# Chapter X
# Information and Organization

## INTRODUCTION

The purpose of this chapter is to define *information*, mainly in terms of cognition units, and also to find out its other perspectives and images. Once we understand information, it becomes possible to define its role in an organization, particularly at the level of information systems. The issue of how more complex information systems may advance an organization to higher levels of structure (configuration) will be investigated. Modern complex organization is still very recent, about 50 years old, but can already be perceived to have some evolutionary phases. Finally, the transformation from the industrial to the informated model of an enterprise is described and both models are compared, with some conclusions about meaning for civilization's well-being.

## PERSPECTIVES OF INFORMATION

### The Quantitative Perspective of Information

This is one of the oldest perspectives on information meaning. From a quantitative perspective, *information* is the successful selection of signs or words that form a given list, rejecting all "semantic meaning" as a subjective factor [1]. Hartley (1928) showed that a message of N signs chosen from an "alphabet" or a code book of S signs has $S^N$ possibilities, and that the "quantity of information" is most reasonably defined as a logarithmic equation:

$$H = N \log S \quad [1]$$

Since Hartley's time, this definition of information as a selection of symbols has been generally accepted, although widely interpreted. As a result, Hartley's theory crystallized into an exact mathematical definition, provided by Shannon (1948). According to him, the probability p of event α is:

$$I = - \log_2 p(\alpha) \quad [2]$$

This approach is not useful in business decision-making. Let us assume, for example, that a message: "the distance from Kalamazoo to Chicago $\alpha$ =150 miles" has p=1 and therefore I = 0, since $\mathrm{Log}_2\, 1 = 0$ (because $2^0 = 1$). In other words, from the quantitative perspective, this message contains no information. However, for the individual using his personal car for a business purpose, this message contains information that can be measured monetarily: if for each mile driven the individual receives compensation of $0.40, those 150 miles mean $60 in information value for him/her.

An increase in information yields a resultant reduction of chaos or entropy. Entropy, in statistical thermodynamics (Second Law), is a function of the probability of the states of the particles that form a gas. In the quantitative communication theory, entropy means how much information one must introduce into a given information-oriented system to make it informationally organized and at the same time reduce its chaos. The relationship between information and entropy is expressed most objectively by the Shannon-Weaver formula (1949):

$$H_{(\alpha)} = - \Sigma\, p(\alpha) \log_2 (\alpha) \text{ (BIT) (Binary digIT)} \quad [3]$$

In a descriptive thermodynamic sense, entropy is referred to as a "measure of disorder." Information introduced to a given system eliminates that disorder and is therefore said to be "like" negative entropy or order. Starr (1971) demonstrates the idea of entropy using the following example: suppose that eight different commands can be transmitted from the bridge of a ship to the engine room. If each of those commands is equally likely, then the probability of any of these being sent is p=1/8. Knowing p, entropy H can be determined:

$$H = 8[1/8 \log_2 (1/8)] = \log_2 8 = 3 \quad [4]$$

This result indicates that eight different orders coded into a binary format (as shown below) can be transmitted via a 3-bit-wide channel of communication:

The entropy function is widely used in communication networks in coding for the assessment of channel capacity and code efficiency. However, from the human communication point of view, this perspective has limited applications, because it does not provide any human-oriented meaning to the "bits and probabilities." This approach has a technical significance concerning how to design a technical communication channel. Finally, the entropy function lacks the semantic meaning of information, which can drive human communication.

*Table 10-1. Eight messages in a binary coded format*

| Order Number | Binary Form |
|---|---|
| 0 | 000 |
| 1 | 001 |
| 2 | 010 |
| 3 | 011 |
| 4 | 100 |
| 5 | 101 |
| 6 | 110 |
| 7 | 111 |

## The Qualitative Perspective of Information

It is obvious that without quality, information loses its usefulness. This idea is reflected in a well-known phrase often used in information processing: "garbage in, garbage out." The emphasis on the quality aspects of information and their importance in organizations is apparent in two streams of research on:

- Message flow (e.g., Monge, Edwards, & Kirstel, 1978; Roberts & O'Reilly; 1978) Decision-making (e.g., Cyert & March; 1963; O'Reilly, Chatman, & Anderson, 1978)
- One can argue that literature addressing message flow can add context and realism to decision-making. Likewise, decision-making literature can help make the outcome variables of message flow more concrete and measurable.

