Evolving networks

Most people have, at one moment or another in their lives, been led to the peak experience of asking the "big questions": Who are we? What are we doing here? Where are we going? Several millennia of recorded history indicate that these questions are eternal, questions that are addressed by every generation but ultimately and finally answered by none.

It is clear to many of us that now is a time when we must again collectively address the big questions and come up with viable means of meeting the awesome challenges and possibilities of the future. The hard work of acquiring a new "worldview," a new context of beliefs about what is real and what is possible, must be done by all of us in our own lives and work.

From our point of view, the most interesting and significant networks are those that manage to maintain an understanding of the larger context while coping with the minutiae of daily detail. For the Community Congress of San Diego, innovation is based on "caretaker" values, and it requires two abilities:

(1) An understanding of the "big picture", which [is] the ability to put suggestions or ideas into context or perspective—a world perspective, state perspective, local (county, city, neighborhood) perspective; and,
(2) An understanding of the very small, very specific operational details required to carry out a particular "big picture" or vision.

We have combined theory and practice, vision and detail, in our work and in our book. This book would have been impossible without countless hours of setting up files, skimming resources,

writing letters, typing addresses, licking stamps, going to the post office, opening mail, and making innumerable small decisions. It also would have been impossible without a larger purpose and vision that guided our choices and led us through the many crises inevitable on any vision-quest. In the end, we could not have pulled together our voluminous and disparate universe of information about networks into a coherent whole without first articulating a theory and a vision that was at least satisfactory to ourselves.

Every person operates out of a mental framework of assumptions and images about the world even while going about the most ordinary of tasks. For most of us, most of the time, this worldview is not articulated.

Since the mental model that informs the networks of the Invisible Planet differs in some fundamental ways from the established worldview, networkers often consider it necessary to set up some theoretical underpinnings for their work and to explicitly state their essential values. Networkers vary, of course, in their predisposition to articulate theory, and there are many "natural networkers" with great intuitive resources who act effectively from inner wisdom without ever consciously creating a theory to explain what they are doing.

Summarizing the "big picture" is a tall order. Indeed, from the specialized point of view, it is an impossible order. Coincidentally, however, the same conceptual crises and influences that have led a few people to think about networks have led a few scientists to think about "general theory." There is an increasingly visible stream in modern science that flows out of the belief that the universe is both detailed and integrated, both infinitely diverse and richly patterned. This new stream has many contributing academic tributaries, from vaguely expressed "interdisciplinary interests" to clearly articulated approaches such as "general systems theory."

A "general" theory grows out of the recognition that many specialized theories may have something in common—perhaps a formula, or coefficient, or key concept. A general theory combines these similarities into a pattern and in doing so creates a transdisciplinary context for understanding the scientifically separated parts of the natural world. We believe that the tenets of general theory are precursors of a new philosophy about ourselves, our planet and our universe. The "new science" provides a "new metaphysics" for reconstructing our shared worldview.

General systems

Holism is a popular expression of the perennial philosophy that the details of the world are all related in broad patterns and encompassing contexts. While the legends of science abound with the search for universal laws and logic, for the most part the practice of science has focused on specific details about how the world works and the search for general patterns has been neglected. Over the past half century, however, a new approach has been developing within science that combines the traditional concern for analysis with a renewed interest in patterns.

In the years between the First and Second World Wars, various thinkers suggested that there are some universal principles common to all the sciences: in South Africa, Smuts propounded "holism", in Russia, Bogdanov developed *"tektologia"* (the general science of organization); in England, Whyte put forth his "unitary principles"; and in Germany, Von Bertalanffy called his approach to unifying science "general systems theory."

In the late 1940s, the ideas of general theory started to coalesce, becoming a visible, permanent part of the scientific community in December 1954, when the Society for General Systems Research (SGSR) was founded, under the aegis of the American Association for the Advancement of Science (AAAS)—an event that occurred at the dawn of the Third Wave in Toffler's evolutionary chronology. While general systems ideas have yet to be absorbed into the scientific mainstream, it is interesting to note that the first president of SGSR, a quarter-century ago, Kenneth Boulding, was chairman of the board of AAAS in 1980.

The general systems idea is simple: it assumes that there are some organizational patterns common to all "systems," whether they be physical, biological, or human. Such patterns are inherent in the evolutionary process of the earth and humankind. A *system* may be generally defined as a *persisting identity of components and relationships.* Atoms, cells, organisms, people, nations, and galaxies are all examples of systems.

Using this definition, we can see that if everything with a patterned integrity is a system, then networks are systems. A *network* may be generally defined as a *persisting identity of nodes and links.* Examples of networks abound in this book. While saying that networks are a type of human organization, we can also say

that networks are a type of system. Our network model is a systems model. By defining a network as having a "persisting identity", we are saying that a network—a system—is a "whole" that encompasses a variety of "parts"—components and relationships. As we said in Chapter 9, holons, such as networks and people, represent two levels: the level of the whole and the level of the parts. Human bodies are wholes of interrelated organs. Nations are wholes of interrelated institutions. Atoms are wholes of interrelated particles. Networks are wholes of interrelated participants.

