Chapter 1

A ROCK AMIDST THE ROUTE

It is generally thought that the question of scientific method resolves itself into two parts: the *problem of discovery* and the *problem of justification*. Scientists tackle the first problem whenever they find out interesting phenomena, and set up innovative practical solutions. Theorists and thinkers address the second problem i.e. they clarify the logic of observed events, they investigate the root-causes, they define mathematical models to explain the phenomena and so forth. Usually the latter follows the former in time and appears somewhat distinct one from another; however some people mistake the problem of justification for philosophical studies. Science shares some elements of its necessity and universality with philosophy, although what distinguishes science from pure philosophy is its mandate to understand the world of empirical experience.

A large number of researchers are interested in gaining a deep insight into computer technologies and hope that exposition of explanatory theories will be brought up to date. Alvin Schrader (1986) has analyzed various conceptualizations that appeared in the literature and has underlined the need for universal definitions and concepts in information science. Edsger W. Dijkstra authored several papers on fundamental topics of programming from the sixties up to the year of his death in 2002. Peter J. Denning is intensely concerned in appropriate principles of Computing and is perhaps the most active advocate for the conceptual development of this field. "*Computing as a Discipline*" – the preliminary report of the ACM task force on the core of Computer Science (Denning et al 1989) – captured the intensive interest of researchers and gave rise to ample debates within the scientific community.

I actively share the feeling and the aims pursued by those scholars. My investigations address topics close to the basic principles of Computer Science but the starting point of my way is rather new in comparison with the current literature.

As a physicist I am inclined to see the *principle of causality* as a solid assumption which offers significant support to those who tackle the problem of justification and provides modern science with a logical basis (Hübner et al 1983). Any material event has a practical origin and the correspondence between causes and effects regulates the logic of natural phenomena, as well as the logic of machines. The principle of causality sustains engineering, and in particular this principle makes clear that the product *w,* carried on by the process *S,* is the logical cause of *S* in that the outcome *w* determines the components of *S* and the entire logic of *S*. Manufacturers install the machine *S* and this in turn outputs *w*. First comes *S*, and then comes *w* on the operational time table; but things go the opposite way in the intellectual sphere due to the principle of causality. The examination of *w* precedes the scrutiny of *S* since this product determines the features of the system *S*.

The principle of causality yields the natural method of study which may be found in many sectors: as first one becomes aware of *w* and later of *S*. To facilitate this process, a student of engineering takes lessons on Chemistry and Electrical Technology, and then can comprehend the operations of a plant that produces caustic soda. He/she masters the electrolytic chloralkali process only when he/she is familiar with hydroxides, acids, chlorides and so forth.

The study of *w* draws the attention of researchers in a special manner when the process *S* is spontaneous in Nature, and no human architect designed the process *S*. For example, accurate inquiries into the components of petroleum were carried out for decades and finally clarified the spontaneous activities which produced petroleum. Presently most experts accept the idea that oil derives from ancient fossilized organic materials, such as zooplankton and algae natural.

The study of *w* appears extremely interesting when the process *S* has been devised by technicians who operated by trial and error. This method, examined by Ross Ashby (1960), is often used by people who have little knowledge or are pioneers in the problem area. Most of the computer devices has been built up and optimized by trial and error. Pascal devised the earliest mechanical calculator and subsequent constructors improved this machine using the 'generate and test' method. Eventually the electronic manufactures produced the modern computer systems on the basis of practical experience rather than on theoretical assumptions. It is evident how our cognition of Computing should be enhanced with an approach using insight and theory.

However, to the best of my knowledge, modern commentators describe analog and digital solutions just created and are not inclined to discuss what makes those solutions happen, or to explicate the great principles that guide – or should guide – computer experts. They overlook the problem of justification and usually introduce the hardware components and the software programs on an *as-is* basis; i.e. they disregard the scientific principles that govern this advanced sector. The simplified illustration of technology seems effortless and effective. Learning just what to do allures the novice in computing but in the long run this method looks rather superficial to the expert since one does not understand the reason for things. Secondly, engineers make a lot of effort to correct and improve technical solutions when they lack accurate notions. Lastly, simplified studies give support to a self-referential sciolism as the links amongst various technical areas appear obscure.

The reasons for this strange cultural tendency typical of the computer sector may be easily assessed.

The computing machine *S* manipulates information, and one should examine information first and computer technologies later. Formidable obstacles restrict or impede the efforts of thinkers to clarify what is information. The course, which appears to be the most natural on the paper, involves a lot of argument in practice. The analysis of technical solutions grounded on the concept of information is an open challenge and I mean to proceed in this arduous task.

1. A CHAMELEON

Various scientists are unraveling the nature of information in numerous areas. Experts in Neurosciences, Linguistics, Cognitive Sciences, Sociology, Education and Communication besides Informatics search for the solid definition of what is information. Different scientific theories have been put forward to explain what is information, but none has gained universal consensus so far.

Ronald Aylmer Fisher, an English statistician, first presented a scientific definition of information in (1922). Measurements are usually imperfect and Fisher meant to specify the amount of information deriving from a measurement process affected by statistical fluctuations. During the same years, electrical engineers began using the term '*information*' to describe data transmission. Observations on electrical nets and circuits lead the American Ralph Hartley to search for a quantitative measure whereby the capacities of various conducts to convey information could be compared. Hartley distinguished the physical transmission of information from 'psychological factors' in (1928) and opened the way to Claude Shannon who devised the most famous mathematical conceptualization of information in the engineering field. His work stimulated investigations conducted from several perspectives but the classification of those theories which mushroomed in the past decades is challenging too. The ensuing partial list – time ordered – can give an idea about the variety of schools of thought:

- The *statistical* theory of information by Fisher (1922);
- The *transmission* theory of information by Hartley (1928);
- The *communication* theory of information by Shannon (1949);
- The *semantic* theory of information by Carnap and Bar Hillel (1953);
- The *utility* theory of information by Karkevich (1960);
- The *cybernetic* theory of information by Wiener (1961);
- The *algorithmic* theory of information by Solomonoff, Kolmogorov (1965), and Chaitin (1977);
- The *descriptive* information theory by MacKay (1969);
- The *semiotic/cybernetic* theory of information by Nauta jr. (1970);
- The *economic* theory of information by Marschak (1971);
- The *pragmatic* theory of information by von Weizsäcker (1974);
- The *qualitative* theory of information by Mazur (1974);
- The *living system* information theory by Miller (1978);
- The *autopoietic* theory on information by Maturana and Varela (1980);
- The *hierarchical* information theory by Brookes (1980);
- The *common-sense* information theory by Derr (1985);
- The *dynamic* theory of information by Chernavsky (1990);
- The *systemic* theory of information by Luhmann (1990);
- The *general* information theory by Klir (1991);
- The *physical* theory of information by Levitin (1992);
- The *organizational* information theory by Stonier (1994);
- The *independent* theory of information by Losee (1997);

– The *social* theory of information by Goguen (1997);
– The *purpose-oriented* theory of information by Janich (1998);
– The *philosophy* of information by Floridi (1999);
– *The anthropological* information theory by Bateson (2000);
– The *biological* information theory by Jablonka (2002);
– The *sociological* theory of information by Garfinkel (2008);
– The *general* theory of information by Burgin (2009);
– The *unified* theory of information by Hofkirchner (2010);
– The *communicative* information theory by Budd (2011).

In sum, it may be said that a circle of followers of Shannon – such as Marschak, Brookes, and Miller – considers the master's theory good but insufficient and refines it or enriches it with new contributions. The rest of the cited writers propose a variety of more or less original alternative definitions of information.

The contrast among the various approaches – *semantic*, *algorithmic*, *autopoietic*, etc. – is evident. The above listed descriptive adjectives – defined by the same authors or by the commentators in the field – can aid the reader's intuition about the diverging intents and purposes of the works. A group – e.g. Burgin, Hofkirchner and Klir – searches for a comprehensive conceptualization of information and others focus on narrower specialist issues. Carnap's view revolves around Semantics; in contrast Shannon deliberately ignores the aspects of Semantics. Kolmogorov reasons at the purely mathematical level, whereas Bateson aims at unifying the view of the mind with the world out there. Engineers focus on the model transmitter/channel/receiver which is nonsensical for Maturana and Varela who deny the existence of information as external instruction. In a way one could call Maturana and Varela 'negationist authors' in this domain. Most researchers investigate the relations between information and technology instead Richard Derr analyzes the term '*information*' in ordinary discourse and conversational utterances. Norbert Wiener rejects the idea that information is physical, and Tom Stonier sees information as much a part of the physical universe as energy and matter. Whilst to Shannon information is inversely proportional to probability, to Wiener it is directly proportional to probability: the one is simply the negative of the other.

Theorists do not concur even on the nature of the problem; a circle sees information as a quantity to measure – e.g. Shannon, Kolmogorov, Fisher and Klir – other thinkers – e.g. Floridi – are convinced of the prismatic constitution of information which one can scrutinize only from the philosophical standpoint. The former are inclined to attack the problems using analytical methods, the latter rejects any analytical approach and claims that pure philosophy can enlighten the argument.

In addition, the reader can find definitions of information which the authors have posited outside any formal theory or have placed inside a rather small theoretical framework; I cite randomly Ackoff (1989), Kullback and Leibler (1951), Loveland (1969), Gabor (1946). All these researches yield a lot of papers and books. Schrader (1986) has conducted an accurate and stirring survey and concludes:

> "The proliferation of notions of what information means staggers the mind: 134 variant notions have been documented in the present research. This proliferation demonstrates the conceptual chaos issuing from the definitional literature of information science."

There is no lack of scientific contributions on the table; however, those proposals have not led to a generally recognized description of information. Ritchie (1986) observes:

> "Confusion has also arisen from confounding the precise technical and statistical usage of words such as 'uncertainty', 'information' and 'communication' with the more common, everyday usage of these words".

Several complaints about the misunderstandings and misuses of the very idea of information are expressed in the literature (Sayre 1976). There are so many irreconcilable issues that I am prone to conclude with René Thom (1975):

> "Information is a semantic chameleon"

My attitude towards this situation is essentially positive and I am convinced that the wealth of theories is a sign of vitality and liveliness of thought. The scientific community begets ideas and projects, and advances even when the works seem to miss the intended targets. In fact multiple views mature the minds of researchers who derive the definitive solutions through debates and common conclusions.

Unfortunately this is not the case in the information domain. Authors have clashing viewpoints and rarely show a collaborative attitude; they even indulge in squabbles and personal arguments. They often refuse to acknowledge that the viewpoints of their opponents have any validity at all and – worse – do not accept disagreement gracefully. For example Shannon's followers interpret this statement in a very radical mode:

> "These semantic aspects of communication are irrelevant to the engineering problem." (Shannon 1949)

And in practice they refuse to engage in a dialogue with semioticians and linguists who methodically focus on the meanings of signs. On the other side a circle of humanists plunges into literary genres and does not bother about the information and communication technology (ICT). Obviously, this uncommunicative attitude of thinkers does not facilitate progress in the field which is presently in a rather sorry state.

Strong divisions, incomplete and generic outcomes do not seem to support my cultural project, that is, to penetrate deep into the computer technologies starting from the notion of information. The lack of solid theoretical references looks like an immense rock amidst the route that obstructs my progress. I have just taken to the road with the ambitious purpose of proceeding along a challenging route and I cannot proceed onward.

A. Odd Opponents and True Friends

Some decades ago I became distressed by this barrier. I felt unhappy of course and had a strong desire to circumvent this obstacle. I investigated all over the literature in the hope of coming up with a better idea. At last this exploration paid its dividends and bore evidence that my initial bleak intuition was partially incorrect.

When a reader explores works on the various aspects of information, or crosses the borders erected amongst the numerous sectors dealing with communication, he/she makes a pleasant discovery: the vast majority of scientists do not dissent from one another completely. Authors are in conflict with the abstract idea of information, but agree on what a piece of information consists of. Pieces of information are *signs*, also named *signals*, *messages*, *news items, reports* etc. Signs take the form of *words, images, numbers, music, sounds, gestures* and *objects* and the interpretation of this great variety of communication items surprisingly proves to be rather uniform. Scholars coming from different areas are prone to believe that *a sign has a material basis and stands for something*. A large group of scholars tends to converge upon two fundamental notions established in Semiotics.