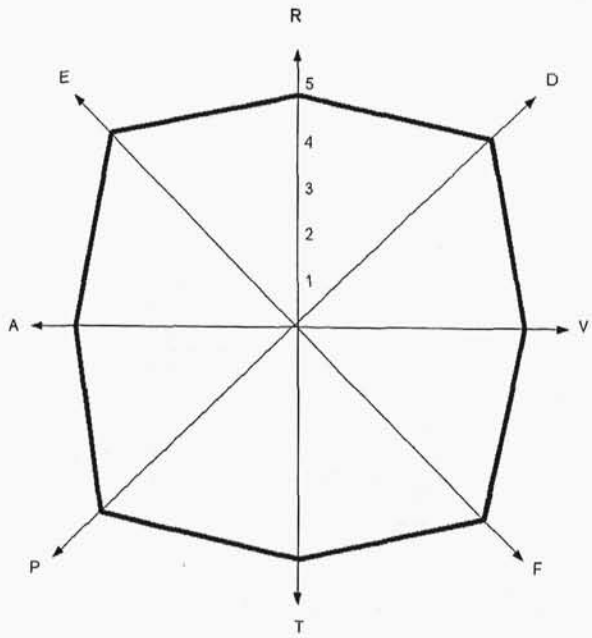
In order to communicate (message flow) or make decisions (decision science) successfully, information must possess eight qualitative attributes (Targowski, 1990a):

- Relevance (R)
- Timeliness (T)
- Exclusiveness (E)
- Format (F)
- Accessibility (D)
- Accuracy (A)
- Verifiability (V)
- Price (P)

Each attribute can be measured on a scale from 1 to 5, in which the highest rating corresponds to the greatest influence of the attribute on the communicated decision-making process. A set of all the attributes creates the information quality space (IQS), which is depicted in Figure 10-1.

The IQS is the sum total of all the attributes' values. The ideal $IQS_i$ has 8 x 5 = 40 points. If

*Figure 10-1. The ideal information quality space (R-Relevance, T-Timeliness, E-Exclusiveness, F-Format, D-Accessibility, A-Accuracy, V-Verifiability, P-Price*



one person's $IQS_1 = 8$ and another person's $IQS_2 = 16$, then the probability of communication success (cs) between them is:

$$P(cs) = IQS_1 : IQS_2 = 8 : 16 = 0.5 \quad [5]$$

The potential of decision-making (dm) by the first person is:

$$PT\ (cs)_1 = IQS_1 : IQS_i = 8 : 40 = 0.2 \quad [6]$$

And by the second person is

$$PT\ (cs)_2 = IQS_2 : IQS_i = 16 : 40 = 0.4 \quad [7]$$

Through the interpretation of message transmission and decision-making values, we are able to obtain the holistic measurement of the feasibility of decision-making driven by information F(dm) in the organizational environment:

$$F(dm)_i = P(cs) \times PT(dm) \quad [8]$$

$$F(dm)_1 = P(cs) \times PT(dm)_1 = 0.5 \times 0.2 = 0.1 \quad [9]$$

$$F(dm)_2 = P(cs) \times PT(dm)_2 = 0.5 \times 0.4 = 0.2 \quad [10]$$

The proposed qualitative assessment of information provides the following rules:

- Rule 1: The larger the information quality space is, the better communication and decision-making potential a given individual has, since a given IQS approaches the ideal IQS.
- Rule 2: The smaller the difference is between the information quality spaces of communication agents, the greater the probability of communication success these agents have, since P(cs) approaches 1.
- Rule 3: The higher probabilities of communication success and higher potentialities of decision-making will lead to the higher feasibility of decision-making, since F(dm) approaches 1.