Virtually every general evolutionary theory that attempts to span the complete spectrum of systems—physical, biological and human—has described existence as a series of semiautonomous levels of organization. *Level* structure appears to be an inherent feature of all systems and thus of networks.

While most people are passingly familiar with the "building block" image of reality—atoms in cells in organisms in societies— people are less familiar with the idea that each level of a system maintains a substantial degree of autonomy within the context of larger systems. Governments, for example, are typically organized as national, regional, and local systems, each level being partially autonomous and partially dependent. Our city, Newton, functions both independently and interrelatedly within the Boston metropolitan area and the state of Massachusetts, which in turn functions in New England and as part of the United States of America. As citizens of Newton, Massachusetts, and the United States, we are also individuals who are autonomous yet dependent within families, which in turn are both autonomous and dependent within neighborhoods and communities. Every level is a holon.

The tension between autonomy and dependence is inherent in the idea of whole-part systems and networks. Since no system can be totally autonomous or totally dependent, forming and maintaining a "persisting identity" involves a dynamic balance between these two tendencies. The general name for this pattern of a balancing twosome is *complementarity*.

Complements are interrelated opposites. On the largest scale, evolution can be seen as a process of complementary tendencies to *order* and *disorder*. On the smallest scale, complementarity provides the explanatory vehicle for modern physics, the theory of quantum mechanics. In this model, reality is both wave-like and *particle-like*. Depending on your perspective, the "same" energy-

matter may alternately appear as a wave and as a particle—a "now you see me, now you don't wavicle." Niels Bohr, the physicist who first propounded this model in the early decades of the twentieth century, later adopted a coat of arms bearing the Chinese yin/yang symbol of complementarity and the Latin inscription "*Contraria sunt complementa*" (Contraries are complements).

Life grows between the scales of the very large and the very small. Early life vibrated to the complements of light and dark, hot and cold, acidity and alkalinity, activity and passivity. Later life exploded in diversity with the emergence of the complements male and female, and birth and death. The human mind seems to harbor a complementary nature based on two brains in one, a right-hemisphere/left-hemisphere functioning. Human social life is a complex balance between the complements of individual freedom and collective responsibility.

Levels and *complements* are the two great interrelated metapatterns of systems theory. *Complementary* processes of order and disorder generate *levels* of evolutionary complexity, each *level* reflecting *complementary* dynamics of autonomy and dependence. The snake swallows its tail in a spiral of emergence.

Bringing these abstractions back into our own lives, we are a man and a woman who are unique individuals at the same time as we are a couple who depend upon one another for love and nurturance while also being parents who give to our children and receive love and affection in return. In short, we are complementary opposites (male and female) who by commitment and marriage have formed into a couple (another level, another complement of husband and wife) that functions to raise a family (yet another level, yet another complement as parents and children). The same is true for you in your relations with others.

We all know the everyday analytic rule of thumb for thinking about complex matters: to understand something, we are taught to break it down. The essence of the classical scientific method is that changing one thing at a time works best. In school, we were given one tool to use for probing the unknown: analysis. *Take the problem apart:* first disassemble, then study the parts, breaking the parts down if necessary, and, finally, reassemble. In practice, the strategy is a good one for a car, and a poor one for a cat. While you can take a functioning car apart piece by piece and then put it back together again and drive away, you cannot do the same

thing to a cat: once disassembled, a cat will never purr again. Some things respond well to analysis; other things do not.

In a similar way, the old paradigm habitually pits opposites against one another, considering them "irreconcilable" and "contradictory." Matter is real and mind is not. Males are better than females. Disorder is the one universal one-way tendency. Objective is good, subjective is not. Black or white. The combinations are endless.

It is important to recognize that duals and opposites are as bound up in Western philosophy and culture as they are in the East. In the industrial West, however, the rule of thumb is that where there are two, one prevails. One is right, two is a disagreement.

In duals (and duels), one wins; in complements (and compliments), both dance.

New paradigms are supposed to subsume the old ones. Obviously, the "dominant-submissive" interpretation of opposites can be accommodated within the framework of complementarity, since paired opposites can take on a variety of balanced and unbalanced forms: sex roles, for example, can be male-dominated, female-dominated, rigorously equal, or flexibly supportive. Similarly, traditional analysis, "breaking down," can certainly be done within the framework of levels simply by continually focusing on "lower" or "smaller" levels and ignoring "higher" or "larger" levels. Analysis and dualism are not "wrong", just limited.

Levels and complements can be useful abstractions, helping to translate experience into the new paradigm and serving as handy conceptual "rules of thumb." *Levels* and *complements* are conceptual tools that subsume and extend the old paradigm tools of *analysis* and *dualism.* As a rule of thumb, *levels* means looking at wholes as well as parts, seeing ever-more-encompassing contexts as well as seeing ever smaller pieces. As a rule of thumb, *complementarity* means looking at process as well as structure, of seeing interplay between contrasting tendencies as well as dominant trends of the moment.

When you are stuck at one level, look for an answer at another level; when you see one process, look for the "hidden face," the complementary process.