I briefly remind the reader that *Semiotics* is defined as the *science of signs* (Chandler 2007), and amongst its most eminent founders are Charles Sanders Peirce, Ferdinand de Saussure and Charles W. Morris.

Semioticians who adopt the terminology deriving from De Saussure (1983) call the body of a sign *signifier* (E); and the represented entity *signified* (NE). The distinction between signifier and signified has sometimes been equated to the familiar dualism of *form* and *content* (Deely 1990). Small bodies of ink on paper, electrical impulses along wires, sonorous waves in the air, and pixels on the display screen are familiar examples of signifiers in the computer sector.

The signified is the thing, the event or the concept indicated by the signifier. It does not need to be a real object but is some referent to which the signifier refers. By way of illustration take:

New York

This film of ink on the paper is the signifier and the large American city considered the centre of the world is the signified NE_1. I can also use this item of ink to denote the idea of New York that I have in my mind (= NE_2) and thus I handle an abstract signified.

When we examine closely Shannon's work, we find:

> "By a discrete system we will mean one in which both the message and the signal are a sequence of discrete symbols. A typical case is telegraphy where the message is a sequence of letters and the signal a sequence of dots, dashes and spaces." (Shannon 1949)

He calls the generic signifier 'signal', the elementary signifier 'symbol' and the signified the 'message'. He calculates signals conveyed in a channel which are physical quantities and carry a message. Shannon adopts a special terminology but recognizes the existence of signifiers and signified, and even distinguishes the overall signal from its components that are 'symbols'. Søren Brier (2008) remarks:

> The Shannon theory "presumes that signals are meaningful codes established in a system of signs, such as the Morse code for the alphabet that makes sense for humans".

Even if modern followers of Shannon dislike arguing over Semantics, their master accepts that an electric impulse (= *E*) signifies something like a letter (= *NE*) or a figure.

The abstract interpretation of information lies beyond the horizon. Nobody can say when the definitive solution will be established; in the meanwhile scientists subscribe to conceptualization on what a sign consists in. The notions coming from Semiotics can be summed up in this way:

A sign has a physical origin and stands for something. [1.1]

B. In the Literature

The material and semantic properties of signs summed up in [1.1] did not follow the same way in literature; they had a very different provenance and fortune during the centuries.

The semantics of signs was recognized since a long time. Very early on, the naïve idea of meaning saw the light of day in Western culture. Aristotle, the genius involved in all the known disciplines of his era, also found the time to bother about human communication. In "*De Interpretatione* (On Interpretation)", a short treatise dealing with language and logic, he writes:

> "Spoken words are the symbols of mental experience and written words are the symbols of spoken words. Just as all men have not the same writing, so all men have not the same speech sounds, but the mental experiences, which these directly symbolize, are the same for all, as also are those things of which our experiences are the images." (Aristotle 2004).

Whilst the semantic nature of signs was evident early on and was developed through a lot of discussion, the physical side of information was muddied up till recent decades. In particular, ideas, thoughts and other products of thinking proved to be the strongest obstacles to the material view of information. A circle of philosophers inherited a certain spiritual conception of the human mind from Platonism and refused the interpretation of ideas – and in turn the interpretation of signs – as concrete objects. Ancient writers marked the basis of linguistic signs using the Latin term '*vox* (*voice*)' which vaguely alludes to a psychological constitution. Ferdinand De Saussure (1983) presumed that the *form* of a sign is immaterial and added that the language itself is "a form, not a substance".

Fortunately, in recent times neurologists have provided substantial evidence on how mental functions are related to neuronal activities and it is natural to assume that also mental signifiers have chemical-electrical basis. Various experiments are inducing authors to converge toward the material interpretation of *E*. Also Gottlob Frege (1892), Tadeusz Kotarbinski (1968) and other followers of the logical schools, who maintain the most abstract stance, partake of the concrete origin of information. Charles Morris (1964) and Doede Nauta coin the clause '*information carrier'*. Some sociologists prefer the terms '*representational medium'* to name the physical substrate in which a representation is instantiated. We even find the terms '*sign vehicle'* highlighting the physicism of a symbol. The base *E* looks like a cart being loaded with goods: a very practical perspective indeed!

Regardless of which interpretation one gives to the tenet of information, the reader can find general consensus on [1.1] which I sum up in the following two distinct points:

(1) *A signifier has a physical basis*,
(2) *A signifier stands for somethin*g.

C. The Semantic Triangle

Pleasant discoveries in literature did not come to an end for me.

Semioticians agree that a third element is necessary to complete the interpretation of signs. The roles of *E* and *NE* do not have mechanical origins and authors come into accord that an *intellectual sense-maker* or *interpreter* links the signifier to the signified.

A large number of thinkers made the three elements progressively intelligible over the centuries. Sextus Empiricus, Severinus Boethius, Thomas Aquinas up to De Saussure analyzed the components of a sign according to the fine reconstruction made by François Rastier (1990). In the late nineteenth century the American philosopher and logician Charles Sanders Peirce formulated the triadic model (Hartshorne et al, 1931-66). In 1923 C. K. Ogden and I. A. Richards (1989) drew a geometrical diagram to clarify the semantic process and fixed the *thought* as the sense-maker.

This notion has a reasonable degree of generality for the present book. The human intellect recognizes/ interprets/ invents the meanings of signs and brings about the entire semantic processes. Saussure wrote that *E* and *E** are "intimately linked" "by an associative link" in the mind and "each triggers the other". This is enough for us to conclude that the *thought* or the *mind ME* connects *E* with *NE* in harmony with the ideas of Ogden and Richards.

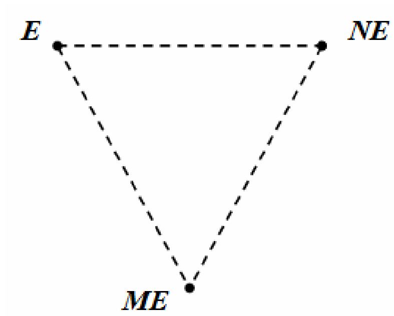


Figure 1.1. The semantic triangle.

One cannot deny that the semantic triangle raises a lot of serious questions. Terms such as: *interpretant, sense, signification, semiosis, significate, thought* and *reference*, connote the vertices of the triangle, and this varied terminology mirrors the contrasting philosophical perspectives and pinpoints the misaligned interpretations of the semantic processes. What meanings exactly signify is rather mysterious. Bertrand Russell and Gottlob Frege believe that *meaning is a nominated subject* (Wolfgang, 1994); Alfred Tarski assumes *meaning is an interrelation between a sign and a significate*; Wittgenstein says that a *meaning is a relation between a sign and people's behavior*. Ogden and Richards mention 23 different definitions of the term '*meaning'* in their monograph (Ogden et al 1989).

The functions of the sense-maker raise debates and lie far from unified conclusions. For example, the recourse to the public character of words begs the question of how the mind is supposed to gain access to the extra-mental world. Some thinkers posit that there must be a realm of concepts in the mind as bearers of meaning, but Wittgenstein and others bring suspicion on treating thoughts as '*mental representations'*. Communication and media theorists stress the value of the mental processes, while others highlight the receptive aspect of the intellect. The psychological and sociological features of significance cast light upon human arbitrariness; on the other hand, logicians focus on the truth/falsity of reasoning, and postulate the precision of the semantic relationships.

Alan Turing, John von Neumann and other modern thinkers on Artificial Intelligence (AI) are convinced of direct connections extant between the computer and the human mind. The brain can be found to be performing something like computational processing. One can read the intriguing history of the efforts of scientists to develop a machine able to think like a human being in (Pratt 1987). The bonds between natural intelligence and artificial devices make it even more difficult to interpret what is significance and enhance the attraction of the semantic triad for commentators.

The semantic triangle raises important points of discussion intimately bound up with philosophical topics and even with unresolved questions concerning the logic and essence of human life. The intellectual nucleus of Semiotics epitomizes the formation of human knowledge and raises debates upon the origin of the mind, upon its unpredictable and free nature, upon learning, memory, will, consciousness and many other knotty issues. At present endless discussions are taking place and any synopsis of current works is at risk of being reductive and incomplete. Far be it from me to talk about these complex arguments.

Stamper (1996) defines the following six levels regarding communication and related issues:

1. *Physical:* This level is involved in the concrete appearance of signs, the media and their preparation through technologies.
2. *Empirical:* The empirical level focuses on the variety and equivocation encountered; sometimes related to the entropy and uncertainty.
3. *Syntactic:* A representation uses a defined set of symbols according to a set of rules. If the syntax is formally defined then symbolic forms may be transformed into other symbolic forms.
4. *Semantic:* This layer concerns the meaning and validity of what is expressed. Meaning is the mapping of a symbol to a real world object or state and is different for different people.
5. *Pragmatic:* The pragmatic level of representation concerns the usage of symbols. It takes into account contextual issues including the intentions, responsibilities and consequences behind the expressed statements.
6. *Social:* The social layer regards the understanding of the meaning of symbols, and takes into account cultural, ethnical, geographical and political issues involved.

This book addresses the computer technologies and the multiple layers of the semantic triangle lie beyond my competence. I restrict the discussion to the physical level 1; and the diagram in Figure 1.1 will be good enough for completing the fundamental semiotic assumption [1.1] in the following manner:

A sign is equipped with three elements in all: the signifier E, the signified NE and the mental function ME which relates the former to the latter. [1.2]

All those components which appear at the corners of the semantic triangle are necessary for creating cognition, information, and communication, and are sufficient for the analysis of computing machines.

2. PRACTICAL PERSPECTIVE

I found out that the semiotic ideas are very popular in the literature and in professional practice, and I intend to provide the reader with evidence. In particular, a wealth of pragmatic inquiries has been done into the material nature of signs. Researchers and practitioners coming from different fields and disciplines exploit the properties of signifiers even though the term '*signifier*' is not formally cited. My interest in signifiers is primarily from the perspective of a scientist and a technician, and the next pages exhibit a concise survey which focuses on the concrete aspects of signs.

A. Experts in Communication Sciences

The fundamental qualities of human communication are derived from the material substance of signs, and linguists categorize languages on the basis of the material essence of languages. The following classification, which is a prerequisite to further studies in communication and media, includes for instance:

– *Textual languages* i.e. signifiers are words printed on paper,
– *Vocal languages* i.e. signifiers are sonorous words,
– *Gestural languages* i.e. signifiers are motions of limbs,
– *Pictorial languages* i.e. signifiers are colored pigments,
– *Musical languages* i.e. signifiers are sounds.

Physical features determine the nature of each language and cannot be swapped. Nobody can switch from one material medium to another medium without losses and modifications. For the sake of reference, in 1725 Antonio Vivaldi published "*The Four Seasons*", a violin concerto that recreates scenes located in spring, summer, fall and winter respectively. Each of the four parts is illustrated by a sonnet – presumably written by the composer – full of allusions suitable for sonic depiction. Concertos and sonnets recount the same scenes; they depict the same vistas. The parallelism is evident but the melodious music gives rise to sensations that the sonnets cannot stir. Ink and music convey untranslatable contents. One cannot exchange the feelings evoked by the poems with the sensations of the concertos because of their different material nature.

Word Order	**Languages Number**	**%**
SOV	497	41
SVO	436	35
VSO	85	7
VOS	26	2
OVS	9	1 <
OSV	4	1 <<
No dominant order	171	14
TOTAL	1228	

Figure 1.2. Popularity of word order (Source: Dryer op.cit.).

Typology, an entire and ever-increasing sub-field in linguistics, spells out the order of the words (Whaley 1996). Authors recognize six basic types of declarative sentences in all: SOV, SVO, VSO, VOS, OVS and OSV, where S marks the *subjec*t, O the *object* and V the *verb*. By way of illustration:

– English is a SVO language
  e.g. "*Tom* (=subject) *met* (=verb) *Sally* (=object)";
– Japanese is SOV
  e.g. "*Gakusei-ga hon-o yonda* (= *student book read*)";
– Welsh is VSO
  e.g. "*LLaddodd y ddraig y dyn* (= *killed the dragon the man*)".

