Chapter XII
Information Laws

INTRODUCTION

The purpose of this chapter is to define information laws which control the development of the global and universal civilizations as well as individual autonomous civilizations.

Mankind progresses in proportion to its wisdom, which has roots in practice, acquired skills, available data, and information, concepts and knowledge. To be wise, humankind needs to be both informed and knowledgeable, otherwise it will not survive its own failures. Progress in knowledge was painfully slow as long as the spatial memory was transmitted only by oral tradition. With the inventions of writing and books, the process of knowledge discovery and dissemination was accelerated. Today, computers and their networks speed up that process far beyond our imagination. In the 21st century, the Information Wave significantly controls the Agricultural and Industrial Waves through millions of computers. IT supports decision-making based on knowledge-oriented systems such as "data mining" that, for example, discover knowledge about customers and organization dynamics to achieve competitive advantage.

Information and knowledge have become the strategic resource that *engineering science* was in the Industrial Wave. However, the discovery of human cognition potential must be guided by *knowledge science*, which is just emerging. One of the signs of any science is its set of data, universal rules, laws, and systems of rules and laws. Hence, this chapter offers the first attempt to develop main laws of information that should increase our awareness about the Information Wave, the new stage of civilization dynamics that is taking place at the beginning of the third millennium. The chapter also provides the framework for the analysis of human capital from an information perspective. These considerations reflect a still emerging approach which I call *macro-information ecology.*

MACRO-INFORMATION ECOLOGY

Macro-information ecology is based on the premise that the growth rate of discovery of new information (knowledge) is the key determinant of macroeconomic activities in the service-industrial-global economy (so-called the "*new economy*").

This new emerging school of macroeconomics may be called *knowledgism*.

Macro-information ecology is the study of information (cognition) as a whole. It is concerned with *aggregates* across nations and markets. Macro-information ecology studies the behaviors of societies and economies (nationally and globally) measuring:

- the value of human capital
- the potential efficiency of human capital
- knowledge output
- Economic output driven by knowledge in a given period, and so forth

It also studies measures derived from many individual nations:

- markets such as the price of human capital
- the total structure of employed workers by such categories as production workers in-person service workers, and information workers

Another interesting facet of this emerging discipline is the qualitative analysis of civilization paradigm shifts and the application of civilization tools as a result of increased cognition about us.

To control national output with the development of a global economy, *knowledgists* stress the need to control the growth of new knowledge discovery. Given the long and variable lags of knowledge and information policies behind events and the difficulty in forecasting future economic events (such as recessions), *knowledgists* question the ability of industrial or service-oriented macroeconomics to implement even "correct" economic policy.

The knowledge approach suggests that direct government intervention within the economic system should be guided by the "predicted *history of the futures*." Knowledge *policy* is the key to this intervention. In this sense, knowledge policy is closer in economic theory to the Keynesian interventionists than to "conservative" monetarists.

The supply and demand of information (knowledge) is the most basic subject of *information ecology* (IE). However, before presenting this model, we must examine the stages of development of the *information reservoir*. Figure 12-1 illustrates this process.

Based on the information reservoir's (IR) dynamics, the general information laws will be defined in the following section.

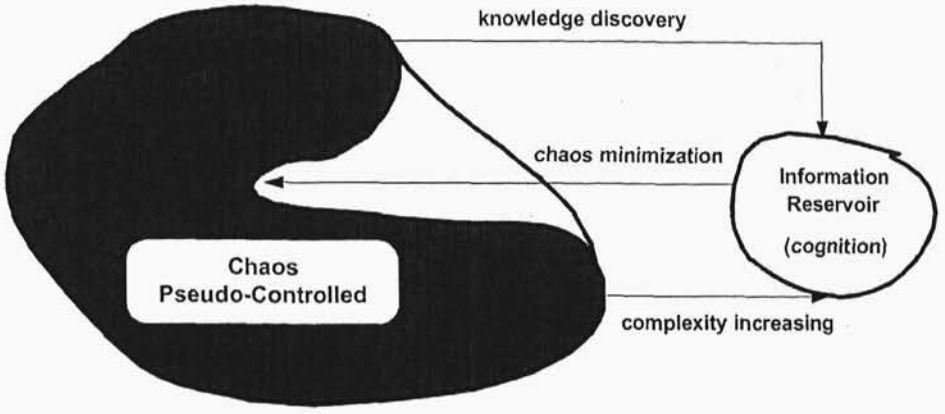
GENERAL INFORMATION LAWS

At the present stage of knowledge discovery, the information reservoir (IR) can only minimize or try to "control" chaos. Every increase in new information also increases the level of complexity of understanding. Based on the analysis of knowledge dynamics provided by Wojciechowski (1989), one can define the following laws of information:

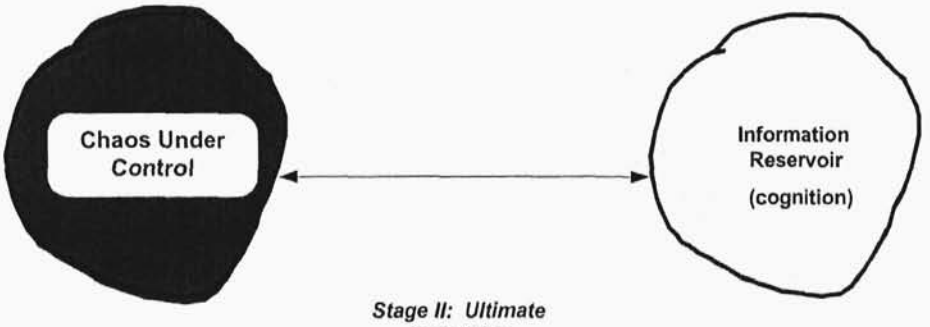
Law I: The complexity of the ecosystem (man, material, cognition, and nature) is growing proportionately to the level of the existing information reservoir.

This complexity is the state of a system whose components and relationships co-evolve through an enormous number of interconnections, creating dynamic structures either chaotic or orderly. The more information we have at our disposal, the more complex the ecosystem is perceived to be. In the old saw, the more we know, the less we understand. The founders of the Santa Fe Institute, which explores the new science of complexity, investigates such questions as why ancient ecosystems often remained stable for millions of years, only to vanish in a geological instant—and what such events have to do with the sudden collapse of Soviet Communism in the late 1980s.

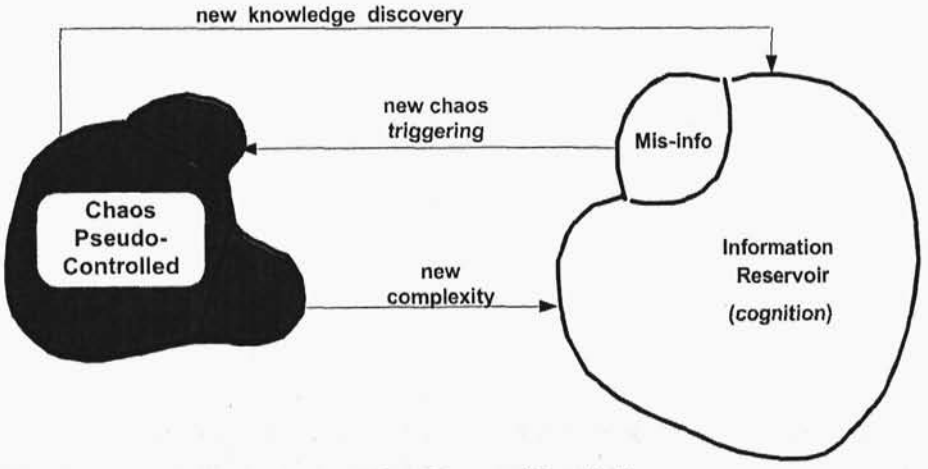
Figure 12-1. Stages of information reservoir development



Stage I: Knowledge Discovery



Stage II: Ultimate Cognition



Stage III: New Chaos and Complexity

Law II: Information generates consequences which it cannot foresee.

One of the forms of information is knowledge, such as atomic physics. Atomic physics produced rules and techniques that allowed man to build the atomic bomb. The consequence was the tragedy that befell thousands of Japanese who lost their lives or, at the very least, their health in 1945. On the other hand, the Cold War, sustained by the balance of atomic weaponry, was relatively bloodless (with some exceptions to Korea and Vietnam and assorted African civil wars still being unraveled). Should science stop research on atomic physics or gene engineering because their consequences may get out of control? Or, being under control, can said research produce positive results, such as the Cold War, which foreclosed another Hot War?