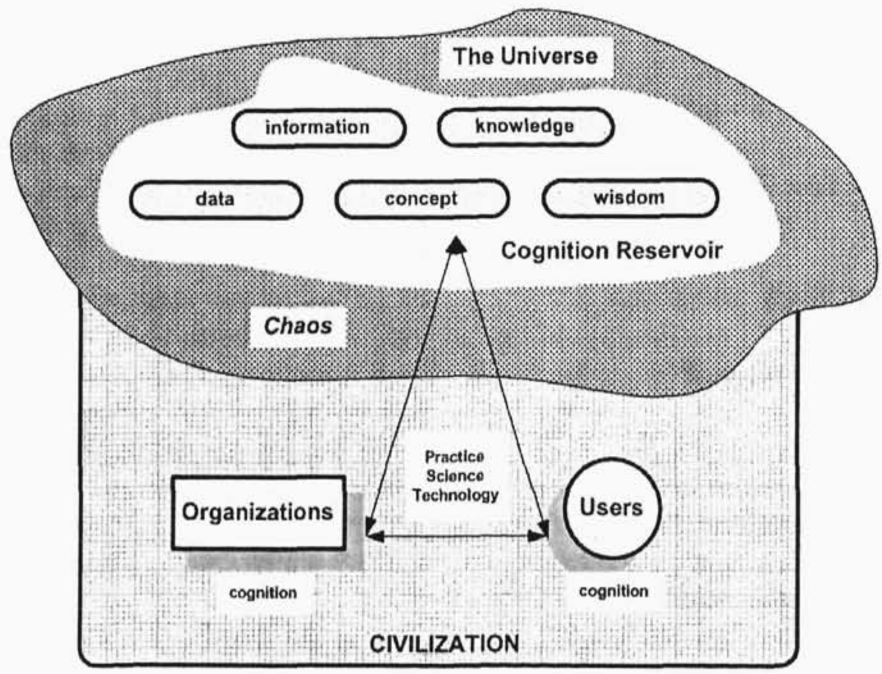
These rules imply that a decision maker either has quality information available [P(dm)] to make choices or will obtain information through successful communication [P(cs)]. The proposed indicators can be integrated into a "theory of choice" and a "theory of search" (Cyert & March, 1963). Some research from the pre-Information Wave period indicates that decision makers prefer to look for inexpensive and easily accessible information[2]. Let us hope that the Internet potential (paid or free information) will improve decision makers' quests for better quality information in the 21st century.

## The Cognitive Perspective of Information

In order to describe the central role of information in civilization development, the theory of information ecology creates a model that views the existing body of accumulated human information as a distinct set of "entities" apart from the minds of information users. This body of information is called a cognition reservoir (CR), as is shown in Figure 10-2. The recognition of the CR permits researchers and users to assign descriptive characteristics to cognition units (among others, information), and treat it as though it were an independent entity of civilization. Information ecology considers the interaction between users and the CR to be the most significant factor shaping human civilization.

The cognition reservoir contains a semantic cross-section of cognition (decreased chaos) with cognition units of data, information, concept, knowledge, and wisdom. These units are created by humans' science and practice (culture in general) and have been stored and retrieved by different kinds of technology, such as writing,

*Figure 10-2. Cognition reservoir of civilization*




papyrus, books, print, libraries, and computers, which lead to the rise of communication information sciences and management.

The information-communication process conveys meaning through five kinds of cognition:

- **Datum (D)**
  A measuring unit of cognition that describes transactions between natural, artificial or other semantic system. In business, data can measure performance characteristics of production, distribution, transportation, construction, or service. For example, the Dow Jones Stock Index (at the New York Stock Exchange) stood at 10,000 points on February 15, 2005.
- **Information (I)**
  A comparative unit of cognition that identifies, specifies, and defines a change between the previous and the present state of natural, artificial, or semantic system. Businesses often compare performance characteristics in two or more periods. For example, if the Dow Jones Stock Index stood at 11,000 points on February 14, 2005. The change is -1,000 or 9% in comparison to the previous day February 13, 2005.
- **Concept (C)**
  A perceptive unit of cognition that generates thoughts or ideas that create our intuition and intention that give us a sense of direction. For example, due to the market's strong change, should an investor sell, buy, or hold his/her stocks?
- **Knowledge (K)**
  A reasoning unit of cognition that creates awareness based on scientific data (e.g., Census Bureau research), rules, coherent inferences, laws, established patterns, methods and their systems. Knowledge is, essentially, old data remembered in an established framework and being used to evaluate

new data. It provides a point of reference, a standard for analyzing data, information and concepts. Knowledge can be categorized in many ways, for example:

- o Domain knowledge (Kd)
- o Societal knowledge (Ks)
- o Personal knowledge (Kp)
- o Moral knowledge (Km)

Once again, elaborating on the previous examples, an investor will apply his/her adviser's financial knowledge (Kd) to find out which concept he/she should apply to a market decision. He/she can also apply the remaining kinds of knowledge to evaluate each concept option.