The disposition of subject, verb and object is a physical property which leads to important classification of languages. SOV (subject-object-verb) is preferred by the largest number of modern languages. SVO (subject-verb-object) is the second group, but has the greatest number of speakers because this group includes the most popular languages such as English, Chinese, French, Spanish, Portuguese, Russian, the Germanic languages, many languages of Africa and of Southeast Asia, including Khmer, Vietnamese, Thai, and Malay.

There are words in a language indicating the relation of the substantive to a verb, an adjective, or another substantive. These words are members of closed classes called *prepositions* and *postpositions*. A preposition is located before the intended substantive X, the postposition is located behind X. For example '*with*' comes before '*me*' in English sentences and is classified as preposition. Take: "*Bob speaks with me*"; the clause '*with me'* is translated in Turkish as '*benim ile'* (literally '*me with'*), i.e '*with*' is a preposition and '*ile*' is a postposition. It is evident how prepositions and postpositions regulate time-space properties of languages.

Linguists go on with their materialistic approach and discuss whether the disposition *adjective-noun* (AN) or otherwise *noun-adjective* (NA) emerges as the prevalent order in a phrase. For instance the English expression "*Good morning!*" is AN; the Italian clause "*piogge sparse*" is a NA form.

Experts even investigate the displacement of the atomic parts in a word. They inquire into *prefixes, suffixes*, and *infixes* and how these parts changed positions down the centuries and influenced the rules of grammar.

In conclusion, linguists dedicate a fair amount of attention to the *order* of words, and make comprehensible the material characteristic of textual signifiers. In fact, the order regulates the spatial place of written words and the temporal priority of spoken words. *The order is a temporal and spatial property*, and it is not an exaggeration to use the designation 'physical linguistics' for typology.

Marshall McLuhan (1965) masterfully explains how tiny physical details which belong to a communication system and which appear trivial at first glance, provoke broad and astonishing social phenomena. The medium has a profound influence on human thought of which the user may not always be conscious. McLuhan's famous aphorism:

"The medium is the message"

Summarizes how the construction of a medium adds contents to the mere message transmitted. The concrete constitution of a signifier and the way it is delivered has a profound effect on the human soul; it alters human perception and affects human consciousness. The make-up of a medium is associated to specific subject contents so that communication media direct listeners' attention, and influence the behavior of social groups.

The physical structure of a medium leads McLuhan to the distinction of *hot* and *cool media*. A hot medium enhances only one single sense and accordingly is rich in detail – note how the richness and poverty of details do not refer to the *content* but to the *form* in which this content is necessarily communicated due to the composition of the medium – the focus on one sense caused by a hot medium makes the recipient refer to his inwardness and thus separates him from the outside world. A cold medium in contrast lacks detail whilst it demands active attendance and a multi-sensory participation from the recipient.

Two examples illustrate this distinction: the radio is a hot medium and the television is cold. In actual fact, the radio only enhances the acoustic sense and stimulates the receiver's self-suggestion. By the way, McLuhan remarks upon how the radio reinforced the excitement of the Nazi propaganda. Television stimulates visual, acoustic and also collective participation and should be considered a cold medium. The multi-sensory structure of TV provokes little involvement and, for example, conditions children into becoming passive observers.

Nowadays the followers of McLuhan apply his method of investigation, and analyze novel media such as the communicative structure of network systems which are revolutionizing people's lifestyle (De Kerckhove 1997).

Paleographers and librarians are aware that a vegetal ink runs the risk of bleaching as time passes, and moreover, the paper on which a historical document is written may deteriorate. Experts take care of and preserve old writings that become darker and unreadable (Cunha et al 1967). The physical state of ancient writing attracts the paleographers' attention and one concludes that even those experts are extremely sensitive to the empirical form of information.

B. Experts in Biological and Social Sciences

Our bodies are complex systems and when something is wrong, our bodies inform us through special warning signs e.g. pain, fever, sweat, vomit, tremors, weight loss, shortness of breath, headache etc. The physical essence of those special signifiers – called *symptoms* – is evident to everybody and does not need further elucidation. *Symptomatology*, a branch of medical science, teaches physicians how to recognize symptoms and how to diagnose a disease correctly (Gray et al 2001).

Essential symptoms are those signs that are intrinsically related to the pathology and necessarily follow from it. The essential symptoms of X provide the complete conception of the disease X. Because of the complexity and the large number of the essential symptoms of X, doctors focus on the *pathognomonic symptoms* which are so characteristic of X as they are sufficient to make a diagnosis. For example the yellowness of the skin, of the sclerotica and of the nails is the pathognonomic symptom of jaundice. On observing this, a doctor is sure that the patient has jaundice without making any further inquiry. Essential and pathognomonic symptoms are judged as the appropriate elements for a diagnosis but a doctor takes into consideration any circumstance of the case to make the correct diagnosis, and also analyses the *accidental symptoms* that are not at all specific to the disease. Frequently, the observation of a feeble accidental sign determines the survival of a patient. In fact some diseases are *asymptomatic*: these diseases do not create any signifier and the patient is unconscious of his state. Cancer is a well known silent illness, i.e. cancer does not show any symptom for a long while and when the signals come to light, successful intervention becomes more difficult.

Gestures and facial expressions are important vectors of communication which make up the so-called *language of signs*. Through looks, behavior, facial expressions, and head movements, people convey information about not only a person's emotional state but also on discursive and syntactic elements. The body organs moving with varying degrees of motion, gentleness or force convey different meanings and make evident the concept of signifier (Fernandez et al 1997).

The language of signs may be found even in the animal kingdom. This territory has been explored by Thomas A. Sebeok, father of Zoosemiotics, by ethologists such as D. Griffin (1985), C. Heyes and others. Researchers decipher the system of signs used by animals to communicate: postures, gestures, cries, excrements, movements, which clearly are material signifiers. Experts subdivide the communication between senders and receivers into two classes:

(i) Those belonging to the same species (*intraspecies comm.*);
(ii) Those belonging to different species (*interspecies comm.*).

For example the signals for mating belong to the first class, and the signals exchanged between predators and preys pertain to interspecies communication.

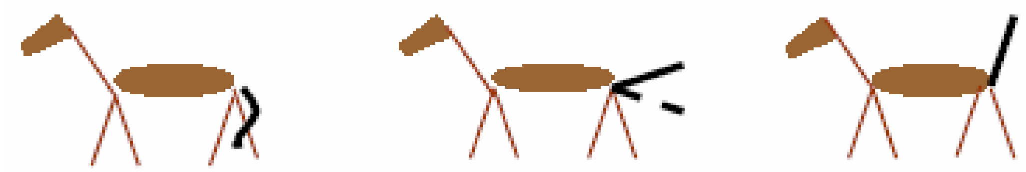


Figure 1.3.

Efforts have been concentrated on finding out whether a common alphabet can be constructed on the basis of animal behavior. E.g. a quadruped makes use of its tail to communicate. It keeps the tail between its legs to denote fear. If it wags its tail, it signifies happiness and devotion. The quadruped is antagonistic and aggressive when it raises its tail. The waving tail may be seen as the basic element of a code shared by various species of mammals: horses, wolves, dogs and so forth (Hailman 2008)

In the nineteenth century, the scientific exploration of the processes of the brain began. In 1861, Paul Broca first described the section of the brain – close to the frontal lobe in the left hemisphere – which is involved in speech production. Later experts discovered how perceptual information from the eyes, ears, and the rest of the body is sent to the right zone of the brain. Other specialized areas were found in the course of later investigations (see also Paragraph 4 in the present chapter) (MacInteyer 2004). Modern techniques keep up the physical origin of mental ideas in a factual manner. I quote *positron emission tomography* (PET), a nuclear medicine system which produces a three-dimensional image of the brain's activities; *magnetic resonance imaging* (MRI) is an effective tool that visualizes the inside of the brain (Vlaardingerbroek et al 2003).

Chemical-electrical reactions embody intellectual activities and the cure of psychological diseases by means of drugs reinforces the awareness about the material origin of information within the brain. Neurological and Psychiatric studies corroborate the materialistic perspective on mental signifiers.

A court of justice gives judgment against an accused or otherwise acquits him after the accurate consideration of *evidence*. Scientists accept a theory if it is supported by experimental *evidence,* or else reject it. A manager chooses to follow a strategy in accordance with positive *evidence*. Crucial decisions are taken on the basic strength of *evidence*. Evidence is a sign, or better still, *evidence is a signifier* which plays a fundamental role in forming a conclusion or judgment.

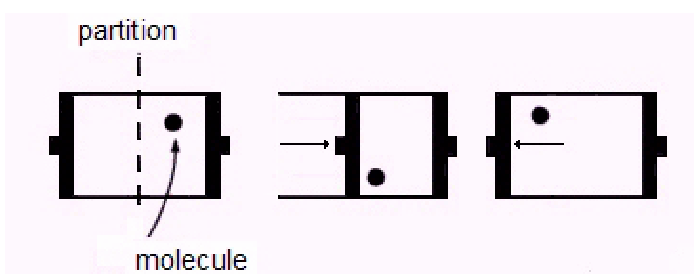


Figure 1.4.

The current literature concentrates attention on the particulars of evidences, on how to acquire evidences, the methods to adopt etc. because of the valuable role which a tiny detail can play. E.g. the scientific method requires that evidence should be obtained through rigorous, standard procedures (Wilson 1952). E.g. legal doctrines determine how objects may be submitted to a jury as evidences. Also verbal testimony is regulated and is physically bound to a real individual, who is officially admitted as a witness (Blazey et al 1996).

C. Experts in Physical Sciences

An intriguing vein of studies sought out the minimal signifiers in classical physics. In 1929 Leo Szilard, inspired by the thermodynamical system elaborated by Maxwell, envisioned a theoretical engine that consists of a cylinder with a single-molecule working fluid. An operator observes a molecule in the chamber on the right and pushes the piston on the left toward the center partition. The molecule in motion impinges on the piston, causing it to slide back to the left. This creates useful work and the cycle can begin anew. Szilard found that the amount of useful work per cycle is

$$W_C = k_B T \ln(2)$$

Where T is the absolute temperature of the system and k_B the constant of Boltzmann. The second law of thermodynamics holds that energy cannot be created from nothing; thus Szilard supposed W_C is the energy absorbed in order to acquire information from the single molecule (Leff et al 1990). Eminent physicists, say Bennett, Penrose, Zurek, Brillouin, Feynman, discussed this argument and eventually converged toward the illustration of Rolf Landauer (1961) who explained how the Szilard engine cannot work unless an operator takes energy to erase acquired information. In substance, a sole molecule is the tiniest signifier in classical physics and absorbs energy W_C to be restored to the initial conditions.

Information has material origin, and demands physical power to be collected, erased, thrown away, and so forth, in the tiniest systems too. We can but agree with the witticism of E.T. Jaynes:

> "The old adage 'knowledge is power' is a very cogent truth, both in human relations and in thermodynamics."

Electronics supports continual evolution in the mechanisms of information rendering. We live amidst several information representations, and a variety of technologies have been developed to record, to process and to exhibit various types of phenomena. Images, sound and other forms of data can be stored by any number of methods: magnetically, optically, electronically or even otherwise. Cathode ray tube (CRT), liquid crystal display (LCD), light-emitting diode (LED) and gas plasma produce ever better images. This is just to say that the technology of signifiers is ever progressing in ICT and is transforming the lifestyles of people. I shall make further comments on this topic later.

Some philosophers define a signifier as the *surface structure* of a language; others mark a signifier as a *shape* of information. The terms '*surface'* and '*shape'* make a signifier similar to a suit whose appearance does not influence the personality of the man wearing it. This terminology hints at the idea that signifiers play an ancillary role instead the contrary is true. This short survey is an attempt to illustrate the material side of information and to highlight its relevance in a variety of environments. Linguists, paleographers, physicians, ethologists, doctors, magistrates, experts in mass media and in cognitive sciences, computer engineers and many others share the idea that information is tied to some substance and is not airy. They delve into the multifold world of signifiers and benefit from their physical properties.