Law III: Precision and certainty of information grow in proportion with the simplicity of the described object or process or, inversely, decline with the complexity of the object or process.

Relatively simple material objects can be described by relatively simple information in natural science. On the other hand, complex social phenomena require complex description, which can be contradictory if proffered descriptions are provided by more than one observer. For example, in the 1991 Persian Gulf War, there was a question among the allied forces whether to go on to Baghdad and to seek the surrender of the Iraqi military regime. Almost every observer of this war had his or her own answer (information) to this question.

Law IV: The progress of the Information Wave generates relative ignorance and interdependence among individuals and globalizes humanity.

The advancement of mediated information requires information skills to access information infrastructure, systems, and services. People without this access are becoming more ignorant than those who can retrieve and apply required information anytime and anywhere. The information poor are becoming more dependent on the information rich; the latter are motivated to seek globally more useful information in order to become even richer. College professors or graduates who know end-user computing have more chances to increase their material well-being than those who do not know how to apply computers to gather and process important information and are ignorant about their possible opportunities. Even an experienced business person, if ignorant about information technology, may lose business resources, or at least not increase them, if he/she does not know how to transform his/her business from *brick 'n mortar* to *brick 'n click*.

At Stage II, ultimate cognition, the amount of information is theoretically equal to the amount of chaos. From mankind's point of view, this equilibrium in macro-ecology never happens, since the amount of time needed for such equilibrium to be attained is infinite. In such disciplines as business management, perhaps one can achieve short-term equilibrium. Therefore, a fifth law can be defined:

Law V: The information reservoir has no saturation point.

Since the ecosystem is imperfect and still developing, the information about it has not yet become definite. What was right in the 19th century is revised in the 20th century, and what is right in the 20th century will perhaps be redefined in the 21st century, and so forth. Examples of Newtonian physics or post-modernism's challenge of "scientific truth" provide data that demonstrate this rule in the 20th century. A new discovery usually decreases the chaos; and, *eo ipso* requires more information to improve understanding.

Stage III -- If the capacity of the information reservoir should exceed the capacity ("quan-

tity") of chaos, then new chaos and complexity are created by misinformation, which begins to penetrate the IR. But this is only an assumption since, according to Law V, such a situation should not happen.

THE INFORMATION MACRO-ECOLOGY MODEL

The macro-ecology of the information equilibrium model (Figure 12-2) indicates that civilization, most of the time, operates in darkness. The mathematical model of the information reservoir is as follows:

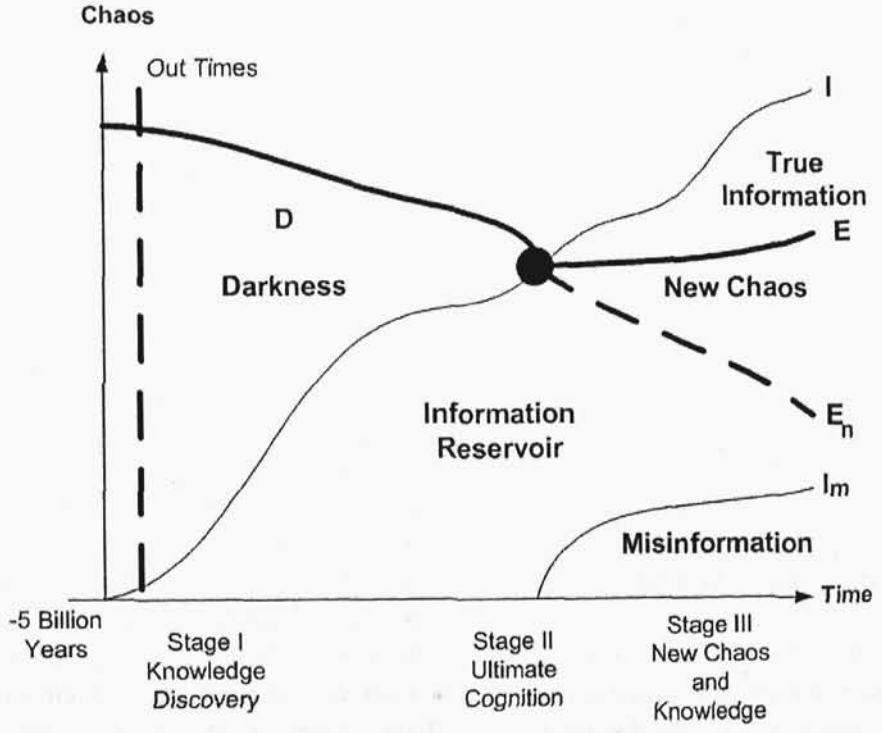
Stage I: $I < E$

where:

I = Information Reservoir capacity
E = Entropy, a measure of chaos
D = Darkness (or net entropy E-I)

The macro-ecology goal is $D_t = 0$ and the task is to determine the elasticity of the increased entropy or information and how a user or organization responds to changes (+, -) caused either by the increase of information reservoir or by its "enemy"—entropy.

Figure 12-2. Information macro-ecology model (I-Information, E-Entropy)



$D(E_t) = f(I_{Mt}, C_t)$ or $D(I_t) = f(E_t, C_t)$

where: I_M = Misinformation [1]
C = Complexity
t = time

The elasticity of *information* is a measure of the sensitivity or responsiveness of the information value demanded to create changes in price, revenue, unemployment, and in other factors of the Information Wave. Information elasticity will be one of the major indexes of the emerging Information Wave.

Macro-information ecology is also interested in the creation of *human capital* as a medium of knowledge generation and application. Particularly, a relation between human capital and economic development is a strategic inquiry of IE.

The mechanism of material civilization in modern capitalistic theory was built on the rule that market growth triggers the specialization of human capital and the growth of its income as well as of its level of living ("net satisfaction per capita"). In the Information Wave, the situation is different. The new motor forces of economy can express the following law of human capital.

THE INFORMATION LAW OF HUMAN CAPITAL

Law VI: Human capital's growth in knowledge generates specialization and productivity and sustains the growth of income.

As Kevin Murphy[2] noticed the old sequence in economic development in the Industrial Wave:

- (old) material sequence: *market growth - specialization - more income* transforms in the Information Wave into a new sequence in economic development
- (new) early information sequence: *knowledge growth - specialization - more income*

The new sequence is true as long as the specialization of human capital sustains the increase of productivity in the material sector or in the information sector. The necessary co-ordination of specialists, particularly those in the information sector, may consume the new "speed" of knowledge and not only contribute to the economic growth, but misguide it.

The most important question, however, is whether or not we should apply new knowledge to promote economic development by growth or whether we should just apply that knowledge's message, when that message says that zero growth is wiser and is the only appropriate policy to achieve a sustainable society and economy.

A ruthless trend occurred in the American human capital system in the 1990s. It is implemented in the name of restructuring and trimming corporate "fat" as a "surplus" of human capital. American human capital is being downsized and atomized; as the Scottish farmers were torn away from their soil, millions of Americans are being evicted from the working worlds that sustained them, the jobs that gave them not only wages, healthcare, and pensions, but also a context, a sense of self-worth, a kind of identity. Work was the tribe: there were IBM reps, Sera's men, GM workers, and Anheuser-Busch people. Those still are there, of course, but their world has changed.

The early Information Wave, controlled only by corporate profit, deconstructed the work force of America and other developed countries. In a time of surreal transition, America is working without a social contract or with one that has been deeply violated.

In the industrial civilization, Americans practiced long-term marriage, careers through apprenticeship, promotions, success, and retirement. Getting fired was a disgrace. That epoch has passed. America has now entered the age of the contingent or temporary worker, of the consultant or subcontractor, of just-in-time human capital—fluid, flexible, and, worst of all, disposable. Is this really the future?

If the Information Wave is to work without knowledge and information policies, the work force of the future will constantly have to sell its skills and invent new relationships with employers, who must themselves change and adapt constantly in order to survive in a ruthless global market.

