-parent families and stepfamilies."²³⁵

A Broader Indictment of Society

Other evidence suggests an even broader parental indictment -- of a society that seems unable to control drugs, that cannot even guarantee its children's physical security in school and on the way to it, that fails to reinforce discipline and high standards, that emphasizes instant gratification over working for the future.²³⁵

The Progressive Policy Institute report, *Putting Children First: A Progressive Family Policy for the 1990s*, quotes from an article in *Family Affairs*.²³⁶

Barbara Whitehead illuminated public reactions to family issues through a series of one-on-one and focus group discussions with a cross-section of middle-class parents. Her overall finding is that there are two languages of the family; one is the official language, spoken by experts, politicians, the media, academicians, and other opinion leaders. The second is family language and it is spoken by ordinary citizens. The first language is the language of economics and politics; the second is the language of culture and values. The first is self-consciously relativistic while the second is unabashedly judgmental.

They summarize the research thusly:

With regard to the family, these views go something like this. A primary purpose of the family is to raise children, and for this purpose families with stably married parents are best. Sharply rising rates of divorce, unwed mothers, and runaway fathers do not represent "alternative life styles." They are rather patterns of adult behavior with profoundly negative consequences for children.

The character of the family, these Americans believe, is the key to raising children successfully. Families have primary responsibility for instilling traits such as discipline, ambition, respect for the law, and respect for others -- a responsibility that cannot be discharged as effectively by auxiliary social institutions such as public schools. This responsibility entails a sphere of legitimate parental authority that should be bolstered -- not undermined -- by society. It requires personal sacrifice and delay of certain forms of gratification on the part of parents. But this responsibility can be fulfilled, even in the face of daunting odds. Generations of Americans have proved that economics and social hardships are compatible with strong families

raising competent children -- and that such families are the key to overcoming these hardships.

Society Is Not Supportive

This, then, is the core of average Americans' moral understanding of the family. But these same Americans do not, for the most part, see contemporary society as supportive of this understanding. On the contrary, they see their efforts to transmit moral values to their children counteracted by many of our society's most powerful forces. In sum, they are experiencing not only an economic squeeze, but also a cultural squeeze.

Two principal objects of parental concern are rampant materialism and the dominance of the media -- value-oriented issues.

Searching for Values

Where do our children receive their values if not at home? As the parents in the above study suggest, popular commercial and entertainment culture play an increasingly central role. Schools and business are also responsible, even though there is a loud chorus that argues for value-neutral education.

Values Are Taught, Learned and Practiced

Washington Post columnist William Raspberry made the point regarding schools by quoting education deputy secretary David Kearns²³⁷

"More and more children are growing up today without the 'nuclear family' that we had . . . No matter what sort of family they grow up in, all children need to develop good ethics. The key to these values is education. We are not born with values. They are taught, learned and practiced . . . at home, in school, on the playground and in our neighborhoods; by the way we act as adults, by the way we conduct our businesses and by the way we treat each other.

"The bottom line is that all of our schools already teach values. They teach them every day in every class and in their halls and gyms." We teach values intentionally, as when, in the wake of the Los Angeles riots, teachers got their students talking about societal neglect and personal responsibility -- right and wrong. And we teach them inadvertently -- whether by setting solid personal

examples or by giving academic credit in spite of skipped classes and indifferent study habits.

"There is no such thing as a value-neutral education. Everything is not relative; there are plenty of constants in our American values. Truth is better than dishonesty. Fairness is better than prejudice . . . If you exclude values from schools, you will only teach that values aren't important. You send the message that the foundation of America isn't worth teaching, and you provide no alternative to what children see on television.

"Yes, children will decide what values are important to them, but they need to know what values are important to *us*, and why."

What is true of schools is also true of companies. As Kearns told his former colleagues, "A company's ethics are reflected in the people it employs, the opportunities it provides them through training and services and the way it conducts internal business . . . You either promote good ethics or you allow bad ethics to develop."

An Epic Struggle between the Old and the New

There is an increasing chorus questioning the values and ethics of our entertainment industry. Todd Gitlin, a Berkeley sociologist talked at a recent conference about the "rage and nihilism" that Hollywood is tossing on screen. He said: "The industry is in the grip of inner forces which amount to a cynicism so deep as to defy parody, 'reveling' in the means to inflict pain, to maim, disfigure, shatter the human image."²³⁸

We see in these trends an epic struggle between the old and the new to influence the tools that shape the values of the society. The outline of some of the forces was identified by the *Generations* and *Paradigm* approaches considered earlier. On one hand, the increasingly conservative Boomers are aligning themselves against the more permissive and liberal philosophies of the older Quiet generation.

James Davidson Hunter characterized it well in the *Wall Street Journal*.²³⁹

Those who dismiss the conflict over cultural issues as the politics of distraction will miss perhaps the single most important "climatological" change in contemporary American politics: that the culture war is about who we are as a nation and who we will choose to become.

Cumulatively, the disputes amount to a fundamental struggle over the "first principles" of how we will order our life together. Through these seemingly disparate issues we find ourselves, in other words, in a struggle to define ourselves as Americans and what kind of society we want to build and sustain.

Indeed, the cultural cleavages with which we have become familiar have taken shape out of a major realignment in American public culture. It has brought together a wide range of previously antagonistic cultural conservatives (evangelicals and conservative Catholics, for example). It has also united formerly estranged cultural progressives (namely, secularists and progressive religionists) into a new alliance. And each uneasy set of alliances stands against the other as they both try to write into public policy what amounts to opposing visions of what America is and what it should be.

Numbness and Cynicism

Writers are beginning to chronicle the tension. Richard Cohen, recounting his reaction to a well-publicized murder, and representing the emerging moralistic position of the Boomers, characterized the numbness that has been brought along by the social change. "It is an awful thing that has happened to us -- to me, anyway. When it comes to crime, our hot anger has become cold cynicism. Where once we would have yelled our heads off, now we only murmur our horror to one another at the water cooler and hope something similar doesn't happen to us. The constant taking of life, the very ordinariness of extraordinary violence, has turned us apathetic. But our loss of anger amounts to more than the loss of innocence: it's the loss of humanity as well."²⁴⁰

The general American (and European) response to the recent atrocities in Bosnia have produced similar criticisms from columnists like Leslie Gelb of the *New York Times*.

Our Youth: An Embattled Generation

So who is bearing the brunt of these changes? Clearly it is our children; in Generational terms, the 13er generation.

A Country of Poor Children

The 1990 census confirmed that The United States remains a rich nation with poor children. The trends toward marital disruption and single childbearing have contributed most significantly to this issue.

In the city of Erie, Pennsylvania, for example, 15.4 percent of adults live in poverty; but 35.6 percent of the young children there are poverty-stricken. In Los Angeles county, 22.0 percent of children under 5 years old live in poverty, and in South Central Los Angeles, 44.1 percent of *all* children under 18 live below the poverty line.²⁴¹

Children's poverty has come to be concentrated in families headed by women. By 1989, well over half (57 percent) of all poor children lived in fatherless families.

As Peter Morrison says, "Poverty curtails education. Eventually, it erodes future workforce productivity. A rich nation that tolerates poor children in its midst wastes the means to enrich itself further."

Most Stressed-Out Generation in Recent History

This could be the most stressed-out generation in recent history said Tufts University child psychologist David Elkind. Over 30 percent of 15-year-old girls have experienced sexual intercourse today as compared with two percent in 1979. The sobering consequences of teenage sexual sophistication will be a soon-to-come explosion in teen AIDS cases.²⁴² *Omni* magazine recently reported that teen pregnancy is greater for Americans than for any other Western society.

SAT scores have declined, and suicide and homicide rates are triple what they were 20 years ago. Children are even less healthy than they used to be: the last two decades have seen a 50-percent increase in obesity among children and adolescents.

Academic achievement has plummeted. "Although there's no overall difference in intelligence, the differences in mathematical achievement of American children and their Asian counterparts are staggering," explained James W. Stigler, co-author, *The Learning Gap: Why Our Schools Are Failing and What We Can Learn from*

Japanese and Chinese Education. American businesses, the authors report, spend some \$25 billion each year on remedial education for their employees -- virtually all of whom attended public schools.

Alcohol Abuse and Suicide

The stress in the 13er generation manifests itself in many other ways. Eight million junior and senior high-school students drink alcohol every week. There is a 1 in 10 chance that teenage boys will attempt suicide; a 1 in 5 chance that girls will try to kill themselves. Of one million teen mothers every year, 25 percent will have abortions.²⁴³

This alienation from the mainstream of American life reflects itself in the confidence our children have in our country's institutions. The *Washington Post* recently reported that children are losing trust in government. Less than half of the more than 300,000 children in grades 2 through 6 who were surveyed in the spring by *Weekly Reader*, a nationwide classroom newspaper, said they believe their government can be trusted to do what's right.²⁴⁴

Pathological Communities

Character is fundamentally influenced by the individual's view of the future. If young people don't see opportunity on the horizon, they won't do well in school or most other endeavors.²⁴⁵

When young people with this same empty outlook cluster together, a negative synergy develops. Richard Carlson and Bruce Goldman have summarized a major aspect of the problem: "Some American communities border on the pathological, imparting ruthlessness, dependency, and despair to their impressionable young instead of skills and values useful to the surrounding society. No single ethnic group has a monopoly on community dysfunction. But inner-city African-American enclaves, victimized not merely by poverty per se but also by rapid economic change, have proceeded farther and faster down the road toward breakdown than any other easily identified communities.

African-Americans Hardest Hit

". . . African-Americans have the shortest life expectancies, the highest rates of teenage pregnancy, and the highest rates of children growing up with only one parent. While African-Americans constitute 12 percent of the population of the United States, they account for more than a quarter of all cases of AIDS reported to date in the U.S. -- a fact for which a higher incidence of intravenous illicit-drug use is chiefly responsible.

"One in four American black men in their twenties -- as contrasted with less than one in fifteen young white men -- is either in prison, out on bail, on parole, or on probation. Blacks are likewise much more likely than whites to be victimized by violent crime."²⁴⁶

The Problem is Embracing Younger and Younger Children.

A new study has found that while the number of adults arrested for murder has declined since 1985, there has been a stunning increase in the number of boys under 18 charged with homicide.

"Murder is plunging to a much younger age group," said James Alan Fox, dean of Northeastern University's College of Criminal Justice and a co-author of the report. "What is so dangerous about this is that a 15-year-old with a gun in his hand is a much more volatile individual than a 40-year-old or even an 18-year-old."

Mr. Fox said the figures suggest that the United States is on the verge of a vast new epidemic of murder, similar to one in the late 1960s and early 1970s, when the rate of violent crime doubled in five years.²⁴⁷

The America of the Next Two Decades

RAND's Peter Morrison summarizes the American trends in this way:²⁴⁸

1. *Families' capacities to meet the needs of dependents will become increasingly narrow.* The family settings in which children grow up will continue to pose enduring problems for social

legislation that confronts inadequacies in prenatal care, childcare, and parenting.

2. *By the year 2000, proportionally more Americans will be members of a minority group.* Each minority group will have growing political clout but will also continue to live in much the same areas as it currently does: Most Hispanics and Asians will be geographically clustered in only a few states; most blacks will be isolated residentially within the metropolitan areas in which they live.

3. *Americans will live longer than ever before and elderly people will become far more numerous.* This shift will be gradual in the next 20 years, followed by a period of intensive change that will commence in the year 2011, when the first members of the baby-boom generation reach age 65.

4. *The aging of the population will affect the lives of everyone.* The prevalence of acute and chronic health conditions rises sharply at more advanced ages, and with them the nation's Medicare bill. The limitations on routine activities of daily living, such as eating and bathing, that accompany those conditions can dramatically increase the need for long-term care. The greater number of elderly people and the rise in their life expectancy also mean that more of the "young elderly" (persons in their 60s and early 70s) will themselves have very old surviving parents.

5. *At regional and local levels, rapid changes in population size will exacerbate infrastructure and human capital concerns.* Growing areas will experience automobile traffic congestion and the need to replace or add to the infrastructure. Declining areas will experience a wastage of infrastructure and a loss of higher-quality workers.

Forthcoming Issues

Demographic changes may subtly shape policy issues and occasionally lend urgency to them. They may also widen or narrow margins for policy action. The following issues are illustrative of future policy concerns that the demographic developments discussed here will precipitate.

1. *The decade of the 1990s represents an Indian summer for the Social Security Trust Fund,* a transitional period during which the large baby boom generation's contributions as workers will boost

the Fund's size considerably. Starting in 2011, this favorable demographic context will begin to turn sharply unfavorable as the baby boom generation becomes eligible for Social Security. The Fund will have to squeeze more dollars out of a slowly growing or possibly shrinking workforce to pay benefits to the swelling number of retirees.

2. Demographic factors that are causing an increasing number of children to be brought up in poverty raise long-term concerns because the future competitiveness in the U.S. economy hinges directly on the productivity of today's youth. Poverty among children curtails educational attainment, thereby reducing the children's future productivity as workers. The issue of economic competitiveness will intensify the congressional focus on childhood poverty and its effect on future workforce quality.

This problem also raises the issue of the possibility of increasing social instability, as more and more people become a part of a system in which they don't have much of a vested interest and see none on the horizon.

3. As support structures within families narrow, issues of both child care and elder care will evolve and intensify. The needs of children in vulnerable or disintegrating family structures are already spilling over into the public sector and probably will increase, broadening the demand for various forms of early childhood intervention.



Notes:

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- ²¹³Conversation with Barbara Torrey, President, Population Reference Bureau, Inc., Washington, DC
- ²¹⁴"Squalid Slums Grow as People Flood Latin America's Cities," *The New York Times*, Oct. 11, 1992:
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- ²¹⁶Morris, Bailey. *Economic Insights*, March/April 1992, p. 1
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- ²²³Morrison, Peter A.; Testimony Before the House Subcommittee on Census and Population, May 26, 1992
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- ²²⁷Morrison: p. 5
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- ²³⁰Morrison: *Congress and the Year 2000*: p. 5 citing Hofferth, 1985. "Other plausible projections imply levels only moderately different from these."
- ²³¹Roberts, Sam. "New York Finds Typical Family Being Redefined," *The New York Times*, Oct. 20, 1992, p. A1
- ²³²Morrison: pp. 3-4
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- ²³⁵ibid.

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Health

In addition to the breakthroughs being made in biotech and genetic engineering, health and health care trends contain both good news and bad news. The good news involves some amazing capabilities emerging around the nexus of medicine and technology, possibilities of lengthening human life, and the hope associated with alternative approaches to medicine. The downside must include the global scourge of AIDS, the resurgence of old diseases thought conquered, and the failure of the American health care system and its threat to the greater health of the country.

Biotechnology

As mentioned in a much larger section earlier, biotechnology holds forth the hope of dramatic gains in identifying and treating illnesses. The Human Genome Project will, over the next decade, identify the whole human genetic code, providing a map for medical researchers that points directly at diseases likely to be acquired very early in one's lifetime.

The genetic engineering of pharmaceuticals is already generating drugs with extraordinary promise and, in some cases, much less cost.

Technology and Medicine

There is a revolution going on in the area of artificial human organs. Technologists and medical researchers are making such progress that industry observers believe that by about 2015 artificial organs will be available to replace every organ in the body except the brain and central nervous system. Some specific projections are illustrative of this trend.

In 1990, the Institute for Future Technology in Tokyo studied anticipated developments in technology for the next two decades. They predict that anti-viral agents will be available by 1998 for widespread treatment of viral diseases. By 2001, synthetic organs will proliferate because of the elimination of undesirable reactions by recipients of semi- or all-synthetic artificial organs. Bionic legs, equipped with computer-controlled actuators and small power sources will become available in 2002, followed closely in 2003 by implantable artificial ears. That year should also bring a cure to cancer and the advent of bionic muscles: compact robots with actuators in a fibrous form resembling human muscle.

By 2006, we should have artificial organs from human tissue. Body cells and tissues will be incorporated into artificial pancreases, kidneys and livers. Two years later implantable health sensors will make their debut. Long-life biosensor implants will monitor disease and manage health. Artificial photoreceptors connected to the optic nerve will restore sight in 2011 and diabetes and senility will be eliminated. Twenty-twelve will see the process of human memory elucidated and by 2014, artificial eyes will end many, if not most forms of blindness.²⁴⁹

These trends will be encouraged and enabled by devices like the "nerve chip" and new capabilities like the emerging ability to transform muscle into hard, well-formed bone (a surgeon and cell biologist recently molded rat muscle into tiny leg and jaw bones.)²⁵⁰

Some of the most interesting new genetically-engineered drugs, available by 2000, will prevent paralysis due to spinal cord injury. Existing drugs, if administered immediately, can already reduce the damage, but the next generation will be able to repair spinal

cords. New para- and quadriplegics will largely disappear by 2020.²⁵¹

Life Extension

One of the most intriguing areas of research is that of the extension of human life. There is reason to believe that we are quickly approaching a number of thresholds that will soon allow people to live to be 100 or more.

Life magazine, in a feature article on the subject reported on advances in genetics and chemistry that have identified genes in fruit flies, nematodes and jelly fish that control aging.²⁵² The lives of fruit flies have been doubled by selective breeding. Futurist Jerome Glenn says that a new group of substances -- geroprotectors -- for slowing the aging process in warm-blooded animals by 20 to 100 percent -- has been identified. He also reported that the then-Soviet publication *Sputnik* claimed that "The drop in temperature of man's body by a mere 2.5 degrees could add 50 percent to his life span."²⁵³

Those scientists working in the area seem unanimous in their feeling that we are close to a breakthrough.

Dr. Edward Masoro, a physiologist at the University of Texas health Science Center in San Antonio said: "If dietary restriction has the same effects in humans as it has in rodents, then human life span can be extended by at least 30 percent -- which would give us an extra 30 to 35 years. But once we understand the mechanisms that control aging, we may find it possible to extend life span considerably more, perhaps by 100 percent -- which would give us an extra 100 to 120 years."

The foremost authority on aging in yeast, Dr. Michael Jazwinski, at the Louisiana State University Medical Center thought: "Possibly in 30 years we will have in hand the major genes that determine longevity, and will be in a position to double, triple, even quadruple our maximum life span of 120 years. It's possible that some people alive now may still be alive 400 years from now." Dr. William Regelson, professor of medicine at the Medical College of Virginia felt: "With the knowledge that is accumulating now about the nutritional

and neuroendocrine aspects of aging, and if we develop ways to repair aging tissues with the help of embryonic cells, we could add 30 healthy years to human life in the next decade. And beyond that, as we learn to control the genes involved in aging, the possibilities of lengthening life appear practically unlimited."²⁵⁴

What these researchers say they need is a clear vision of the whole, a grand unified theory of how human beings age. Dr. Judith Campisi, a cell biologist at the Lawrence Berkeley Laboratory in Berkeley, Calif., believes that such a theory will soon take shape. "Right now," she says, "aging research is where physics was 50 years ago, just before Enrico Fermi split the atom. In the next five years, progress will be exponential."²⁵⁵

Profound Implications

If these scientists are right -- if suddenly, human life is increased by 30 percent to around 100 years -- the implications for society would be profound. All of our systems of work, education, economics and recreation -- our very sense of self -- are based upon an average length of life of some 70 years. In some cases the change would be catastrophic: the insurance industry, for example, would be hard pressed not to fail.

Some people presently find revolting the idea of living significantly longer (they think that it would be horrible, extending ones elderly years) while others would love to have more time to accomplish that which they find interesting and important. Breakthroughs in life extension would almost certainly result in a series of new, very strongly debated, social issues.

AIDS

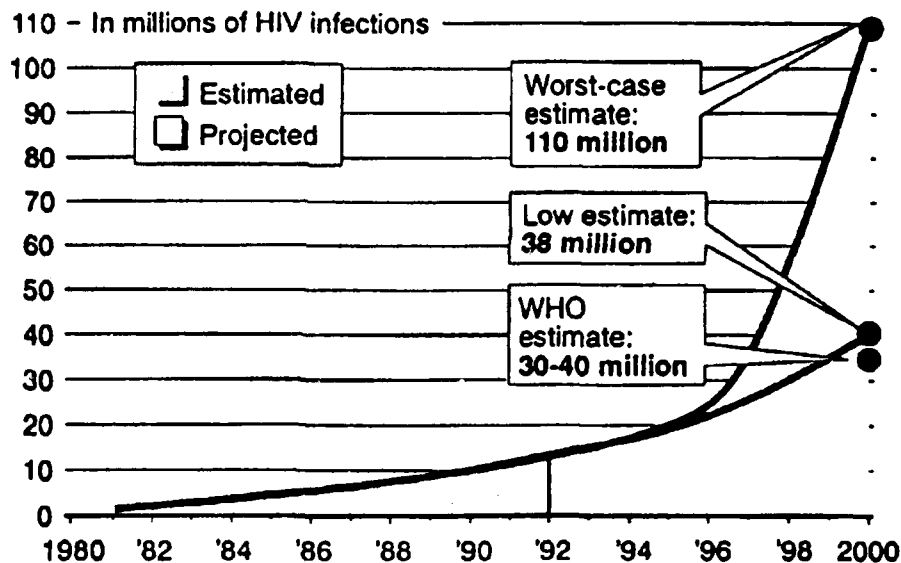
Some of the implications of the global AIDS scourge are obvious and well cataloged. They will take a very serious toll in personal torment, economic devastation and perhaps, political upheaval. Other potential twists in this epidemic are less obvious but much more explosive.

Global Exponential Growth

The current trends are, by themselves, compelling. Although they differ on their projections, both the World Health Organization and the Global AIDS Policy Coalition show rapidly rising incidents of AIDS.

AIDS in the year 2000

Harvard-based Global AIDS Policy Coalition has issued a new worst-case projection of world number of adult HIV cases. Its worst case figure more than doubles earlier estimates by the World Health Organization:



SOURCE: Boston Globe, Global AIDS Policy Coalition

(Reprinted courtesy of The Boston Globe)

With no cure in sight, the WHO estimates at least a million adults were newly infected with the HIV virus that causes AIDS during the first half of 1992, and 13 million worldwide have been infected since the epidemic began. Most of the new infections -- well over 70 percent -- have involved heterosexuals in developing countries of Africa, Asia and Latin America. Women are the fastest-growing growing group of newly infected in the industrialized world. Each week, 15,000 women contract the HIV virus, said WHO's Global Program on AIDS head. WHO predicts 30-40 million people will be infected with HIV by the year 2000, more than 90 percent of them in developing countries that lack the resources

to mount prevention campaigns or treat the ill. For its part, the Global AIDS Policy Coalition has developed a computer model that predicts as many as 110 million people will be infected by the year 2000. WHO says their own estimates are conservative.²⁵⁶

AIDS AROUND THE WORLD						
REGIONS	TOTALS	INFECTIONS			CASES	
		ADULTS 1992 (est.)	WOMEN 1992 (est.)	ADULTS 1992 (est.)	1992 (est.)	1995 projection
		2,728,000	4,117,000	17,454,000	2,018,500	4,918,000
North America	1,167,000	128,500	1,495,000	257,500	534,000	
Western Europe	718,000	122,000	1,186,000	99,000	279,500	
Australia/Oceania	28,000	3,500	40,000	4,500	11,500	
Latin America	995,000	199,000	1,407,000	173,000	417,500	
Sub-Saharan Africa	7,803,000	3,901,500	11,449,000	1,367,000	3,277,500	
Caribbean	310,000	124,000	474,000	43,000	121,000	
Eastern Europe	27,000	2,500	44,000	2,500	9,500	
Southeast Mediterranean	35,000	6,000	59,000	3,500	12,500	
North East Asia	41,000	7,000	80,000	3,500	14,500	
Southeast Asia	675,000*	223,000	1,220,000	65,000	240,500	

* minimum estimate

SOURCE: Global AIDS Policy Commission

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To put this in an historical perspective:

The Black Death killed about 25 million suffering souls in the 14th century. But by the year 2000, 30 million to 110 million people will be carrying HIV, the virus that causes AIDS, up from some 12 million today. By 2000 the epidemic could drain between \$356 billion and \$514 billion from the global economy. In the worst-case scenario, the dollar loss equals 1.4 percent of the entire world's gross domestic product. That's the equivalent of wiping out the economy of either Australia or India. In the United States, for example, U.S. News estimates that the plague will siphon off between \$81 billion and \$107 billion by the year 2000.²⁵⁷

The New York Times confirmed that the disease is now spreading much more rapidly through heterosexual transmission, particularly in Africa and Southeast Asia. It is following roads and navigable rivers into rural areas, and as it begins claiming more women each year, many more children will be born with the disease or will be left orphans by it. The price of caring for AIDS is skyrocketing: the lifetime cost of treating an AIDS patient in the U.S. now is \$102,000, up from \$57,000 as recently as 1988.