General network theory

Efforts to understand networks benefit greatly from the general systems perspective and collectively may be considered a species of systems theory. So well does the concept of a network capture the essence of a system that, for some purposes, "network" may be a better vehicle to describe general phenomena than ''system."

The essence of a network can be expressed in terms of just two characteristics, holons and values:

(1a) A network is a set of free-standing participants cohering through shared interests and values.

Participants may be individual, groups, or nations, but it is the essential autonomy of the composing parts that identifies the network pattern of organization.

"Network" is a word brought into the domain of social entities because of its strong, clear metaphorical roots. A need to describe a value-based, spread-out, process-oriented, multicentered social form was spontaneously met by the word network and its associations from fishing nets to telephone nets. Its use as a clarifying concept has just begun to be tapped.

Our "public" definition of a social network (la above) is actually a special case of a more general definition. A computer network, for example, is composed of free-standing computers cooperating through shared protocols. Or, more generally:

(1b) A network is a system of semi-autonomous subsystems cohering through shared qualities.

In a formal definition, it is important to emphasize the *semi*-autonomy of a network part, for no entity that we know of is totally self-sufficient. Every entity in the universe is part of a more inclusive entity, and is itself composed of semi-autonomous subsystems. This is the *holonomic* nutshell of the systems perspective.

Now in its second quarter-century, systems theory has progressed from the Leibnizian dream of a "universal calculus" to a dynamic discipline drawing resources from both mathematical and intuitive sources. Anatole Rapoport, a mathematician and psychologist who was a Society for General Systems Research founder, often described general systems theory (GST) as a meeting ground for ''hard'' and ''soft' science.

"Hard" science is about "hard" systems. "Hard" systems are those that can be mathematically modeled, which, writes Rapoport,

unfortunately apply to a relatively limited class of systems. Rapoport s more inclusive, "soft" definition of a system is:

(2a) "A system is a portion of the world that is perceived as a unit and that is able to maintain its 'identity' in spite of changes going on in it."

In Rapoport's view, his definition covers both material systems and nonmaterial systems, like languages. It is easy to see networks of all types meeting this definition, whether physical networks, social networks, or abstract networks. Look closely, however:

(2b) A network is a portion of the world that is perceived as a whole and is able to maintain an identity in spite of the changing identities in it.

Bringing the network holon aspect into this definition has sharpened the perception of complex whole parts making up the inclusive network whole. A network is not made up of a dependent collection of parts with no meaning in themselves. A network is made up of parts that themselves have identities.

(3a) A system is a whole of interacting parts.

(3b) A network is a whole of interacting parts with whole identities.

While a general definition of general phenomena can use either "system" or "network" as the entity, the network perspective brings parts into a complementary balance with wholes. This provides powerful conceptual leverage when applying systems principles to the perennial problem of the human sciences: how to distinguish what is important in the buzzing, booming, confusion. What a network perspective suggests is this: look inside for the semi-autonomous parts, the interactions that compose the whole; and look outside to a greater whole of which this whole is a part.

GST and GNT

Kenneth Boulding, SGSR's first president, once characterized GST as "not so much a body of doctrine as it is a point of view or even an intellectual value orientation…" It is in the broadest meaning of systems theory that the network concept might have the most to offer.

Networking seems to attract people who strive to combine the practical and the theoretical. For the past fifteen years, Anthony J.N. Judge has been in the Brussels office of the Union of Inter-

national Associations (UIA) composing network theory alongside his compilation of international networks. A remarkable companion volume of the ULA directory series, the *Yearbook of World Problems and Human Potential* (1976, 1985), brings together both abstract and concrete networks of organizations, problems and concepts. In the 1976 appendix, Judge writes:

> A fundamental difficulty today is the predilection for simplistic hierarchical representation of the interrelationships between concepts, between organizations, and between problems. This is so despite the constant exposure to the evidence that these hierarchies do not contain the complexity with which society has to deal.... Neither a hierarchical organization nor a hierarchy of concepts can handle a network of environmental problems, for example, without leaving many dangerous gaps through which unforeseen problems may emerge and be uncontainable.

From the earliest days of GST, systems taxonomists have endeavored td sketch outlines of how everything is included and related to everything else. Such efforts and the methodologies that followed were quite successful with concrete things but less satisfactory with respect to abstract entities. While abstraction—relational reality— was acknowledged, the main stream of systems theory has stuck with the concrete. James G. Miller provides an excellent example in *Living Systems*, arguing that while abstract entities like a "presidency" may be real, as a practical matter it is easier to study a concrete "president." He commented that when scientists deal with abstracted systems, they "easily forget the intrasystem relationships in concrete systems."

The term "network" seems to have been naturally adopted precisely to describe the fuzzy, complex, relationally rich associations like brains, languages, personal behavior and social groups that "system" is so poor in illuminating. Connotations of structure, control and predictability accompany the system concept, qualities important, of course, to the understanding of many concrete, physical entities. However, the network concept represents dynamic processes, loose structure, and unpredictable entities, viewpoints essential for understanding abstract and human realities. What the network concept seems to do well is provide a context for perceiving both intra- and intersystemic relationships

of recognizable wholes and parts in both abstract and concrete phenomena.