This is the new metaphysics of work. Companies are portable, workers are throwaway. The rise of the Information Wave means a shift, in less than 20 years, from the overbuilt systems of large, slow-moving economic units to an array of small, widely-dispersed networked economic centers. In the early stages of the Information Wave, highways are becoming electronic: even "Wall Street" has no reason to be in Manhattan anymore. Companies become virtual, based on a networked concept and their dematerialization, and strangely conscienceless. In 1988, contingent workers were about a quarter of the labor force; by 2008, they are expected to make up half of it.

The Industrial Revolution was inevitable even as the Luddites howled and broke the machines. There are solid economic reasons for a current restructuring of the American work force (e.g., low productivity due to overstaffed companies), but the human capital costs are enormous.

The uncontrolled development of the Information Wave may lead to another economic sequence:

- further information sequence: *knowledge growth - specialization - collapse of economy (?)*

This sequence produces an economy that is too specialized and productive, requiring a small workforce without the means to create a demand for economic output. In current practice, robots and computers do not pay taxes.

Information ecology has to include a human dimension of the Information Wave in its inquiry. Better knowledge should provide a better level of living, not inspire self-destruction and limit progress to technology alone. Technology is not neutral; the new knowledge should define *telematic* technology as a tool of honorable and sustainable living. This is possible if we consider the Electronic Global Village as a tool of information and knowledge creation and distribution (bottom-up and top-down), and as a globally interconnected aware tribe.

The steered Information Wave should offer the following sequence of events:

- expected information sequence: *knowledge growth - solutions - sustainable economy*

If "human capital" becomes wise enough, this sequence should probably be implemented in the 21st century. Otherwise, the population and ecological bombs (around 2050) will return us to the beginning stages of the history of mankind (Paleolithic).

HUMAN CAPITAL DEVELOPMENT

Human capital in the 21st century will become the most important economic resource. This is a medium which generates and applies knowledge. Its architecture of "organs" is depicted on Figure 12-3.

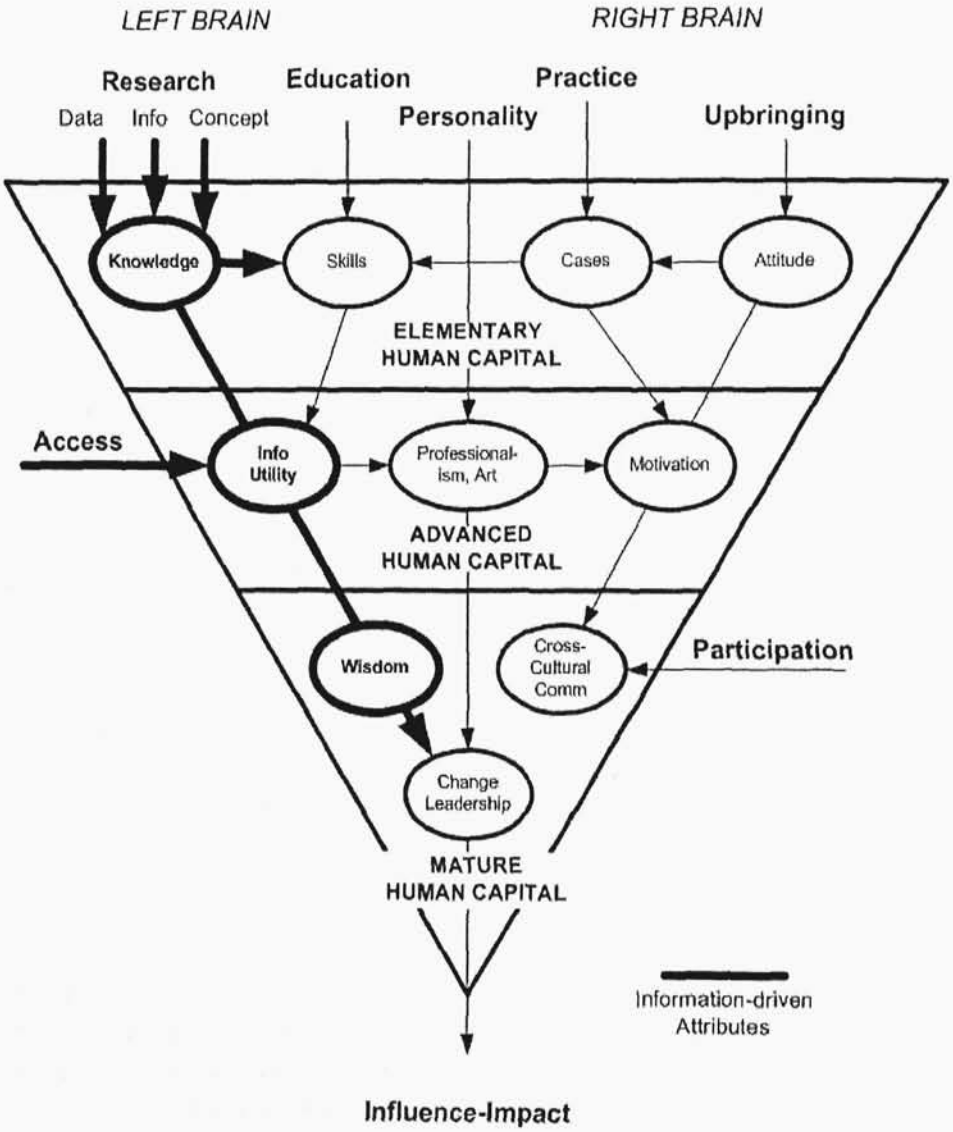
In post-modern notation the architecture contains left brain and right brain attributes, which in combination determine the value of human capital. This capital develops in three stages:

Stage I: Elementary Human Capital: Knowledge, Skills, Cases (Experience), Attitude

Stage II: Advanced Human Capital: Info-Utility Access, Professionalism and Artistry, Motivation

Stage III: Mature Human Capital: Wisdom, Cross-culture Communication, Change, Leadership

Figure 12-3. Human capital on development stages

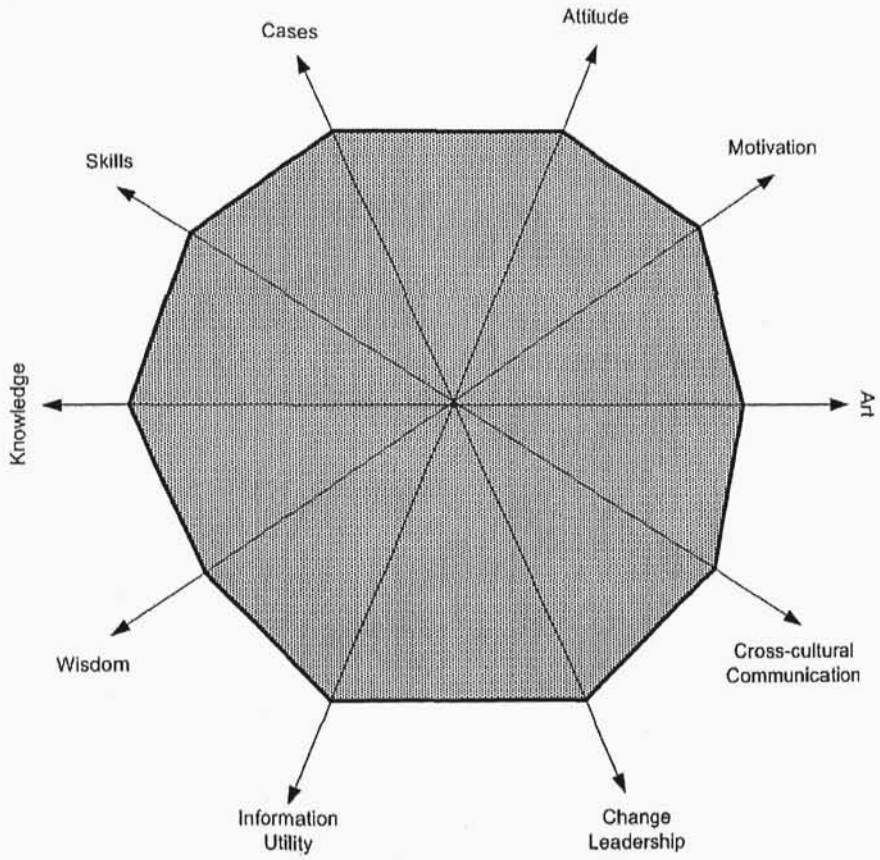


Only four attributes are information-driven: knowledge, skills, information utility access, and wisdom. This means that the development of human capital cannot be limited only to issues of information. The process of socialization into a society plays a very important role in the development of human capital values, and this process is culture-driven.