Disparity between rich and poor is evident in AIDS treatment as in other things. The U.S. spends \$38,300 per person, \$22,300 is spent in Western Europe, \$2,000 in Latin America -- and \$393 in Africa.²⁵⁸ Clearly, many are not being treated.

The economic implications of the epidemic look ominous. Michael H. Merson, director of the World Health Organization's AIDS program said the alternative to spending more up front on AIDS prevention is political and economic collapse, which will send shock waves rippling through industrialized countries. "Thailand estimates the minimum cost of the epidemic to that country alone by the end of the century will be \$9 billion. Imagine that happening throughout Asia, where the economies are thriving." WHO estimates that about \$120 million is being spent each year to *prevent* AIDS. Researchers estimate that the effort needs \$2.5 billion.²⁵⁹

Unidentified Cause of AIDS

In July of 1991, new cases of AIDS began cropping up in people who didn't have any trace of HIV, the virus commonly thought to cause the disease. The new patents displayed HIV risk factors, (needle-sharing, unprotected sex or history of blood transfusions) but didn't have the virus. This anomaly, now seen in several dozen cases around the world, highlights the fact that scientists don't really know whether the AIDS-like illness is caused by one virus, several viruses, or any infectious agent at all. Some scientists, in fact, suggest AIDS is a result of things other than HIV, but their ideas have been depreciated in the past because they were not in the mainstream of scientific thought.

Asia is the AIDS Epicenter

Asia is now the epicenter of the AIDS epidemic. There, the most troubling rates of growth should approach 42 percent by 2000. Africa held that position for a number of years, but the tide has shifted. Two of the worst hit countries are Thailand and India.

In Thailand, by 2000, 3 to 6 million people may be infected, fully 5 to 10 percent of the population. The problem is particularly bad there (as it is in Africa) because the disease will attack those most responsible for the country's economic success -- people aged 14-44. An entire generation will be put at risk. Local sexual

patterns exacerbate the spread: 75 percent of Thai men have had sex with prostitutes -- almost half before they were 18. There are 800,000 prostitutes in Thailand; 20 to 30 percent already are HIV-infected. In northern Thailand the rate is 44 percent. Sixty-percent of budget for public health will be consumed by AIDS-related expenditures during next 5 years.²⁶⁰

HIV infection in India is hard to pin down. Estimates have 300-400,000 infected, but the number is perhaps closer to 1 million. Bombay, for example, has 100 - 150,000 prostitutes in a population of 12 million. The HIV infection rate for these women increased from 1 percent in 1987 to 30 percent in 1990. If one figures an average of 6 contacts per night, it means that there are 600,000 heterosexual prostitute contacts per night, maybe 200,000 exposed to HIV. With HIV transmission rates ranging from 0.1 percent to 1.0 percent efficiency, Bombay alone probably gets a minimum of 6,000 new HIV infections each month.²⁶¹

AIDS Hot Spots in Asia

Myanmar The World Health Organization estimates that in Myanmar, formerly Burma, more than 100,000 people are infected with H.I.V. out of a population of 40 million.

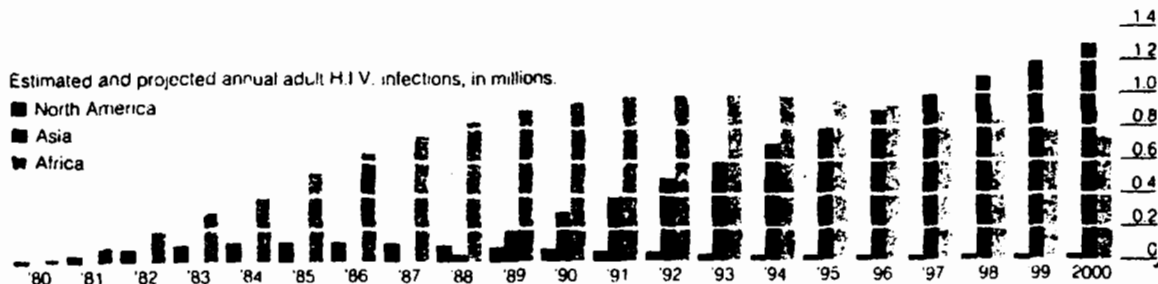
Japan The Government says about 2,400 people are reported to have the AIDS virus. But researchers believe the number of Japanese infected by H.I.V. is several times larger, and the number of cases is growing at a startling rate.

The Philippines: The Government estimates that 30,000 Filipinos now carry the AIDS virus, but many believe that number is far too low.



India The W.H.O. estimates that more than 1 million people in India, out of a population of 860 million, are infected with the AIDS virus -- more than in all of Europe and about as many as in the United States. The Indian Health Organization projects that 20 million to 50 million Indians will be infected with H.I.V. by the year 2000.

Thailand The Government estimates that 200,000 to 400,000 people of a population of 58 million are infected with the AIDS virus; experts say that number could reach 2 million to 4 million, or as much as 6 percent of the Thai population, by the end of the decade.



"AIDS is expected to retard much of the progress made in the late 1980s by countries like India," says DRI/McGraw-Hill's Nariman Behravesh. The number of youngsters orphaned by AIDS could more than double in the next three years to 3.7 million worldwide.²⁶²

Even Japan is having to deal with the problem. The Japanese government has begun to admit that their country is as vulnerable as any other to the disease and has started new programs to educate its largely uninformed citizens about it. Behind the new worries is the troubling rise in recent figures and the fact that the pattern of its spread is similar to that in other countries with a tragically high incidence of the disease, such as Thailand.²⁶³

Only China appears to have controlled the incidence of AIDS. Very strict border checks are made of those coming into the country, and some travelers must undergo mandatory blood tests. Some visitors report that China has been able to cure some of its few AIDS cases using traditional Chinese medicine which focuses on bioenergy systems -- the natural energy of the body.

Africa Devastated

Africa has been devastated by AIDS. In last five years, the cumulative number of Africans infected with HIV has tripled to about 7.5 million and projections indicate 11.5 million victims by 1995. It has been reported that the merchant infrastructure is being eliminated in some countries as large numbers of these people die.

The U.S. Problem

In the United States, more people will die from AIDS than have died from all of our wars combined -- 25 times as many as died in the Viet Nam war.²⁶⁴ A million and a half will probably die by 1995. About 50,000 Americans now get the AIDS virus each year and by 1994 about 50,000 will be dying annually.

By 1994, perhaps a third of the deaths will be drug abusers, a third gay men, and the rest heterosexuals [mostly black and Hispanic women].

Newsweek reported that AIDS is spreading unchecked among the nation's adolescents, "regardless of where they live or their economic status." It is now the sixth leading cause of death among 15- to 24-year-olds.

Futurist Marvin Cetron predicts that the AIDS epidemic in the U.S. will be largely finished by 2000, with children who acquired

the disease from their mothers during gestation being the only new cases.²⁶⁵

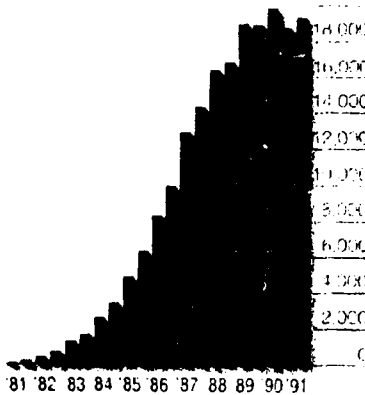
The Implications to the U.S.

America has not yet come to grips with the likely and possible implications of this disease. In *The Catastrophe Ahead*, a book based on a two-year research study by the Hudson Institute, William B. Johnston and Kevin R. Hopkins, the book's authors say, "The HIV epidemic is currently at an early stage. As the epidemic grows during the 1990's, it will dramatically alter the American economic, political, and social landscape."²⁶⁶

AIDS will threaten our already reeling health care system. It could well change our social mores and the permissive attitude

New AIDS Cases in the U.S.

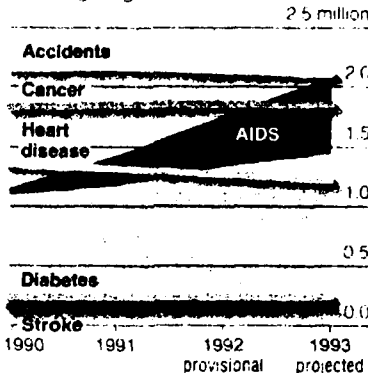
Reported diagnoses of AIDS for six-month periods. Federal statisticians estimate that 18 percent of AIDS cases go unreported.



Source: Centers for Disease Control

Years of Working Life Lost

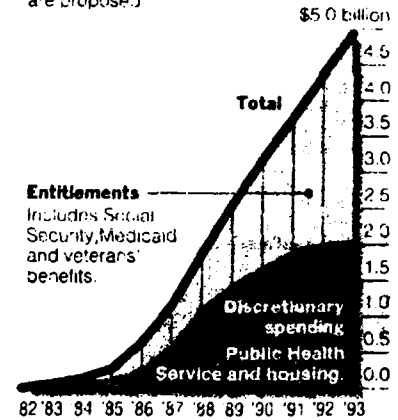
Estimated number of years before age 65 lost to each cause of death. Estimates of how many people will die of AIDS vary more than estimates for other causes, so a range is given.



Source: U.S. Public Health Service

The Federal Response

Total spending on AIDS each fiscal year in 1992 dollars. Figures for fiscal 1993 are proposed.



Sources: U.S. Public Health Service; AIDS Action Council

Used by permission. The New York Times

that has been associated with sexual conduct. Already a new tide of lawsuits are making their way through the courts as the result of 500 new statutes, "inspired, sometimes in fits of panic, " by the epidemic.²⁶⁷

By 1993, the yearly cost for care of those dying of AIDS could be over \$10 billion.²⁶⁸ The economic cost of this disease will peak at a time of extraordinary pressure on our economy from other sources and could well be one of the events that galvanizes the conservative response by the boomer generation forecast by the Generational Model of social change.

AIDS will change the way we trade and interact with some countries, and who we allow into the U.S. The fact that we don't know exactly what causes it opens the door to a number of potential scenarios. One, advanced by the American Enterprise Institute's, Michael Ledeen: "The day we learn that AIDS has been spread by a fly or mosquito is the day we see the first quarantine of an entire continent."²⁶⁹

Alternative Medicine

As a reaction, perhaps to modern medicine's high-tech, reductionist orientation, Western nations have seen a rather significant growth in alternative medical practices -- some harkening back many centuries. No less than *The New York Times Magazine*, in a recent cover story, said: "In recent years, unconventional therapies such as meditation, acupuncture and homeopathy have begun to gain a foothold in American medicine."²⁷⁰

This alternative approach to wellness is based on a variety of techniques that encourage healing without invading the body, and taking advantage of natural body repair functions. It is holistic and systems-based in that the practitioner takes into consideration many aspects of a person's life, not just bodily symptoms. Much of it is based upon concepts that assume that the mind has significantly more influence on health than mainline medicine believes.

Relationship Between Mind and Body

Numerous studies support the validity of many of the underlying concepts that alternative medicine is built upon, particularly the relationship between the mind and body. Dr. Dean Ornish, in a landmark cardiac study found that patients could reverse their heart disease through diet and exercise -- and the love of their friends. People with many friends or family ties tend to live longer than loners. Good relationships seemed to protect the human immune system from stress, just as in monkeys.²⁷¹ Mononucleosis has been linked to stress in school. Herpes has been linked to loneliness. Positive mood, hope and social support have been

linked to cancer survival, toughmindedness and a will to live with survival in AIDS.

Heart attack victims who have emotional support survive longer than those who do not. Among medical students under the stress of examination at the end of the semester, those who reported close relationships with family and friends had a stronger immune response to vaccination.

Theodore Melnechuk, who helped organize psychoneuroimmunology conferences in the 1970s has cited dozens of studies showing that psychological factors have been linked to the four broad types of immune dysfunction -- cancer, infections, allergies and auto-immune disorders.²⁷²

New Office at NIH

The National Institute of Health recently established an Office for the Study of Unconventional Medical Practices to investigate a wide range of treatments, including herbal medicine and massage therapy. Next year Harvard Medical School plans to offer a course on unorthodox medicine. Similar courses and lectures are already available to medical students at Georgetown University, the University of Louisville, the University of Arizona and the University of Massachusetts in Worcester.

Transition to Biophychosocial Medicine

Many physicians now speak of a transition from the narrow biomedical model of Western medicine to a "biophychosocial" one. More than 2,000 physicians use acupuncture in conjunction with conventional medicine, according to the American Academy of Medical Acupuncture, and 5,000 use hypnotherapy, according to the American Society of Clinical Hypnosis. One thousand doctors practice homeopathy, the treatment of disease by using minute, highly diluted doses of the very substances that, in large doses, can cause it.

Bioelectromagnetics

There are also some the new theories about the interaction of humans with electromagnetic fields that are changing aspects of health care. Appliances, computer monitors and even portable

cellular phones are all designed with increasing consideration for the amount of electromagnetic radiation they produce.

A growing number of scientific studies suggest that the risk of leukemia and other malignancies rises with exposure to electromagnetic fields, which are generated in varying degrees by all electrical devices from high-voltage power lines to hair dryers. Two studies in Sweden established that children who lived near high-tension lines had a higher risk of leukemia, and on-the-job exposure to electromagnetic fields increased the risk to cancer in working men in proportion to the strength of the electromagnetic field. Men who used electric razors had a higher cancer rate than those who didn't.²⁷³

These alternative approaches to medicine represent a very large change from the direction that medicine has been going for most of a century, and if ultimately embraced by mainstream medicine, would revolutionize both the practice of medicine and the role the patient plays in the recovery from an illness. Most physicians would have to fundamentally re-think the underpinnings of the theory that supports their practice.

Old Virulent Diseases Becoming Resistant to Traditional Cures

A number of old diseases, thought long destroyed, are making a comeback, with a vengeance. Many traditionally effective agents no longer work against these newly-acclimated bugs.

The most publicized superbugs are the strains of drug-resistant tuberculosis bacteria that have caused outbreaks of the disease in U.S. hospitals and prisons over the past few years. And in a sobering series of articles in a recent *Science* magazine, researchers point out that the problem of drug resistance is not limited to a few germs but spans an entire spectrum of disease-causing microbes, including those responsible for gonorrhea, meningitis, streptococcal pneumonia and staphylococcus infections. Enormous increase in tourism and business travel in recent decades spreading them. Overuse of antibiotics has accelerated the evolution of superbugs, and hospitals, in particular, are major breeding grounds. Day-care centers provide another setting.²⁷⁴

In recent survey at Cook County Hospital in Chicago, 46 percent of sample group of doctors in training to become internists had become infected with the TB germ. The recommended remedy: wear scuba-like masks of thick rubber connected to a motorized air pump on the belt and/or redo ventilation systems with expensive filters. To the prisons and inner-city clinics that serve the majority of tuberculosis patients, the adjustments mean huge new expenses at a time when their coffers are already bare. And because there is no precise science dictating how to adapt an old building to prevent the spread of TB, there have been many false starts.²⁷⁵

The *Associated Press* recently reported on a surge of malaria. Though it was once thought conquered fifteen years ago, it is on rise again, killing millions of people worldwide. Presently, there are about 2 million deaths annually in 102 countries, including the U.S. The parasite became resistant to most drugs and the carrier mosquito became less sensitive to insecticides.

Our increasingly complex and interdependent world provides many new avenues for the spread of viruses. Every decision made anywhere, in any sphere of life -- environmental, political, demographic, economic, military -- carries with it implications about disease that reverberate halfway around the world. When the Aswan High Dam was built in Egypt, the new body of still water allowed mosquitoes to thrive, and the viruses they carried became a new threat. When used tires were shipped from Japan to Texas, mosquitoes hitched a ride in the wet rims; because the mosquitoes carry viruses never before seen by Texans, their presence was a new threat to public health. And when the city borders of Seoul were pushed farther into the countryside, urban Koreans were exposed to a virus that rats had been carrying for centuries -- and many contracted a raging hemorrhagic fever that kills at least 10 percent of its victims.²⁷⁶

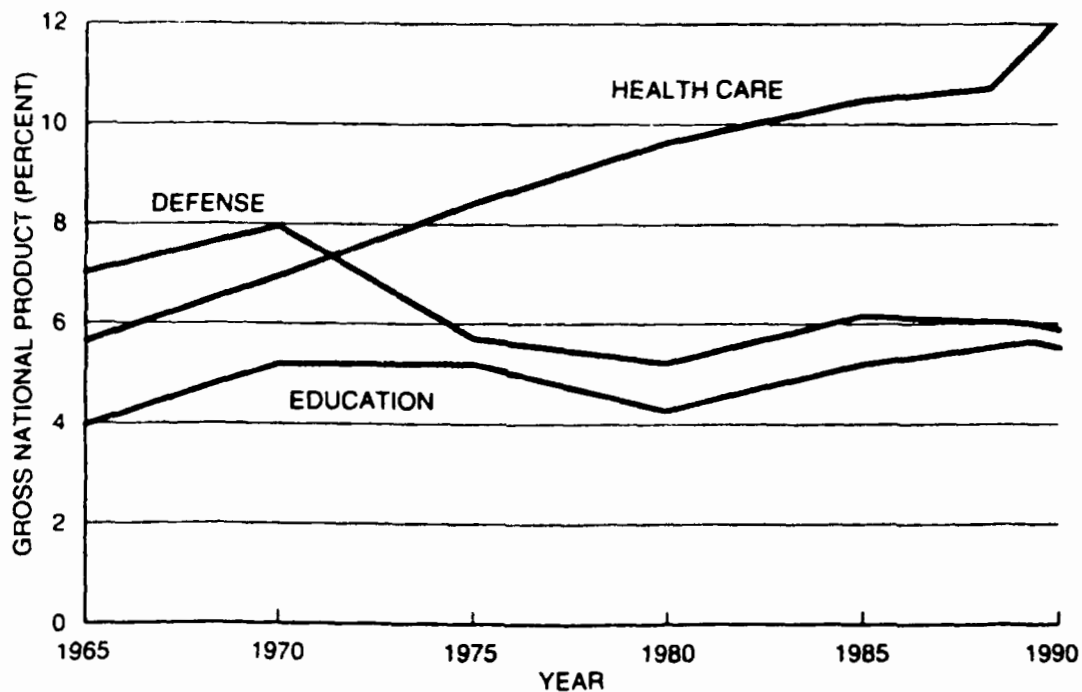
U.S. Health Care Problem

National health care expenditures have risen to some \$800 billion per year, an amount approaching 13 percent of GNP. The continuation of past growth rates will bankrupt the entire

government before the end of the decade. The American health care system is an inefficient patchwork of 1,500 health insurance programs in which 22 cents of every dollar goes to administrative costs.

In 1940, health care absorbed \$4 billion, a mere 4 percent of our gross national product (GNP). In 1990 such expenditures equaled

Comparison of Costs for Health Care, Defense and Education



SOURCE: Consumer Reports. U.S. National Center for Education Statistics. Health Care Financing Administration, U.S.

\$666 billion, or 12.2 percent of the GNP. Projections suggest that in 1992 the country will spend more than \$800 billion on medical care, or 13.4 percent of the GNP. In 1990, business spent 61 percent of pretax profits and 108 percent of after-tax profits on health care benefits for employees (as opposed to 20 and 36 percent, respectively, in 1970). The U.S. also spends more of its gross domestic product -- the value of items produced solely within U.S. borders -- on health care than any of the 23 other members of the Organization for Economic Cooperation and Development.

One out of nine working families has no insurance.

History of federal health care legislation has been a dismal cycle of failed "reforms." Every effort to control federal expenditures

has succeeded in shifting costs by providing new loopholes. Special interests and bureaucratic inertia have prevented any significant overhaul of the system. State legislatures are more creative, but it is too soon to determine if these measures will prove to be solutions or will repeat federal experience by shifting the costs to new areas.

What is clear is that without rapid reform, the entire U.S. health care system, as well as the U.S. economy, faces the possibility of financial collapse.²⁷⁷



Notes:

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Transportation

Transportation is a particularly important issue because it directly influences so many other ones. Energy, technology, economy and environmental (to say nothing of social) concerns are influenced to a great extent by how we move ourselves and our commodities.

It is interesting that given this importance, few writers about future trends and the state of the world deal separately with transportation -- despite the fact that they call for less dependence on fossil fuels, less congestion, less consumption, and less energy use.

Here, we will look at the significant advances taking place in all sectors of transportation that will dramatically change the way we work and travel in the next two decades.

Public Transportation

Perhaps the area where the greatest contribution to society could be made in the long run is public transportation. As Vice President Gore has written, "We should be emphasizing attractive and efficient forms of mass transportation. . . . New and improved forms of mass transit, like the magnetically levitated trains in

Japan and [rapid trains in] France, should be enthusiastically encouraged." ²⁷⁸

There are some exciting developments in transportation technology which may help us travel quickly and efficiently while treading lightly on the environment.

Magnetic Levitation and High Speed Trains

Maglev

Emile Bachelet, a French born New Yorker, received a U.S. patent in 1912 for a magnetically levitated train. However, it wasn't until the advent of the large superconducting magnets that the repulsion scheme of magnetic levitation, as it has become known, became practical, as recognized in 1966 invention by Powell and Danby of Brookhaven Laboratories, also in New York.

The technology employs the opposing force that develops between a moving magnet and the eddy currents it induces in stationary conductors fastened in the guideway. The advantage of magnetic levitation is that it eliminates mechanical contact between a vehicle and the surface over which it rides, thus eliminating wear, contact noise, and problems of precise alignment. The vehicle floats as much as half a foot above the surface, supported and guided entirely by magnetic forces.

A subsequent innovation was the recognition that contactless propulsion could be provided to this system with a traveling magnetic wave produced by ac currents supplied to the guideway, thus eliminating reliance on friction for traction.

Although the initial development of a practical high-speed maglev system took place in the United States from 1971-1976 under Federal Railroad Administration and National Science Foundation sponsorship, the Japanese soon embraced the technology and proceeded to break the tracked vehicle speed record (still unbeaten) with a 320 mph run in 1979 with a full scale research vehicle at the Miyazaki test track.