- **Wisdom (W)**
  A pragmatic unit of cognition that generates volition—a chosen way of acting and communicating. Wisdom is a process of choosing among available concept options, based on knowledge, practice, morale, or intuition, or on all of them. Concluding our example, an investor may choose the "hold" concept option to wait and see what will be the Federal Reserve Bank's decision on interest rates.

The cognition units that compose the cognition reservoir can be structured from simplest to most complex in the semantic ladder, shown in Figure 10-3. Events that occur at the existence level are communicated as data and inserted into the semantic ladder of a person, discipline or orga-

*Figure 10-3. Semantic ladder*

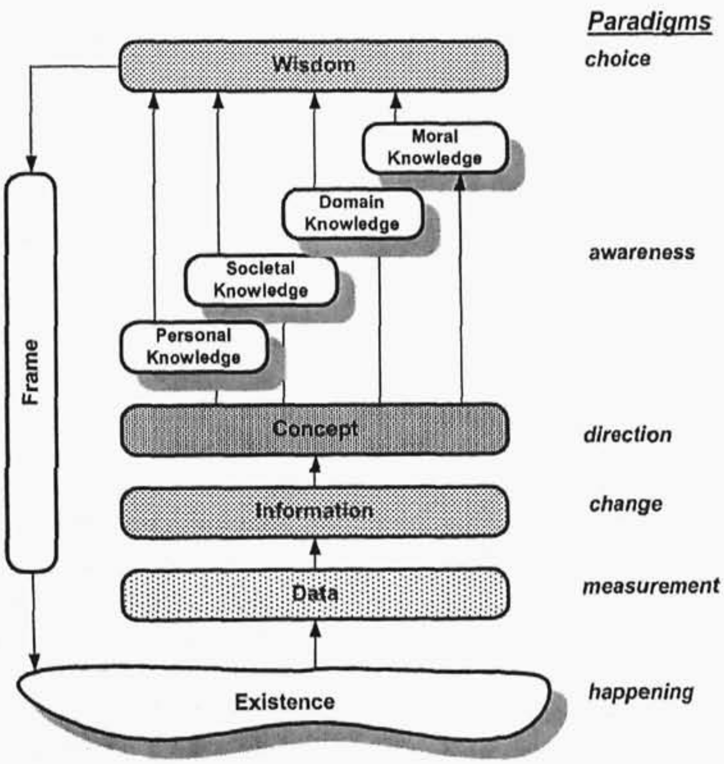
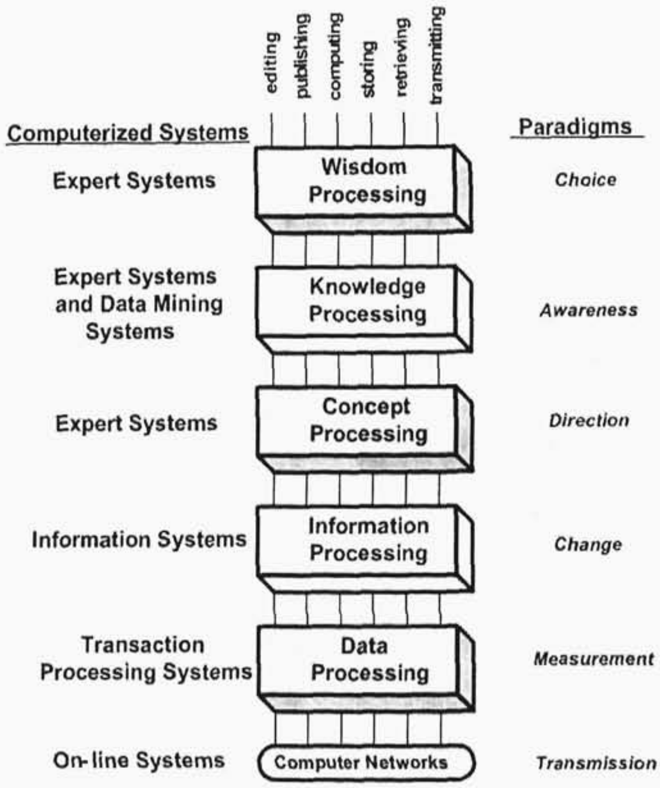


*Figure 10-4. The hierarchy of computer cognition-oriented systems*




nization. These data are subsequently processed into information, and information is processed into concepts, which are later evaluated by available knowledge—that is, filtered—before one of those concepts is chosen by the decision maker's wisdom. Then, a *frame* consisting of a message and the decision maker's intentions (very often different than the message's content) is returned as a feedback to the level of existence.