"General network theory" (GNT) arises out of the recognition that "network" can meaningfully replace "system" in all nonmathematical GST formalisms without loss of generality. Using the notion of network in abstract and human domains is extending systems insights to these crucial intellectual areas.

GNT is not proposed as a replacement for GST, but rather as a complement. As Judge wrote in a prescient paper entitled "System-network complementarity," "Rather than attempt to resolve the distinction between system and network, it may be useful to conceive of the two terms as being different but complementary conceptual approaches to a structure-process continuum."

Networking, secret is buried in the verb. While networks represent structures as do systems, there is no "systeming" like "networking." The active "to network" has accompanied the development of social networks. In networking, people recognize the essential reality of relationships, of perceptions, of information flow. Networks and networking captures process in a metaphor cross-hatched with structure.

Convening an information philosophy

As Robert Muller says, "What is really needed today is a new philosophy of life within our global conditions, a new hope, a new vision of the future...not... the product of any one person, but a collective product" (see Chapter 8).

By the end of this millenium, a global information philosophy will have coalesced. With roots at the start of the century, this worldview will include the ideas we so seem to need and cherish—global and human—while also being scientific and philosophic.

Early in this century, Einstein and the "Copenhagen Group" of physicists offered the first glimpse of successful nonmechanistic scientific models. In the 1920s and 1930s, theoretical biology shook off its reductionist limits and began to view whole cells, organisms and environments. Through the 1940s, cybernetic and information pioneers laid the theoretical foundations for the technological explosion to come. New concepts of "information" passed through the materialistic paradigm without stopping.

In *1945*, humanity crossed a threshold.

In a six-month period, three events announced the irrevocable coming of a new world, for better and for worse. In June, the charter of the United Nations was ratified; in August, the atomic bomb was dropped on Hiroshima and Nagasaki; in December, ENIAC, the first electronic computer, completed its tests. Each of these events had antecedents, precursors and a history, but each presaged a fundamental change in human experience. The biophysicist John Platt points to 1945 as Year 0.

With the dawn of the 1960s, developing hot spots of change in the Western world burst into the social sphere. In the US, civil rights opened the floodgates of social activism. Vietnam came and went. The women's movement and ecology came and stayed. Social movements transformed into personal explorations. Explorations and movements spawned networks.

Now, in the 1980s, as we look to the last decade of the millennium, we see the emergent events of forty years ago clearly shaping our daily present. A global economy and society, linked by information technologies, is poised to flower, yet it may instantly perish.

Shifting worldviews

The structure of the emergent society is the network.

Virginia Hine's 1977 four-page cornerstone in the foundation of information philosophy begins: "[In] piecing together a range of observations by anthropologists, sociologists, economists, and political scientists, (it seems) that the basic paradigm of a future socio-cultural system is already born—muling and puking in its infantile state, but here."

In the posthumously published sequel to her classic essay ("How do we get from here to there?"), Hine related the rise of networks to a concomitant change in the sieve of concepts through which we filter the world. "A shift in the *structural paradigm—the* basic pattern of social organization and institutions"—is occurring with "a shift in the *conceptual paradigm*, the cultural world view, the framework of thought, a shared set of basic assumptions," she wrote.

While the "new age" predictions of "transformation" and "paradigm shifts" have gone out of style, the recognition that we on

planet Earth are undergoing *some* rapid (r)evolutionary change is now a regular feature of Sunday supplements.

For most of us, the 1980s recognition of undeniable change is composed in concrete technological and economic images. As the microchip blinks and chirps its way into everyone's life, common experience of work and play shift into the fast lane of change in the still-embryonic information economy. Change from "industry" to "information" clearly affects the nature of work, and surely affects the home and play conditions surrounding work.

Accepting the concrete evidence of an "information age provides a model for perceiving a network of related large-scale changes. The driving dynamic of escalating computing power and plunging computer costs paves the paths of change across society. New social forms, different from the bureaucratic box chart mass-produced by industrialism, are aborning.

Networks are now "new" because the information age is providing a ripe environment for their nurture. And extinction. Astonishingly various and notoriously fragile, today's social networks are in that part of the evolutionary spurt that requires experimentation. Standards and models are still in the making.

At the same time, networks are very old, as sociological historians attest. The small-group network was likely the original human organization, and has probably played a background role ever since.

Like organisms, organizations evolve. Consider the "emergence" of mammals as a metaphor for what is happening now with networks: mammals existed for millions of years as a backwater evolutionary branch before their moment came. "Suddenly" they exploded in diversity and numbers after the precipitous decline of the reptile family and drastic changes in global climate. While it might be a bit harsh to liken bureaucracies to reptiles (though it's not uncommon to hear them referred to as dinosaurs) and perhaps premature to equate the greenhouse effect to drastic climate changes, the evolutionary analogies for the development of human organizations can be instructive.

Yoneji Masuda, writing for the past three decades on the rise of "the information society" with the development and spread of computers, begins his book *The In formation Society as Post-Industrial Society* with a quote from Nobel Prize winner Herbert Simo n, the pioneer information theorist: "In recorded history there have

perhaps been three pulses of change powerful enough to alter [humans] in basic ways. The introduction of agriculture.... The Industrial Revolution ... [and] the revolution in information processing technology....” Instrumental in Japanese government planning for the present and future information society, Masuda sees the network form as basic to both the electronic and social expressions of change.