The Germans have developed a prototype based on the different concept that employs the familiar force between an ordinary electromagnet on the vehicle and an iron rail on the guideway. Since this is an unstable force, it requires the gap between magnet and

rail (typically less than half an inch) to be maintained by continuous adjustment of the magnet current. The prototype is expected to be operated in Orlando in the next few years. The Japanese and Germans have spent approximately \$1 billion each on research.

After a hiatus of fifteen years, the U.S. Government has reentered this competition on a much smaller scale via the National Maglev Initiative, a partnership among the U.S. Departments of Transportation and Energy and the U.S. Army Corps of Engineers.²⁷⁹

A network of maglevs could shuttle passengers between American cities at over 300 miles per hour, using far less energy and time than automobile and air travel. One could go from a downtown office to a weekend cottage 100 miles away in just 20 minutes, or have portal-to-portal trips of about an hour and a half between the air shuttle cities of Los Angeles and San Francisco, Washington and Boston, and Chicago and Minneapolis.

Maglevs would be twice as fuel-efficient as cars and four times as efficient as airplanes while producing no air pollution themselves. Commuter maglev systems could be built alongside existing highways, decreasing construction disruption. The requirement for space is far less than aircraft: the land area occupied by Dallas-Fort Worth airport is equal to a 60 foot swath from coast to coast. The trains would be considerably more comfortable than aircraft and -- as fast, roomy trains in Japan and France have shown -- could grow to be a significant segment of the public transportation sector.

High Speed Trains

The U.S., most notable the National Railroad Passenger Corporation (AMTRAK), has undertaken a major program of increasing the speed of passenger trains in the northeast corridor routes between Washington, New York and Boston. This effort is expected to make travel by train more attractive by reducing travel time previously associated with this mode.

Much of the high-speed capability of the Japanese and French "bullet" trains comes from electrification and significantly upgraded or even dedicated right of way coupled with lighter weight vehicles and microprocessor train control systems. For high-speed service, track curvatures are normally shallow and

banked making it possible for conventional train technology to transverse the curve safely with a high ride quality for the passenger. This is typical of the French Train a Grande Vitesse (TGV), The German Intercity Express (ICE) and the Japanese Shinkansen "Bullet" train operations.

So as not to have to redesign and rebuild the existing trackbed, a tilting train technology has been developed. An example of this technology is found in the Swedish X2000 train that has been tested up to 155 mph but travels at 135 mph in its demonstration service along the Northeast Corridor. This train has axles that passively adapt to the curvature of the track, thus allowing significantly increased speed on existing track curvatures. An automatic system tilts the car while executing a curve, so as to reduce the lateral force experienced by the passenger. This train is being evaluated in a once-a-day round trip between Washington and New York, and later New Haven in an effort to determine rider acceptance of its new performance standard.

The X2000 tilt train will be followed this fall by a demonstration service with the German ICE which is of the more conventional non-tilting design. The ICE regularly operates at 150 mph in service in Germany, but will also operate at 135 mph in the Northeast Corridor. It possesses a somewhat higher degree of sophistication than the X2000 system. Both of these trains are being studied by AMTRAK as it prepares to solicit proposals for a number of trainsets that will be needed to service the Boston to Washington corridor when the New Haven to Boston electrification is completed in 1997. Neither trains as they now exist are built to U.S. standards and practices, and would require modification to achieve compliance.

Operating on a totally new dedicated train in the "Texas Triangle" (Dallas/Ft. Worth-Houston-San Antonio) will be the French TGV (Atlantique) traveling at speeds up to 200 mph. The first operational phase between Dallas/Ft. Worth and Houston is planned for 1998.

Five existing rail corridors have been selected for development as high-speed corridors under the Intermodal Surface Transportation Efficiency Act of 1991. These corridors are being further studied for their potential for upgrade to initially 90 mph service with promise for gradual increases thereafter. The principal limiting factor being the existing infrastructure which includes

roadbed, alignment, signaling, highway-rail at-grade crossings and non-electrified propulsion.²⁸⁰

Supersonic Transport Aircraft

Twenty years ago America decided against the supersonic transport because it was too expensive, too dirty and too noisy. New technological advances, however, are now dealing with all of these objections. Furthermore, the air travel market to and within Asia should boom during the next two decades.

NASA, working with aircraft and engine manufacturers is at the halfway mark in a seven year, \$400 million initiative to develop environmentally compatible technology. The goals of this project are to:

- Develop reliable predictions of an HSCT's (High Speed Civil Transport) effect on stratospheric ozone
- Reduce engine emissions of NOx (Nitrogen oxides)
- Develop quieter aircraft and engines; and
- Determine how well sonic booms can be softened to permit limited supersonic flight over unpopulated land corridors.²⁸¹

Flying at mach 4, the SST would make a trip from Los Angeles to Tokyo in only 2 hours, instead of the present 12 hours. If the costs were kept in the same ballpark as current air travel, such a vehicle would, of course, revolutionize air travel.

National and international air transportation systems are growing. Increases of about a trillion revenue passenger-miles are projected for each decade between now and the year 2020, resulting in two trillion revenue passenger-miles in 2000, three trillion in 2010, and four trillion in 2020. Much of this growth is projected to be in international markets. The North Atlantic market is expected to double by 2005, but more importantly the Pacific market (with its longer ranges) is forecast to quadruple during this time to about the same size as the North Atlantic market. The Europe-Asia market is also projected to experience significant growth.

Based on these market projections, if a reasonable fare premium is assumed, an HSCT is optimistically thought to be able to attract about 300,000 passengers per day away from advanced subsonic

transports by the year 2000, and about 600,000 passengers per day by 2015. This translates into a worldwide potential market for 600 to 1,500 HSCTs, depending on economic returns, aircraft specifications, operating constraints, and subsonic flight over land. The aircraft would introduced about 2005, cruise at speeds of Mach 1.6-Mach 2.5, have ranges between 5,000 and 6,500 miles, carry 250 to 300 passengers, and operate in the existing infrastructure (airports, runways, and air traffic management system) to maximize productivity.²⁸²



Already, the economic growth of China is causing air travel to expand very fast. Estimates call for Asian travel to grow at least twice as fast in the next decade as air travel in Europe and North America.²⁸³ China has launched a massive effort to build new airports with some 20 plus major facilities now under construction or in the planning stage across the country. Where the rest of the global airline business is in a slump, new airlines and joint ventures are being formed to serve the burgeoning China market.

Magnetohydrodynamic Ship Propulsion

A revolutionary technology being tested for ship propulsion, magnetohydrodynamics, has the seeds of a major shift in the way humans travel on the ocean. The principle is based in a fundamental law of electromagnetism: when a magnetic field and an electric current intersect in a liquid their repulsive interaction propels the liquid perpendicular to both the field and the current. In sea water the salt conducts electricity. In the prototype Yamato 1, the seawater, through which an electric current is being passed, is channeled through the magnetic field produced by superconducting magnets cooled with liquid helium. The water is propelled out the rear, moving the boat forward.

The advantage is that this propulsion system has no moving parts to break down, and is quiet and vibration free. The present disadvantage is that the system cannot move the prototype boat, the Yamato 1, faster than 8 knots with a maximum efficiency of 4%. The efficiency of commercial ships ranges between 22% for hydrofoils and 60% for cargo ships.

Initial research on this application of MHD was done in the United States, but was abandoned when researchers found that

then current metal magnets were too heavy to be efficient. The Yamato 1's designer, Kensaku Imaichi is a specialist in superconductivity which makes the current prototype possible. He anticipates that if new ceramic or other supermagnetic material can be found, ships can be propelled at speeds of 40 to 50 knots and speeds could go even higher if hulls could be made more stable.

²⁸⁴

Such a combination of breakthroughs would revolutionize ships, in general, and ocean shipping, in particular. Japanese technologists believe this will happen and predict that full-sized ocean freighters traveling at over 100 miles per hour will ply the seas by the year 2007, shortening the trip from Japan to California to 2 days.²⁸⁵

Private Transport

Electric "Zero Emission" Automobile

In the 70s the electric car seemed just around the corner. Now, it again seems to be a viable alternative to the internal combustion engine. The difference is new advances in technology and in government regulations.

California's law which mandates that 2 percent of the cars sold by any manufacturer in the year 1998 must produce zero emissions, and that by 2003, 10 percent of sales must produce no pollutants, has provided a much needed spur to research. Manufacturers are now scrambling to produce electric cars. The federal government is supporting new research and almost every major automaker plans to introduce a model within five years.

In contrast to fifteen years ago, there are lighter and stronger materials available and electric motors and batteries have improved in efficiency. Electric motors are 90 percent efficient and battery packs are about 80 percent efficient. Of course, the batteries still must be charged using electricity generated by fossil fuels. The average efficiency of electric plants is about 32 percent. This makes the current energy efficiency of an electric car about 23

percent -- less than that of a high mileage gasoline car on the highway.

However, these cars are planned primarily as commuter cars. A study done by the Electric Power Research Institute (EPRI) in 1989 compared nearly identical gasoline powered and electric powered minivans. They found that in urban use, electric vans required only 60 to 75 percent of the energy consumed by the gasoline vans. A converted Geo Metro is about 63 percent more efficient. And the Impact, by GM, which is designed from the ground up as a high performance sports car is even more efficient because of its lightweight aerodynamically designed body and low rolling-resistance tires.

Drawbacks to Batteries Remain

Some of the drawbacks which stood in the way of economical electric cars fifteen years ago still remain: battery expense, life, and weight; recharge time overnight as opposed to a few minutes filling up with gas; availability of recharging stations; short range without recharge. And if the electric car is to reduce pollution significantly it is necessary for the plants which generate the electricity for recharging batteries be clean as well.

Although the state of battery technology may allow battery-powered cars to be the first to qualify under this new restriction, there is a problem, in that the battery approach has only moved the pollution source from the car back to the powerplant.

Fuel-cells Present Promise

Fuel-cells, though, are quite different. Fueled by hydrogen, these devices produce electricity directly and cleanly (the only byproduct being water). Hydrogen is the most plentiful energy source on the planet. It can be produced from water and also from natural gas. Studies have shown that by the turn of the century, present technology will make it as safe and cheap to convert and distribute hydrogen for use in fuel-cell powered automobiles as it is for gasoline now. Small units could be installed in residentially garages that convert natural gas -- already present in most homes -- directly to hydrogen. Alternatively, H₂ could be trucked (as gasoline is now) to service stations, for distribution there.

In time, safe offshore nuclear power plants, could be used to produce hydrogen directly from sea water. A long term suggestion is the use of hydrogen produced by using wind or solar generated electricity. The problem of storage must then be solved. Because of its low density, hydrogen needs even more space than does natural gas. Increased end-use efficiency could reduce storage requirements, however. According to Christopher Flaven, "Fuel cells are the most obvious alternative, since they allow the efficient production of electricity . . . with an efficiency about twice that of today's engines. . . . Solar hydrogen could eventually become the foundation of a new global energy economy."²⁸⁶

If fuel cells become the ultimate choice of automobile buyers, we could see the end of the age of internal combustion engines and the entry into the hydrogen era.

Alternative fuel vehicles

Compressed natural gas is being reconsidered to power motor vehicles. Natural gas powered vehicles produce minimal amounts of key pollutants. Natural gas can be burned in a high-compression engine, which allows efficiency to improve 15-20 percent and CO₂ emissions to be cut 30 percent. The exhaust from a hydrogen powered car contains only water vapor and small amounts of nitrogen oxide (NO_x). NO_x is a greenhouse gas, but since natural gas burns cleaner than gasoline, engineers believe that a simple catalytic converter can eliminate virtually all emissions.²⁸⁷

Intelligent Vehicle Highway Systems

The road and highway system in the U.S. is so mature (and so expensive to expand) that new infrastructure-based efficiencies for automobile and truck travel are going to come not from building new larger roads, but from using our present road and highway structure more intelligently.

Increasing the level of interaction between the road infrastructure and an individual vehicle is what MIT's Intelligent Vehicle/Highway Systems is about. This project, centered in various MIT labs, is based on forming partnerships with industry to develop a road and highway system that "knows" its state of use and can communicate transparently with individual vehicles so as to

allow them to utilize the system in the most efficient way. Essentially the road system (responding to the initiatives of human highway controllers) would, through signal lights, control the flow of traffic and, through direct communications with vehicles alert them to problems on the road. Drivers, on the other hand, would have far more information available to them to help them make decisions on routes to a destination, location, and road information.

There are many interesting problems associated with such a system. The interface with the driver, for instance, can be accomplished in a number of ways. The "back seat driver" would use a voice simulator to tell the driver, "turn right next corner then make a sharp left on the street with the red house on the corner." Then, there is the need for computer generated maps (Japan has already digitized maps of all of the roads in the country in preparation for more intelligent cars) or interactive maps that can report on the condition of the road ahead.

The Global Positioning System will certainly play a central role in any final scheme. Any of these proposals require a very high degree of accurate positioning information to be available, not only to drivers but also to highway controllers who manipulate the flow of traffic.

This is a new regime, with new ground being broken; many human factors questions will need to be answered before a working system can be put in place. On the traffic control side, there is the need for models of how people are likely to use such a service so that the system doesn't, for example, simply shift all of the congestion from an accident from a highway to a secondary road. Computer models and simulations will be needed to help answer these questions.

Commercial Transport

In commercial transportation, people are beginning to understand the value of integration and cooperation. The watchword is *intermodality*. The idea is that transport is arranged door-to-door and rail, truck, and air and ship lines pool their resources to give the most efficient service. This cooperation is a direct derivative

of the innovative use of information technology. Intermodality results in a savings of costs, fuel, and time; all of which mean savings for the consumer and profits for the transport companies.

There are two major components to this trend; one is the physical and procedure-oriented issues associated with moving an item easily and seamlessly from one location to another. This includes the technology, regulations, multilateral agreements, tracking systems, etc. The other significant segment is the change in the marketplace that these capabilities will enable.

Cooperation Between and Among Carriers, Customers and Government

At its base, an intermodal system involves the close cooperation of many different types of carriers. As Ralston Purina's Vice President Marty Tandler says, "Partnerships between railroads and trucking firms bring a new level of efficiency and economy. That efficiency adds value. It makes the U.S. a competitive entity in the world."²⁸⁸

An example of the power of this new intermodal information tracking is the partnership between the Stride Rite Corporation, American President Lines (APL) and the U. S. Customs Department. In combination, these players have put together a system that will cut the time required to move products from manufacturers in the Far East to customers in the United States.

New product styles are shown to customs officials twice yearly and duty rates are set. APL scans the bar code labels on cases as they are loaded into containers for shipment. All the information is consolidated and sent to Stride Rite in the U.S. electronically. The unit price and factory of origin are added and forwarded to the customs broker. This data is used to make an automated broker interface (ABI) entry which clears the goods through Customs while it is still on the ship enroute.

Stride Rite benefits by knowing exactly what the costs will be and exactly what is in each container. They can look at existing inventory and know which container to process first. There is no wait for customs clearance.

The key to this system is information technology and coordination between the various companies which handle Stride Rite's goods. According to Dan Wolf, director of transportation for Stride Rite, "All parties work together well, contributing in their

areas of expertise. We're using what each party does best. My job is to coordinate."²⁸⁹

This rather simple example is illustrative of a national and international trend toward a new intermodal system that will be enabled with the new information technology that is coming into the marketplace. In time, the infrastructure should be in place to allow one to send most anything to most anyplace without talking to a person.

A New Marketplace

Although one can now arrange with a freight forwarder to take care of all of the details of a particular shipment, the intermodal arrangements that are made are ad hoc, designed for only one (or a specific group of) transactions. Information technology that is now making its way into the marketplace will ultimately allow the evolution of a permanent international intermodal marketplace.

As the information needed for each step of a shipping process becomes increasingly standardized and available in digital form, it will begin to be communicated and manipulated exclusively in electronic form. This will open the door to automated transactions.

Like the Stock Market

The stock market is a good analogy. Where originally, financial equity transactions were between individuals, in time, with the standardization of instruments there became a marketplace -- a clearinghouse -- where the financial "products" could be bought and sold. Initially all aspects of the business (offer to buy/sell, record keeping, buy/sell transaction, billing, analysis, and knowledge of the market) were manually produced. But with the advent of sophisticated information technology, every piece of the marketplace became automated except for the simple, buy-sell transaction (which was maintained for a unique set of reasons). There is a broad digital stream that encompasses every single aspect of the business that leads to and from the trading pit.

The client interface with the marketplace is also completely electronic and in the largest, most sophisticated cases, the client's trading decisions are made by computers, and the complete

transaction is initiated, confirmed and reported without any human intervention. It is a seamless, almost organic system that allows the automatic purchase or sale of any of the thousands of varieties of products that are bought and sold in that marketplace.

An Electronic Intermodal Marketplace

The intermodal shipping marketplace is moving in the same direction. Think of it as an organic system, comprised of space and land-based communications and positioning capabilities that move and provide the information needed for any transaction that is allowed in the marketplace. It seems that ultimately, one will be able to access the marketplace (via computer) and offer to buy shipping services for most any given commodity. Automatically, all of the shippers in the marketplace (electronically, of course) will bid on the business. Perhaps, the client's computer will analyze the offers and automatically select and initiate one option. At the least, the offers will be presented to the client and he or she will decide which option to take. The rest of the process would be completely automatic -- production of shipping documents, inter-shipper coordination, customs clearance, billing, exchange of funds and fees, tracking of the shipment, etc. Humans would deal with the exceptions -- the problems.

This is not just speculation. There are many highly complex activities in other areas that are inexorably moving in this direction.

Transportation and Information Technology

It may well be that advanced information technology will do away with many travel needs. This is likely to be particularly true with the advent of realistic virtual reality and projection holography. When people are able to make and maintain long distance personal working relationships, they need to travel less. For the first time in recorded history, in many aspects of life, information technology is *moving information instead of people*.

Al Gore identified the first manifestations of the trend: "We can also replace conventional commuting wherever possible with what is now known as telecommuting. This technology is

already in widespread use, as increasing numbers of people work at home but keep a direct connection to co-workers through a communications link between their computer stations. As the capacity of computer networks increases, this trend is likely to accelerate."²⁹⁰

Technology and Transportation Regulation

It is an understatement to suggest that technology will have a profound impact on transportation in the next twenty years. But to make the case clearer, and show how some particularly powerful information technology will crosscut all aspects of transportation, let us briefly consider the implications of virtual reality (VR) on the different pieces of the Department of Transportation (DOT) transportation puzzle. Keep in mind that any of a number of other technologies mentioned earlier in this report (like chaos theory, nanotechnology, zero point energy, et. al.) will similarly sweep through all aspects of our lives, changing them forever.

One important aspect of VR is that it allows very sophisticated simulation. Most any situation that can be modeled in a computer can theoretically be simulated, from the smallest atomic environment to large, even global or cosmic, contexts. Because they are more flexible and do not involve the kind of expense of full scale models, VR applications allow researchers to try out designs and evaluate human factors before prototyping or building. This saves expense, time and often is much safer. Of course, some contexts (like the aforementioned atomic environment) that could never be actually experienced can be virtually experienced. VR can be a real advantage in both research and training. Consider how it is working its way into a variety of DOT areas.

Federal Aviation Authority (FAA)

The FAA has a dynamic modeling system of air traffic, airspace, airport area, surfaces, and buildings, which helps with airport design, air traffic flows, and design changes. It also uses simulator modeling as a tool for analysis and contingency planning for dealing with bottleneck delays, sector saturation and gate holds.

In the future the FAA plans to link their systems together to achieve less expensive distributed simulation.

Already some virtual reality applications like helmet displays, and cockpit and flight-deck simulations have been found to be a less expensive alternative to large physical simulators. The FAA may use virtual reality in the analysis and prevention of accidents by re-creating activities where the human-machine interface is poorly understood.

National Highway Traffic Administration (NHTSA)

Here the use of simulation, models and virtual reality has the capability to enhance research on the relationship between vehicles and between vehicles and pedestrians. This may help in the understanding and prevention of accidents. Safety situations can be "experienced" without exposing anyone to physical harm.

The Federal Highway Administration (FHWA)

The highway administration has a long history of using computer simulation especially in the area of traffic optimization, on both micro and macro scales. They expect virtual reality to be an especially useful tool for evaluating a complete range high risk safety situations involving driver/vehicle/highway interactions because there is no risk to lives or property.

The design and modeling of the Intelligent Vehicle Highway System will provide applications for VR. A "test car" could be driven on a prototypical highway system in different stages of development without leaving one's office or lab.

The Merchant Marine Academy (MARAD) and the Coast Guard (USCG)

The Merchant Marine Academy uses computer-aided operations research as a training aid to mimic ship maneuvers and evaluate harbor designs. Their system can accommodate a large range of weather, traffic, channel and environmental conditions.

Vessel traffic control simulator systems are used in the same way as air traffic control simulators and help in the evaluation of human factor issues. *Vessel simulators* are also similar to those used for

aircraft pilot training. Three dimensional virtual reality simulators may be used to assess the design of ship systems, especially places of limited space like engine rooms. There are already simulators in use as training aids at the Coast Guard Academy in New London, and at the Reserve Training Center in Yorktown, Virginia. They have been quite successful and should produce long range savings in training costs.

Federal Railway Administration (FRA)

The FRA uses a full scale locomotive control simulator to evaluate human factors and evaluate work standards related to fatigue and alertness. VR could be helpful in simulating many different safety situations, particularly in advanced systems collision avoidance and accident survivability studies to evaluate proposed new Maglev and high-speed rail systems under various operating scenarios and accident threats, thereby reducing developmental design risks.

The Office of the Secretary of Transportation (OST)

Although it will not be practically available for a number of years, in time, VR can produce the ultimate telecommuting environment. One can transport themselves at will into any other virtual office, be it at headquarters or at some other location, for meetings, etc., without leaving home. There is no travel time and none of the overhead costs and expenses associated with maintaining a work space in an office environment. Time can be used much more efficiently.

DOT has found there is a 20% improvement in worker productivity since the introduction of a telecommuting program. They are sponsoring research into areas where expanded telecommuting promises to be successful by mid 1995.²⁹¹

Transportation Planning as a System

In all that we have considered, there is a hard truth that colors almost all transportation planning:

We don't see our transportation as a system.

We don't see it as a system because we haven't designed it as one. Instead of establishing a rationalized land use and transportation policy, transportation decisions have often been made on the basis of a reaction to overcrowded roads and political lobbying.

The San Jose California light rail is a case in point. People wanted to have light rail and to ease congestion. They invested \$500 million. But now that it is built, the rail line doesn't run near anything. It goes near the airport but not near enough -- 3/4 of a mile -- for people with baggage to take advantage of it. It doesn't connect up with the railroad, nor does it connect with the subway. This is because the system wasn't designed to serve concentrations of populations; it was designed to hit as many political districts as possible. As a result it serves less than 11,000 people although it was designed to serve 40,000.²⁹²

Successful transit must follow the pattern of Toronto, Paris and Stockholm, where the location of stations was linked to residential and commercial development. Transit projects need to be designed to make it easy for people use them. For example, connecting bus and train routes with bike paths within the city and making provision for carrying and/or storing bicycles. This would give people the convenience of efficient inner city transport, without parking problems, and a traffic-free commute.