3. SHARPNESS

The idea that a sign has a physical origin proves to be very popular in various fields. However, experts rarely study Semiotics. Engineers show little interest in the science of signs and normally use *E* and *NE* by intuition. Why does Semiotics, which establishes two fundamental tenets, seem to be alien to scientists and to engineers in a special manner?

I am inclined to believe that this behavior originates from a precise cause; in particular, from the cultural gap between the humanities and technologies. The first use verbal descriptions, the second are grounded on measures. Semioticians argue about the nature of signs, whereas engineers need equations to calculate quantities concerning machines and products. The signifier and the signified are popular ideas, but ICT practitioners put them in the background due to methodological divergence. A special divide keeps Semiotics away from the exact sciences and frustrates our initial, cultural project. The contrasting definitions of information seemed to prevent me from advancing; now the generic notions of signifier and signified build a second barrier against my initial purposes.

A. Toward a Principle

Actually engineers describe their objects using the mathematical idiom: a method that does not tolerate any exception. Things are to be standardized, quantified, and measured using rigorous equations; thus *E* and *NE* wait to be redefined in accordance with the rules of the scientific method. The semiotic concepts could be appropriately used by technicians and could provide an epistemological support to computing as long as one begins to provide the formal definitions of the signifier and the signified.

Semiotic issue (1) “A signifier has a physical basis” – cited in the previous pages –sounds rather vague from the perspective of the exact sciences and one wonders:

When may a generic body be a sign?
What are the properties that determine a signifier?
How could those properties be formalized?

Four different groups of experts, which seem to move toward a precise direction, suggested an answer to me.

i. There are experimentalists who scrutinize information phenomena in biological and mechanical systems.
   - Physiologists bring evidence that an individual perceives reality through his senses, which detect differences in stimuli, and in turn influence individual cognition. When a sensory message to the brain is constantly repeated, the sensitivity weakens and is finally suppressed. In short there is no information when there are not any differences. Lack of contrast does not make people informed and the receptors are capable of reporting news to the brain only when something changes. Nerve endings do not sense stimuli but *differences of stimuli* (Somjen 1983).
   - We learn from Neurology that a nerve impulse moves along the axon and consists of a self-propagating series of polarizations and depolarizations. The spike reaches the *action-potential* +40 mV (millivolt) whose value is far from the *resting-potential* located at – 70 mV. The nervous signifiers – about 110 mV apart – prove to be absolutely distinct (Partridge 2003).
   - Electronic engineers calculate the distance that makes any two signals distinguishable. They recognize this quality as essential for handling signals (Smirnov 1999).
   - Nature long ago learned to encode information about organisms in Deoxyribonucleic Acid (DNA). When a cell receives a biological material with different DNA, it rejects such material; this means that the genetic code X contrasts with the genetic code Y and has the evident property of being distinguishable (Loewenstein 1999).

ii. Ever since the classical age, philosophers recognize that clear-headedness is a necessary requisite for humans; to understand what happens in the world, sense data and non-sense data alike are to be neat. I mean to quote the reflections by Wilhelm Gottfried Leibniz who argues about the *indiscernibility of identicals* and the *identity of indiscernibles*. He attaches great importance to the special property of becoming distinct which renders indiscernibles clear to the mind (O'Leary 1995). In substance, the ideas developed by Man can be elaborated as long as those pieces of information are neat. Fuzzy tenets impair correct reasoning and it is natural to conclude that even clear ideas are to be definite signifiers.

iii. Linguists highlight the distinctiveness of forms and Saussure (1983) says in explicit terms:

> Sign's "most precise characteristic is to be what the others are not".

And John Arthur Passmore (1985) offers a charming aphorism:

> "Languages differ by differentiating differently".

A principle of communication and art refers to the arrangement of opposite elements in a piece so as to create visual interest, excitement and drama. Authors adopt a wide set of contrasting items to arouse strong feeling e.g. light vs. dark colors; rough vs. smooth textures; large vs. small shapes. An artist can employ contrast as a tool to direct the viewer's attention to a particular point of interest within the piece.

iv. Several theorists of information argue about the concept of dissimilarity. MacKay writes in (1969):

> "Information is a distinction that makes a difference."

Mark Burgin (2009) places the concept of change at the base of his general theory of information. He assumes that information causes changes either in the whole system that receives a message or in a part of it. A measure of information is some measure of provoked diversities.

At the base of his theory Gregory Bateson (2000) places the following:

The "elementary unit of information" is "a difference which makes a difference".

Bateson feels the need to specify the notion of 'difference' that is central to his definition, and notes that any object is characterized by a large number of special features that are the 'differences' typical of that object. It is precisely because of this infinitude that an object cannot enter into a communication or mental process such as. People normally select or filter out a limited number of differences of the intended object which becomes information. Thus mental information is an abstract, simplified entity. The object-hammer is material with several peculiar attributes; the information-hammer has the reduced set of attributes accepted by the individual's mind.

Four groups of authors – experimentalists, philosophers, experts on communication and information theorists – spell out the idea that the ability to be distinct is the essential characteristic of information. The act of distinguishing by comparing differences turns out to be of universal use. *Sharpness influences the existence of any piece of information and one can reasonably conclude that a signifier must be neat in order to work properly.*

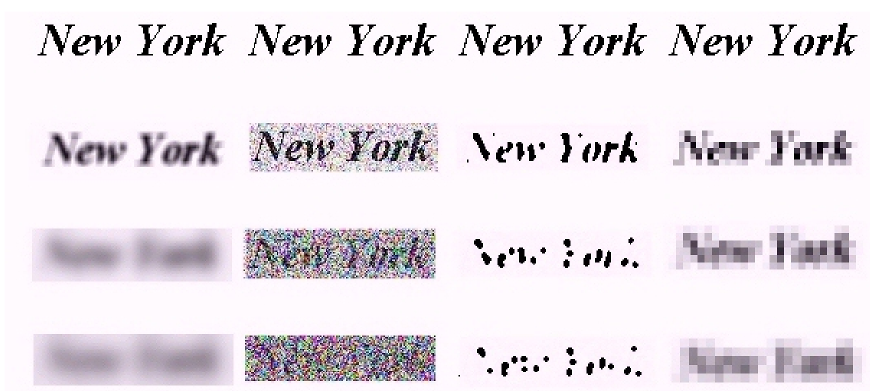


Figure 1.5. Four different deterioration processes (from left to right: blurring, noise, erosion, granulation) cause progressive loss of information.

However the concept of sharpness sounds like an airy characteristic unless one establishes the conditions necessary for verifying this property. The analysis of functional aspects is of great significance in arriving to a formal conceptualization. I mean to delve into some practical features of distinctness and pinpoint the following factors:

- Human speech, animals' signals, mass media messages, symptoms of sickness, mental ideas, and impulses in electric devices are to be sharp. A signifier inevitably vanishes and cannot be employed if it lacks this characteristic. A generic entity is capable of informing because of the essential property of being distinct in a manner. If a signifier becomes fuzzy, it no longer carries on any content. Therefore *sharpness establishes the condition of existence for signs*.
- Secondly distinctness does not appear as a yes/no property but *distinctness presents different degrees of quality*. Take the following object of ink which conveys information provided that the ink film contrasts with the white sheet:

  New York

  Under the influence of different deterioration processes this signifier has a blurred outline, or it bleaches, or it thins out etc. (Figure 1.5); the effectiveness of this film of ink gradually decreases until it finally ceases to exist as a signifier.
- As a matter of fact, *a signifier contrasts a close element with respect to the observer* R. The dissimilarity between any two signals makes a difference in R which acquires information. The agent R may be natural or artificial; e.g. a sense organ, a biological receptor, or a mechanical device. In practice R gives effect to the property of *E* which is distinct using an adjacent comparison term *E**.

The above remarks lead to the following statement which I call *principle of sharpness:*

The element or entity E is a signifier if E differs from an adjacent entity E with respect to the reference R* [1.3]

The verb *differs* can be translated into the symbol 'NOT=' (literally 'not equal') and [1.3] can be stated mathematically as

$$E \text{ NOT}=_{\text{R}} E^* \qquad (1.1)$$

Where E and E^* are elements of the algebraic space $\mathcal{E}_a$.

The reader can verify (1.1) in everyday life. All the day long we act as R and acquire information from mass media and also from the objects placed around us. Everything which appears clear to the sight or to another sense organ is a signifier. Also the chair, the table and the glass full of wine which are easily distinguishable, are signifiers.

The observer R perceives *E* and executes the perception process that is independent of recognition, interpretation or other semantic processes that revolve around the link between *E* and *NE*. Dissimilarity is the condition of existence for signs and is prerequisite to any subsequent semantic study. If *E* does not contrast in a way, *E* is no longer extant, neither can it represent *NE*. Discussion of the material nature of signs precedes Semantics in point of logic and hereunder I shall develop the calculation of sharpness.

B. Various Measures

Bateson holds that any object is characterized by several special features that are the 'differences' typical of that object. Attempts have been made to quantify the differences existing between any two items, but the *calculus of diversities* applied to complex items has not produced conclusive outcomes so far. Similarities and dissimilarities amongst compounds cannot be measured using manageable approaches – see the classical work (Gordon 1999) – in that an aggregate exhibits a variety of facets which resist linear methods of comparison. By contrast the dissimilarities of *elementary items* can be quantified by using simple criteria. To exemplify, a physical quantity – e.g. 3.8 volts, 0.3 amperes, and 4 millimeters – is a common elementary signifier in ICT. I subdivide this calculation into two subsections: the first works out *single elementary signifiers*, the second *multiple elementary signifiers*.

Figure 1.6. Separated subsets and overlapping subsets.

1. Single Elementary Signifiers

Let us calculate three popular forms of signifiers that are *subsets, vectors* and *points*.

A) Let E and E^* be subsets in the set space $\mathcal{E}_s$. From (1.1) one concludes that the signifier E is distinct if the subsets do not overlap and the *intersection set* is empty

$$I = \{E \cap E^*\} = \varnothing \tag{1.2}$$

In fact, the signifier becomes a blur when I is not empty

$$I \neq \varnothing \tag{1.3}$$

As an example take the letter J of ink as a signifier and the white sheet all around as E^*. The letter is fuzzy due to the grey zone including black and white spots as well. The letter J becomes sharp when it complies with (1.2) and the grey zone disappears.

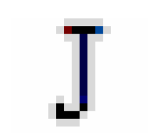


Figure 1.7.

B) Let $\vec{E}$ and $\vec{E}^*$ be applied vectors in the vector space $\mathcal{E}_v$. $\vec{E}$ is distinct from $\vec{E}^*$ when the application-points P_E and P_{E^*} are distinct; in other words, when the modulus of the *distance-vector* does not equal zero

$$\left|\vec{v}\right| \neq 0 \tag{1.4}$$

When (1.4) is false, $\vec{E}$ and $\vec{E}*$ add up and automatically produce the resultant vector $\vec{G}$. The initial vectors $\vec{E}$ and $\vec{E}*$ cannot be individually detected once $\vec{G}$ takes their place. The resultant vector $\vec{G}$ may be subdivided into two or more vectors at will, and there is no general rule to go back to the original vectors $\vec{E}$ and $\vec{E}*$ once they are summed up. Notably, when the *distance-vector* is null, $\vec{E}$ and $\vec{E}*$ become indistinguishable.

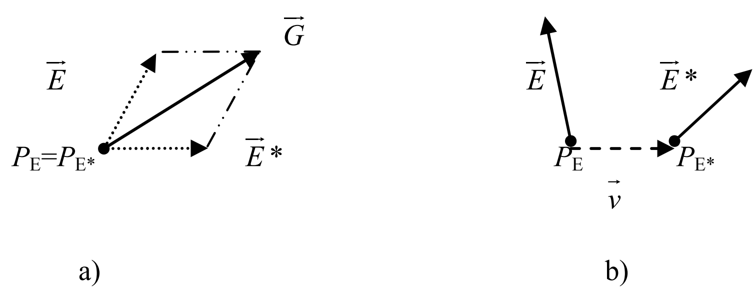


Figure 1.8.