In formation reality

As environment and behavior change, so does the mind. As technology shifts from heavy metal to light silicon and burdensome bureaucracies break up into nebulous networks, so do conceptual filters change. In our mind’s eye, we shift from seeing discrete autonomous dismantleable things to understanding increasingly complex, inextricably entwined relationships.

This is truly how it is for people using computers—which is perhaps why so many users experience such mental anguish. One example is this: you work all day on something, then in a stupid moment of forgetfulness, nothing more than a single keystroke, you destroy all you have done. In the modern experience of computing, the mind is stretched to keep track of dozens of simultaneous interactive considerations, none of which can be “seen” in any literal sense.

Computers are clearly affecting bedrock perceptions of reality. The complementary interaction of space and time, long an abstraction of theoretical physicists, is the daily experience of the computer user, juggling processing time with memory space before dinnertime. Asynchronous computer-mediated conversations across continents and time zones leave participants with a curious *deja vu* sense of the ordinary and extraordinary as new patterns of social interaction rapidly coalesce and disintegrate. Like a mail “experience” of a letter from someone in Texas arriving on top of one from the person in Colorado who mentioned the Texan to you, electronic synchronicities also occur, and temper our adventure with time— J & J’s morning in Boston being Kerstin’s evening in Sweden, and Peter’s next day in Australia.

In its essence, information reality differs from material reality. Matter, when used, is used up. Information, when used, adds up.

Ontology, esoteric ruminations on the nature of reality, now has

literal, practical implications for everyday life. It is *ontological* differences between matter and information that lie behind the unfolding industrial/information shift.

Industrialism is based on transformations of matter. Entropy, the inevitable decline and decay of matter, ensures an economics of scarcity. A still not fully understood economics of abundance is based on transformations of information. This economics copes with overload and copying, the problems of multiplication rather than substraction.

Industrialism came with an ontology that declared matter to be the basic and only constituent of reality. Information comes with its own ontological bias—to relations. New paradigms, however, do not necessarily destroy their antecedents; they may include them. To spin an information reality of complex weaves of ephemeral connections, we still need a loom of the hard knocks-on-the-table material reality.

In the information paradigm, matter and relations are comp lements, both part of reality.

Philosophy follows practice in the information era. Information philosophy, what little there is of it, has been pragmatic stuff leaving us with new daily words like feedback. Cybernetic principles survive because they so obviously work in the electronic world. Networks arise in multinational companies and urban neighborhoods because they meet people's needs. An information economy is becoming dominant in America and Japan because that is where new wealth is being created.

Though in the background, the new information philosophy can already be seen in outline. In classical philosophical categories, it has an ontology of relations, an epistemology of levels and complements, and an ethics based on the reality of value.

These features of an information worldview were already present two decades ago when Kenneth Boulding wrote *The Meaning of the Twentieth Century*, a prophetic anticipation of the current industry/information shift. In his conclusion, "A strategy for the transition," Boulding describes the network of thinkers and doers fashioning the new paradigm:

> There is in the world today an "invisible college" of people in many different countries and many different cultures, who have this vision of the nature of the transition through which

> We are passing and who are determined to devote their lives to contributing towards its successful fulfillment. Membership in this college is consistent with many different philosophical, religious, and political positions. It is a college without a founder and without a president, without buildings and without organization.

This college remains invisible, but has swollen by millions of people in networks around the world who are engaged in changing themselves and the world. The college convenes in many places simultaneously. Its seminars are held in storefront offices and penthouse suites, continuing through the mail, on the telephone, and online. Leadership is fluid and hard to spot. Distinctions between teachers and taught are blurry. Curricula are under perpetual revision.

Times are tough. Everyone seems to be talking about the delicate balance between hope and despair. If we're too hopeful, we're unrealistic, failing to confront the magnitude of our problems. If we're too despairing, we're paralyzed, immobilized by the overwhelming impossibility of being able to change anything. But remember! Ours is a time of transition. Lessons from evolution are becoming part of human history.

Transformation

One idea in the new worldview is "transformation". Transformation means radical, fundamental change, usually occurring suddenly and out of chaos. The idea is not abstract. It is of the essence of our time.

In 1948, the English philosopher/physicist/banker Lancelot Law Whyte published *The Next Development in Man*, written during the years 1941—43, while he was immersed in the fire and rubble of war among the great industrial-scientific nations of the world. As part of the team developing the first jet for the Allies, Whyte was thoroughly involved in the war effort. Even so, Whyte was also peering through a new scientific lens of general theory, seeing the indicators of a great transformation in the development of the human species.

To think effectively about the plausibility and significance of a major evolutionary change in our time, a long view of the whole

of human evolution is required. Whyte saw first important transformations in human history, beginning with the primordial transition of primate biology to symbolic consciousness and continuing to the now-occurring transition from the industrial European age to an age of global unity.