These principles work. In Curitiba, Brazil, a city of 1.5 million people, an efficient mass transit system was designed based on integrating land use and making provision for bicycle and pedestrian traffic, and a network of express and local buses. As a result gasoline use is 30 percent lower per vehicle and people spend only 10 percent of their income on transport, one of the lowest in Brazil.²⁹³

Building Relationships

Looking at transportation as a system in the context of the larger society also means facilitating communication between the different participants in system. Relationships must be built between policymakers within the transportation community, for example, departments of highways and rail must work together; and between agencies: housing, land use, and transportation. There are cities where transportation and land use have been considered

concurrently (Toronto, Portland, and Amsterdam), and the efficiency is noticeable.

Consider Life Cycle Costs

At issue here is not just the operating costs and byproducts of a given transportation system, but also the costs and benefits that attend the construction and dismemberment of the system.

In this time where the government is considering the need to stimulate the economy and help produce jobs, one of the considerations relative to investing in transportation is where does a dollar spent produce the most economic return. As it turns out, the most efficient and environmentally benign forms of transportation also produce the most number of jobs during their construction. German figures show that highway construction generates the fewest jobs of any public infrastructure investment. Spending 1 billion deutsche marks (\$580 million) on highways yields only 14,000-19,000 jobs, compared with about 22,000 in railway tracks, or 23,000 in light rail track construction.²⁹⁴

One of the most important employment questions is the extent to which the skills now used in the automotive industries are adaptable to the operation of rail systems. Markus Hesse and Rainer Lucs of the Institute for Ecological Economics Research in Wuppertal, Germany conclude that given some overlaps and similarities in skill patterns, the shifts should not be too difficult. Both motor vehicle manufacturing and railroads require a broad distribution of occupations. The skills needed to construct highways, railway tracks, and bike paths - such as engineering, concrete pouring, and trucking - are relatively similar, although workers will need to adapt from one to the other.²⁹⁵

Efficient transportation alternatives to the private gasoline powered vehicle must be found in order to allow for sustainable economic development and a cleaner environment both in the U.S. and the world.

Notes:

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- ²⁸⁰Contributed by Arne J. Bang, Senior Manager, Special Programs, U.S. Department of Transportation, Federal Railroad Administration
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- ²⁸²*Aeronautical Technologies for the Twenty-First Century*, [Washington, DC: National Academy Press, 1992] p. 64
- ²⁸³"Asian Air Travel Boom," *International Update*, [Chicago: Marvin Zonis and Associates, Inc., Febr. 15, 1993]
- ²⁸⁴Dennis Normile, *Popular Science*, November, 1992
- ²⁸⁵*Future Technology in Japan: Forecast to the Year 2015*, Institute for Future Technology, Tokyo, 1988
- ²⁸⁶*ibid.* p 38)
- ²⁸⁷Flavin, Christopher ; "Building a Bridge to Sustainable Energy ," *State of the World 1992*, [Washington, DC: World Watch Institute, 1992] p. 35-38
- ²⁸⁸E. J. Muller, *Seatrade* November, 1992
- ²⁸⁹*T&D*, August, 1992
- ²⁹⁰Gore: p. 327
- ²⁹¹Paper by CDR D. M. Egan, USCG presented to the Federal Coordinating Council on Science, Engineering and Technology (FCCSET), Working Committee on Virtual Reality, November 1992, quoting USDOT Report, Telecommuting: Moving the Work to the Workers; (DOT-T-92-04), Sept. 91
- ²⁹²*2020 Visions*, p. 172
- ²⁹³Lowe: *State of the World 1992*
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- ²⁹⁵*ibid.*

Commercial Space

In the past, space has been primarily used by the military for communications and remote sensing. The first commercial applications of note were repeater satellites to beam television signals down to large regions of the globe followed by telephone systems, both for conventional long-distance service and more specialized maritime ship-to-shore capabilities.

In the last few years, though, the commercial use of space has begun to build, starting with more regional television broadcasting units, the private use of the Global Positioning System, and now in the planning stages, a number of private global communications systems.

Applications

There are six areas of use for commercial space: communications, power, materials processing, remote sensing, manned flight, navigation, and on-orbit services.

Communications

Satellites can be positioned in one of two general locations: *geosynchronous* orbits (the satellite's orbit is matched with the rotation

of the earth and remains positioned above one point on the equator), and *low earth orbits* (the satellite constantly flies around the earth in any of a number of possible orbits).

Geosynchronous Orbits

Because they need to provide constant coverage to one geographic area, television broadcasting and some telephone communications satellites are positioned in geosynchronous orbits. This is a high orbit -- 22,500 miles above the earth -- that requires greater launch capability for payloads that are usually on the larger end of the scale. A single GEO satellite usually works independently (as in the case of television broadcasting), or in some cases, telephone and image information is uplinked from, say, the Pacific and re-sent to another geosynchronous system positioned over the Atlantic, before returning to earth, thus allowing data to be moved from one side of the globe to the other.

Low Earth Orbits

Most of the new growth in commercial space appears to be in low earth orbit (LEO) systems. The U.S. and other countries have used LEOs for surveillance, because their orbits are much closer to the earth than geosynchronous ones. But that means that the satellite constantly travels around the earth, crossing a given surface location only once each orbit.

At the present time, commercial firms are planning and beginning to launch constellations of LEO satellites, configured so that a number of spacecraft are above the horizon of any point on earth at any time. These constellations are referred to as Big LEOs and Little LEOs, depending on the number of satellites in the constellation.

The World Administrative Radio Conference has endorsed the use of radio spectrum by two types of small satellite constellations in low earth orbits -- one for wireless telephone calls and one for messaging services.

Big LEOs use 66 to 77 satellites, all linked together electronically to form a telephone service web that completely covers the earth. A telephone call started with one overhead satellite is handed-off to the next one that arrives overhead. In theory, it is very much like the operation of a cellular telephone system where the signal

is passed from one antenna to another as the caller moves from one region to another. Big LEO operators are now negotiating for FCC frequency allocation, may have approvals by 1996-97 and should begin launching very soon after that.

The best known big LEO is Motorola's Iridium. If the corporation is able to obtain the financing that they require, the system should be operational by 1997. Technology is moving so fast in this area that Motorola assumes that their satellites will become obsolete within 2 to 3 years and therefore plan to have at least one launch a month after the complete constellation is in place just to replace old satellites.

Little LEOs, which use 8 to 24 satellites are designed for messaging and positioning services. Some have pioneer licenses and should begin launching in the early part of 1993. There are five applicants to provide telephone service and three who want to supply messaging services. These systems will allow messages to be sent and received from any place in the world to laptop computers with very small antennas built into the covers and to paging units that can be made small enough to be a part of a wrist watch.

These services will be further enhanced by the development of VSAT (very small aperture antennas) for business and home high definition television.

Power Generation

In an example of the ultimate high-tech solution to a problem (that may well be overcome by other, far more efficient technologies) there is some talk about using large satellites to convert solar energy to electrical energy and beam it, in the form of microwave transmissions, to large collection stations on earth. These surface facilities would then convert the radio energy back to common electricity that could be used to supply the projected increase in the nation's requirement for electricity.

One variation of this scheme is to build the equipment on the moon and move the completed satellites to geosynchronous earth orbits from there. For any number of reasons, we do not believe that this is likely to come to fruition.

Material Processing

On earth, gravity presents an intrinsic problem to the manufacturing of certain materials and conducting certain experiments. Space presents an option to earth-based conventional processes through the use of microgravity factories designed for specific applications. Pharmaceuticals are one area of opportunity. Protein crystals and medicines could be produced and genetic experiments done much more effectively in a microgravity context. Space-based furnaces for mixing alloys and electroplating would also be much more efficient than those available now.

At the present time, there is no commercially viable microgravity manufacturing process available. Additionally, the availability of payload processing facilities and launch costs are important parts of the equation that will ultimately determine if microgravity manufacturing becomes a reality. In November of '93 a new experiment will be done to see if high-purity semiconductor substrate material can be manufactured taking advantage of the vacuum, not low gravity in space. If that is successful, it will be the first process and product that appeared to have near-time economic viability.

Again, as in the case with orbital power generation, there are other technologies on the horizon, notably molecular nanotechnology, which could offset and eliminate all of the usual gravity problems associated with manufacturing. Far more effort is being made to develop nanotechnology than microgravity manufacturing, and if it is successful, the economics are so much better that space may well be only used for manufacturing things that are used there with nanotechnology being the manufacturing process used.

Remote Sensing

The current commercial market for remote sensing satellites is closely tied to government policies, as most of these payloads are operated by governments. The number of remote sensing payloads now depends primarily on the level of government funding and the types of satellites government agencies decide to operate (e.g., a few large satellites containing many sensors, versus many small satellites, each containing a few sensors). The influence of

government policy could decline if lower-cost sensors or launch systems (which clearly are coming) are developed, making remote sensing satellites more affordable for private operators.

The number of future remote sensing payloads is also strongly linked to the cost of processing the data collected through such systems. Presently these costs constrain the market for such systems. In many cases, so much data is generated by a sensor that years (decades, in some cases) are required to effectively analyze the huge flow.

There are a host of remote sensing capabilities that are utilized for many different satellite-based applications. Sensors for visible wavelengths, infrared, laser, radar, and millimeter wavelengths are available and can be configured for a variety of missions. Additionally atmospheric sampling equipment can be used to map the chemistry and dynamics of the upper atmosphere with extraordinary sensitivity. Current satellites can measure chemical constituents, as well as winds for the first time, and the altitude and range over which they occur.

One satellite going up later this year will measure the circulation of the earth's oceans. The Laser Geodynamic Satellite measures geo-potential, the gravitational potential of the earth. There are weather satellites, of course, that are constantly being launched, and instruments to track hydrology and sea ice are included on some defense satellites. When the Shuttle Radar Laboratory goes up in 1993, it will make synthetic aperture radar (SAR) measurements of the topology of the land. The U.S. and Canada are jointly putting up a Radio Detection and Ranging Satellite which will measure the topology of ice. A series of two-year missions will monitor the ozone, and the coupling between the oceans and the atmosphere. A joint Japan/U.S. mission will measure the rainfall in the tropics, and other joint projects with Europeans and Japan will observe the polar areas.

These capabilities can be used to predict weather disasters, spot oil slicks, find downed seamen, monitor natural resources, help manage renewable and nonrenewable resources, monitor global warming and ozone layer depletion,

The Commerce Department and NOAA are looking for better incentives for private corporations to use existing remote sensing satellites like Landsat and GeoSat. Japan is interested in the possibility of acquiring fishing industry information. Petroleum

prospecting interests believe that these capabilities might be helpful to them. Farming organizations are also using the images for analysis of land use. In Europe and the U.S., there is an increasing emphasis on using both commercial and military capabilities to track environmental changes.

These same platforms can, of course, be used for national and military surveillance and there is an interesting political issue arising around the ability of small countries to launch satellites that are used for surveillance. Some argue that, ". . . space surveillance and reconnaissance will be affordable to most nations throughout the world. This will result in a new reality in which all countries can have surveillance for the asking. Forever gone will be the days when surveillance and reconnaissance from space were the exclusive domain of the superpowers."^{29b}

Manned Flight

The fact that an increasingly large investment in hardware is being put into orbit -- and largely abandoned -- suggests that humans will soon go into space on a commercial basis to repair and refuel these assets, thus extending their useful lives. Industry sources believe that there will be a new, big market for maintaining satellites in space and bringing them back for repair. Similarly, as needs change, it will be valuable to move a space craft rather than abandoning it.

One project in the planning stages, COMET, will put devices into space and recover them for repairs and refueling within the next five years. It almost certainly is a harbinger of similar, but more sophisticated services to come. Certain communications satellites will need to be refueled on station so that they can continue to maintain their appointed station. The orbital transfer of other fluids, raw materials, finished products, and cryogenics could also be accomplished from microgravity factories.

Beyond 2000, the Japanese are looking at the possibility of hotels in space. There is also interest in mining on the moon, Mars, and asteroids, but the costs of doing so compared to other options that are becoming available are likely to put such expeditions off for more than two decades.

Navigation

Global Positioning System

The most significant new advance in navigation in centuries is the advent of the Navistar Global Positioning System (GPS), a constellation of satellites that surrounds the globe. Users can now, for the first time in history, obtain very accurate geographic position information anywhere in the world.

A small battery-powered, hand-held GPS receiver can deduce its position to less than 10 meters in three dimensions by comparing signals received simultaneously from up to six different satellites.

Until now, humans have not generally had an accurate method of establishing the location of something if that item was not within sight of someone who knew specifically where he or she was located. We have become used to this, building systems and processes to keep track of where something was last reported and weaving rough estimates deeply into the fabric of everyday life.

Little positioning problems, like not remembering where in a large lot one parked a car, are rather easily (if frustratingly) resolved. Things become much more acute when people do not have a good idea of even where they are. Such situations, in unfamiliar cities, at sea or in the air, sometimes carry serious premiums if not resolved in a timely manner. Then, there are the matters of things being in route between two known locations, or stolen or lost. Now, with a small, increasingly less expensive device, position can be known almost exactly. Already it is revolutionizing major activities.

Business, Recreation and Transportation

GPS was conceived and launched first by the U.S. military in 1978 and became pre-operational with 16 satellites in '91. But its greatest benefit in the short term is certain to be in the business, recreation and transportation areas.

The Persian Gulf war was won because of GPS, which allowed tank drivers to surely navigate the featureless Iraqi desert at high speed in bad weather. Airplanes are switching over and are, for the first time, able to tell their location, altitude and attitude with

no linkage or initialization from the ground. Fishing captains can return exactly to a spot that brought an earlier catch.

Already some GPS units are equipped with automatic cellular phone responding devices that cue them to report their position, direction of travel, present speed, average direction and speed, etc. Fleet owners will know exactly where each of their trucks is located, 24 hours a day, as will shippers of containers on trains and ocean ships. Devices on stolen cars will be activated by a telephone call by the police and immediately give away their position.

Consumer Market

But the greatest ultimate influence may be in the consumer market. *Space News* recently reported that Japanese electronics manufacturers are actively targeting consumers with their GPS products. Some cars in Japan are already equipped with GPS positioning devices which feed into a moving-map display in the car, constantly showing drivers exactly where they are. American manufacturers predict that by the end of the decade many new car models in the U.S. will be GPS equipped.²⁹⁷

As unit sizes decrease with advances in microelectronics, personal units, perhaps built into watches, could become commonplace. Motorola and Mayo Clinic's laboratories are already working to develop a wristwatch-size GPS receiver using multichip modules.²⁹⁸ Coupled with personal global cellular telephone systems, these items could assure that, appropriately equipped, a person would never get lost again.

The former Soviet Union, the Commonwealth of Independent States, operates Glonass, a system similar to GPS. Like GPS it will ultimately have 24 space vehicles; 15 satellites are active now. Some manufacturers are considering designing combination GPS/Glonass receivers to be used primarily for vehicle navigation and tracking, and aeronautical applications.

GPS Transforming Aviation

Satellite-based services are beginning to revolutionize the aviation business. Where in the past, aircraft transiting an ocean made an hourly voice position report to the appropriate air traffic control agency by high frequency radio, now some 160 airliners and

private jets are equipped to automatically send written reports via the Inmarsat satellite communications system at five minute intervals. Helicopters are also being equipped with the satellite equipment.

GPS-determined position reports are also being coupled to the Inmarsat system to provide automatic position reports, with no crew involvement. Ultimately pilots want a two-way system that allows bi-directional written communication so that requests and answers can be traded between pilots and controllers.

GPS has greater, much more profound implications for aviation than just position reporting. Recent studies have shown that by using three antennas located on the tail and tips of the wings, GPS can provide highly accurate attitude information. This input could be coupled to an autopilot that can -- also using GPS-derived position information -- fly the aircraft over the flight route and through an instrument approach almost to landing. Throughout the process, the pilot can monitor the aircraft's progress on a moving map display that during the approach phase, can show both geographic location and altitude information -- all without any linkage to the ground. The cost of this is likely to be inexpensive enough that it will be easily available to the general aviation fleet.

On-Orbit

The physics of space operations make the cost of overcoming the earth's gravity the most relatively fuel-demanding portion of a long range flight to geosynchronous orbit. It would therefore be advantageous to have a "gas station" in low earth orbit where, having broken free of the braking pull of the earth, a vehicle could top-off for the further mission. Fuel and other services may therefore be in LEO in less than two decades.

The need for fuel presumes that the motive force of 2010 will be similar to that which we use now. But, if zero point energy production becomes feasible, completely new space vehicle power plants will be possible, and the need to carry along fuel will be moot.

General Trends

Growing Market

The commercial space market is growing faster than anticipated. Commercial satellite sales had been expected to drop by 15 percent over 1991 levels, but contracts were placed for 18 satellites in 1992 compared to only 15 the year earlier.

According to the U.S. Commerce Department, the "commercial space" economic sector currently accounts for approximately \$10 billion in revenues annually. Most of these revenues originate from the sale and operation of communications satellites, with remote sensing, ground processing, and launch services accounting for most of the remaining business activity. These statistics, however, do not fully describe the economic impact of space operations on U.S. commerce, as they do not reflect expected future trends and other activity that is, for technical reasons, not considered "commercial."

New regional satellite operators and satellite services were the principal reasons for the growth, according to industry sources. New satellite owners were established in Hong Kong, Japan and the U.S.

Steven Dorfman, president of major payload manufacturer Hughes Space and Communications Company, said the satellite market is experiencing a proliferation of what he called second-generation spacecraft -- those that offer television programming directly to households, mobile communications or transmission links for private business networks.²⁹⁹

US commercial space activities have tripled since 1988, even though the U.S. share of the communications satellite market has declined by about half in the last two decades.

Launch Services

Much of the expense of space launch services is associated with infrastructure and vehicle development costs, therefore there is a real advantage to finding alternative approaches for launching that offset or bypass some of the usual expenses. China recently

entered the commercial launch market with lower costs that directly targeted the dominant French position in the field. Now, the Russians are doing the same thing and driving costs still lower.

Russian Proton

Recently the State Department approved a request by Lockheed Corporation to work on a joint venture with Krunichev Enterprise of Moscow, builder of the Proton rocket, to provide commercial satellite launch services. Proton launchers, which previously have been used for delivering weapons, are much cheaper than any others on the market and this move brings a whole new set of economics to satellite operators. Some suggest that launch costs using the Proton could be as small as 20 percent of what past costs have been.

Until now, France's Arianespace, which builds the Ariane rocket series has controlled more than two-thirds of the commercial launch market and has seen China as their major competitor. This new development could spur new space options and open up new market segments that would not have been economically feasible.

Sea-Launching

An alternative to the expensive launch infrastructure costs on land is to move offshore. Serious planning is underway to provide very inexpensive (about 10% of current cost) small satellite launch services from ships or offshore platforms. Ship-based launching has additional advantages in that a launch can be made from any latitude (thus taking better advantage of the earth's rotational momentum), rather than being constrained by the physical restrictions of fixed land-based sites.

A problem with sea launching is getting the rockets and payloads out to the ship so that the ship doesn't need to come into port between each launch. There are also a new set of safety problems associated with sea launches that do not attend land-based launches.

Reusable Vehicles

The great cost of developing and launching satellites will spawn increasing attempts to reuse space launchers and payloads. McDonnell Douglas Space Systems Company has planned a Single Stage To Orbit vehicle (SSTO) which will operate like airplane; launch into space, drop off a payload, and then land on earth again. It is designed to turn around in days or hours. The prototype will be tested in May of 1993 with full-scale development scheduled in '94-'96. If successful, this approach will decrease launch costs from \$2500 per pound to hundreds of dollars per pound.

Competition Over Satellite Parking Spots

Because geostationary communications satellites operating at the same frequencies jam each other if they are parked in space too closely to each other, there are a limited number of orbital positions available for certain applications servicing certain geographic regions. In the past, satellite operators have petitioned to the International Telecommunications Union (ITU), which is part of the United Nations, for positions, with the assurance that all operators would conform to the ITU decisions.

Now, with more than 15 launches for satellites serving the Pacific planned for the next two years, every satellite space in the region is in demand and several disputes over rights to the spacecraft slots have erupted. Operators from the U.S., Hong Kong and the Philippines are all claiming common positions over South East Asia.

John Hampton, deputy director of Intelsat, said that mutual self-interest has sustained voluntary cooperation with ITU guidelines. However, he and other senior officials in the industry are concerned that once one company abandons compromise, the system will slide into an electronic chaos of jammed frequencies.³⁰⁰

Space News reports that with widespread confusion and disagreement over which operators have priority to run their satellites under ITU rules, few observers expect an orderly resolution of all the conflicts.

Future Prospects

Analyses carried out for the Office of Commercial Space Transportation (OCST) indicate the following anticipated developments during the period through 2010:

- Launch rates will increase gradually with most growth occurring in the area of small launch vehicles.
- Spacecraft will get smaller. At a recent Institute of Navigation meeting a proposal was made to develop a system of small, low-cost "econosats," that could augment the GPS system.³⁰¹
- The greatest payload growth will be in the area of Low Earth Orbit (LEO) communications networks, which will require both initial launches of constellations and replacement launches as satellites wear out.
- Remote sensing and microgravity markets could grow, but only as markets mature.
- An average of 44 commercial payloads will probably be launched annually during period 1993-1999; this will rise to an average of 55 per year during the period 2000-2005.
- The number of commercial microgravity payloads will rise steadily, but not dramatically during the two periods
- At this time, the most growth in commercial launch demand appears to be likely in the area of LEO communications satellites
- The number of GEO communications and remote sensing satellites launched annually is likely to remain at current levels through the end of the decade, and marginally higher during the first five years of the next century.
- Lower launch costs could also greatly affect the general approach payload operators take to payload design and operations. Lower launch costs might lead operators to deploy greater numbers of less expensive satellites with shorter lifetimes and more limited capabilities; this could, in turn, increase the number of launches.
- In recent years, market trends have tended to favor foreign companies in the areas of launch services, while

U.S. companies have maintained market share in the sale of payloads. The growth in LEO communications systems will favor U.S. launch companies and payload operators, as most of the interest in LEO communications are U.S.-based.

Coast Guard Role

In the evolving market, the U.S. Coast Guard (USCG) has two roles. The first role is that of *using space-based services* or in responding as these services become more readily available to the commercial maritime community. Additionally the USCG has major responsibilities for *safety in and around launch sites*.

Using Space-based Services

The primary examples of these services are (and most likely will continue to be) communications of various kinds (e.g., routine voice, data, emergency) and navigation.

GPS

The Global Positioning System will, in a relatively short time, influence many aspects of the Coast Guard's business. Already, ships are using it as a primary method of open-ocean and coast-wise navigation. In time, it will allow ships and aircraft to make approaches to harbors and airports in marginal weather with no outside link.

It also is likely to revolutionize the search and rescue process, increasingly eliminating the search portion for those vessels that have a GPS and are in radio contact with land. It seems reasonable that in time, emergency transmitters will be developed that automatically issue an emergency call giving a specific location to the search aircraft or vessel.

Differential GPS

GPS is owned by the U.S. military and was designed principally to provide navigation information for military vehicles and weapons delivery systems like cruise missiles. In order to deprive potential adversaries of the similar use of the system for their weapons, the DOD degrades the accuracy of the signal during routine operation.

But a new, inexpensive technique developed by the USCG -- differential GPS -- can broadcast an error correction signal up to 150 miles from a transmitter site, allowing all users in the area to have available the most accurate position information. The USCG is installing these DGPS sites up and down all of the coasts and in the Great Lakes region over the next couple of years.