C) Suppose E and E* are points in the continuous metric space $\mathcal{E}_m$. The signifier E is distinct if the points do not occupy the same place. The signifier disappears when E and E* coincide. The following inequality derives directly from (1.1)

$$E \neq E^* \tag{1.5}$$

And leads to the *separation* which is greater than zero

$$s = \left|E - E^*\right| \neq 0 \tag{1.6}$$

Digital experts set the voltage gap s that ensures the separation between the bits (Figure 1.9). Even if the high-value and the low-value fluctuate, the bits remain distinct because of the prudently chosen size of s.

The equations derived from (1.1) conform to the criterion of nearness. This notion was first developed by J. H. Poincaré who was involved in the study of earliest sensation-sensitivity experiments (Peters and Naimpally 2012). Equations (1.3), (1.4) and (1.6) have different meanings and purposes: the intersection set I depicts the low quality of a signifier; the distance-vector $\left|\vec{v}\right|$ and the separation s give the margin that guarantees the distinctness of two elements.

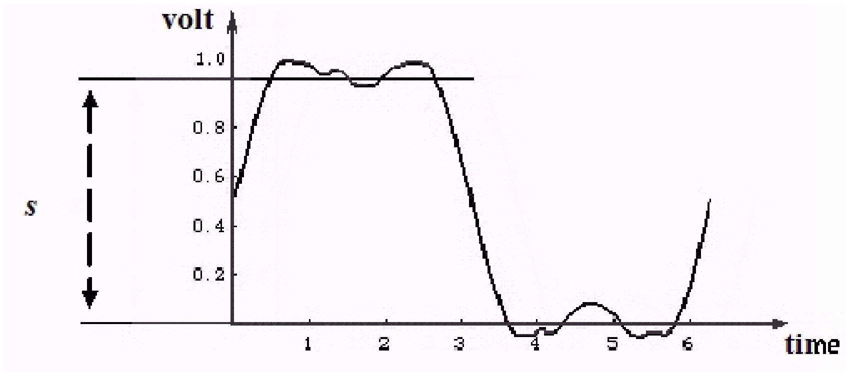


Figure 1.9. Electric square-wave.

2. Multiple Elementary Signifiers

A point is the simplest signifier and a set of points (E_1, E_2, E_3, … E_n) makes a multiple elementary signifier. When R perceives a set of scores which belong to the metric space $\mathcal{E}_m$, statisticians indicate the suitable course to follow:

> "The object of statistics is information. The objective of statistics is the understanding of information contained in [a wealth of] data". (Miller et al 1994)

However I cannot extensively examine the statistical methods and have to restrict myself to some basic notions.

First statisticians locate the value capable of representing the whole data set; they identify the center of a set of scores applying objective criteria. The most widely used measure of central tendency is the *mean* $\overline{E}$.

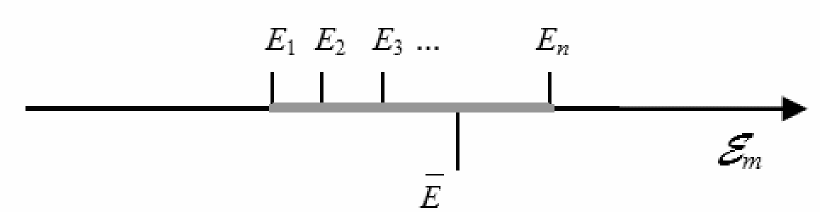


Figure 1.10.

The background space $\mathcal{E}_m$ is the term of contrast E^* for each signifier and the fuzziness of the set (E_1, E_2, E_3, … E_n) is given by the spread of the set. The variability of the scores is the overall quality of $\overline{E}$ over $\mathcal{E}_m$. The *range* of the distribution namely the mere difference between the largest value and the smallest value of the data set, gives a rough idea of the quality of $\overline{E}$. More accurate measures for the spread are the *variance* and the *standard deviation*. The standard deviation is an appropriate measure when the score distribution is reasonably symmetric and does not exhibit multiple concentrations of scores. Let us see three cases.

D) Suppose you are working with a set of discrete values E_1, E_2, E_3,.. E_N belonging to the metric space $\mathcal{E}_m$, the arithmetic mean is computed simply by adding the values together and dividing by the total number of values

$$\overline{E} = \frac{1}{N}\sum_{i}^{N} E_i \tag{1.7}$$

The mean (1.7) yields the following standard deviation

$$\sigma = \sqrt{\frac{1}{N}\sum_{i}^{N}(E_i - \overline{E})^2} \tag{1.8}$$

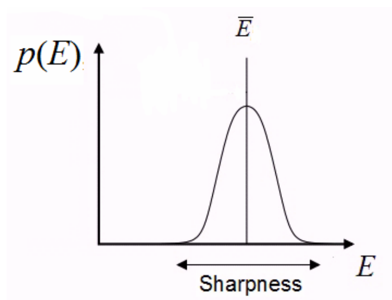


Figure 1.11.

E) When the signifier is a continuous parameter with probability density function $p(E)$, the mean is obtained in the following way

$$\overline{E} = \int E \cdot p(E)\, dE \tag{1.9}$$

And the standard deviation is calculated in the ensuing manner

$$\sigma = \sqrt{\int (E - \overline{E})^2\, p(E) dE} \tag{1.10}$$

Where the integrals are definite integrals taken for E ranging over its field of observation.

When all the scores coincide with $\overline{E}$, the standard deviation is null and one has valuable information in hand

$$\sigma = 0 \tag{1.11}$$

Conversely the larger σ is, the more $\overline{E}$ becomes dim. When the scores scatter all over the axis $\mathcal{E}_m$, the standard deviation tends to infinity and the calculated mean does not make sense

$$\sigma \to \infty \tag{1.12}$$

F) When there are two or more statistical distributions, experts find an appropriate measure of *divergence* or *discrimination* between those distributions. A number of divergence measures for this purpose have been proposed and extensively studied by Jeffreys, Kullback, Leibler, Renyi, Kapur, Sharma and others. Some measures are specific cases of the divergence devised by Csiszfá (1967). His work is consistent with the principle of sharpness but I refrain from expanding the discussion of this theory.

3. Complex Signifiers

Complex signals cannot be treated by mathematical tools in an easy manner, but the *diffracted images* make a notable exception.

G) *Diffraction* is a physical phenomenon resulting in the light waves that change in direction and intensity after passing through a small medium whose size is approximately the same as the wavelength of the light. By way of illustration suppose a beam of light passes through a single thin slit; then the produced pattern is a central bright spot, surrounded by dark/light/dark/light spots. The spots become fainter and less distinct the farther away from the center they are.

Diffraction has the effect of turning a sharp beam of light into fuzzy images. This loss of detail leads to an inability to discern two sources of light which are very close together. In particular two sources of light produce two diffraction patterns E_j and E_k when they shine through the same slit. If the light sources are somewhat distant, the patterns are still distinguishable.

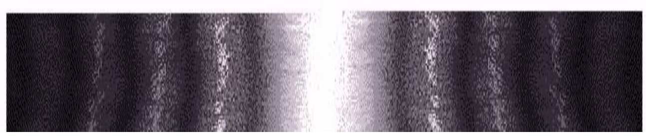


Figure 1.12. Diffraction pattern.

When the two sources get close, the patterns E_j and E_k start to overlap and become hazy. Lord Rayleigh examined two diffraction patterns and established the minimal distance so that (1.1) is still true (Longhurst 1974). He found that two close images are distinct when the first diffraction minimum of the pattern E_j coincides with the maximum of the pattern E_k (Figure 1.13). The ensuing equation determines the parameters for the minimal distance between two sources of light according to Rayleigh's criterion

$$\theta \approx \frac{\lambda}{w} \tag{1.13}$$

Where θ is the apparent angle between the light sources E_j and E_k, λ is the wave length and w is the width of the slit.

H) Laymen appreciate the ability of an optical device – say a microscope or a telescope – to magnify an image which can be scarcely seen with the naked eye. However, an enlarged image can become fuzzy due to the diffraction effect and the viewer loses the zoom benefit. A microscope and a telescope are good when they allow us to see two very close spots as distinct points. An optical instrument should be capable of separating two close spots of light and experts calculate the performance of an optical system using the Rayleigh criterion. They calculate the smallest angle between close objects that can be seen clearly to be separate. The *angular resolution* ϕ or *separation* of two object points is

$$\phi \approx 1.22 \frac{\lambda}{D} \tag{1.14}$$

Where λ is the wave length of light and D is the diameter of the lens of the optical device.

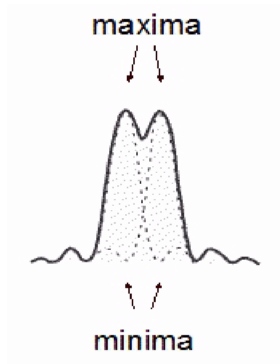


Figure 1.13. The criterion of Rayleigh.

In conclusion, the statement [1.3] expresses the principle of sharpness, and the calculus of diversities itemizes the features of signifiers in accordance with the current technical methods of work. The symbolic formula (1.1) gives the condition for the existence of a signifier in absolute terms while the mathematical equations derived from (1.1) and illustrated from A) to H) quantify the degrees of quality reached by signifiers depending on their distance, fuzziness etc. It may be said that the principle of sharpness tends to unify the view of various signifiers and thereby facilitates the analysis of the analog and digital appliances.

4. Information Relativism

The principle of sharpness sets up perception as the cornerstone of the definition of signifiers, but many thinkers mistrust the generality and reliability of perception. Things do not always turn out actually to be as they seem to human senses. There is ample reason to wonder about the epistemological reliability of perception, and theories of perception offer a variety of responses (Hirst 1992), (Dretske 2000), (Robinson 2001). Maturana and Varela (1980) argue about the illusory nature of human capabilities which plays a significant role in the autopoietic theory.

A wealth of evidence gives support to these skeptics. I restrict myself to the literature on human eyesight which shows how the eye is not camera-like as initially believed, but the eye and the brain build up images (Landy et al, 1995). The visual cortex covers five areas from

V1 to V5 which perform different operations, at different times and with differing organizations. Visual operations sometimes provide unfaithful outcomes. For example, the area V2 of the brain computes the visual contours in absence of light or color gradient, and offers some cases of *visual illusion,* which provoked the curiosity of Gaetano Kanizsa, Matthew Schmolesky and others (Seckel 2002). Phenomena of perception raise questions such as:

- Is perception true or fallacious?
- Does the perceiver create the perceived world?
- Does information cause distinction or does distinction, on the contrary, depend on the receiver?

The present account offers support to this discussion. The principle of sharpness holds that the perception of a sign relies on the adjacent term and presumes an observer who accomplishes the detection process. The intervention of E^* and R causes double relativism of necessity and one is obliged to conclude that information is not an absolute concept in the present framework.

Let us see four paradoxical effects resultant from the information relativism discussed in current literature.

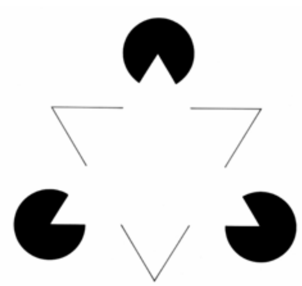


Figure 1.14. Kanizsa triangle.

A. First Paradox

Pompeii was severely damaged by an earthquake in AD 63 and was completely destroyed in AD 79 by an eruption of Mount Vesuvius. The eruption also changed the course of a neighboring river and raised the sea beach, placing the river and the sea at a considerable distance from the ruined city and obscuring the original site. Most of the knowledge about Pompeii was lost. For more than 1500 years people were deprived of information about Pompeii and the details of the destructive eruption. In 1748 excavations were undertaken and the complete picture of everyday life in that Roman provincial city was available over again.

At the end of the Second World War a large number of diplomatic documents were sealed by the Allies. These information items disappeared for decades until the end of the Cold War. In the nineties these secret documents became available and then information forgotten by everybody came into existence once again.