(1) *Circa 5—2 million* BC With an indistinct ancestry at least 2 million and perhaps *5* million years old, nomadic, hunter-gatherer "hominids" gradually developed the skills of symbol making, tool making, fire use, and speech. These hominids were the primate precursors of the modern human subspecies, *Homosapiens* sapiens, who appeared around 40,000 BC.

(2) *Circa 10,000 BC* Suddenly, where bands of twenty had roamed, settled agricultural communities of 200 now appeared, marking a shift that is often considered to be the ancient dawn of civilization. Within a millennium, agriculture had sprouted, flowered, and taken root, and religious tombs and temples multiplied, "inventions" that were to become the central pillars of the ancient era. By 5000 BC neolithic towns had grown to cities of 10,000 and the great theocracies of Egypt and Mesopotamia had started their ascent to splendor. Under stress resulting from multiple influences such as intercultural trade, the adoption of writing, savage war, and geological catastrophes, the towering but fragile hierarchies of ancient gods and priestly rulers began to disintegrate in the last two millennia BC.

(3) *Circa 600* ***BC*** Out of the confusion of multiple deities, a new voice in human consciousness emerged, an early self-conscious rationalism that was archetypified in the Golden Age of Greek thought, beginning with the Athenian lawmaker Solon and culminating in the twin wellsprings of Western worldviews, Plato and Aristotle. Often recognized as the dawn of Western civilization, this period is also the era of Gautama Siddhartha (Buddha), Lao-tse (the founder of Taoism), and Confucius (Kung Fu-tse), who represent a similar transition in the East.

(4) *Circa AD 1600* Modern history begins with the shift to the scientific-industrial worldview, which developed out of the monastic ponderings of Bacon, the movable type of Gutenberg, the astrological reveries of Kepler, the telescope of Galileo, and the absolutes of Newton. This set of ideas, which reached its

peak of certainty and influence at the end of the nineteenth century, still dominates the thinking of modern society.

(5) *Circa AD 1 920—2000* The signs of the next great transformation in human development first became visible in the years following World War I. Predicting that the many threads of change would rapidly coalesce into a coherent worldview in the post-World War II years, Whyte said that this transition would probably be complete by the end of the twentieth century. Or else, he felt, humankind would be in serious trouble.

In 1964, Kenneth Boulding, one of the first scientists to recognize the potential applicability of general systems theory, published *The Meaning of the Twentieth Century*. In this little book, Boulding proposed that within the broad sweep of human evolution two really important transitions are apparent: one happened roughly 12,000 years ago and the other is happening now. Boulding sees all human history, from the agricultural dawn of civilization to the beginning of the twentieth century, as one huge epoch—that he calls simply "civilization," and that he sees as coming after several million years of "precivilization" hunting and gathering. The meaning of the twentieth century" is that *now* is the time of a second great transition in human evolution—to what Boulding calls "postcivilization."

In 1980, the futurist Alvin Toffler published *The Third Wave*, a best-seller, which interprets human history in terms of three "waves of development." The First Wave on Toffler's calendar, which he characterizes as agricultural, begins after the earliest precivilization era and spans the period from 10,000 BC to the emergence of science in the sixteenth and seventeenth centuries AD. The Second Wave, which he characterizes as industrial, is the worldview that dominated the globe until around *1955*. For the past three decades, Toffler says, we have been hurtling into the future on the crest of a great Third Wave of human evolution.

Perhaps the most apocalyptic example of this viewpoint is the widely quoted remark by the biophysicist John Platt, who wrote, "The present generation is the hinge of history.... We may now be in the time of the most rapid change in the whole evolution of the human race, either past or to come."

Although they differ on the stages of human evolution, these

writers have a common theme: we live in an evolutionarily significant moment, a period of confusion and instability that nevertheless carries the seeds for the emergence of the next level of human development, both personal and social.

Emergent evolution

Where do networks fit in on this scale? We believe that networking—people making connections between people—is as old as the first symbol-making hominids and has survived and changed over the several million years of crucial transitions in human development. Networks of tool makers, fire starters, cave painters, mammoth hunters, and sign speakers must have organized into various social support systems to cope with personal and collective survival during the first millions of years of human existence. Informal networks were undoubtedly important in the era of ancient civilization, dominated by the development of elaborate control hierarchies, when, for example, those rejecting the prevailing authority, such as the early Jews and Christians, survived and grew on the branches of their network tree.

Networks have certainly been important during the industrial-rational age. Operating within bureaucracies, this period's characteristic organizational form, is the so-called "old-boy network," a term that belies the real influence and power such a peer group holds. While informal networks of people with a common world-view have performed a crucial integrating function for established institutions, networks also have been the foundation for revolutions in this era—from the Committees of Correspondence of the American Revolution to the Spanish anarchists to the cells of the classical communist revolution to the many contemporary media voices and congregations of single-issue movements.