Imaging Satellites

A number of recent events suggest that Arctic shipping routes may be used on an increasing basis for moving passengers and cargo between Europe and the Far East and northern Siberia. The Northeast Passage, paralleling the Siberian coast has just recently been opened for international shipping traffic by the Russian government along with access to a number of Siberian ports. During a 4 to 5 month period in the summer, some ships can make the icy transit largely unaccompanied. Depending on their destinations and routes, ships may need the help of Russian icebreakers.³⁰² This route is much shorter way to get from the Atlantic to the Pacific than the usual trip through the Panama Canal. As much as two weeks can be shaved from the time in route by taking the northern route.

On the other side of the north pole, a similar Northwest Passage through the islands of northern Canada is being probed by ships using current satellite ice map imagery for determining the routes that are least ice-jammed. The ERS-1 satellite which supplies the pictures uses a synthetic aperture radar (SAR) device that allows it to penetrate cloud cover and operate at night. The ice charts are faxed to the ship via Inmarsat to give it a 2-3 hour-old picture of the ice dispersion.

Peter Wadhams, director of the Scott Polar Research Institute at the University of Cambridge in England recently said, "The use of

SAR for ships could make it possible to establish international trade routes across the north of Canada and the north of Russia, at least in the summer if the data can be made available quickly to users . . . then it will make it possible to establish trade routes through the Arctic in a way that more likely will be successful.³⁰³

The USCG will almost certainly play a role in developing and refining the use of this new tool.

This imaging capability could also be put to good use in oil spill remediation.

Expanded Communications Capabilities

Any area of Coast Guard operations that would be better served with unlimited voice and text communications will have it available as global telephone and message constellations go into place during the next few years. Information that previously was sent by high-frequency radio message traffic will be instantly transmitted directly to the user's computer at far less cost. Ships at sea will be as close as a telephone. Increasingly dense imagery and other forms of information will be immediately available to and from ships and installations, regardless where they were located.

New "appliances" will be designed that combine various technologies (like GPS, satellite data transmission, and virtual reality) to produce new capabilities not yet conceptualized.

Their Impact on USCG Customers

The proliferation of space-based point-to-point mobile communication systems will potentially affect virtually all USCG customers. The primary USCG interest in this development will likely concern whether it will include requirements for such systems in its safety regime. The same will be true (although probably to a lesser extent) for the availability of small, low cost navigation and geolocation systems.

Regulating Maritime Activities Associated With Space Operations

Safety Zones at Sea-launch Sites

In the same way that the USCG is responsible for establishing safety zones around and down range from land-based launches, so they will, in the near future, also be called upon to monitor sea-based launches in and around U.S. waters. New concepts will have to be developed that protect ocean traffic and populated land areas from a wayward missile.

Sea-launch Operations

As incidents of sea-launch, and recovery operations of launch vehicles and spacecraft become more likely, a new set of regulations will be required that prescribe safe procedures for these hazardous operations. Recovering spacecraft at sea will be a particularly demanding operation. As the COMET project gets closer to operation this year, many of the issues will become more obvious.

Oversight of Vessels Used in Sea Launch or Recovery

A number of areas of concern arise around the loading, storing and handling of rockets while at sea. Since this has not been done in the civilian arena before, the safety considerations will have to be well thought-out. There are also unique environmental issues that attend sea launch operations that will have to be studied.

It may well be the Department of Transportation Office of Commercial Space Transportation will, along with the Coast Guard, be the principal agencies responsible for the regulation of returning space vehicles in the future, functioning like an FAA of Space or a Coast Guard of Space.

New Customers

In the area of maritime-based launch and recovery, it is most likely that the USCG "customers" will be new organizations either associated with or contracted by the launch vehicle or recovery system operators. These maritime operations are analogous to that currently suggested by OSC's Commercial Pegasus

operations in which a launch vehicle is operated off of a nongovernment, FAA-approved L-1011 or NASA B-52.

Commercial Space and National Security

Strategic foreign policy implications associated with space launch services are technology transfer driven because launch services are the gateways which basically provide developing foreign nations and transnational corporations with space-based communications and surveillance systems. In the Cold War era, access to these systems was largely controlled by the major developed countries associated with either the U.S. and its major allies or the Soviet Union and its major allies.

As a remnant of our containment strategy as well as our associated technology transfer policy, the U.S. exerted strong influence to deny former Soviet space launch services to Western markets. In an extraordinary set of circumstances, in the waning days of the Bush administration, Russian and Kazakhstan space launch officials, in some U.S. officials' opinions, extorted the U.S. State Department into allowing access to formerly Western commercial space markets, with the understanding that advanced missile and surveillance satellite technology would otherwise be provided to Mid-East clients and possibly terrorist organizations with potentially adverse impact to U.S. security interests.

Despite the fact that controls to prevent sales of former Soviet space technology to Mid-East clients could not be guaranteed anyway, the mere linkage of this threat to access to Western space launch markets was sufficient to sway President Bush to approve the policy change over the strong objections of DOD, JCS, Department of Commerce and the Department of Transportation.

Commercial proliferation of space-based systems became the reality of the 1990s as former Soviet space launch systems became available to an international marketplace, with the primary objective being to raise hard currency to preserve the space technology sector of their economically devastated economy. China entered into this competition, offering space launch services to Mid-East clients and transnational commercial interests of the developing world. France and the European Space Agency have been very active providing access to space for devices serving the developing world.

Commercial space access is swiftly becoming a free for all, lacking international cooperation, regulation and enforcement. Space junk orbiting the earth has taken on serious implications for the safety of very expensive orbital devices. Staking claim to geosynchronous orbital sites and orbital paths are taking on the unregulated implications of an "Oklahoma land rush" and has taken on new international policy implications concerning the inability of enforcing property rights of sovereign nations in space.

Space control, as a concept, is the 21st century metaphor to the concepts of Sea Control or Sea Denial used by major naval strategists of Britain, France and the U.S. during the 18th through 20th centuries. In Desert Storm operations, U.S. and allied forces enjoyed unprecedented strategic advantage through use and control of space-based systems, including cooperation by Russian and French officials to deny or delay Saddam's accessibility to space surveillance information.

Access to space surveillance images showing changes in the U.S. force disposition, such as Gen. Schwarzkopf's war-breaking flanking maneuver, might have resulted in substantially increased U.S. casualties against a more sophisticated adversary. It will be a major challenge for our forces to sustain continued ability to control or deny access to space-device gathered intelligence, especially with transnational commercial proliferation of such space-borne devices. Such capability will require a coordinated combination of political, diplomatic and military strategic policies.



Notes:

²⁹⁶"Surveillance: an Inalienable Right," *Space News*, March 1-7, 1993

²⁹⁷Boyer, William; "U.S., Japan Foresee GPS Market Growth," *Space News*, November 16-22, 1992, p. 10

²⁹⁸*GPS REPORT*, January 28, 1993, p. 8

²⁹⁹"Commercial Space Sees Growth, Problems," *Space News*, Vol. 4 No. 1, January 4-10, 1993

³⁰⁰Tucci, Liz; "Firms Jockey for Pacific Satellite Parking Spots," *Space News*, January 25-31, 1993, p. 20

³⁰¹*GPS REPORT*, p. 8

³⁰²See Brigham, CAPT Lawson W., USCG; "The Russians Open the Arctic for Business," *Naval Institute Proceedings*, January 1993, p. 93

³⁰³"ERS-1 Guides Ship Through Icy Passage," *Space News*, October, 1992

Crosscuts & Wild Cards

The future is a complex combination of trends -- never a single "economic," or "transportation" event, but interaction between and among various driving forces. The only way (using this medium of a report) to begin to communicate what, in fact, might transpire, is to overlay the major trends and look for crosscuts -- obvious areas where combinations of trends might interact together in a significant way. Mini-scenarios can then be built to provide the mental images of how a particular crosscut might evolve. These, then, form the basis for an "evolutionary" view of how the future might play out.

But there are revolutionary events that will come along -- wild cards -- which have a low probability of occurrence and very high impact. Wild cards are important because it is guaranteed that they will happen; what is not certain is which ones they will be. Although some wild cards are so catastrophic that they cannot be realistically planned for, nevertheless, if we array a variety of wild cards before us, we will have at least raised the possibility of their transpiring and provided a new framework from which to assess evolving events.

We began this report by introducing the Global Business Network scenarios of *Market World*, *New Empires*, and *Global Incoherence* as a framework of broad, general paths leading toward the horizon and we encouraged the reader to keep them in mind as we systematically exposed the many trends covered here. Now, we will see how some crosscuts and wild cards -- the byproducts of the driving forces -- might push the world toward each of the three

GBN scenarios. These examples are not exhaustive, of course, but will identify some obvious linkages and provide a framework for thinking about other alternatives.

The planning value of crosscuts and wild cards vary with how well they can be anticipated and what can be done about them once it is clear that they will happen. We have therefore suggested, in each case, how much lead time might be available for an event and whether a positive reaction can be made to it. Some of the wild card examples are also found in *Wild Cards: A Multinational Perspective*, published by the Copenhagen Institute for Futures Studies and two other groups.³⁰⁴

Market World

The *Market World* scenario was characterized by cooperation, growth and development. New technologies benefit business and society. Innovation is unencumbered.

SIGNIFICANT POSITIVE REACTION POSSIBLE; EARLY INDICATORS AVAILABLE

Crosscuts

A HYDROGEN ECONOMY EVOLVES

Driven by the need to design pollution-free automobiles, manufacturers push hard to develop fuel cell technology in order to meet the 1998 deadline for California. All indicators suggest that fuel cells will be much more efficient and have better operating characteristics than any other approach, as well as being completely pollution-free.

Since the natural gas infrastructure is already in place it becomes relatively easy to supply this fuel to converters that produce the hydrogen for the fuel cells. About 2000, it becomes apparent that fuel cells are really going to work, and there will be a need for large quantities of hydrogen. Concurrently, molecular nanotechnology begins to produce its first usable products. It quickly becomes obvious that an easy, clean way to generate hydrogen in large quantities is to use nanotech-based generating plants that

produce hydrogen from sea water. Thus, by 2012, the ocean becomes an inexpensive fuel source for both developed and developing economies, eliminating in the U.S. much of the pollution that has attended the use of the automobile in this country.

EDUCATION REVOLUTIONIZED

Before the turn of the century it becomes obvious that *experience* is a much better teacher than *study*. By 1998, five years into the virtual reality explosion that begin with home VR entertainment "boxes," it is clear that this powerful technology dramatically changes the way people think and learn. New advances in artificial intelligence and the easy availability of the Cyc commonsense knowledgebase gives education technology designers the basis for developing a fundamentally new approach to learning.

Instead of checking out books in libraries, students find laser-disc VR "contexts" there which allow learning to happen in a number of new ways. Mathematics is learned through a series of interactive games; students "walk" through certain periods of history; science involves moving virtual atoms and molecules while observing the reactions. In engineering, projects are designed using sophisticated computer aided design programs and then the device is "tested" by using VR to run them through their paces. The rate of learning increases dramatically as it becomes far more interesting for students.

COMPUTER INTERFACE BECOMES TRANSPARENT

As holographic neural technology matures, computers become able to interpret most any voice command. This capability is coupled with Cyc and other artificial intelligence programs to produce machines that understand common language. Logically, this capability is quickly moved into the interface with computers applications for control, analysis and writing, resulting in machines that are operated completely with common voice commands and discussion.

Next, success in transducing and translating brain waves, allows people to interface with specific systems by thought, perhaps sensed through transducers in a headband or another such brain-machine connection.

NEW UNDERSTANDING OF NATIONAL BEHAVIOR

Chaos theory opens up the opportunity for beginning to better understand and perhaps predict how large dynamical systems, like nations or cultures, might behave. If this theory was married to Cyc, and human commonsense was added to the equation, it could well yield a tool of unusual analytical value.

Many "what if" scenarios could be run in order to build a broad understanding of possible behavior. The border between ordered and chaotic behavior might be able to be charted, thereby identifying when a group would go to war, (either externally or internally), or shift from one state to another.

UNDERSTANDING THE WEATHER

The combination of chaos theory, far better techniques for monitoring the oceans, and significant increases in computing power suggest that sometime after 2000, our knowledge of how the world's weather works will increase substantially. This will not only allow better weather prediction, but will also generate a much better understanding of what contributes to our weather and changes in it.

Wild Cards

***MICRO DEVICES SAVE LIVES*⁶⁰⁵**

Miniature devices allow medical professionals to monitor and control diseases by replacing malfunctioning organs, valves, or other body parts, and by monitoring and correcting bodily functions. Currently, micro-electromechanics engineering couples electrical and mechanical parts that are 100 nanometers or smaller (about the size of a human hair). These devices consist of servo-mechanisms operating mechanical devices in residence to electrical signals. Typical devices are motors, relays, pumps, and sensors.

In the future, these devices provide technological breakthroughs in health care. Small electromechanical devices implanted in the

body monitor, enhance, and/or replace malfunctioning valves, joints, and tendons. Such devices perform several life-saving functions:

- The miniature mechanisms of such devices mimic the functions of the body -- opening and closing to regulate blood flow as a valve, controlling movement as part of a joint, even responding to electrical impulses of the brain.
- The implanted devices monitor certain bodily functions such as blood sugar level, blood pressure, and cholesterol level. If the micro sensor receives an abnormal reading, it takes measures to correct the problem. If the problem is immediately controllable, the sensor automatically activates a micro-electromechanical pump that delivers a medication or otherwise corrects the problem. The sensor also can signal the person to take a pill or notify a medical professional that there is a problem that needs immediate attention.
- The devices deliver consistent, up-to-date information about the health status of an individual by transmitting data and other information to logical devices located inside or outside the body, to the physician, or to other interested parties.

MEASURES

- *Heart disease is no longer the number one killer.* The number of morbidity cases for diseases of the heart such as coronary disease, arteriosclerosis, and malfunctioning valves decreases, sending heart disease to the number two spot, behind cancer.
- *More people comply with doctors' orders* for treating diabetes, ulcers and cholesterol, as measured by as much as a 50% decrease in the number of emergency room visits for diabetes, stomach, and heart-related problems.
- *Increased use of technology implants* replaces major surgeries such as heart, liver, and kidney transplants, and hip and knee joint replacements. The number of such transplants falls by 30%.

IMPLICATIONS

- *Lower morbidity and mortality.* The use of micro devices to control or fix health-related problems inside the human body revolutionizes the practice of medicine. The incidence of major surgeries

such as heart, liver, and kidney transplants decreases as more implanted micro devices take control of bodily functions rather than replacing whole malfunctioning organs. Patients with arthritis have working micro-implants to replace failing joints. The devices are used to increase the effectiveness of fetal and infant surgery. The constant monitoring of disease conditions decreases unexpected problems. The ultimate result of micro devices is decreased morbidity rates and a general increase in life expectancy.

- *More elderly people in developed countries.* Because the technology for creating such micro devices is less accessible in developing countries, the use of these devices by highly skilled specialists also increases the age gap between developed and lesser developed countries.

FUEL CELLS KEEP THE AIR CLEAN³⁰⁶

By the year 2000, fuel cells become a major source of electricity. Technology permits a gradual buildup of fuel cell use (utilizing natural gas or coal gas and an electrolyte to convert the chemical energy of a fuel into electricity). The oil companies lose their tight grip on the world as fuel cells make a major breakthrough to achieve a safe, clean, and inexpensive technology.

This new fuel source revolutionizes the electric generation and transportation industries. The electricity obtained from the fuel cell can be used as an independent source of regular or standby power to drive traction motors in vehicles. These fuel cells operate safely at relatively low temperatures of about 600°, have lower emission levels, run efficiently, give an uninterrupted supply of power, and use very little space.

MEASURES

- The price of fuel cells drops to \$1,500 per kWh -- comparable to fossil nuclear fuels.
- Fuel cells weighing one to three ounces or less per watt are developed.
- One-half million vehicles in the United States are equipped with fuel cells.

- Five billion watts of fuel cell capacity are manufactured in one year (5 percent of new power capacity).
- Import oil consumption drops in OECD countries.

IMPLICATIONS

- *Major prolonged power shortages are no longer an issue. Companies are able to access power on demand -- anytime, anyplace.*
- *In facilities where uninterrupted power supply is critical, such as hospitals and airports, the risk of exposure is reduced dramatically due to the inherent reliability of the technology.*
- *Gas replaces oil as the critical fuel in the event of supply disruptions (such as during the Gulf War).*
- *Activities in space (such as manufacturing) will pick up, since constraints on power supply and resupply are sharply reduced.*
- *A major new fuel supply market opens for Third World countries where the power grid is inadequate or nonexistent. The Pacific Ocean archipelagos are the biggest beneficiaries since they do not have grids.*

NANOTECHNOLOGY EXPLODES

By 1998, it has become clear that molecular nanotechnology will probably work. Global environmental problems have also become much worse and there is rapidly growing pressure to find solutions to these mammoth issues. Governments and industry see nanotech as a way out of their predicament and begin to plow great amounts of money into all aspects of the discipline. The more work that is done, the more extraordinary become the possibilities for applications. . . and the more investment is made.

MEASURES

- *Japan significantly increases its investment in nanotechnology. As progress is made in research, Japan increasingly ups its \$185 million budget for nanotech (established in 1991) and MITI begins to push the technology hard within corporate Japan.*
- *U.S. computer chip manufacturers' attempts to use nanotech as a process to move U.S. integrated chip production into a new era appears encouraging. The initial foray, in 1993, by a group of 12 computer component manufacturers into the nanotech area shows signs of*

paying off; and the principles (and possibilities) of the technology become much better known in Silicon Valley and throughout American industry from the increase in technical papers and articles.

- *Germany, India, Taiwan, Korea and Russia begin to become seriously involved in the area.* As the value and potential of nanotech becomes more widely apparent, other developed countries and those with significant intellectual capital become involved in the race for development.

IMPLICATIONS

- *Solutions to previously-considered intractable problems become apparent.* Great hope and effort would be invested in the new technology. A rapidly growing segment of public and hi-tech industry would see its revolutionary potential and push hard for faster development.

- *Existing manufacturing companies are seriously threatened.* Nanotech would clearly threaten the status quo, and all of the interests that are vested in the world's existing manufacturing infrastructure. A great political "war" would ensue between the proponents of the future and the defenders of the past with heated arguments about jobs, sunken costs, etc.

Some companies, of course, would see the writing on the wall early enough to shift their focus from the old techniques to the new ones. Many others would find it very hard, if not impossible, to change from being fabrication oriented, with its heavy emphasis on machinery, to being design-centered, which revolves around intellectual skills.

As long as the marketplace prevailed, the economic differential between the old manufacturing and molecular nanotechnology would be so great that there would be no question about nanotech quickly replacing significant industrial segments.

- *A huge, rapid "torque-ing" of developed societies would take place as they reconfigured their whole notion of how things are made, and the infrastructure that is required to support that industry.* This shift would be very painful for many people; displacing many manual laborers, restructuring huge sections of society, changing values (both for things and people), retraining many people, changing education, restructuring economies, etc. Knowledge workers would be

greatly enfranchised causing a greater gulf between the information haves and have-nots in societies.

- *National social psychologies would be turbulent.* On one hand, great hope would attend this new way of solving huge, global problems. A new era would loom on the horizon. On the other hand, shifting to the new mode would not be easy for those who cannot change easily and quickly. This would produce great despair for many.
- *The geopolitical landscape is reoriented.* Countries whose economic health was dependent upon their natural resources would suddenly be threatened, as junk yards and garbage dumps became very valuable (and convenient) "mines," producing most every raw material required for feed stock. Oil would retain some of its value as a feed stock, since it is rich in carbon and therefore could easily be converted into diamond structures.

ENERGY BREAKTHROUGH

Zero point energy production is proved and moves into engineering and manufacturing. The methodology has absolutely no negative byproducts, and the now free energy source exists everywhere and is unlimited. During the same period, breakthroughs are made in room temperature superconductivity, essentially making electricity transmission loss-free.

MEASURES

- Research that had been ongoing in Japan, Germany and the U.S. since the 1980s, converge about 1996 to show incontrovertible evidence that energy can be extracted from the "ether." Environmental pressure had increased each year so much so that significant investment was made to find alternative energy sources.
- Many researchers using both traditional experimental methods and new computational materials science came together mid-decade to produce a material that superconducted at room temperatures and was relatively easily manufactured and configured. It could be shaped into wires and other forms and was durable.

IMPLICATIONS

- *All existing energy production methods become obsolete.* An immediate shift in R&D resources is made away from every existing

energy generation method (both conventional and unconventional), toward ZPE-based applications, both large and small. Electrical power generation devices ranging from small batteries up to major power plants are explored.

- *An immediate shift in emphasis is made toward using electricity as a primary source for all heat and transportation energy. The combination of ZPE and high temperature superconductivity would make electricity far more cost effective than any other energy source.*
- *Fossil fuel-based conversion devices become obsolete. An immediate shift in R&D resources is made away from internal combustion engines, and gas, oil and coal-fired furnaces and boilers to electric motors and heating devices.*
- *The geopolitical structure is shaken. The long term value of oil and gas as a fuel plummets with similar changes to the importance of countries that produce those materials.*
- *The amount of pollution that is produced by human kind begins to decrease precipitously as new ZPE-based electrical power generation plants come on line and transportation moves away from fossil fuels.*

New Empires

The *New Empires* view is less open. Business and countries compete more stridently; possibly in closed, protectionist ways, or alternatively, in a largely free trade mode. It is a picture of a regionalized world.

SIGNIFICANT POSITIVE REACTION POSSIBLE; EARLY INDICATORS AVAILABLE

Crosscuts

MAJOR FIGHT OVER GENETIC INFORMATION

Although at the present time, a majority of Americans believe that people found to carry a genetic disease or a defective gene do not have a right to absolute privacy about their condition, any

changes in the outlook and common understanding of the vulnerability of personal genetic information could change that quickly. If the uses that people with an immediate concern, like spouses and other family members, insurance companies and even employers had for information about an individual's genetic defects were to be questioned, a significant political conflict could ensue over who should have access to this knowledge.

The public is currently extremely optimistic about the progress of gene therapy and other experimental approaches to taming inherited diseases, and believes that therefore the more open everybody is about genetic disorders, the more quickly all will benefit.³⁰⁷ If insurance companies, employers and even family members were thought likely to use this information against the interests of the individual, the battle would be joined.

AMERICAN CULTURAL INFLUENCE INCREASES

As the intercontinental transmission of television becomes ubiquitous and the global information network becomes mature (allowing international subscribers access to a huge amount of American-based knowledge), American culture, the U.S.' most powerful export, will grow in influence. This will have both positive and negative affects. It is likely to broaden the links of commonalty between and among the younger generations of the developed world while at the same time threatening and further alienating the U.S. from more conservative cultures.

EDUCATION AND PARENTING CHANGES

It is obvious that as the underlying understanding of reality changes in a growing segment of a society, it will manifest itself in changes in both parenting and education. What changes might arise is less clear, but inevitably this will be a cultural battleground in the future.

The Consciousness is Causal philosophy focuses around personal responsibility for one's situation and argues that one has, within his or her self, the basic ability to change their reality. There is a corollary to this approach which says that we are all interconnected and individuals have a responsibility to contribute to the greater good (because they will affect it, one way or another).

The current social framework, on the other hand, puts much more emphasis on society, rather than the individual, and attempts to assign some of the problems that an individual might have to society's reaction to the individual. The remedy to personal problems lies more with getting others to change their behavior rather than the "victim" changing his or hers.

As the emerging paradigm segment becomes more sizable, it will begin to question the principles being taught in schools to their children, who have been raised with quite a different perspective on how life works and one's responsibility to it.