The measurement of human capital value can be done through the estimation of the value space of a work force (macro-ecology) or through a given person (micro-ecology). Figure 12-4 illustrates the value space of human capital.

Each attribute (A) can be measured on a five-point scale. The sum total of all attribute points provides a value of given human capital (V). This

Figure 12-4. The value space of human capital



is a comparative unit of human capital value. It can be applied in comparisons of economies, organizations, or persons. It can also be applied in the analysis of human capital efficiency potential.

CONCLUSION

Macro-information ecology is just emerging, along with the development of Information Wave practices. Researchers should turn their attention both to the application of the information laws and also to their further discovery and corrections in the analysis and design of values and tools of the Information Wave and civilization in general.

A. Further Research Directions

- Develop more information laws and investigate their impact on human existence in macro-information ecology.
- Investigate information laws, rules, and observations and their impact on human existence in the micro-information ecology.
- Investigate the value space of human capital in different spheres of civilization.

B. Research Opportunities

- The research opportunity is in investigating how information clarifies the complexity and chaos of civilization activities (including nature, society, culture and infrastructure).

C. Additional Ideas

- A symbol-based language developed the human brain and led to advanced thinking, differentiating *Homo sapiens* from other hominids and animals. How will high-speed and unlimited-memory computers impact the human ability to process information? Will this process improve or diminish the human capacity for information handling and processing?

D. Rationale

- Research on the nature of information is an effort recently undertaken in the 20th century, mostly in the its last quarter. This new research concentrates on genes, which may lead to a new paradigm of life. This research first focused on the concept of DNA, which is like a molecule (or atom if two molecules are considered) of human biology. Recent medical research has been aiming at the concept and role of RNA, which is in charge of bio-communication among DNA molecules. It looks like information is *Decoding the Universe* (Seife, 2006). Seife claims that whether information is packed into a bar code, encrypted in a secret wartime message, or sucked into a black hole (St. Howking, the author of the black hole theory, thinks this way), reaches the galaxy, it is everywhere, and it is not just an abstract concept. Information is a concrete property of matter and energy that is every bit as real as the weight of a chunk of lead, something that is inside every living cell and is inscribed upon every cosmic phenomenon. The information theory is nowadays the main research subject of biologists, physicists, chemists, engineers, businesspeople, and others, who without it could not open the black boxes of their disciplines.

E. Additional Reading

Arndt, C. (2004). *Information measures, information and its description in science and engineering* New York, NY: Springer.

Ash, R. (1990). *Information theory.* New York, NY: Dover.

Bamford, J. (1983). *The puzzle palace.* New York, NY: Penguin Books.

Bayer, H. (2004). *Information. The new language of science.* Cambridge, MA: Harvard University Press.

Bekenstein, J. (2003). Information in the holographic Universe. *Scientific American, 289*(2), 58.

Brillouin, L. (2004). *Science and information theory.* Mineola, NY: Dover.

Cover, T., & Thomas, J. (2006). *Elements of information theory.* New York, NY: Wiley-Interscience.

Eager, W. (1995). *The information payoff.* Englewood Cliffs, NJ: Prentice Hall PTR.

Floridi, L. (2005). Is information meaningful data?. *Philosophy and Phenomenological Research, 70*(2), 351-370.

Gallagher, R. (1968). *Information theory and reliable communication.* New York, NY: John Wiley and Sons.

Goldman. S. (1969). *Information theory.* New York, NY: Dover.

Hartley, R. (1928). Transmission of information. *Bell System Technical Journal, 7,* 535.

Kelly, J., Jr. (1956). A new interpretation of information rate. *Bell System Technical Journal, 35,* 917-926.

Khinchin, A. (1957). *Mathematical foundations of information theory.* New York, NY: Dover.

Landauer, R. (2000). Irreversibility and heat generation in the computing process. *IBM Journal of Resource Development, 44*(1-2), 261-270.