This pair of events shows that a sign does not work unless one perceives it, and a sign dies as soon as it becomes invisible or cannot be detected. This phenomenon may be summed up in this way:

A sign does not exist whenever it is not perceived by somebody, and all over again a sign disappears when it cannot be examined. [1.4]

Not only the form of a sign can vary depending on the specific agent who senses it, but a sign even ceases to exist when it is no longer perceived by somebody. An observer can kill information and can even revive it. This miraculous intervention sounds paradoxical since the decease of a sign and its resurrection seems to deny the material nature of signs. Matter exists due to its inner essence and does not need any support to be in the real world, hence one could conclude: "Information disappears whenever we close our eyes or forget about it; therefore the physical origin of information has no foundation". The observer should not be capable of destroying and recalling to life a message if information is physical.

I shall try to give an answer to the above objections using eqn. (1.1) which I write anew

$$E \text{ NOT=}_{\text{R}} E^* \qquad (1.15)$$

This inequality particularizes the conditions for the factual determination of a signifier and holds that a generic object is a potential piece of information but its capability becomes effective provided that R intervenes. The operational role of R does not impact on the physical essence of signifiers. The observer does not modify the entity *E* but *changes the information state of E*. The agent R allows an object or an event to pass from the *potential state* to the *real information state.* Remove the perception relation and *E* ceases to be a signifier while it is still existing as a thing in itself. Also ancient Latin thinkers recognized the difference between an 'ens reale (a real thing)' as *knowable* and an 'ens reale' as *actually known*. Thomas Aquinas coined the terms 'relativum secundum dici' which translates as 'being expressed in a discourse', and 'relativum secundum esse' that is the essential property of being in itself (Deely 2009). An element goes on living as a signifier when R applies (1.15) and *E* disappears for as long as that element is not available to observers.

The interference of an observer denies the physical existence of information as long as one argues from the abstract standpoint. Inevitably one infers radical conclusions and finds out irreconcilable statements if he/she reasons on the metaphysical plane. Instead the detection process described by (1.15) is a physical event and eqn. (1.15) suggests adopting the *operational perspective* to interpret the existence of information.

Scientific experiences and even the observations of everyday life support the present view. Because the state of existing of information is not a metaphysical issue but a practical occurrence, people are able to step in and to surmount a number of obstacles in perception using appropriate countermeasures. Experimentalists teach us how the *reference relativity* – namely the influence caused by the receiver R on *E* – may be managed using effective tools. I quote four cases to exemplify this argument.

1. In a number of circumstances the human senses are incompatible with *E*, the subsidiary probe R^ is sandwiched and the operator R controls the readout of R^.

People face the impossibility of direct perception and amend through *indirect perception*.

2. Cascade detectors make a complex arrangement and augment risks of distortion. Indirect perception makes even more evident how the properties of E may diverge from those possessed at the process outset. For example detection takes time and one should accept that all the events we perceive are to some extent in the past. In extreme cases the objects in the world may no longer exist at the moment when the process of perception occurs. As a case assume n is a positive number and light takes n years to travel from a star to us. Astronomers are aware of perceiving the star as it was n years ago. Perhaps, at present that star is no longer extant.
3. Sometimes R has a physical contact with the signifier which does not remain the same afterward the detection process. A sensor is capable of modifying the form of information and scientists accurately ensure that *a measurement is not invasive* and interferences are negligible.
4. The observer's actions result in critical consequences when E is *a quantum particle*. In fact the Schrödinger equation gives the possible positions of a quantum particle. One can calculate the probabilistic distribution of a quantum particle but this distribution remains true until a measurement is made. At this point an event known as the *collapse of the wavefunction* occurs, and the Schrödinger equation is no longer valid. The probabilistic wave collapses to a single point after a measurement of position. The particle E that has a generic place in advance of measurement, occupies a precise point after the intervention of the observer R.

The above listed measures and other maneuvers show how a sign depends on the observer's perception which may be modified, corrected, optimized, reduced and so forth. Practical experience is consistent with inequality (1.15) which suggests us to dissect the perception mechanisms in terms of operations, and provides analytic explanation for paradox [1.4]. This approach appears particularly appropriate for the consideration of the effect of Quantum Mechanics (QM) quoted in point 4.

In the early twentieth century theorists discovered that the observer R causes systematic alteration of information acquisition in QM. Several thinkers feared that the wave collapse could entail the downfall of the cornerstone in modern positive sciences: the tests. Vivid debates arose within the scientific community. Reams have been written upon a number of thought experiments including *Schrödinger's Cat*, *Wigner's Friend*, and *Heisenberg's Microscope*. A variety of theories have been proposed in order to clarify the weight of the observer over a quantum particle e.g. the *Copenhagen interpretation* (Petersen 1968), and the *Hidden variables theory* (Hooft 1999). David Bohm (1993) proposed ontological interpretations of Quantum Mechanics under the influence of philosophical considerations. Also extravagant theories were put forward such as the *Many-worlds interpretation* (Everett 1957). The measurement problem in QM raises broad debates from which two major philosophical positions emerge. On the one hand, one sees Cartesian and Lockean accounts of observation as the creation of inner reflections and, on the other hand neo-Kantean conceptions of observation as a quasi-externalized physiological process. The interpretation of quantum measurement becomes really intricate when experts address those phenomena from the philosophical perspective. I am not sure that the metaphysical approach is the better way to follow.

Since the beginning of the present section I noted that the observer can influence the state of the signifier. Model (1.15) sustains the *reference relativism* which however is not a philosophical notion but is scientific and subjected to measurements. As example, let us examine two well-known equations that calculate the signifiers in relation to the features belonging to human observers.

About the middle of the nineteenth century physiologists inquired into the relationship between an objective magnitude and the perceived intensity of a stimulus. They started to test whether persons could notice a difference between a couple of similar stimuli. On the basis of experiments it was found that the smallest noticeable difference was roughly proportional to the intensity of the stimulus. For example when a person consistently feels that a 110 g weight is heavier than a 100 g weight, he can also feel that 1100 g is more than 1000 g. The *Weber-Fechner law* calculates the behavior of human senses in this way

$$E_{FI} = a \log\left(E_I\right) + b \qquad a \neq 0 \tag{1.16}$$

Where E_I is the magnitude of a physical stimulus, E_{FI} is the intensity or strength that people feel, a and b are constant. This logarithmic relationship explains the special behavior of the human observer, notably the intensity E_{FI} of a sensation varies by a series of equal arithmetic increments as the strength of the stimulus is increased geometrically.

Engineers relate the intensity of the signifier E_I emitted by that source to the sense minimum threshold E_{I0} typical of the human being R. As a case, experts work out the intensity E_s of a sound in the following way

$$E_s = 10 \log_{10}\left(\frac{E_I}{E_{I0}}\right) \text{ dB} \tag{1.17}$$

Where E_I is the acoustic power of the sound and E_{I0} is the *minimal acoustic threshold* of humans equal to 10^{-12} watt/m^2. Since the human ear is incredibly sensitive, E_s is measured in *decibel* (dB); in practice E_I=E_{I0} corresponds to 0 decibel and an individual does not perceive any sound. A sound 10 times more powerful than E_{I0} is 10 dB. A sound 100 times more powerful than E_{I0} is 20 dB, and a sound 1,000 times more powerful is 30 dB.

In general, the observer R – biological or mechanical – has the *minimum threshold* E_0 and the *maximum threshold* E_m as well. A sense organ, a device, a signal conveyor, or a probe does not handle an infinite set of signals but solely those varying from the maximum threshold E_m to the minimum threshold E_0 which are typical of R. For instance, physiologists have measured the minimal acoustic threshold quoted above and also find that 134 decibel is the maximum threshold E_m for human ears, which is usually called *threshold of pain* since a man suffers intolerable pain when he hears such an intense sound.

In conclusion the influence of R on the perception process does not constitute a philosophical argument; but rather is an analytical, scientific topic.

B. Second Paradox

Neurologists hold that the sensory neurons once stimulated respond immediately, but then respond less and less until they do not respond at all (Bullock et al 2001). To exemplify, if you press a digital pulp for a short while, the tactile receptors are no longer able to transmit this single sensation. The mechanical signal vanishes and you feel no pressure. A sense receptor detects stimuli if and only if the input varies, and cannot perceive a constant stimulus, that is to say *a sensory neuron cannot perceive only one stimulus*. The so-called *sensory adaptation effect* causes a receptor to detect differing stimuli whereas a single stimulus declines through time and eventually disappears.

Norbert Wiener (1961) discovered how one elementary signal cannot be handled during his work on the automatic aiming and firing of anti-aircraft guns in the Second World War. He describes an evident experiment to summarize this astonishing property of information:

> "If people always get the same signal, this becomes inessential and nothing may be transmitted with the same result".

Shannon illustrates the phenomenon quoted by Wiener through refined formalism. He introduces the entropy of a source conveying m signals with probabilities p_1, p_2, p_3,.. p_m

$$H = -\sum_{i}^{m} p_i \log_a (p_i) \qquad a,\ m \geq 2 \tag{1.18}$$

The entropy H tends to zero when the probability of one signal is unit and the remaining probabilities are null. Suppose m=2 we obtain

$$\begin{aligned} H &= \lim_{p_1 \to 1} \left[-p_1 \log_a (p_1) - p_2 \log_a (p_2) \right] = \\ &= \lim_{p_1 \to 1} \left[-p_1 \log_a (p_1) - (1-p_1) \log_a (1-p_1) \right] = 0 \end{aligned} \tag{1.19}$$

This result means that information is null when a source emits a unique signal.

Experimentalists and theorists describe a rather paradoxical phenomenon which one can summarize by the following sentence:

A single elementary sign cannot exist. [1.5]

Everybody perceives several messages all the day long. People usually handle a lot of data and [1.5] seems to restrict our personal freedom to inform. It seems contrary to what intuition or common sense would indicate. It is natural to wonder:

For what reason is a single elementary sign not extant?

I mean to answer the paradox using the following inequality

E NOT$=_R$ E^* (1.20)

This mathematical expression precisely indicates how an observer is capable of seeing a signifier as long as this signifier contrasts with an adequate term of comparison. The inequality has no less than two terms and property [1.5] appears as the natural consequence of the basic element E placed vis-à-vis E^* in (1.20). The existence of E relies upon the adjacent element and one sole elementary entity cannot work.

Statement [1.5] is true for an elementary signifier and is false for a *complex* signifier in fact one can manage a single complex signifier that is usually stored, transmitted etc. A complex signifier includes several elementary sub-signifiers according to Bateson's lesson. Inequality (1.20) should be applied to each part of a message and the result is not univocal.

In principle one can detect a single complex signifier, but universal experience shows how sometimes one handles two complex signifiers in easier manner. Pedagogues confirm the advantages of teaching two opposite concepts: good/evil; love/hate; youth/senility etc. instead of one single concept. A student can grasp a sole tenet with difficulty, whereas the tenet E appears far more clear to a student if he grasps the opposite notion E^*. This book examines the analog and digital side to side in order to provide a clear account. Psychologists have noted how a repeated linguistic expression annoys and diverts the attention; conversely the variety of expressions attracts the consideration of humans. In conclusion two or more complex signifiers become more evident than a single signifier.

C. Third Paradox

For clarity's sake the following practical cases introduce this paradox.

- People often communicate by their voice and gestures. People notify their mind even through silence, namely sometimes the absence of words is sufficient for communication, and nothing is enough to communicate. Men/women use no sign to present a precise content or a state of the soul. The ability to effectively communicate with others relies on the use of words, pauses and interruptions too (Morrison et al 2003).
- Mr. A purchased ticket #99 and Mr. B purchased ticket #87 of a lottery and later they have checked the Lottery results on newspapers. Ticket number #99 printed on a newspaper notifies A is a winner, but the absence of #87 in the newspaper also conveys information; the absent number tells: "Mr. B is not a winner". This event spells out that a printed number is a sign and even a lacking number signifies something.
- Doctors analyze the symptoms of a patient and consider the presence of a symptom and even the absence of a symptom alike in order to diagnose the disease. The former are called *positive symptoms* and the latter *negative symptoms*. For example, if a sick person is vomiting, has high fever and stomach pain, there are three positive symptoms and the disease is X. If a sick person has vomit and stomach pain but no fever – the fever is a negative symptom in this case – he suffers the disease Y. If a sick person has stomach pain but has no fever and is not vomiting – two symptoms are negative – he has the disease Z. The medical science of symptoms confirms that a missing sign is a sign all the same.