This movement will be congruent with some of the conservative characteristics that should be exhibited by the Boomer generation when it begins its takeover of American society toward the middle of this decade.

EUTHANASIA GROWS

The aging of the populations of the developed world, coupled with the growing belief that the mind exists apart from the body, and the fact that the support systems for health care will be increasingly stressed, suggests that more elderly will opt to control the time and conditions of their death than in the past. The activity of people like Dr. Jack Kavorkian and new legislation like that in the Netherlands legalizing euthanasia point to a liberalization of this activity.

Wild Cards

***THE END OF THE NATION-STATE*³⁰⁸**

International agencies become more effective in resolving interstate issues. That and the globalization of the media create a global village with a growing demand for nation-states to cede not only power but responsibility to supranational processes and organizations.

The effectiveness of the newly established United Nations (UN) as a global conflict manager leads to an increasing level of responsibility for the most important international issues, such as health care, the environment, and population movements. What follows

is a new predictability in the resolution of global problems. The populations of the nation-states adjust their world view to the regional and the international level. The nation-state, languishing at a superfluous midpoint, is functionally eliminated.

The UN's acceptance and administration of a wider variety of interregional affairs create a collateral increase in the adoption of international statehood by smaller regions, which feel less compelled by the former safety of the large nation-state. In the United States, there is a marked movement away from national administration, following 20 years of multi-issue devaluation from national to local government responsibility. The Articles of Confederation are revisited and, in some instances, taken further. In all regions of Europe, there is a move to dissolve large national structures in favor of smaller, historic regions. In Germany, for example, the Lander seize complete independence from the national government. In Asia, multiple states are created on the basis of local handicraft or technological production.

What starts with the increase in UN power and acceptability continues as a trend for global regionalism. The model of the Czech and Slovak republics becomes the norm. This trend allows for an effective nationhood based on religious, economic, or political allegiances. Groups as diverse as the Kurds and the Greens can have limited statehood. Common interest becomes the defining principle for a new series of smaller ideological states and closer ties between competing international treaty groups.

On the private level, some organizations achieve nation-like sovereignty with representation in international agencies. Private entities are nominated and internationally accepted (for example, International Committee of the Red Cross) as legally functioning international stakeholders whose interests are managed in the same manner as the newly formed regional states.

MEASURES

- The world map becomes colored according to a layered, micro-regional plan.

The UN, as the de facto beneficiary of the emerging supranational structure, expands its role to include financial arbitration between member states. There is a 30% increase in the UN budget beginning in 1995.

- Sovereignty is granted to multi-regional economic or ideological nations, despite their lack of physical territory.
- UN membership undergoes a change as many micro-states join.

IMPLICATIONS

- Sovereignty spreads among many smaller, semi-autonomous physical and ideological regions. This reduces large-scale conflict, but ultimately leads to special interest warfare.
- The current high levels of trade continue to grow at rates more than double that of the GDP.

From the UN membership list in 2002:

Colombia
Committee on Refugees
Committee of the Red Cross/ Red Crescent
Comoros
Congo
Corsica
Costa Rica
Courland . . .

THE GROUP OF SEVENTY³⁰⁹

By the year 2000, trading blocs have taken over from national governments as the new focus for international trade. With the Asian, American, and European trading blocs firmly in place, the old Group of Seven leading industrial countries have given way to the new Group of Seventy that have come to dominate the global negotiations over terms of trade. They exert enormous influence over the GATT agreements that are forged in the late 1990s, and they are an active lobby in global discussions involving the intersection of energy, environment, and development.

MEASURES

An early indicator of the emerging Group of Seventy is Business Week's "Global 1000." The U.S.-based business publication publishes an annual list of the world's largest global firms ranked by market value. Morgan Stanley Capital International compiles the data, which are based on the current market value of the companies on the world's stock exchange. In 1992, the Global 1000 had

sales of \$7.7 trillion, exceeding the U.S. GNP by 30% and close to the combined GNP of the United States and Japan.

The top 10 companies have sales that approximate the GNP of Belgium or Denmark and revenues that exceed the GNP of all Latin American countries except Brazil. They are big economic players today, and as their global clout grows, they will flex their muscles increasingly in the international arena, in some cases overriding the sway of national governments. This is particularly true because they are concentrated in industries subject to domestically oriented regulations: telecommunications, pharmaceuticals, and financial services. Together these three industries account for 40 of the top 100 global firms ranked by market value:

- *Telecommunications.* Telecommunications accounts for 14 of the top 100 and includes the giants Nippon Telephone and Telegraph (NTT) and AT&T, as well as all seven Regional Bell Operating Companies.

- *Pharmaceuticals.* Pharmaceutical companies account for 13 of the top 100. This industry is becoming totally global with Swiss, British, and American firms having multiple representation in the top 100. These companies may become increasingly active in shaping the national health policies of the countries in which they operate. As a result, they become agents of global harmonization in health systems, which traditionally have been influenced by national culture and history.

- *Financial services.* Banks and other financial services companies also account for 13 of the top 100. An astonishing 7 of the top 26 global companies are Japanese banks. They will have disproportionate clout on the world financial scene because of their sheer scale. The globalization of financial services will be fueled by the increasing trend toward diffused global ownership and management of companies, and it will be enabled by the telecommunications and computer systems that will encourage continuous 24-hour global trading.

In 1992, the top 100 global companies include the oil companies and the giants of the industrial era. But they also include some surprise companies that represent new industries with global influence. Software, utility companies, franchised retailing, and environmental services may become huge global players in the next decade.

IMPLICATIONS

The rules for the new global economy are shaped more by companies than by governments. Some of these companies have global ownership and global management. Others, like the Japanese firms, play on the global stage with strong national interests at stake. The challenge for American and European companies is to determine which stakeholders they are serving -- their global shareholders, their domestic work force, or the national government where they are headquartered.

A NO-CARBON ECONOMY WORLDWIDE³¹⁰

Rising temperatures, caused by greater concentrations of greenhouse gases in the atmosphere, are scientifically proven in the mid-1990s. At the same time, world climate deteriorates (more droughts, cyclones, heat waves, and so forth). Public awareness of this situation grows, bringing with it a greater understanding of the limitations of development based on abundant and cheap energy.

The EC, at the forefront of the issue ever since the "green tax" was mooted in the early 1990s, is the first to levy a tax on fossil fuels to discourage their use by means of a market signal (price) rather than by quotas. The new tax starts at \$ 10/barrel in 1997, gradually reaching \$ 100/barrel 30 years later, making the use of fossil fuels prohibitively expensive. The goal is to achieve a "carbon free" economy by the year 2050, the only way to ensure that temperatures return to their previous levels.

MEASURES

Two indicators are used in the 1990s to determine whether the introduction of this tax is inevitable:

- Confirmation of global warming. Advances by scientists in modeling the effects of higher concentrations of greenhouse gases in the atmosphere settle once and for all the debate about whether this phenomenon has a climatological effect. Confirmation of global warming, a northward shift by plant species, and growing

public awareness of ever more frequent climatic accidents finally force political officials to take vigorous steps.

- Politics restricting greenhouse gas emissions prove to be a failure. Concentrations of greenhouse gases in the atmosphere increase sharply as a result of rapidly rising energy consumption due to relatively inexpensive oil.

IMPLICATIONS

- *The United States and some developing countries oppose the no-carbon economic agreement.* The EC proposes the adoption of a global agreement aimed at the long-term elimination of fossil fuel use through a tax. The other European countries (including the Eastern ones) support such an agreement, as does Japan, which fears reprisals involving imports. However, the United States (where per capita CO₂ emissions are twice as high as in the EC or Japan) rejects out-of-hand this plan that it feels will deal a death-blow to its industries. claiming the ability to achieve the same result more gradually through tax incentives and funding of research into renewable energy sources and rational energy use. The countries of the former USSR -- particularly Russia, the leading world energy exporter -- react the same way. In less developed countries, there is disagreement among those who already have moved beyond the primary industrialization stage with their high-energy consumption industries and support the European project (newly industrialized countries, China, South American countries) and among those who reject it, citing their right to industrialize and their proportionally small contribution to the problem (sub Saharan Africa, the Middle East, India). The tax therefore is adopted by a group of countries representing more than 60 percent of the world economy. These countries introduce a special border tax on imports, based on the fossil energy content of imported goods, to prevent imports from non-signatory countries from being substituted for local products on which the fossil fuel tax is levied.

- *Fuel is more expensive.* The use of automobiles begins to decline, and the U.S. automotive industry collapses in less than a decade. With air traffic also hard hit, aircraft manufacturers find themselves in a similar situation. Electricity prices increase significantly, but more slowly than fossil fuel prices. New life is breathed into nuclear power programs in Europe: hydropower resources not previously developed become a viable proposition under the

new price system. Some industrial sectors (metallurgy, mechanical engineering) disappear almost completely, while others (chemicals, construction materials) undergo in-depth restructuring. A return to collective housing, which is less energy intensive, is inevitable for low- and middle-income households. Mass transit develops to the detriment of the automotive industry.

- *Nuclear power grows.* The public accepts the construction of new nuclear power plants, giant tidal power stations, and the burial of nuclear waste. The budget neutrality of the "green tax" is abandoned. Tax cuts (in particular, VAT) are restricted in scope and cover carbon-free products only. The socialization of earnings increases, and the state is more interventionist and coercive.

- *More international research leads to an industrial revolution.* The bulk of the portion of tax revenues not offset by a drop in taxation of other products is used to finance major international research programs on new energy sources, storing electricity, new materials, and nuclear power plant safety. These programs produce qualitative leaps of knowledge in numerous fields: miniaturization of batteries enables electric cars to be developed; development of a maglev train whose speed is competitive with that of aircraft on a continental scale; substitution of new materials (composites, "green" plastics) in almost all applications where metals previously were used; a revolution in air transport with conventional aircraft replaced by orbiting devices (on the space shuttle principle), the rocket launching of which does not cause greenhouse gas emissions; marked improvement in nuclear power plant safety and commercial operation before the mid-21st century of breeder reactors; progress in the area of solar power, mainly affecting households (home heating and electricity); and so forth. A real industrial revolution takes place because most industrial processes have to be replaced.

- *America finally signs the no-carbon economy agreement.* Although most of these research programs and the conversion of production facilities take several decades, all signatory countries to the carbon-free economy agreement benefit. The United States finally realizes this and joins them five years after the agreement comes into force. Nevertheless, the technological lag that built up contributes to the decline of the American economy, and the country loses its position of leadership. The other countries that have signed the agreement see their standard of living rise to nearly that of the most developed countries. They benefit tremendously

from the international scientific and technical cooperation necessitated by the scale of the problems to be resolved and from voluntary assimilation of new technologies.

- *A changed system of values comes into being.* The recession caused by the tax gradually gives way to a new phase of development based on a changed system of values. The external cost of human activities increasingly is taken into account by economic agents. A sense of shared interest and frugality replaces the worship of abundance and individual freedom.

- *The balance of economic power is altered.* The holdouts -- those developing countries that, for the most part, were already lagging far behind the others -- succumb irremediably as their nascent industries disappear with the closing off of markets in developed countries. The uncontrolled population growth causes the major urban centers in these countries to explode. The resultant chaos stimulates the population to return en masse to the land, which divides the world into two relatively self-contained parts: developed countries that have found a new mainspring for more harmonious and sustainable development, and the have-nots living on international handouts, firmly entrenched in under development.

HONG KONG TAKES OVER CHINA³¹¹

Great Britain relinquishes control of Hong Kong, but the joke is on China. Hong Kong, Taiwan, and the five special economic zones of mainland China become the supernova of the late 20th century, gobbling the Chinese communist dinosaur and blasting the possibilities of another Tiananmen Square into the prehistoric mists.

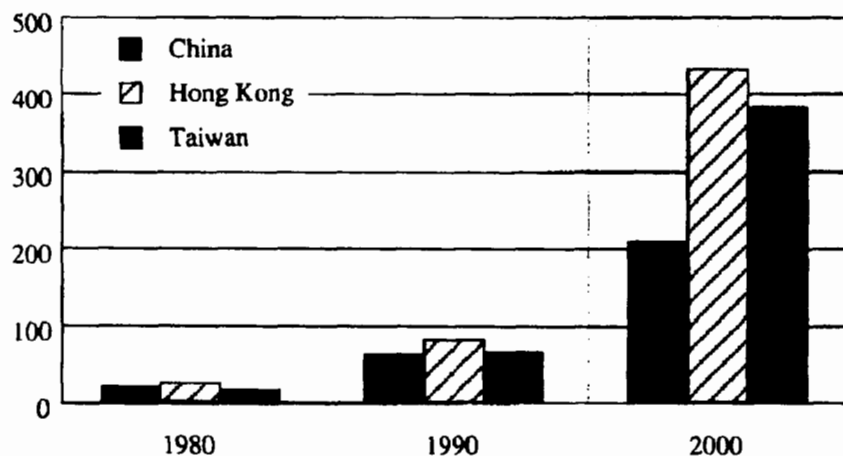
The establishment of the Shenzhen Economic Zone in China's Guangdong province has created a vital free market in the coastal area surrounding Hong Kong. The special economic zones offer foreign businesses lower tax rates and special investment facilities and attract numerous joint ventures, particularly in oil, textiles, and telecommunications equipment. Throughout the rest of the decade, these zones proliferate, strengthen, and grow roots. By the turn of the millennium, Chinese capitalism is alive and well, thriving on the Soviet demise and on Western desires to jump on the Asian Russian/Central Asian economic bandwagon.

MEASURES

- By the year 2000, Hong Kong is serving as the main conduit for Chinese exports. Mainland China's average annual growth rate stays constant due to a lack of infrastructure, while Hong Kong's exports jump from \$82.2 billion in 1990 to \$430.2 billion in 2000. Taiwan's exports increase from \$67.1 billion in 1990 to \$382.1 billion in 2000.

Exporting Becomes Big Business

Billions of dollars



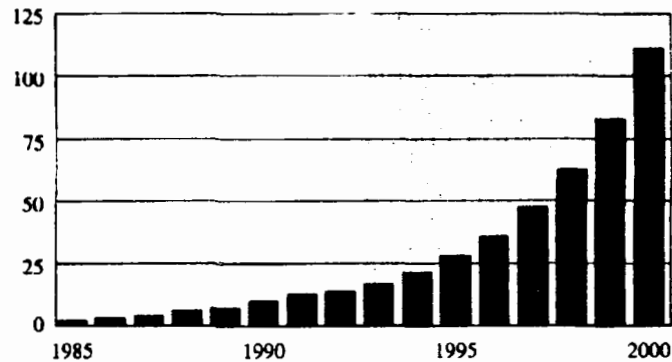
Source: World Bank, *World Development Report*, 1992

- Direct foreign investment in China, via Hong Kong and Taiwan, spirals upward from \$14.6 billion (January to June 1992) to \$100 billion in 2000.
- Taiwan's exports to Hong Kong (as the main entry point to China) have experienced an average annual growth rate of 28% since 1985. In 1997, China becomes a de facto open market, and the average annual growth rate of Taiwan's exports leaps to 33% (see

chart below).

Taiwan Exports to Hong Kong

Billions of U.S. dollars



Source: IFTF; Hoare Govett (cited in *The Economist*, August 1, 1992, p. 30)

IMPLICATIONS

- A weakened China subjugated to a financially strong and influential Hong Kong serves as the economic hub of the proposed Tumen delta trade zone and changes the world balance of power.
- A Chinese-Russian-Korean-Japanese economic alliance completely eclipses the United States and Europe (both too busy with regional preoccupations) and offers an attractive new trading partner for the developing world.
- A new (or strengthened) drug and arms trafficking network emerges.
- The removal of traditional "Great Game" rivalries provided by economic alliances completely changes the strategic politics of the Central Asian steppe, Iran, Turkey, Pakistan, India, Nepal, Mongolia, Tibet, and Afghanistan, not to mention the smaller East Asian countries.
- New areas of investment open up -- particularly in oil services, textiles, printing, dyeing, transportation and infrastructure, apparel, consumer electronics, fast food, and telecommunications.
- Corruption runs rampant on the out-of-control Shanghai and Shenzhen Stock Exchanges, and a whole new spate of sophisticated Chinese Michael Milkens arises (with a little help from Taiwanese, Hong Kong-based, and Western "advisors").

BIG BUSINESS DISAPPEARS³¹²

The era of the large industrial enterprise is over. For the past 200 years, large enterprises have had real advantages because of economies of scale in production, financial clout, and international contacts. But more affluent and educated consumers are changing the character of markets: more purchasers are switching from buying necessities to discretionary items; more products are turning over quickly on the basis of styles and fashion; and more advertising is aimed at individual consumers with tailored products.

New information technologies, with emphasis on quick product turnover and informal alliances, smash the power of the large firm. Medium-sized firms that bring together entrepreneurial and management talent gain access to finance and distribution channels as easily as large companies, and they can turn over products at a much quicker pace. Medium-sized firms using effective partnerships and alliances become the new kings of the hill.

MEASURES

- By the year 2000, the share of medium-sized firms employing fewer than 1,000 people will increase market share by an average of 40 percent at the expense of large firms. The largest gains will be made by manufacturing and distribution firms that provide specialized consumer and business products.
- The rates of new product introductions will increase in consumer electronics, apparel, food selections, autos, home furnishings, communication and office information equipment, and styles of service delivery.

IMPLICATIONS

- The vast majority of the increases in both consumer and business spending is on discretionary items tailored to the needs and tastes of individuals and companies.
- The more successful marketing and distribution channels respond quickly to changing trends among affluent consumers and force very rapid product responses to these changes.

- Partnering and alliances among smaller and medium-sized firms make international operations much easier for them; the share of international business goes up for most successful smaller and medium-sized firms.
- Successful firms can respond quickly to new opportunities with a mobilization of substantial resources.

SERVICES BECOME AUTOMATED³¹³

Rapid development of automated processes in the services industry reduces the number of jobs by more than 20 percent. Over the past few decades, developed countries have relied heavily on the automation of the manufacturing industry. Robots, computer simulation, automated assembly lines, and Total Quality Management (TQM) concepts help increase productivity. With fewer productivity gains in manufacturing, countries look to other industries for the application of these automated technologies. Since the services industry accounted for more than 32 percent of U.S. jobs and 18 percent of the U.S. GNP (second only to manufacturing) in 1990 -- typical for most other developed countries -- it seems ideal for automation.

The automation of the services industry includes automated payments and expert systems in the financial services industry; remote retail shopping from home; customer capability to tailor products through technology rather than people (choosing sizes, colors, styling, pricing, and delivery times without salespeople); and more embedded capabilities in hardware, which reduces the number of software, legal, and business services people. As the services industry becomes more automated, the number of workers needed declines. More automated processes encourage more profitable and competitive companies. As profit soars, the services industry begins to account for a growing share of GNP.

MEASURES

- New automated developments applicable to the services industry are increasingly implemented.
- The number of newly created jobs in business services, financial services, and sales declines as the sales revenue per service worker increases.

IMPLICATIONS

The automation of the services industry enhances the competitive nature of developed countries as some are able to compete more effectively in the short run. In the long run, the number of displaced workers and increasing unemployment undermine the economies of these developed countries. Less developed countries, relying on developed countries for trade, finance, and economic aid, suffer immensely.

A more highly automated services sector requires shifts in education. Not only are advanced education degrees in finance, economics, law, and other curriculum areas necessary to enter this newly transformed industry, but workers with computer robotics, and other technical skills become highly desirable. Service automation provides new opportunities for aeronautics and defense engineers who face a declining industry with government cutbacks.

Intellectual property rights and technology transfers that are intrinsic to the manufacturing industry are issues for the automated services sector.

WOMEN LEAVE THE WORK FORCE³¹⁴

After three decades of constant growth in the number of women in the labor force, there is a turnaround. Tired of the "glass ceiling" effect and the high level of stress at work and home, women begin to put family values ahead of career aspirations. They leave the paid labor force in large numbers, and their participation rate declines to 1970 levels. Fewer women aspire to top management positions in private business, accept mommy-track career pathways, or fast-track in an attempt to break the glass ceiling. Women leave traditionally held "female" jobs such as nursing, teaching, legal, health, and business service positions. The pink-collar work force shrinks drastically. Those women who remain in the work force tend to work for small businesses, especially in the service sector, and for women-owned businesses. Jobs women hold tend to be highly skilled, usually involving strong interactive management skills, orientation toward team work, and open communication.

Many women who turn away from the paid work force pursue other rewarding and productive activities such as volunteering for a wide variety of organizations (educational, religious, cultural/arts, social service, and local enterprises); developing and managing community activities; and participating in local politics, lobbying groups, and other non-labor force activities. As women leave the paid work force, men are forced to be the sole provider for the family. The average male salary rises as career opportunities increase. Because of their high education levels and work experience the women leaving the labor force develop an active network of resources committed to social change, social policy, and improvement in the quality of life. These women form the social and political backbone of most communities; control an effective degree of power in the political and business communities; and are responsible for providing services that are exchanged through the network, ranging from child and elder care to educational and professional advice.

MEASURES

The United States has long been a leader in offering women career opportunities. But the late 1990s see a sharp reversal. In the early 1990s, the labor force participation rate for women reached a plateau and then began to decline. The overall participation rate for women starts to dip into the low 50 percent range in 1997 for the first time in two decades, and the exceptionally high participation rates for baby-boom women really takes a plunge. The high level of participation by women between 35 and 54 falls from the low 80 percentile back to the 1980 level of about 65 percent. By 2000, the average participation rate for women is at a 35-year low of 45 percent.

The major exodus from the labor force is driven by disillusioned baby-boom women, many with children and with high levels of education. Their model of performing other non-labor force activities catches on among younger women in their late 20s and early 30s who remain in the work force for only a few years after graduation.

Several occupations and industries are drastically affected. Between 40 percent and 90 percent of these positions lack workers. The health and education fields feel the most impact as traditional female jobs, such as technicians, technologists, health assistants, and paraprofessionals, lose employees. Professional fields, such

as business and law, also are hurt by a reduced administrative support and paraprofessional work force. Sales workers and sales-related occupations are held predominantly by women, and these occupations feel the employment crunch from fewer women in the work force.

IMPLICATIONS

Smart use of the work force will be one of the key challenges for employers in the year 2000. They will have to reexamine the way they use technology to manage and provide goods and services, the way they hire and recruit new workers, their strategies for continually training and fine-tuning their core work staff, and how they may restructure their organizations to make the most effective use of their employees:

- *Use of labor and integration of technology are management issues of the future.* Fewer women in the work force means that employers must develop ways to integrate technology into their work processes in order to operate with drastically reduced staffs. Companies have to learn to maintain production and increase productivity with a greatly reduced work force. Massive labor shortages may be the driving force that pushes organizations from using information technology only as a replacement for routinized and automated tasks to using it as a tool to enhance workers' decision making, creativity, and innovation.

- *New strategies are required for hiring and retaining.* Incentives, rewards, and career mobility are key to hiring and keeping workers. Educating and training workers to take on new and growing responsibilities will remain one of the more critical challenges for companies to maintain their competitiveness. Women who leave organizations will take their experience and skills with them. Doing more with less will be the mantra of companies experiencing an outflow of women workers. Small core staffs will feel tremendous pressure to perform well and keep up productivity. Training is at a premium, as low-skilled jobs are automated on a wide scale and knowledge work becomes real. Minimally educated workers find themselves without any opportunities in the formal work force.