_____(1993). Information is physical. *Proceedings of the Workshop on Physics and Computation PhysComp'92* (pp. 1-4). Los Alamos: IEEE Comp. Sci.Press:

Leff, H., & Rex, A. (Eds.). (1990). *Maxwell's demon: Entropy, information, computing.* Princeton, NJ: Princeton University Press.

Libicki, M. (2000). *Who runs what in the global information grid?* Santa Monica, CA: RAND

MacKay, D. (2003). *Information theory, inference, and learning algorithms.* Cambridge: Cambridge University Press.

Mansuripur, M. (1987). *Introduction to information theory.* New York, NY: Prentice Hall.

Poster, M. (1990). *The mode of information.* Chicago, IL: The University of Chicago Press.

Reza. F. (1994). *An introduction to information theory.* New York, NY: Dover.

Shannon, C. (1948). A mathematical theory of communication. *Bell System Technical Journal, 27,* 379-423; 623-656.

Shannon, C., & Weaver, W. (1949). *The mathematical theory of communication.* Urbana-Champaign, IL: University of Illinois Press.

Seife, C. (2006). *Decoding the Universe.* New York, NY: Viking.

Siegfried, T. (2000). *The bit and the pendulum.* New York, NY: Wiley.

Slack, J., & Fejes, F. (1987). *The ideology of the information age.* Norwood, NJ: Ablex Publishing Books.

Yeung, R. (2002). *A first course in information theory.* London: Kluwer Academic/Plenum Publishers.

REFERENCES

Badaracco, J., Jr. (1991). *The knowledge link.* Boston, MA: Harvard Business School Press.

Beach, L., Mitchell, T., Daeton, M., & Prothero, J. (1997). Information relevance, content, and source credibility in the revision of opinions. *Organizational Behavior and Human Performance, 21,* 1-16.

Bohm, D., & Peat, F. (1978). *Science, order and creativity.* New York, NY: Bantam Books.

Bell, D. (1973). *The coming of the post-information society: A venture in social forecasting.* New York, NY: Basic Books.

Blumenthal, A. (1977). *The process of cognition.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Drucker, P. (1988). The coming of the new organization. *Harvard Business Review, 88*(1), 45-53.

_____(1993). *Post-capitalist society.* New York, NY: HarperBusiness.

Ekecrantz, J. (1987). The sociological order of the new information society. In: J. Slack & F. Fejes (Eds.), *The ideology of the information age.* Norwood, NJ: Ablex Publishing Corp.

Gore, A. (1991). Information superhighways: The next information revolution. *The Futurist, 1,* 21-23.

Karraker, R. (1988). Highways of minds. *Whole Earth Review, Spring,* 4-15.

Laszlo, E. (1972). *Introduction to systems philosophy.* New York, NY: Harper and Row.

McWhirter, B. (1993, March 29). Disposable workers of America. *Time,* pp. 41-43.

Nowell, A., Perils, A., & Simon, H. (1987). What is computer science?. *Science, 235*(4794), 1373-1374.

Parker, E. (1976). Social implications of computer/telecoms systems. *Telecommunications Policy, 1,* 3-20.

Porat, M. (1977). *The information economy.* Washington, D.C.: U.S.Office of Telecommunications.

Poster, M. (1990). *The mode of information.* Chicago, IL: The University of Chicago Press.

Pricher, W. (1987). Tours through the back-country of imperfectly informed society. In. J. Slack & F. Fejes (Eds.), *The ideology of the information age.* Norwood, NJ: Ablex Publishing Corp.

Sakaiya, T. (1991). *The knowledge-value revolution.* New York, NY: Kodansha International.

Shannon, C. (1948). A mathematical theory of communication. *Bell System Technical Journal, 27,* 379-423; 623-656.

Targowski, A. (1999). *Enterprise information infrastructure.* Harrisburg, PA: Idea Publishing Group.

Toffler, A. (1980). *The third wave.* New York, NY: Bantam Books.

Wojciechowski, J. (1989). Progress of knowledge and right-left dichotomy: Are existing ideologies adequate?. *Man & Development, XI*(1).

Van Doren, C. (1991). *A history of knowledge.* New York, NY: Ballantine Books.

ENDNOTES

1 Misinformation means that an explanation of an object or process is incorrectly provided, whether purposely or accidentally.

2 During his public lecture at Western Michigan University (December 13, 1992).