- *Stylometry* is the field of linguistics that recognizes and measures the distinctive, unique aspects of a writer. Experts assume that the essence of the individual style of an author can be captured with reference to a number of quantitative values. As an example, "*The Federalist Papers*", a series of articles published in 1787-88 with the aim of promoting the ratification of the new US constitution, were originally written under the anonymous *nom de plume* Publius. However the author of the papers is not unique, the papers are now known to have been written by James Madison, Alexander Hamilton, and John Jay (Hamilton et al 2007). The authors of most papers were recognized except twelve papers for which there were persistent doubts as to whether their author was Madison or Hamilton. Stylometric analysis provided an answer in this way. One particular stylometric technique includes measuring the frequency of usage of different words. One particular example of this is based on the choice between '*while'* and '*whilst*', two English function-words with the same meaning but with two alternate forms. The papers authored by Hamilton for sure include 36 instances of the adverb '*while*' and only one instance of the adverb '*whilst*', while the papers known to have been written by Madison include no instances of the word '*while*', and twelve instances of the word '*whilst*'. The Federalist Papers of unknown authorship include no instances of the world '*while*', and nine instances of the word '*whilst*', thereby analysts are inclined to credit the authorship of the last Papers to Madison. This research spells out that '*while*' is a piece of information even if this word is absent.

All those phenomena lead us to conclude:

A nonexistent sign proves to be a sign. [1.6]

This remarkable proposition raises two orders of questions.

1) A logician very likely sees [1.6] as a statement that is at variance with itself. This sentence has a contradiction in terms and poses problems in point of logic:
   If a sign is no longer extant, how can be it a sign?
   How can a sign be transmitted or perceived if that sign is not extant?
2) Statement [1.6] appears as the definitive disproof of the material origin of information:
   If a non-existent sign can convey information, how can one assert the concrete basis of signs?

The paradoxical phenomena which yield [1.4] and [1.6] played a significant role in the history of information science. Those effects were deemed so serious as to deny the physical nature of information. Wiener (1961) provided a firm conclusion:

"Information is information, not matter or energy. No materialism which does not admit this can survive at the present day."

Several theorists are prone to believe those paradoxes should be solved through abstraction and they search for a special impalpable quantity which should be called 'information'. The conspicuous production of theories on information presented at the inception of this book is not alien to issues [1.4] and [1.6].

I mean to explain [1.6] following a different way and recall eqn. (1.1) that is symmetrical and may be inverted

$$E^* \ \mathrm{NOT}{=}_{\mathrm{R}} \ E \qquad (1.21)$$

This entails that even E^* is a signifier and can convey information provided that E^* contrasts with E. Eqn. (1.21) assumes that E is given and the adjacent term is any, thus we take E^* null

$$E^* = 0 \qquad (1.22)$$

We obtain that the null element can inform people as long as this special signifier contrasts with another entity

$$0 \ \mathrm{NOT}{=}_{\mathrm{R}} \ E \qquad (1.23)$$

The symbol zero spells out that 'nothing' is a potential vehicle of information. Eqn. (1.23) explains that normally a signifier has a body, and by exception a signifier may be body-less. People communicate with the signifier (1.22) when they employ silence instead of sound to transmit positive feeling or personal disagreement. Here vacuum is in use instead of matter; darkness in place of light; blank instead of a black form and so forth.

Someone calls the present argument as the paradox of the *absent signifier*, but this label sounds somewhat misleading in the present context. Eqn. (1.23) includes two terms of comparison which are zero and E. If the reader assumes that 0 symbolizes an absent signifier, there should be no possibility of perception since a single elementary sign cannot work according to [1.5].

Eqn. (1.23) does not deny the physical essence of signs since silence, vacuum, blankness and other body-less signifiers are real entities, and these should not be understood as ethereal entities. For example, I mention the interstellar vacuum which is not an abstract entity, but it is the very vacuum that we are living in. Similarly, silence may be viewed as a sonorous wave with zero energy; silence owns precise physical properties and technicians do not see silence as bare absence of sound.

D. Fourth Paradox

Where do stars go during the day?

Astronomers claim the stars are still there and continue to glow. Something similar happens with a writing which disappears when the paper darkens – for example – because of smoking. The printed words are still there but one no longer can read them. Many other common cases could be quoted in order to conclude that a perceived sign can absolutely vanish even if the signifier does not undergo any physical effect.

A perceived sign can disappear even if the sign and the observer alike do not change. [1.7]

The principle of sharpness offers an answer to this paradox for consideration.

A signifier needs an appropriate adjacent term. If E and R are stable but E^* varies and no longer complies with (1.21) inevitably E ceases to exist. When the principle of sharpness is false, the touchstone E^* is equal to E, and E becomes invisible

$$E =_{\mathrm{R}} E^* \tag{1.24}$$

By way of illustration, the star E contrasts with the dark E_1^* in the night

$$E \text{ NOT}=_{\mathrm{R}} E_1^* \tag{1.25}$$

In the daylight the rays of the sun scatter in all directions due to the water vapors, gas and dust present in the atmosphere. The whole atmosphere E_2^* shines and does not match with the principle of sharpness

$$E =_{\mathrm{R}} E_2^* \tag{1.26}$$

Outside the atmosphere the sky E_1^* remains dark during daylight and (1.25) is still true.

Technicians pay great attention to the features of E^*. As an example, in Optics experts adopt various criteria to measure a signifier in opposition to the background E^*.

- *Luminance contrast* – This equation calculates the quality of vision by relating the luminance of the item E to the luminance of E^*

  $$C_L = \frac{E_L}{E_L^*} \tag{1.27}$$

  Where E_L and E_L^* are measured with luminance units; e.g. candela per square meter ($\mathrm{kcd/m^2}$), stilb (sb) or lambert (Lb). The *factor of contrast* calculates the difference of the luminance of the item and the luminance of the background, divided by the luminance of the intended item (Hendee et al 1997)

  $$C_F = \frac{\left|E_L - E_L^*\right|}{E_L} \tag{1.28}$$

  Both the equations show how the contrast vanishes when the luminance of the signifier and the background are equal.
- *Color contrast* is the relation of two items measured in a suitable chromaticity system.
- *Dark-room contrast* is gauged with no ambient illumination.
- *Ambient contrast* is gauged in the presence of environmental illumination.
- *Successive contrast* is established between two optical states that are perceived or measured one after the other.

Concluding, the principle of sharpness supports the skeptical feelings of thinkers about the process of perception, but does not match with certain abstract or metaphysical considerations. The definition of the signifier E NOT$=_R E^*$ yields answers to paradoxes [1.4], [1.5], [1.6] and [1.7] that are consistent with universal experience whereas philosophical reasoning yields drastic and conflicting conclusions from which one cannot see the way out.

5. ANARCHIC ISSUE

The notion of signified awaits being formalized and made to conform to the exact sciences. Let us turn our attention to the semantic triangle and enter the intriguing territory of Semantics.

A. Arbitrariness

There are more than 10,000 different languages and dialects currently in use in the world. The variety of the entries in multilingual dictionaries shows how meanings do not comply with general rules and individuals can denote an object using whatsoever symbol or sound. Meanings are not controlled by obligations. This idea emerged from the classical philosophy, Hermogenes claims in Plato's "*Cratylus*" (2004):

> ”Any name which you give, in my opinion, is the right one, and if you change that and give another, the new name is as correct as the old. We frequently change the names of our slaves, and the newly imposed name is as good as the old; for there is no name given to anything by nature; all is convention and habit of the users”.

Saussure (1983), perhaps the most authoritative advocate of semantic freedom, holds:

> The first principle of linguistics "refers to the fact that the forms of linguistic sign bear no natural relationship to their meaning“.

Saussure points out that the traditional use of a word to designate an entity is not obliged by internal rules. He fixes *the principle of arbitrariness* which may be expressed in the following terms:

> *There is no necessary, intrinsic, direct or inevitable relationship between the signifier and the signified.* [1.8]

In a language a form is not determined by what it signifies. No specific symbol is naturally more suited to an object than any other symbol. In general E does not result in NE neither is E motivated by the represented entity.

A circle of linguists inquire into the special profile of each language; in particular, scholars delve into the unrepeatable connections of a language with the human group which speaks it, its culture, and its historical evolution. *Linguistic relativism* originated in German national romantic thought in the early 19th century was later developed by Sapir and Whorf

(Gumperz et al 1996). Authors hold that the semantic structures of different languages should be fundamentally incommensurable, with consequences for the way in which speakers of specific languages might think and act. Language, thought, and culture are deeply interlocked, so that each language exhibits a distinctive profile. It may be said that the supporters of the linguistic relativism expound the principle of arbitrariness in a very pragmatic, accurate manner.

B. Universal Principle?

Lévi-Strauss, John Lechte, and others, deny or streamline the arbitrariness principle because of the large number of exceptions which seem to disprove [1.8]. Currently researchers are identifying the *linguistic universals* as the properties that all languages have in common and that appear as negation of the human arbitrariness. For example, all languages have nouns and verbs; all vocal languages have vowels and consonants. Other phenomena such as the morphology of nouns, adjectives, and verbs motivate to a certain extent every language. Significance is in part determined by imagination and is in part fixed by norms:

Should the arbitrariness principle be abrogated or expressed in a feebler way?

Saussure derives the principle of arbitrariness from the analysis of languages. He chiefly deduces his issue on the basis of empirical observations, and this is the vulnerable side of his method in my opinion. Solely the complete survey of all the parts of a language – morphemes, lemmas etc. – could establish whether motivated significance is prevailing or does not prevail.

But a comprehensive analysis of syntax, semantics, phonology, morphology and typology should be conducted into all the languages of the world, a workload so enormous that it possibly cannot be put into practice. The immense set of linguistic elements makes unviable the exact determination of linguistic arbitrariness. In addition this inquiry would result in ambiguous conclusions since novel expressions which will be defined in the future could contradict the outcomes just obtained. In conclusion the rigorous experimental test of [1.8] appears unworkable and unreliable; and I am inclined to proceed in another direction.

The semantic triangle just seen offers an aid.

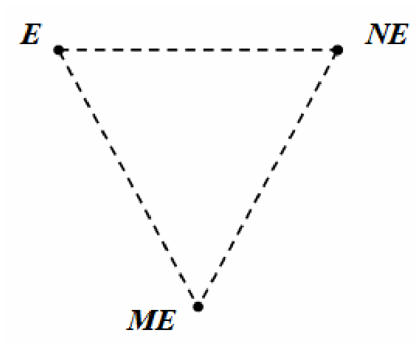


Figure 1.15. The semantic triangle.

The triad makes clear that the mind *ME* brings forth a variety of semantic activities; the lower vertex of the triangle creates/ recognizes/ modifies/ assigns the significance etc. By doing so *ME constructs the reality*. In fact the brain does not merely label the objects of the world existing out there, but organizes the reality which is divided up into arbitrary categories by every language. The conceptual world with which each of us is familiar could have been divided up very differently using another language and this is an evident expression of human creativity.

An individual or a group determines the correspondence *E-NE* and resolves to follow imagination, or an impulse of the soul, or otherwise a logical reasoning. The variety of languages is the symptom of human caprice, creativity, freedom or even dependence on mere historical accidents. Human thought operates in unpredictable ways and has a conduct which by and large cannot be foreseen. This is the most characteristic quality of human languages as opposed to animal languages, which appear specific and rather rigid. *The autonomous behavior of the mind ME* leads me to conclude that *in principle no intrinsic property connects the signifier to the signified* and statement [1.8] should be assumed true.

C. Anarchy to Delimit

The principle of arbitrariness complies with the individuals' liberty but generates a lot of difficulties on the practical plane. The free nature of *E-NE* in the mind of the perceiver/observer/communicator confuses any issue and wastes the communication necessary for individuals to survive. Unpredictable meanings oppose the discipline which must be established for dialogues. A community is based upon converging wills and collaborative behaviors, whereas principle [1.8] does not support human harmony. Arbitrariness is absolutely an anti-social precept since it does not sustain any rule for imparting knowledge and for carrying out operations. People cannot have any interchange because of the impossibility of treating significance in a systematic manner. The principle of arbitrariness proves to be a non-positive principle and leads human communities to self-destruction.