In addition to management implications, there are other impacts on the economy and society that arise from the decreasing participation of women in the labor force:

- *New definition of work.* Activities outside the traditional "employment" and "paid work" setting become highly valued in society. Local communities and governments get revitalized and take new shape as women devote more time and attention to these institutions. The political and civic power that develops outside of the paid work force creates a new standard for valuing time and effort.
- *Decreasing average household income.* Families that cease to be dual earning team to live within their economic means. Consumption of unnecessary products and services decreases, so marketers need to refocus their selling efforts to consumers who turn away from superfluous purchasing. A new source for resources develops within the women's network.

LIFE EXPECTANCY APPROACHES 100³¹⁵

Progress in scientific and genetic research reaches the stage in the late 1990s where the genes that cause aging can be isolated. A certain number of medical treatments are developed and put on the market. Life expectancy increases by about 20 years.

The percentage of people over 65 rises from 6% of the world population in 1990 to 12% in 2040. Distribution of the population by age bracket undergoes a fundamental change as the result of this sharp increase in life expectancy.

It is, nevertheless, the relationship between the working and non-working populations that is of concern. In fact, medical progress makes it possible both to extend the duration of life and to modify the physical and intellectual capabilities of individuals. This affects the life cycle and delays all the principal stages of life (puberty, menopause, and so forth). Thus, an increased life span does not constitute a social catastrophe. The challenge is limited to coping with a difficult period of transition before arriving at a new balance.

MEASURES

- *Rising population growth in developed countries.* This goes toward reducing the discrepancy that currently exists within the southern hemisphere. The situation becomes easier to bear in the developing countries since the reduction in mortality in part filters

through to these countries, and the prospect of living to an older age leads to a reduction of the birth rate.

- *Pensions finance housing and health.* The number of working age people is not large enough to guarantee decent provisions for elderly people, so to a greater extent, they would have to finance their own pensions. The transfer of housing by succession drops off considerably, and a serious housing shortage results. Other serious consequences, such as the financing of the health care system, soon make the situation unsustainable.
- *Reorganization of the life cycle.* The effect on our state of health allows a lifestyle at the age of 70 that is currently enjoyed at the age of 55.
- *Prolonging working life.* We work from age 25 to 85, so a new form of job sharing takes shape to avoid unemployment and inactivity. It is almost impossible to do the same job for 60 years, so in-company training and reorientation make great advances and become the main considerations of educational systems.
- *Shifts in family life.* It is unlikely that the housing shortage will lead to a regrouping of generations under the same roof, especially when prolonging life expectancy by about 20 years would lead to four generations living together. Female fertility lasts to age 60, so many births often are planned for about the age of 45 or 50. Moreover, life becomes a sequential process. Divorces multiply since it is inconceivable to some people to live 75 years with the same person, and parental relations become complex.
- *Widening of the generation gap.* Dealing with the demographic transition becomes the primary short-term objective. It leads to a new balance between the working and non-working populations and between generations, since the age spread of the latter would be increased (having a first baby at the age of 45 or 50 is no longer exceptional).

IMPLICATIONS

The aging of the population alters the relationship not only between the working and non-working populations, but also between young and old within the working population. The theory of human capital states that individuals accumulate a certain core of knowledge in the course of their career, and the increases in remuneration only reflect this acquisition of skills. The seniority model goes further, claiming that remuneration is lower than

labor productivity for the youngest employees, higher for the longest standing, with the latter benefiting from the rights of seniority they have acquired during the first half of their career. This model is viable as long as the differences between productivity and remuneration balance each other out. The increased age of the staff leads to a worsening of companies' balance sheets. It therefore is indispensable, according to this scenario, that the accumulation of human capital be reflected in a major increase in productivity.

We can expect a series of crises initially in the domains of public finance, pensions, or possibly housing, and then a second phase when new equilibrium is attained. For example, with 80 years to plan for, we could imagine new attitudes toward the payback of investments, which would be realized over a much longer period of time.

The new opportunities outweigh the transitional difficulties. The burden of the elderly does not become too great; the predominance of mentalities hostile to change does not occur. The quest for adventure and the joy of creating remain.

THE END OF INTERGENERATIONAL SOLIDARITY³¹⁶

The steady medical progress made in all countries of the world, especially in the OECD countries, has considerably improved life expectancy. This increases the proportion of elderly people in the overall population. At the same time, the drop in fertility observed in rich countries decreases the proportion of young people in the population, compounding the aging problem. The combination of these two phenomena radically changes the pyramid in the developed countries and becomes recognized as a demographic revolution.

Age differences cause a new set of conflicts. Older people are frequently rich and white. The generation conflict is becoming more intense and is crystallizing around three age brackets. The first group consists of young working people who often are recent emigrants suffering from cultural and economic disadvantages. At the other end of the scale, we find pensioners who hold on to their advantages: the "Grampa Bust." The middle group consists of the baby boomers who, because of their hedonistic desires,

want to reduce compulsory contributions. Baby boomers are concerned about their approaching retirement, and they are in an arbitrator position because of their economic and social power.

Thus, without causing abrupt changes, the baby boomers have gradually reduced the material and moral conflict of older people while trying to prepare for their own future within the limits of the economic and social situation.

MEASURES

- *Pension financing is a headache.* Most OECD countries finance compulsory pensions by the so-called sharing-out method (a formula by which pensions are financed by the contributions from the currently working population) rather than by capitalization (whereby the actualized value of all contributions for one age group is equal to the benefits it will get in the future -- a system similar to insurance). Because these contributions are almost always charged to payroll costs, the future rate of such contributions increases excessively (see table below).

Contributions Required for Public Pensions Financing

(Percent of wages)

<i>Year</i>	<i>United States</i>	<i>Japan</i>	<i>Germany</i>	<i>Sweden</i>
1990	12.1	4.5	13.6	15.8
2010	12.0	12.9	18.6	16.3
2030	12.3	19.8	29.3	21.0
2050	16.4	23.0	28.9	20.1

Source: *Economie & Statistiques* N° 233, June 1990

- *The average age of the working population goes up.* Wage agreements provide varying levels of higher wages as age increases, despite a drop in the retirement age. Thus, the average salary will increase, lowering corporate profits.

- *Social security systems are affected.* The cash difficulties of health insurance and unemployment funds are already increasing. An increase in the number of older people means more treatment, care, and supervision expenses, exceeding the potential savings of a decreasing younger population.

- *The drain saps the vitality of developed countries.* Lower inventiveness -- mathematicians are creative before they turn 30 -- and the difficulty young people have in obtaining responsible corporate positions, because of the large number of older managers, will help to stifle society and foster social antagonisms based on age differences.

IMPLICATIONS

Three remedies are implemented simultaneously to check the money drained by pension funds. Systems and acceptance differ from country to country:

- *Reduced benefits.* The reduction of services is organized gently and gradually. Under-indexation, compared to the rising cost of living, higher user fees, and higher income taxes, are burdening real income while superficially avoiding nominal income by factoring inflation.

- *Postponed retirement.* People are encouraged to create savings funds, the effectiveness of which becomes apparent after many years when the large class of baby boomers reaches retirement age. The age at which people can retire with full benefits is regularly increased.

- *Higher taxes.* The contributions by the working population are increased substantially.

None of these remedies prevents the material and moral conflict of older people from deteriorating compared to the existing situation. As a result of the generation conflict, older people are more frequently shunted aside, losing income or getting stuck in long-term unemployment. Some older people, veterans of the struggles of the 1960s, organize clandestine structures ("White Panthers" in the United States, "Roten Armee Fraktion" in Germany). Most withdraw into an ivory tower and decide to "eat it all." The disappearance of inheritances causes serious difficulties for young people struggling to improve their standard of living. The old-boy network of parents from the upper classes giving children their first job opportunities breaks down.

Deprived of the dynamism of a young working population, developed societies witness stunted economic growth while their world leadership is challenged by more authoritarian continents. China, which for thousands of years has been able to combine the dynamism of its merchants with the static structure of its family

system, shows a remarkable capacity to recover domination of the world. The decline of the Roman Empire surely began the same way. As the old African proverb says, "We don't inherit the land of our parents, we lend it to our children."

GERMANY MOVES EAST³¹⁷

With German reunification and the end of the Soviet Union, threats that were the basis of Europe's system of cooperation are dissolved. For most, the potential for a large-scale European war has been laid to rest. Thus, the stage is set for this newly created power vacuum to be filled by historical forms of international relations. The concept of a single Europe acting as one entity becomes an unnecessary contrivance in the midst of new economic realities. The new reality is that of Russia as partner, both politically and economically, rather than as adversary.

While maintaining a weakening link to the EC, by 1997 the German state embarks on an alliance formulation with key members of a revived Commonwealth of Independent States (CIS). This alliance focuses primarily on energy, infrastructure, and technology, and it is characterized by Germany as the big link between the EC and Eastern Europe. This preempts any efforts by Japan and the United States to partner with Russia.

Through this strategy, Germany becomes an economic member of both the CIS and the EC. The continuation of political linkage enhancement within the EC is virtually halted by this alliance, leaving the other EC partner states in a prolonged holding pattern. Germany's bargaining position within the EC and internationally is unrivaled.

MEASURES

- The level of German investment in the CIS goes well beyond that offered by the United States and by the EC.
- The German GDP begins to grow at a rate higher than the EC average.
- German investment becomes a major component of total CIS investment.

IMPLICATIONS

- *The uncertainty of the international business community results in a period of low international investment. While new customs and rules are sorted out, the economies not affiliated with the new trading blocs are devoid of investment.*
- *All EC members return to a national economy. This results in localization of all finance policy to the exclusion of the centralized structures of the EC.*
- *The open market gradually closes as national barriers resurface in the wake of the new balance of economic power. EC members excluded from the new trading blocs return to a historical version of the national market.*
- *Changes within the EC eventually result in a reevaluation of investment in Pacific Rim activities. The United States and Japan are strengthened by this return of investment and increase cooperation to combat the threat of a complete shift in global capital to the new alliance in Europe and the CIS.*
- *Investors in southern European countries lose interest, creating large holes in the economies of southern Europe and leading to greater political unrest.*

SIGNIFICANT POSITIVE REACTION UNLIKELY; EARLY INDICATORS AVAILABLE

Crosscuts

BACKLASH AGAINST AIDS VICTIMS AND LIFESTYLE

At the same time that the Boomer generation should begin becoming more conservative, reacting against the frustrations of policies and structures that haven't been working, the brunt of the AIDS epidemic will be hitting the U.S. What before then had been a relatively small (in the opinion of most Americans) sprinkle of deaths, will grow into what seems to be a thunderstorm.

The stress on the health care system will be very great and may further threaten an economy that at that point is ill from a combination of others blows (natural disasters, insurance company failures, restructuring around the information technology revolution,

etc.) Americans will be looking for relief and solutions and see the deluge of AIDS costs as a major cause of the problem.

The growing profile of the new paradigm tenet, that individuals are responsible for their own situations, will nest snugly with the similar emerging Boomer conservatism and may translate into a backlash against AIDS victims and the lifestyle that is thought to encourage the disease.

AFRICA UNRAVELS

If the situation in Africa looks bleak in 1992, the high rate of population growth and slow to negative economic growth in the region suggest disaster before 2025. Without coordinated international efforts, Africa will be a teeming wasteland by 2025, an incubator of global plagues, and a harbinger of poverty and great military violence.

Africa's average growth in GNP per capita over the period of 1979-1989 was less than 1.7 percent. Unless measures are taken to increase average annual GNP growth rates in Africa above 3 percent, GNP per capita will plunge much lower than it is today.

While Africa had only 56 percent of the population of Europe in 1950, by 2025 they will have over 300 percent of the population of Europe.

The pressure upon most African environmental systems will be extreme because net capital flows will be, beyond doubt, insufficient to pay for imported energy and environmental technology. The developing world relies upon bulk commodities to trade for hard foreign currency, and Africa's problem is that they are suffering from severe commodity deflation. For instance, in real dollar terms, a market basket of food items in 1989 cost only 61 percent of its cost in 1975. Timber, on the other hand, climbed on world markets, in real dollar terms, by over 80 percent in that period. Net result: logged off forests, floods because water run-off is so rapid without trees, and declining revenues from food productions. Tropical forests are being decimated for firewood.

Because of high levels of debt and reduced commodity revenues, African nations will greatly suffer in the 1990s. The world's capital crunch is impacting the African continent more than is immediately obvious. Because of lack of capital, transportation

infrastructure will remain very inefficient for food distribution. Mass starvation on an unprecedented scale could result.

As agriculture fails (due to war, depleted soil, and inability to afford fertilizers) a resultant migration of large rural populations to squatter communities near urban centers will put severe strain on urban political systems, water supplies and sanitation systems (such as they are). Disease and political chaos will result. Millions will die of AIDS.

GENOME PROJECT KILLS HEALTH INSURANCE³¹⁸

Enormous predictive capabilities result from breaking the code of the human genome. A blood sample of an infant will allow the analysis of about 100 selected genes for flaws known to be pre-diagnostic for certain diseases. A potential life history of the person's health will be available at the push of a computer button. If a complete genetic map were available from every person, is it not reasonable to assume that mandatory genetic screens would be standard before employment-based health insurance was issued? Further, would a job be offered those with less than optimal genetic makeups, or jobs and insurance be offered while denying coverage for those diseases that the individuals' genetic maps indicate they are most likely to get?

It seems likely that, armed with this information, insurance companies will sell their services to those with the least risk for one price, and those with the most at another.

The genome project, therefore, raises the specter of differentiating our insurance groupings according to an assessment of genetic risk, a specter so unpalatable and unjust that our society could not tolerate it. A new system will necessarily evolve that provides access to anyone who is sick or who needs appropriate preventive services.

MAJOR INFORMATION SYSTEM DISRUPTIONS

The Clearing House Interbank Payments System, owned by 11 big New York banks, is an international computer network that automatically transfers more than \$ 1 trillion -- more than the entire money supply of the United States -- throughout its system each day. Similar extraordinarily complex computer systems control regional and national telephone systems, electrical grids,

global stock and commodity trading transactions and other similarly important functions.

The complexity of these systems is accelerating -- probably exponentially, like the rest of the information technology area -- and therein lies the probability that there will be more, bigger system failures in the future. Already whole areas of the country have lost long distance telephone service because of program bugs.

As these systems expand, so does the opportunity for crime and mischief, if not just mistakes -- all pointing toward more breakdowns.

Wild Cards

THE NEW CHERNOBYL³¹⁹

Nuclear energy is a key part of Western European energy policy, particularly in France. In 1995, a nuclear accident occurs in the Soviet-built reactor of Bohunice in Slovakia. This fulfills the prophecies of pessimistic experts who feared such a serious accident in the RMBK and VVER 440-230 models -- the oldest and most unsafe power stations built in the former USSR.

Fueled by media broadcasts that followed the path of radioactive clouds above Western Europe, the disaster defines nuclear power plants in Western opinion as "an unacceptable hazard." Pressure from a frightened public, led by rising Green parties in Germany, Scandinavia, and some small countries inside the EC, causes industrialized countries to totally abandon nuclear power.

MEASURES

The debate on nuclear safety is fierce. Most scientists stress the advantages of the non-polluting nature of nuclear energy, as it is free from fossil fuel threats to the environment, acid rain, and global warming. But people's fears, increasing since the 1970s, are stronger about the problems of nuclear waste disposal and the possibilities of large-scale accidents (see table below).

Europeans Turning Against Nuclear
(Percent of respondents)

<i>The Cleanest Energy</i>	1984	1989
Renewable energies	52	43
Natural gas	18	21
Nuclear	10	10
Coal	9	7
Oil	4	2
No answer	<u>8</u>	<u>18</u>
Total	100	100

<i>Nuclear Energy</i>	1984	1989
Unacceptable danger	38	52
Without interest	7	6
Worthwhile	43	30
No answer	<u>12</u>	<u>12</u>
Total	100	100

Source: European survey for the EC Energy General Director, Energy and Environment, 1982, 1984, 1986, 1987, 1989

- *All industrialized countries must revise their patterns of energy usage.* Increases in nuclear use and development programs are stopped. There is a strong push for a nuclear moratorium aimed at an immediate shutdown of plants worldwide. Most shaken are the countries that implemented ambitious nuclear development programs: France, Belgium, and Japan.

- *A dramatic political test for European cohesion.* The conciliatory solution advocates a balanced dispatching of shortages in Europe. But implementation creates a crisis; France unilaterally decides on an extended closure program lasting 15 years. Lack of solidarity results in a cacophony, and closure programs are voted on case by case, depending on the share of nuclear power of total energy production in each country. This occurs quickly in the United States and slowly in France and Japan.

IMPLICATIONS

The worldwide uproar depresses financial markets, reactivates aggressive trade practices, and brutally breaks the momentum of

the global economic recovery. Economic activity is depressed by the energy shortages. Vast campaigns promoting energy conservation are launched with some success as they meet the ecological concerns of the public. Of course, research on innovative solutions, especially on renewable energies, receives more credit. But because new energy sources – geothermal, wind, thermal solar power – will not be available until after 2020, they do not represent a reliable short- or medium-term answer.

- *Oil is market-regulated.* A sharp rise in oil prices gives new negotiation power to the oil-exporting states.
- *Natural gas is popular for being the less-polluting fossil fuel, but production limits global growth.*
- *Coal, with its 200- to 300-year-old reserves, emerges as the great solution to the nuclear crisis.* Boosted activity goes along with progressively cleaner technical processes. In particular, fluidized bed combustion and combined cycle turbines with gasification are the big winners.

THE BALKANIZATION OF WESTERN EUROPE³²⁰

Long before the introduction of the nation-state, Europe existed as a set of culturally distinct regions. These regions merged into the conceptual tool of the nation-state as a hedge against economic and political danger. The security of the national borders was viewed as far superior to those of the regions. This concept was extrapolated to the construction of the EC for similar reasons. The EC offered economic and political security.

By the year 2000, the regions of Europe decide to dismantle the nation-state in favor of strong regional representation in the EC. The EC still is seen as necessary to protect the interests of its founders, but the nation-state as an intermediate step in the hierarchy of decision making has been obviated over time. The EC is less threatening to regional values when the nation-state is removed. The cost of two, often-competing, centralized interests is no longer acceptable.

The motivation for this activity emanates from grassroots movements throughout the European regions. In much the same way as the restructuring of the late 1960s was brought on by a struggle

of values, this European regional revolution is fought from common interest rather than from a desire for competitive advantage. In areas formerly boasting little or no indigenous local culture, there is a new tendency to invent a locality of cultural identities. These identities strengthen in all regions.

MEASURES

- National parliaments dissolve in favor of regional and European parliaments. The regionals become the key administrative units.
- The regional revolution has its basis in cultural activities. Thus, most economic issues are decided at the EC level. The key issues dealt with at the regional or decentralized level include culture, art, education, local planning and infrastructure, local environment, health, and social security. All other matters are addressed at the EC level.
- A new series of economic alliances forms across old national borders. These alliances initially will be based on common cultural or religious compatibility and involve a common regional activity -- for example, fishing, shipping, agriculture, heavy industry, or national resources. They are not operated on a basis of exclusivity but on economic complementarity. Most regions carry on multiple trading/production arrangements with multiple patterns. The grid is quite large and multidimensional.

IMPLICATIONS

- The open market functions more efficiently than it did as a national/EC unit. Regional trading strengthens both local and European economies.
- The lack of national power structures results in the oppression of minorities within regions. These conflicts are addressed by the EC, but response is slow. Minor conflicts arise at a greater rate than under the national structure. The conflict resolution within the EC is initially one of mediation and arbitration, followed later by internal peacekeeping forces.
- Most companies must adapt their infrastructure to the regional trading concept. The necessity for regional representation in all departments requires a more political allocation of funds.

- The European decentralized system becomes a model for sustainable structural change in the southern hemisphere.

CHINA FINANCIER TO THE WORLD

In 2002, China, having already taken its place in the G7 some years ago and quickly on its way to becoming the largest economy in the world, unleashes its great resource of saved capital and become the world's principal source of financing.

MEASURES

- Through the last seven years of the '90s, China's economy continued to grow at the rate of 8 to 10 percent annually.
- The Chinese people continued to maintain the second highest saving rate in the world, close behind the leader, Liechtenstein.
- The Chinese version of capitalism flourished during the decade of the '90s and the government of China became more liberal after the death of Deng.
- The U.S., Japan and Europe continued to economically muddle through the last half of the '90s without any strong economic showing on the part of any of them.

IMPLICATIONS

- China becomes a major global economic and political influence.
- China begins to take significant equity positions in Western companies and uses its influence to draw the leading high technology to itself.
- China is the biggest market in the world for consumer products.

Global Incoherence

In the *Global Incoherence* future, "the sum of all fears is realized." It is a "world adrift -- lacking leadership and the motivating vision of the future that can propel societies forward. The weight of

the past proves more powerful than the inspiration of any potential future.

SIGNIFICANT POSITIVE REACTION POSSIBLE; EARLY INDICATORS UNLIKELY

Wild Cards

OFFICIAL CONTACT IS MADE WITH EXTRATERRESTRIALS

A team of volunteer researchers makes active contact with a UFO and videotapes the initial interchange with the extraterrestrial crew aboard their ship in 1995. The tape is widely broadcast around the world. The media, in following up the story, determines that this event is the culmination of a sophisticated international, multi-year strategy of a U.S.-based nonprofit group that has resulted in a number of earlier UFO contacts of increasing levels of interchange.

MEASURES

Although the mainline press had not lent much, if any, coverage to this story before its landmark event, after-the-fact research establishes that there had been a well-organized international network of UFO researchers who, since 1991, have been actively attempting to initiate the first official contact with extraterrestrials. Using a sophisticated strategy and unusual techniques, small teams from an international group of over 400 trained persons first initiated contact with UFOs in 1992 when they were successful in drawing ships into their immediate neighborhoods in Florida and England, getting them to hover overhead, change their flying formation, reply to light signals, and in one memorable case, hover within 100 meters of the team.

After the initial encounters, the group's leader had been invited to a meeting with a very high White House official who had confirmed that the government had, for some time confirmed UFO activities, most significantly from photographic data received from U.S. surveillance and reconnaissance satellites.

A much higher profile, government sponsored initiative had been launched in 1992 which had focused on using radio telescopes for listening in deep space for signals from other civilizations. This

project, supported by an international group of well-known scientists, had so far, not produced any significant results.

IMPLICATIONS

- *Pockets of wonder; pockets of panic.* For many in the majority segment of people in industrial societies who believe that UFOs are real, this event, though disquieting, was seen as opening up the window to a whole new world and reality full of immense questions -- but not at all necessarily negative. There was wonder and questioning in the context of a desire to solidify relationships and learn more from these strange "people."

At the same time, pockets of people (and some governments) reacted as though acutely threatened. The assumption was that these beings were coming to take over, or unduly influence the world and that the appropriate response was to quickly build up corporate and individual defenses.

- *The world is shaken.* All societies with access to television are transfixed by this event. Never before seen levels of global excitement and anxiety are experienced. The implications of this event causes an ultimate change in most every aspect of life on earth.

- *Conservative theologians search for answers.* One of the hardest hit groups are conservative religious organizations, for whom this event does not fit into their relatively narrow explanation of reality. This, perhaps the biggest event in recorded history, causes religious leaders to scramble to explain (and in some cases, modify) theology to fit this new situation.

- *New technologies give hope.* Although some groups see the benefit of the new visitors in terms of new technology that can be made into weapons, many others see it as a hope for solving some of the very serious, intractable problems the world is confronted with at that time. Energy production is of particular interest.