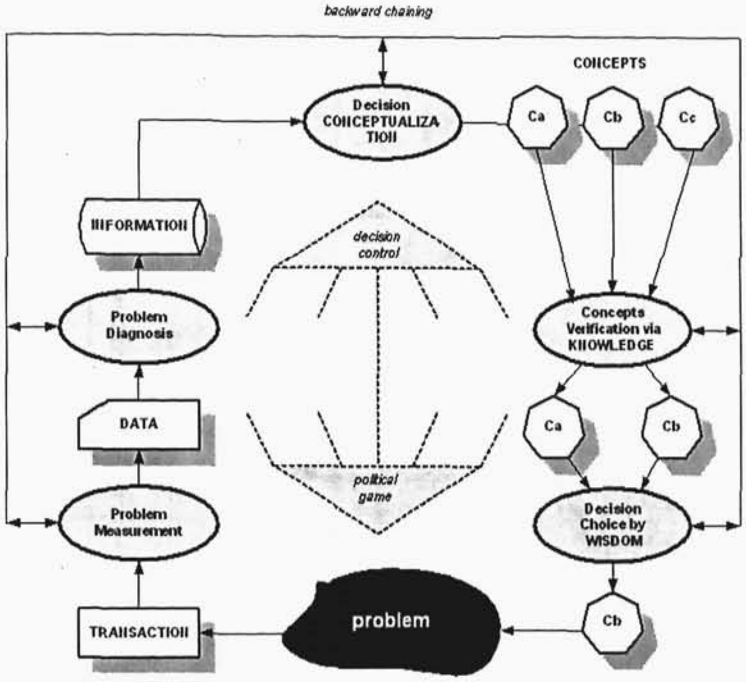
## The Computer Perspective of Information

Human cognition increases along with the development of information-communication technology, at first: printing, later stereotyping and recently tele-computing. Tele-computing is the present application of the label "information systems (IS)," that is, computerized information systems. However, every level of cognition requires a different kind of IS.

At the lowest level, cognition is *data processing* under a format of transaction processing systems. At the level of information, supporting systems are of the information system kind, which compare "planned" with "actual" performance characteristics. The higher levels of cognition require expert systems based on artificial intelligence, with the exception of *knowledge processing*, in which data mining systems are also of great value.

The hierarchy of computer cognition systems is depicted in Figure 10-4. Every kind of these systems requires a different architecture, skills

*Figure 10-5. The cognition units-driven generic phases of problem solving (Ca-Concept A, Cb-Concept B, Cc-Concept C)*




to build, timeline, and budget. It is similar to the situation in construction, in which residential houses need different know-how than public buildings, and so forth.

## The Decision-Making Perspective of Information

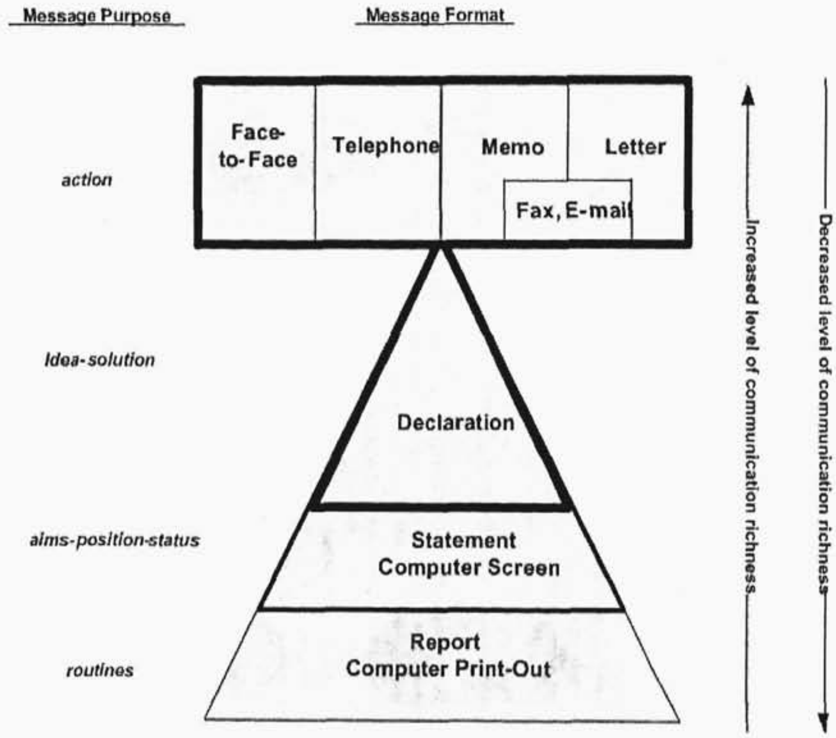
The cognitive perspective of information can be useful in understanding how decisions are made. A decision is an act of wisdom in choosing the right course of action at the right time. To reach the cognition level of wisdom, one must pass through four semantic levels, each one specializing in a specific cognitive unit processing.