The idea of transformation on the largest scale is based on a radically revised view of evolution—a very charged word at the end of the twentieth century, as evidenced by a 1981 US court battle over what children should be taught about the origin of life. Unnoticed in the current political confusion surrounding the debate of "creationists" versus "neo-Darwinians" is a growing scientific underground that is merging Darwin's evolutionary theory into a new, more comprehensive model that is sometimes called *emergent evolution.* Emergent evolution is a simple term encompassing the

many converging ideas of the past quarter century of anthropologists such as Gregory Bateson, biologists such as Ludwig von Bertalanffy, philosophers such as Lancelot Law Whyte, economists such as Kenneth Boulding, psychologists such as Abraham Maslow, and humanists such as Arthur Koestler.

Four ideas in the new paradigm of evolution are important to us in understanding contemporary change networks: emergence, inclusion, transition and acceleration. The principle of *emergence* suggests that there are some qualities in networks that are clearly new in human history. The principle of *inclusion* suggests that earlier forms of human organization are carried into future forms. The principle of *transition* (including both periods of "chaos" and moments when the process seems to "step-back-to-leap-forward") explains the current period of confusion and also suggests that new networks are reaching back to earlier stages of human evolution in order to fashion a synthesis for the future. Finally, from our present vantage point in time, it appears that terrestrial evolution is a process of progressive *acceleration.* Each cycle of stability and transformation leading to a new level of organization is shorter than the cycle that went before—which explains why momentous evolutionary change is possible in our time.

(1) Emergence

For millions of years, hominids existed without fire. Then, suddenly (in terms of paleo-archaeological time scales), they discovered how to use and conserve fire. In evolutionary theory, this idea is called emergence, referring to the notion that evolution seems to proceed through cycles of long, slow swells of "horizontal" change followed by wind-whipped chops of rapid "vertical" change. This pattern is sometimes represented as a series of "steps," like a set of stairs, up a scale of progressive development. But the steps of evolution do not always march steadily up the slope of progress. Rather, they appear to zigzag their way toward greater complexity, with evolution sometimes appearing to be retreating, rather than advancing.

The Darwinian-industrial concept of evolution portrays a process of sluggish continual change: from slime to slug to reptile to ape to human. According to the conventional model, isolated, random mutations, which are recorded as genetic variations, have

survived a natural competitive struggle (the survival of the fittest), slowly building up terrestrial complexity to human life—layer by sedimentary layer.

While natural selection is certainly a powerful process in evolution, the new paradigm of emergent evolution also recognizes another process, transformation, in which sudden and sharp discontinuities punctuate the progress of slow change. These rifts either signal a leap to a new, more complex level of life or they signal a devastating crash to some earlier level of life. Over the long haul, human life and civilization are testimony to the fact that, so far, life on this planet appears to have leaped more often than collapsed. The theory of emergence suggests that evolution does indeed generate "new things under the sun," that there is a creative principle of order operating together with the randomizing principle of disorder. There is a process of building up as well as a process of tearing down.

In the longest view, there have been two fundamental, sharp transformations in life on earth: between purely *physical* systems (such as atoms, minerals and clocks) and *biological* forms (such as amoebas, reptiles and rats); and between purely *biological* life and *human* life (such as us and you). The biologist Theodosius Dobzhansky has called these transitions the "quantum leaps" of evolution and the "points of evolutionary transcendence." An amoeba is as different from a rock as a person is from a dog.

Each of these major levels—physical, biological and human—contains clearly identifiable levels of organization. Quarks, subatomic particles, atoms and molecules are successive levels of physical organization; cells, organelles, organs and organisms are levels of biological organization. What Whyte, Boulding, Toffler and others are trying to perceive are the significant transitions that mark the evolutionary development of *humankind*, the levels and periods of emergent transformation in human psyches and societies.

(2) Inclusion

The theory of emergent evolution provides a context for understanding networking as both an extremely old and an entirely new human activity. Emergent evolution describes a process of long, slow change alternating with short, rapid change and sudden trans

formation. As a cumulative process, earlier levels of life are absorbed into later levels of life. In biological development, for example, the cell could not have coalesced without stable molecular structures; organs could not have arisen without pre-existing cells; and complex organisms could not have appeared without the existence of specialized functions. Smaller worlds are subsumed into wider worlds.

Within the human world, we can see this process of successive inclusion at work in communications. The invention of the press on which this book is printed was only possible because writing was developed 3000 years before, itself an impossible invention had not the first spoken words been uttered several million years earlier. The telephone, television and the computer all stand on the shoulders of speaking, writing and printing, at the same time as these electromagnetic media possess qualities of speed, distribution and flexibility that are entirely new in human experience. The concept of the computer includes the first symbol ever conceived and the first word ever spoken by our most distant human ancestors.

(3) Transition

In his now-classic essay *The Structure of Scientific Revolutions*, Thomas Kuhn brilliantly described the chaos that exists just prior to and during periods of transition between "old" and "new" scientific worldviews, a recurrent pattern in the evolution of scientific thought. Dominant scientific models reach a certain peak of success in being able "to explain everything" just when anomalies—odd fragments of experiments and theories that do not fit the prevailing view—become numerous and troublesome. Adherents of new viewpoints—generally younger, uncommitted scientists—attack the dominant model and promote a profusion of alternative models.