SIGNIFICANT POSITIVE REACTION UNLIKELY; EARLY INDICATORS AVAILABLE

Crosscuts

MAJOR SHIFT IN GLOBAL WEATHER - U.S. INSURANCE INDUSTRY FAILURE

Changes in the world's weather and increased natural disasters could easily come together to deliver a knockout punch to the American (and probably international) casualty insurance industry. Nineteen ninety three was the worst year for claims in the history of American casualty insurance, most losses being the result of natural disasters.

Additionally, the social conditions within which the Los Angeles riot occurred (another big casualty loss), continue to exist and are getting worse as the disparity between the American haves and have-nots increases. If the economy does not respond to the stimulus of 1993 and produce significant new jobs, the possibility of additional urban unrest is not remote.

If hurricanes, earthquakes and volcano eruptions increased and produced significant damage to developed areas [a big California quake could produce \$60 billion in losses] the industry would likely fail.

TECHNOLOGY INCREASINGLY GETS OUT OF HAND

The extraordinary capabilities which technology is offering to society could well get out of hand because we were not able to control it or use it effectively. Already, for instance, experts are warning that our technical expertise may be advancing more rapidly than our ability to manage genetic information. Amniocentesis, widely used to detect genetic abnormalities in developing fetuses, also reveals the baby's gender, and doctors report a surge in the practice of eliminating children of an undesired sex through abortion.³²¹

Any number of other evolving technologies will become helpful or not, based upon the values of the people who develop and use them. Because the technology is moving so fast, it is clearly possible that there will be a increasing instances of technology being used negatively, and in ways not anticipated during development.

THE POOR KNOW THEY ARE POOR AND GET WEAPONS

Unlike anytime in the past, as the result of television poor people understand how poor and disenfranchised they are. At the same time, the weapons manufacturers of the world are actively

attempting to open new markets for their wares to offset the significant decrease in market associated with the end of the cold-war. Nuclear weapons are also reported to be beginning to leak out of the former Soviet Union into radical hands.

On a smaller scale, this trend can be seen in urban groups in our own country: the most disenfranchised are the most well-armed.

This all suggests that increasingly more poor people will have the perceived reason and means to threaten others -- and will probably do it.

HARD TIMES FOR THE FISHING INDUSTRY

As outlined in the environmental section, the global fishing fleet has increased its catch systematically from 22 million tons in 1950 to 100 million tons in 1989. When catches plateaued in the '70s, larger-yielding fishing techniques, including higher technology sonars and the use of driftnets, were instituted to restart the growth again in the 80's. These larger and larger catches threaten many commercially important fish species and have forced fishing fleets to pursue far less valuable fish -- because that is all that is available.

At the same time, the destruction of habitats and breeding grounds by coastal development, nutrient contamination of offshore waters from industrial effluents, agricultural runoff, ocean dumping and litter contribute to the decrease in sea life. From 1980 to 2000, coastal urban populations are expected to increase by 380 million -- about the 1990 population of Canada, the United States and Mexico. The U.S. has already lost over 50 percent of its coastal wetlands. Italy had lost over 95 percent of its historic wetlands by 1972.³²²

Thirdly, ozone depletion is certain to increase in the coming years (because of CFCs already in the atmosphere) and may well begin to affect the phytoplankton, on which the ocean fishing industry is ultimately dependent.

The fishing catch has already begun to fall, [down 4 percent in 1990 alone], which may be a harbinger of much worse times for commercial fishing in the future.

Wild Cards

A LOSS OF FINANCIAL UNDERPINNINGS³²³

By 1995, there is a sharp reversal of the trend toward increased international financial interdependence that we have experienced during the past 40 years.

It is heralded by the complete collapse of the Japanese property market after rampant inflation. Even the Japanese have trouble meeting international payment obligations. The Japanese repatriate foreign investment at an incredible rate. The wide currency swing leads to a new era of mistrust. In the United States, this lack of trust leads to cries for a protectionist trade policy; it is compounded by the failure of the European Community (EC) to ratify the Treaty of Maastricht.

Investors lose all confidence in the concept of international enterprise, which creates a credit crisis in a wide range of dependent institutions. This financial crisis, in combination with falling material prices in industrialized countries, leads to unemployment rates of more than 15 percent in all OECD countries.

The "pull back to the border" mentality that is instilled by this immediate lack of international confidence acts to heighten an already notable return to nationalist policy and isolationism. There is a push for returning to the gold standard and away from electronic money. This move is also based on a newfound lack of trust in anything associated with international relations.

MEASURES

- Japanese property values continue their plunge.
- The Japanese foreign investment figures drop by more than 15 percent annually.
- Total international lending drops 3 to 4 percent each year through the 1990s.
- German public debt increases dramatically until the year 2000.
- Unemployment rates in OECD countries rise an average of 1.5 percent annually from 1992 levels.

- OECD growth figures reflect a drop to less than 1 percent for the latter half of the 1990s.

IMPLICATIONS

- The legislative output from the mid- to late-1990s reflects a new era of national priorities. Trade legislation to limit the importation of Japanese and other foreign goods is passed by the United States and the EC, and new financial controls on capital flows are planned.
- Corporate reaction to the changes are reflected in the immediate downsizing of operations to account for the loss of a global market. In the United States, there is a new age of domestic strategic alliances. The antitrust laws are restructured to allow for a more cooperative "Japanese" model to emerge. The year 2000 sees the advent of U.S. domestic business groups. This new domestic alliance mentality results in a renewed capability for internationally competitive development and production.
- In Japan, the unemployment problem causes more internal strife than the country has seen since 1947 and results in three changes of government between 1995 and 2000. The cycle of low growth is perpetuated by domestic unrest.
- In the EC, the problem is unemployment, which already had been high prior to the collapse of international flows.
- By the year 2000, there are wild fluctuations among world currencies.

U.S. ECONOMY FAILS

In 1996, after three and a half years of attempting to fight off both short-term and long-term attacks on the U.S. economy, the conventional mechanisms fail to have any effect and hyperinflation takes over. Because of the size of the federal debt and its interest cost, funding for government shrinks to a fraction of what it was just two years earlier and a wholesale run begins on the entitlements that had previously been politically "fenced," and unavailable.

MEASURES

- *The federal budget deficit continues to grow during 1993-96. Attempts to build a serious bipartisan attack on growing budget deficits fails. Growth in programs more than offset savings from cuts and increased tax income. Debt service consumes 70 percent of the total tax revenues of the country.*
- *Attempts to redesign the nation's health care system end with a poor compromise between the providers and government. Threatened with a significant decrease in income, drug companies, hospitals, physicians and others in the health care industry drag their feet and refuse to go along with significant system reform. A compromise is worked out that holds costs from rising significantly, but makes no material cuts in the nation's cost of health care.*
- *An increase in natural disasters strikes a body blow to both government and industry. A major earthquake in California, a number of East Coast and Gulf Coast hurricanes, and the explosive reactivation of Mount Rainier come together with significantly increased flooding that accompanies much stronger thunderstorms to bankrupt the casualty insurance industry and put significant pieces of the U.S. economy out of business. Federal government disaster relief funds are exhausted.*
- *The AIDS epidemic begins to peak, with 50,000 or more deaths per year. The dramatically increasing costs of tending to the rapidly escalating AIDS death rate, then \$15 - 20 billion yearly, offsets any savings that the health care reform process produced.*
- *As the economy stagnates, failing corporations bankrupt the Pension Benefit Guaranty Corporation. The federal government is forced to come up with \$40 billion of the over \$90 billion of the unfunded guarantees that the PBGC has amassed.*
- *The trade deficit increases 50 percent. China's economy continues to grow at 8 percent per year and it overtakes Japan as the country with which the U.S. has the greatest trade deficit. The combination of Japan's slowly rising and China's rapidly rising exports increases the U.S. trade deficit almost 50 percent.*

IMPLICATIONS

The domestic and international implications of this scenario are all negative, in most cases very much so. Not only would the U.S. economy be in extraordinary trouble, but such an event would shake, if not mortally wound, the global economy as well.

THIRD WORLD EXODUS³²⁴

By the year 2000, the economy of the developed world has cured itself of the recessionary tendencies evident during the 1990s. The GATT talks have resulted in a world trade agreement more equally balanced among North America, Europe, and Asia. With the newly revived global economy comes an even greater disparity between the developed countries and the less developed countries. The latter, still struggling with very high population growth and low per capita income growth, are no longer able to hold their people back from the economic carrot of the North. The result is a mass exodus.

The Mediterranean becomes a veritable flotilla. The borders within Africa crumble into a patchwork of armed conflicts and emigration toward Europe. The economic and ethnic conflicts in Eastern Europe and the former Soviet Republics result in a similar, albeit smaller, influx of refugees to Western Europe. In Southeast Asia, there is a rerunning of the Vietnamese exodus, but at levels 1,000 times greater. The economically viable regions of Malaysia, Indonesia, and Thailand are overrun by this en masse migration. In North America, the Mexican borders are compromised from all angles with a spill over into the United States and Canada

These alien landings can no longer be held back by traditional border controls on entry roads and at airports. The desperation of the fleeing masses will be completely unanticipated, weakening the effectiveness of the response.

MEASURES

- Per capita GNP growth rates in less developed countries are barely measurable.
- Per capita GNP growth rates in developed countries are between 3.5 percent and 4 percent.
- Population growth rates in less developed countries continue to rise during the 1990s.
- There is a distinct rise in the incidence of illegal alien populations along the fringes of the industrial world in Mexico, Southern Europe, and Malaysia.

- There is an increasing integration of traditional military activities into border patrolling and planning.

IMPLICATIONS

Initially, there will be mass incursions -- of the Normandy type -- by residents of poor countries. Lacking any other quick-fix solutions, this will require a military response. The brutality of responding militarily to economic hostility will not play well in developed countries. The media will be sending visuals of a new holocaust to the developed countries. Global public opinion requires a more humane and lasting solution. The failure of such a solution will allow this conflict to progress into the major cities of the industrial countries where it will cause the absolute destruction of state-supported social services. The consequence to the North is the very destruction of its isolated economic system. The weapon of developing country population growth has proved more effective than advanced military technology in the battle for effective global policy.

There will be an immediate multilateral conference and agreement among developed countries to sacrifice growth for the effective placement of development aid into the less developed countries. The range will be up to 9 percent of GDP. This will be seen as the only method by which a seemingly endless global North-South conflict may be averted. The cost to the developed countries will be small compared to the essentially continuous state of the global emergency having emerged as a consequence of the economic disparity between North and South. This will be the first truly effective policy of development aid, involving total developing country debt relief as well as a revision of all archaic infrastructures.

URBAN TERRORISM COMES TO THE U.S.³²⁵

America has lost its national cohesion, the family is fragmented, the pace and complexity of life is increasing, there is increased loneliness and ever encroaching impersonal technology along with eroding moral standards. All tend to push those who are on the edge, over.

If the U.S. domestic economic situation is not controlled, the federal deficit could get out of hand, the government monetizes the debt, we have hyperinflation, millions of people lose their jobs,

and we're back into a '30s-style crash. But this time it would be a lot worse. There are more people, there's not the cohesive effect of shared spiritual/moral beliefs, a greater percentage of the population is near the breaking-point, and even in "good" times the anxiety level is extremely high.

In such a "crash" climate, one can imagine desperate inner city minorities having nothing to lose in organizing and carrying out of urban guerrilla activity against established authorities and commercial interests. It is a latent state that already exists in many of the hard-core inner city areas.

SIGNIFICANT POSITIVE REACTION UNLIKELY; EARLY INDICATORS UNLIKELY

Wild Cards

NUCLEAR TERRORIST ATTACK ON U.S.

In 1996 a container ship brings a small nuclear device into New York harbor hidden in one of 700 containers on the ship. It is detonated by remote control, spreading a radioactive cloud of water over all of New York city and Eastern New Jersey. An Islamic Fundamentalist organization claims responsibility for the blast, citing America's bias toward Israel in the latest U.N. vote on the settlement of the West Bank.

New York city panics, and closes for months, if not years.

MEASURES

- *It is confirmed that tactical nuclear weapons were sold by former Soviet republics to Middle East buyers in 1992-3.*
- *The global economic have, have-not disparity increases.*
- *U.S. society makes a social decision that runs counter to deeply-held Islamic teachings.*

IMPLICATIONS

- *Extraordinary blow to the U.S., its economy, and its national psychology.*
- *A very serious, if not mortal blow to the global financial system. New York is the largest node in the global financial system. If it, and the financial institutions located there were to suddenly be*

eliminated from the larger system, it would be extremely damaging.



Notes:

- ³⁰⁴*Wild Cards: A Multinational Perspective*, Bipe Conseil - Paris; The Copenhagen Institute for Futures Studies; Institute for the Future - Menlo Park, CA; used with permission
- ³⁰⁵Stephanie Bardin, Institute for the Future - Menlo Park
- ³⁰⁶Arvind Khilnani, Institute for the Future - Menlo Park
- ³⁰⁷"Many Americans Say Genetic Information Is Public Property," *The New York Times*, September 29, 1992
- ³⁰⁸J.D. Rockfellow, Institute for Futures Studies - Copenhagen
- ³⁰⁹J. Ian Morrison, Institute for the Future - Menlo Park
- ³¹⁰Bruno Delemotte, Bipe Conseil - Paris
- ³¹¹Jennifer Wayne, Institute for the Future - Menlo Park
- ³¹²Gregory Schmid, Institute for the Future - Menlo Park
- ³¹³Nancy Vattuone Ozawa, Institute for the Future - Menlo Park
- ³¹⁴Andrea Saveri, Institute for the Future - Menlo Park
- ³¹⁵Laurent Pouquet, Bipe Conseil - Paris
- ³¹⁶Phillippe Cuneo, Bipe Conseil - Paris
- ³¹⁷Roy Jensen and J.D. Rockfellow; Institute for Futures Studies - Copenhagen
- ³¹⁸Bulger, Roger J.; "How the Genome Project Could Destroy Health Insurance," *The Washington Post*, August 4, 1991
- ³¹⁹Stephane Remy; Bipe Conseil - Paris
- ³²⁰Roy Jensen and J.D. Rockfellow; Institute for Future Studies - Copenhagen
- ³²¹"Brave New Genes," *OMNI*, January 1992; p. 14
- ³²²*World Resources 1992-93*, [Washington, DC: The World Bank, 1993] p. 177
- ³²³Economic Staff, Institute for Futures Studies - Copenhagen
- ³²⁴J.D. Rockfellow, Institute for Futures Studies - Copenhagen
- ³²⁵Wishard, Wm. Van Dusen; WorldTrends Research, Reston, VA

Appendix

Appendix 1

These books may be of interest to those who would desire to pursue these subjects further:

- The Art of the Long View*, Peter Schwartz; [New York: Doubleday Currency, 1991]
Megatrends 2000, John Naisbitt & Patricia Aburdene; [New York: Wm. Morrow, 1990]
Strategic Planning and Forecasting, William Ascher & William H. Overholt; [New York: John Wiley & Sons, 1983]
The Borderless World, Kenichi Ohmae; [New York: Harper Collins, 1990]
2020 Visions, Richard Carlson & Bruce Goldman; [Stanford: Stanford Alumni Association, 1991]
American Renaissance, Marvin Cetron & Owen Davies; [New York: St. Martin's Press, 1989]
PowerShift, Alvin Toffler; [New York: Bantam Books, 1990]
Global Mind Change, Willis Harman; [Indianapolis: Knowledge Systems, Inc., 1988]
State of the World 1992, Lester Brown, et. al; [New York: W. W. Norton, 1992]
The Third Wave, Alvin Toffler; [New York: Bantam Books, 1980]
The Knowledge-Value Revolution, Taichi Sakaiya; [New York: Kodansha Intl., 1991]
Generations, William Strauss & Neil Howe; [New York: Wm. Morrow, 1991]
New Realities, Peter F. Drucker ; [New York: Harper & Row]
Bankruptcy 1995, Harry E. Figgie, Jr.; [Boston: Little, Brown & Co., 1992]
The Future, Ronald D. Rotstein; [New York: Carol Publishing Group, 1990]
Future Worlds, Norman Myers; [New York: Doubleday, 1990]
GAIA, An Atlas of Planet Management, Norman Myers; [New York: Doubleday, 1984]
Future Mind: Artificial Intelligence, Jerome Clayton Glenn; [Washington: Acropolis Books Ltd, 1989]
Megatrends, John Naisbitt; [New York: Warner Books, 1982]
Earth in the Balance, Al Gore; [New York: Houghton Mifflin, 1992]
Bionomics, Michael Rothchild; [New York: Henry Holt & Co., 1990]
Ecocide in the USSR, Murray Feshbach & Alfred Friendly, Jr.; [New York: Basic Books, 1992]
Disappearing Through The Skylight - Culture and Technology in the Twentieth Century, O.B. Hardison, Jr.; [New York: Viking Penguin, 1989]

Appendix 2

BUILDING MINI-SCENARIOS

The next two pages list a framework of the predominant driving force elements which were discussed in this environmental scan of the future. The reader is encouraged to use the first list as a quick reference guide or menu to flesh out the several mini-scenario frameworks suggested in the second chart, within a context of the reader's business. (To learn more about using scenarios to develop visioning skills in senior executive management, refer to the first section of CG-2002 and The Art of the Long View, a book by Peter Schwartz, Doubleday Press (1992).)

TREND MATRIX

In order to understand the broad systemic nature of the rapidly evolving environment, it is necessary to "helicopter" above the whole landscape and see how different trends might interact between and among themselves. This matrix is a simple tool that can be used to facilitate that perspective.

Technology	Social Values	Economics	Politics	Environment	Energy	Population
Artificial Intelligence	Boomers	World Recession	Integrationist	Greenhouse	Oil	International
Global Info Network	Conservative	China	New Party	Ozone Depletion	Natural Gas	Global teens
Artificial Life	Responsible	Depression	New Government	Wetlands	Coal	Global Growth
Chaos	Culture War	US Debt	Power Diffusion	Rain forests	Nuclear Power	Urban Migration
Virtual Reality	Community	Trade Balance	Demilitarism	Acid rain	Photovoltaics	Immigration
Virtual prototyping	Values-laden	Insurance weak	Multilateral	Habitat loss	Wind	US
Nanotechnology	Consciousness-Causal	Pension funding	Info-politik	Fisheries	Efficiency	Ethnic diversity
Biotechnology	Television's Influence	Education Sys	Fragmentation	Drinking Water	Superconduct.	Rich/Poor
Cryogenics	Generational Revolt	Health care	Weapons trade	Desertification	Zero Point Eng.	Aging
Superconductivity		Bionomics	WMD	Weather Change	Nanotech.	Immigration
Holography	Health	Global Finance Mkts	Islamic Revival	Ocean Knowledge	New Perspective	Fertility
Robotics	Biotech		Identity Crisis	Smog		Single Parents
Holographic Neural Net	Tech/Medicine	Sources / Sumps	TV Influence	Toxic/ Nuc Waste	Transportation	Value Loss
CYC	Life Extension	Pacific Rim/Africa	Less Sovereignty	Garbage	MagLev	Youth Stress
Bioelectronics	AIDS		Information is free	Phytoplankton	HiSpeed Trains	
Bioelectromagnetics	Mind/Body	Space		Biodiversity	SST	
	Old Diseases	Communications			MHD	
	Economic Load	DGPS-Nav			Fuel Cells	
	Human Genome	Messaging			Intel Veh/Hwy Sys	
		Remote Sensing			Intermodalism	
		Russia/China launch			Electronic Market	

Market World	New Empires	Global Incoherence	
Positive Reaction Possible Early Indicators Available <i>Cross Cuts</i> Hydrogen Economy Evolves Education Revolutionized Computer Interface Becomes Transparent New Understanding of National Behavior Understanding the Weather	Positive Reaction Possible Early Indicators Available <i>Cross Cuts</i> Major Fight Over Genetic Information American Cultural Influence Increases Education and Parenting Changed Euthanasia Grows	Positive Reaction Possible Early Indicators Available <i>Cross Cuts</i>	Positive Reaction Possible Early Indicators Not Available <i>Cross Cuts</i> Official Contact Is Made With Extraterrestrials
<i>Wild Cards</i> Micro Devices Save Lives Fuel Cells Keep the Air Clean Nanotechnology Explodes Energy Breakthrough	<i>Wild Cards</i> The End of the Nation-State The Group of Seventy A No-Carbon Economy Worldwide Hong Kong Takes Over China Big Business Disappears Services Become Automated Women Leave the Work Force Life Expectancy Approaches 100 The End of Intergenerational Solidarity Germany Moves East	<i>Wild Cards</i>	<i>Wild Cards</i>
Positive Reaction Not Possible Early Indicators Available <i>Cross Cuts</i>	Positive Reaction Not Possible Early Indicators Available <i>Cross Cuts</i> Backlash Against AIDS Victims Africa Unravels Genome Project Destroys Health Insurance Major Disruptions in Big Info Systems	Positive Reaction Not Possible Early Indicators Available <i>Cross Cuts</i> Major Shift in Global Weather Technology Increasingly Gets Out of Hand The Poor Know They are Poor and Get Weapons Hard Times for the Fishing Industry	Positive Reaction Not Possible Early Indicators Not Available <i>Cross Cuts</i> Urban Terrorism Comes to U.S.
<i>Wild Cards</i>	<i>Wild Cards</i> The New Chernobyl The Balkanization of Western Europe China Financier to the World	<i>Wild Cards</i> A Loss of Financial Underpinnings U.S. Economy Fails Third World Exodus	<i>Wild Cards</i> Nuclear Terrorist Attack on U.S.

Projected Special Operating Forces Technology (Appendix 3)

2000	2010	2020
• Miniaturized resuscitation & stability kit	• Multi-spectral vision devices	• Whole blood replacement
• Voice translators	• Pharmacological performance sustainability enhancement	• Multi-spectral invisibility
• Modular food systems	• Human sensory enhancement	• Soft tissue regeneration
• Advanced clothing & individual systems	• Applied skin protection	• Hand-held medical diagnostic equipment
• Chamelogical camouflage	• Broad spectrum immunity to most biological agents	• Robotic weapons (large and small)
• Chemical ballistics & agile eye protectors	• Injured tissue adhesives	• Families of micro-robotic war-fighting systems
• Advanced sniper weapons	• Exoskeleton armor	• Families of micro-robotic war-fighting systems
• Optical laser weapons	• Small remotely guided agile destruction systems	• Hybrid mechanical-biological robotic vehicles
• Selectable yield munitions	• Directional explosives	• Agile individual & crew multipurpose vehicles land/sea/air
• Enhanced explosives	• Hand/tactile guided virtual presence weapons	• Biogenetic sensor systems with genetically engineered biological electromagnets
• Non-ballistic weapons systems (hypervelocity weapons)	• Non-lethal, incapacitating micro-minaturized munition clusters	• Emplaced multi-purpose auto-robotic modules
	• Unmanned air resupply	• Hand-held multi-sensor fusion system
	• Deceptive signature generators	• Surreptitiously acquired DNA identification
	• Multi-spectral decoys & mimics	• Microchip destabilization

Other Projections:

- By 2000, 15%-20% blood doping will be proven to provide up to 25% enhancement of soldier's performance in a variety of environments.
- By 2000, special operating forces will have commercially available voice translation devices weighing less than 1 lb.
- Vehicles will use vapor from exhaust of vehicles, providing clean water source

Source: U.S. Special Forces Technology Seminar - November 1992

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