A number of frameworks have been offered to define the phases of decision-making. Perhaps the best known of these is Simon's (1965) "intelligence-design-choice of decision" triad. Ackoff (1978) perceives the decision-making process as a function of problem solving. Mintzberg, Raisinghani and Theoret (1976) add that the decision-making process is subordinated to political game and decision control in a given circumstances.

The information-oriented approach to decision-making in problem solving is presented in Figure 9-5, in which the following five phases are recognized:

1. *The Problem Measurement Phase* – identifies a problem based upon transactions which are processed into organized data, indicating problem symptoms and implicit stimuli for action.
2. *The Problem Diagnosis Phase* – involves comparisons of different but relevant sets of data, which leads to the production of information on a change in a given state of a problem's affairs.

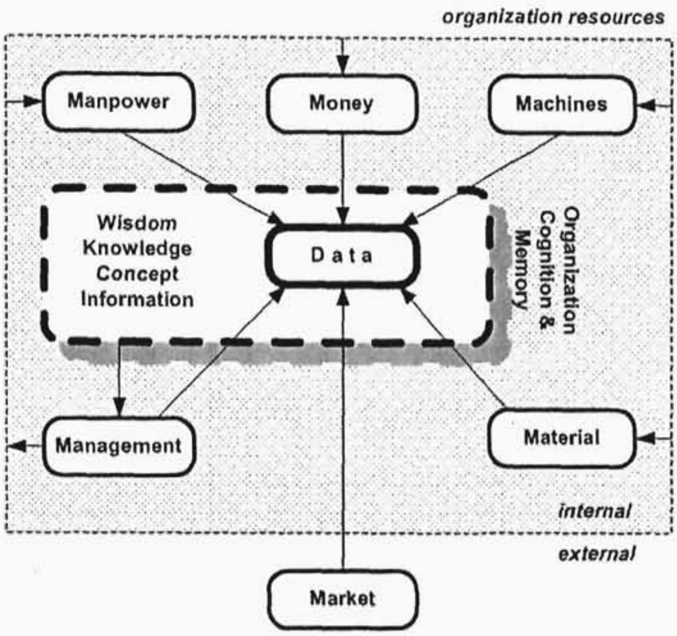
*Figure 10-6. The hierarchy of message formats-driven by media choice*




3. *The Decision Conceptualization Phase* – defines concepts of actions, triggered by the change diagnosed in phase two. The automation of this phase is very difficult; however, knowledge engineering proposes some techniques of discovering new facts. One cannot exclude the possibility that one day a new concept will be generated by the computer.
4. *The Concepts Verification by Knowledge Phase* – screens solutions by knowledge of the planned concepts and eliminates those that are unfeasible. The scientific facts, rules, and laws of a given domain of knowledge are applied in this verification. This phase creates awareness for a decision maker about consequences of possible courses of action. A data-mining technique can useful in this phase.
5. *The Decision Choice Phase* – chooses wisely a given decision concept from many evaluated by knowledge in the previous phase. Wisdom applied at this phase is a result of accumulated (recorded in a human or computer memory) experiences coming from analysis of existence (the ontological aspect of being) or the study of knowledge (the epistemological aspect of being).