A "clash of worldviews" between scientific perspectives creates a period of confusion and tension that is suddenly resolved by the presentation of a new synthesis. The new paradigm invariably incorporates the now-apparent partial truths of the older model, provides consistent explanations for the precipitating anomalies, and opens up new territory for scientific exploration. In time, the "new synthesis" becomes the "established model" and begins to

reach its exploratory limits, as a new cycle of challenge, chaos and transformation ensues.

While many modern theorists have recognized that "chaos-in--transformation" is a natural part of the evolutionary pattern, some have gone farther and perceived that in major transitions there is also a distinct "step-back-to-leap forward." Kuhn, for example, suggests that new paradigms emerge not from established, successful, "mature" scientists but rather from newcomers who are ''embryonic'' scientists not locked into the old structure—like the young Swiss patent clerk Albert Einstein. What Kuhn and others have suggested is that when evolution gets "stuck" at a certain level of organization, it may revert to an earlier, more plastic level of order before the leap to a new synthesis is possible. This back-and-forth pattern also contributes to evolution's "zigzag" appearance. In our culture, the idea is encapsulated in the expression ''one step back and two steps forward.''

The author and systems theorist Arthur Koestler, who used the French expression *"reculer pour mieux sauter"* to describe this pattern, has drawn a parallel between biological change and the process of human creativity in science, art and humor. Koestler suggests that when a creative person has become consciously stuck on a problem, his/her mind retreats first to a lower level of consciousness in order to find the pathway to a creative solution. Below the level of full wakefulness, previously unrecognized associations crystallize, exploding in a sudden synthesis—a flash of insight. In a moment, the mind leaps over the problem to the solution, from the stuck place to a new level of understanding. Referring to the subtle part the unconscious plays in scientific creativity, one physicist cracked that all great discoveries are a product of the "three B's": insights come while in Bed, in the Bath, or while waiting for a Bus.

John Platt believes a new international order is developing in the retreat-to-advance pattern. We are stuck, he contends, at the nation-state level of human organization. World order is not emerging from alliances of nations, which are notoriously fragile and incomplete. Rather, he says, thousands of subnational organizations are forming multinational associations and creating an increasingly interdependent web of international corporate, institutional, and professional relationships that are not directly dependent on national governments. That is, we are not moving directly

from national to international government but, rather, are detouring through earlier subnational stages in order to re-form at a higher transnational level.

(4) Acceleration

A popular view of evolution's vast time span is dramatized by Carl Sagan's use of a one-year calendar to represent the significant dates in cosmic-terrestrial development. Sagan's calendar begins with the Big Bang birth of the universe on 1 January, shows the formation of the earth on 14 September, the dinosaurs reigning around Christmas, and the first humans appearing on the last day, 31 December. In the last minute of this last day, 11:59:20 p.m., to be precise, agriculture emerged along with gods and priests. All the rest of human history occupies only the last few seconds of this cosmic calendar.

Seeing human history as but a flash in the cosmic drama and the human home as but a mote in the vastness of the universe certainly rids us of our bloated sense of anthropocentric self-importance. Yet, minuteness also robs us of a sense of significance, the sense that we play some role in the drama that has meaning for the largest whole. Viewing the vastness of cosmic time, it is difficult to imagine significant evolutionary shifts happening in our lifetime—the equivalent of fractions of a second on the scale of Sagan's calendar. Transformation over a few generations is understandable only when the accelerating pace of evolution is recognized. A quick review of "the big picture" illustrates this idea.

Life first appeared on earth a billion or so years after the planet's birth almost 5 billion years ago. The bacteria-based bioplanet developed slowly for more than 3 billion years (!) until life exploded in diversity with the coemergence of sex (male and female) and mortality (birth and death) 500 million years ago. Mammals became numerous 75 million years ago. Erect, tool-making primates appeared between 2 and 5 million years ago. Humans settled towns 12,000 years ago. The "ancient" cultures of Greece and Rome flourished 2500 years ago. The industrial era is less than 400 years old.

Galactic change is measured in billions and millions of years, biological change in millions and hundreds of thousands of years, and distant human change in thousands and hundreds of years.

Billions, millions, millennia, centuries—today, change of evolutionary significance is measured in decades and years.

Textbook Darwinian theory portrays evolution as slow moving and incremental—a process that "takes a long time." Within that worldview it is difficult to imagine that evolution is accelerating, apt to suddenly shift direction, and may indeed be recognizable within the span of a single human life. Yet, through the mental lens of the new paradigm, our responsibility, right now, for the evolution of ourselves and the planet is inescapable.

We can only wonder how long it will be before evolutionary changes will seem to approach "light speed," the recognition that it is the moments of spontaneous human creativity which are the pulsing tip of the evolutionary process unfolding on the terrestrial stage. Even when human history is seen as a flicker and flash in time, it is the *last* and *next* flash of earth's evolution, and it inherits the significance of all the earlier flashes.

The future

"The future" is not something that will "happen" to us. We make the future every moment we live, an ancient idea that is the very essence of "karma" and most readily understood in the West through the biblical passage "As you sow, so shall you reap."

Our future is born out of our transforming ideas, out of our original and most basic human attribute, which is the ability to create images of a world that has not yet existed, but may.

May there be peace on earth—all else follows.