The phases of a problem-solving cycle are guided by the decision support routine—the operating system which plans the cycle (schedules, conceptualizes strategies, commits resources to the cycle, etc.) and switches the decision maker from one phase to another. The implementation

*Figure 10-7. Information as a resource*




of the selected decision depends on the power game and on consensus among the persons affected by it.

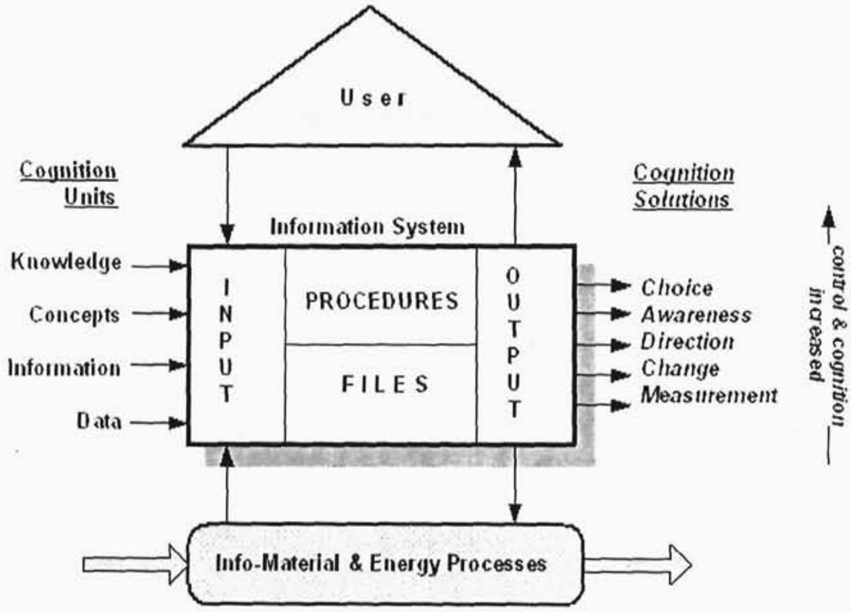
The decision-making cycle incorporates a backward path in the events that feedback indicates the need to correct, clarify or repeat the previous phase. It also is implied that the cycle is applicable only to rational decisions, as Simon defined bounded rationality, where formal rules are applied.

## The Managerial Perspective of Information

The premise of this perspective is that management is looking for explicit information to make rational decisions, therefore is ready to process the desired kind of information in certain manners to achieve this goal. Managers and executives apply a variety of media to process and communicate information in a correct manner. The hierarchy of professional message formats-driven by applied media is modeled in Figure 10-6.

Computer print-outs and reports describing routines are located at the lowest level in the hierarchy. These types of messages are processed by the heavily computerized information systems. At the next level one finds aims/positions/status-oriented messages which are described by statements on computer screens. These kinds of messages can be processed by computerized information systems with a friendly graphic-user interface (GUI). The third level of the hierarchy contains declarations describing ideas/solutions such as "read my lips, no more taxes," or "freedom everywhere." It is at this level where the meaning of

*Figure 10-8. Information as an information source*




the message is of greatest importance but is very difficult to automate. At the top of the pyramid are action-oriented messages such as face-to-face communication, telephone and fax, memoranda, and letters. This type of message format is the richest in content and it will soon be a luxury to practice some of them.

The hierarchy of message formats driven by applied media reflects a concept of information richness, defined by Daft and Lengel (1986) as the potential of the information to carrying capacity of data. In this study, richness is defined as the ability to communicate a message in the most meaningful and effective manner[3].

## THE IMAGES OF INFORMATION

### The Image of Information as a Resource

The wide applications of computers since the 1960s first in data processing and later in complex enterprise-wide applications turned our attention toward the reliability of data files and databases. The latter approach led toward better integration of information about all resources of an enterprise, such as manpower, money, machines, material, management, market (6M) and eventually data as a new resource.

Data is a meta-resource which measures the values of 6M other resources. These data are organized in information systems that are processed by computers or manually. As a result, information, concept, knowledge, and wisdom are generated to influence or direct further *control* and *cognition* in a given action/circumstances. It is interesting to notice that without the 6M, "data" has no meaning and is useless in such a case.

Figure 10-7 depicts the role of data-information as an organization's reservoir of cognition and memory. Data-information properly gathered and processed can become a product, which can be packaged, sent and sold as a "soft commodity." Commercial databases are one such product. Another example is computer software, such as