Happily the origin of arbitrariness offers an aid to delimitate semantic anarchy.

When one agrees on the idea that the principle of arbitrariness originates in the human mind *ME*, one naturally concludes that [1.8] may be mitigated in the sense that individuals spontaneously can relinquish or limit their own intellectual freedom. If the arbitrariness principle has its origin in the liberty of man, the obvious solution consists in the voluntary restriction of liberty. Actually all of us learned how to communicate very early in the life and accepted a set of common rules during childhood and in this way we began refraining from our absolute license.

Social conventions govern the arbitrariness of signs and make the laws which bring Semantics under control. A group of individuals generates a language as long as those individuals accept the law which confines their liberty within limits. In exchange for the restriction of freedom people can cooperate and live a more satisfactory life. As a matter of fact, a solid linguistic agreement makes easier the dialogues of men/women belonging to a social group.

A vast circle of linguists are concerned with the social aspects of languages. Even those who inquire into the universal aspects of language – e.g. see Chomsky (1980) and Davidson (1984) – recognize the importance of linguistic conventions. Other researchers delve into the linguistic concords and search for deeper understanding of this matter. David Lewis treats the social nature of language in a systematic theory (Lewis, 1969). Lewis' conventionalism dissects the relation between the communicator and the listener and defines the language as a function that assigns truth conditions to sentences. Here it is worth mentioning the *theory of speaker's meaning* by Herbert Paul Grice (1957) from which some theories on the social nature of language are descended.

There is no necessary relationship between the signifier and the signified; the broken lines in the semantic triangle (Figure 1.15) symbolize the free and unpredictable behavior of the human mind.

$$E \bullet\!\!-\!-\!-\!-\!-\!-\!-\!\!\bullet NE \qquad (1.29)$$

When a social convention settles the semantic process, the connection between *E* and *NE* become fixed on the inter-subjective plane. I formalize the significance which becomes objective in a way using a solid line. Because *E* indicates *NE*, it may be said the former is the input and the latter the output of the semantic process which can be represented by an arrow.

$$E \longrightarrow NE \qquad (1.30)$$

Philosophers looks at signs in a broader perspective; they investigate very intricate forms of representation; science is often judged as reductive although the model (1.30) is adequate to tackle technical applications as we shall see next.

A language towers as the fundamental pact for people who live in common-interest communities, and all the subsequent operations people achieve – e.g. industrial activities, commercial exchanges, economic agreements, cultural advances etc. – have dependence on this linguistic pact (Wardhaugh 2002). Semantic agreements are preliminary to any other collaborative accord and I append a few comments which regard the exact sciences in a special manner.

1. Types of Signs and Types of Agreements

A broad variety of criteria intervenes in the linguistic accord symbolized by (1.30). Contrasting movements emerge in a community and determine a linguistic covenant. Imagination and rigid logic, intuition and facts, fantasy and historical tradition contribute to define a language, and modify it without a pause. It is rather impossible to condense this argument which thousands of specialists scrutinize from the *synchronic* perspective, namely without reference to their historical context, and from the *diachronic* perspectives namely as the changes occur through time.

In search of a compendium I find support in Peirce's *typology of signs* (Hartshorne et al, 1931-66). He classifies signs according to the ways in which a signifier refers to the signified. In substance Peirce recognizes that people establish three principal types of semantic relations.

i) *Symbol* – Symbols are purely conventional and fundamentally arbitrary, so that *the semantic relationship E-NE must be learnt*. Peirce holds that “A symbol is defined as a sign which becomes such by virtue of the fact that it is interpreted as such”.

ii) *Icon* - The appearance of the icon *E* resembles the aspect of *NE* and *the semantic relationship evokes NE in ME*. In other words the signifier recalls the signified to the mind of the members of the community in a way. An icon is symmetrical to its model, and the linguistic agreement sometimes is suggested by psychological emotions.

iii) *Index* - The significance of an index reflects the reasons that connect the cause to the effect, the antecedent to the consequent. *The bond between E and NE is fixed on the strength of a precise logic* which cannot be modified by an individual’s will. The logic of an index is frequently a part of an entire logical framework. For instance, a doctor recognizes the fever as an index of the sickness X in that the interpretation of symptoms pertains to the medical science.

Any language includes signs belonging to the groups i, ii and iii, and one can recognize the details of the social convention which sustains that language.

I close this section with a brief remark on the *motives* which actuate people to define or to change the words of a natural language. At the present time experts investigate a variety of linguistic motivations (Radden and Panther 2004) of which I give a succinct account within this small list.

- *Phonetic motivation* – An *onomatope* provides an example of phonetic motivation. An onomatopoeic word denotes a thing or action by a vocal imitation of the sound associated with it. The English has several onomatopoeic terms like ‘*bang’, ‘burp’, ‘splash’*, and ‘*tinkle*’.
- *Morphological motivation* – By way of illustration a new word is created just because the new word is easier in pronunciation, or a new word is a combination of familiar words. Common cases of morphological motivation are *abbreviations, analogies*, and *metaphors*.
- *Semantic motivation* – A *metonymy* exemplifies this motivation. A metonymy is a figure of speech in which one word or phrase is substituted for another with which it is closely associated such as ‘*crown*’ for ‘*royalty*’.
- *Etymological motivation* – This is the most usual reason of language creation and evolution. The meanings of the words are suggested by their sources. The linguistic convention refers to the etymology that is the root-causes of words through the time-scale. In language learning, particularly in the vocabulary study, the etymological motivations can strengthen both the understanding of the vocabulary and the input of its related culture.

2. Small and Large Communities

The study of the social origins of languages requires that each language be put in relation to the community which uses that language, the dimension of that community, the covered geographic area, the history of that community and so forth (Lehmann, 1992). The *diffusion* of a language is an important parameter that reflects convergence and harmony amongst people. For example the scientific community currently uses English as a universal medium, while some decades ago scientists also resorted to French and sometimes Russian and German for international reporting. Current uniformity shows how the inclination to separatism is regressing.

On the other hand the emergence of a dialect shows the opposite tendency toward segregation or, at any rate, toward the closure of a social group. Cities often contain a variety of ethnic groups which tend to keep specific identities. Lower social classes and even upper classes who do not wish to mix with others, create slang. The popularity of a language underscores even the importance of it. *Dialects, slang* and *jargons* rank the lower levels because they embody smaller social phenomena with respect to the *natural languages* from which the dialects derive (Berns et al 2002).

The enlargement or restriction of a linguistic agreement furnishes evidence of movements toward social union or separation. These phenomena embody social dynamics that can even influence the world electronic market. In broad strokes, social aggregation recompenses mass production and semantic confluences benefit standard models. Globalization renders the computer market tempting, and massive production rewards the inventor of an ICT solution with high profits.

The *mathematical language* is the second language used by scientists besides English.

Some scholars classify the mathematical language as a jargon or a specialist language as it cannot be designated as a natural language. However the mathematical language – especially the written representation of numbers – infiltrates all the languages used by people in the past and in the present, and it will do the same in the future, hence it could be considered as a '*super-language'* from this perspective. Mathematical notation lasts for an indefinitely long period and has survived several languages. These and other features lead me to append some comments on the language of the numbers.

3. Flexible and Rigid Conventions

Mathematicians handle information very carefully, and they take an active interest in the physical and the semantic aspects of numbers. They adopt standard symbols *E* and exact rules to determine *NE*. The reader is aware that Arabic numerals *0, 1, 2, 3, 4, 5, 6, 7, 8* and *9* have universal use and no variants are allowed such as upper and lower case figures. Mathematicians take care of Semantics by means of a rule called *positional notation*. This notation consists in the use of the same symbols for the different orders of magnitude. A generic number includes a finite number of digits and each digit has its value multiplied by its place value. For instance:

$$3508 = (3 \times 10^3) + (5 \times 10^2) + (0 \times 10^1) + (8 \times 10^0) = 3000+500+0+8.$$

One can recognize whatsoever number never seen in advance thanks to the support of the severe positional notation rule.

Mathematicians communicate on the basis of social conventions; however mathematical agreements differ from the other linguistic covenants due to three significant reasons. Mathematicians deal with topics far less influenced by every-day living and ignore subjective arguments related to personal emotions. Secondly mathematical rules cross the boundaries of nations and continents. For instance, no written alphabet is as popular as the Arabic numerals. Thirdly mathematical information is absolutely precise in contrast with natural language terms which are approximate. As an example, the number '19' is an exact value, by contrast the word *'young'* sounds generic and one wonders: What age does the adjective '*young'* denote?

Objectivity, universality and *precision* emerge as fundamental qualities of the number representation. This is a matter of fact, not an opinion. As a practical consequence of the three properties of the numbers' language, the mathematical conventions cannot be easily modified and are far more stable than other linguistic agreements. Real events show how updating a mathematical notation in use runs the risk of generating a burdensome task. I discuss an historical case to demonstrate the consequences of mathematical universalism and precision.

In principle the friendliest base to write numbers is not decimal but is duodecimal. Twelve can be divided by 2, 3, 4, and 6, whereas ten is divisible only by 2 and 5. The hours of the day and the months of the year are organized on the duodecimal base and everybody takes the easy way to divide daytime by regular intervals. For instance a sick man can take medicines once a day, twice, three, four, six, eight, twelve or twenty-four times a day and can easily infer the relative hour intervals. Because the digits *0, 1, 2, 3, 4, 5, 6, 7, 8, 9* are already in use, it should be sufficient to append whichever couple of symbols to the decimal base and the duodecimal base is ready. This obvious suggestion, put forward during the French revolution when scientists revisited and unified the most important scientific conventions, was rejected. The change from decimal to duodecimal, absolutely easy on paper, appears impracticable due to the enormous social consequences and very heavy risks which may occur in everyday life. Think how many people may be swindled by using a base in the place of the other when they pay or collect money.

As a counter-example I quote numerous upgrades of the Latin alphabet achieved during the centuries. The original Latin alphabet included 21 letters and expanded up to 26 letters to the joy of the writers. For example, the Anglo-Saxons appended the letter ***w*** (double u) that was not used by the ancient Romans. Further regional extensions were created by adding *diacritics* to existing letters, by joining multiple letters together to make *ligatures*, by inventing completely new forms, or by assigning a special function to *pairs* or *triplets of letters*. For example the Germans use the symbol β in the place of **ss** (double s). All these changes were made in a natural manner and did not cause writers any problem.

4. Abstract and Concrete

Natural languages turn out to be rather approximate. A noun in natural language refers indifferently to a physical entity or to a mental-abstract entity. Take '*Rome'* that symbolizes the capital of Italy or otherwise the abstract idea of Rome that one has in mind. Also the mathematical language signifies practical entities and abstract entities alike, but the mathematical conventions exclude any confusion between these groups that make two precise classes.

Abstract numbers are pure values used without connection to any particular object; abstract numbers are coded by numerals such as '*3', '9841'* and '*72'* and represent ideas residing in the brain. A *concrete number* is the counterpart of determined physical entities and is qualified by a word or a symbol that associates the number to the intended physical entities in explicit manner. A writing rule discriminates the concrete number *'3 eggs'* that means something real, from the abstract number '*3'* that is a mental idea unrelated to practical and specific entities. The pure number *'3'* makes no direct reference to the objects in the world out there.

This note on the Semantics of numerals paves the way toward the concept of numerical data-processing which will be treated in Chapter 4.

6. MECHANICAL ACQUISITION OF INFORMATION

In the preceding pages I noted how a special divide is placed between Semiotics and the information and communication technologies (ICT). Engineers adopt mathematical methods and focus on special topics that appear ancillary to literary men. The principle of sharpness throws some consequences which could seem unimportant for men of letters but are of great value for technologies. For instance, the mechanical acquisition of information, ignored by philosophers, emerges as a noteworthy matter for engineers.

A. When Is an Object a Sign or a Thing?

The sharpness principle includes E and E^* which are *algebraic elements*

$$E \text{ NOT=}_{\text{R}} E^* \qquad (1.31)$$

No constraint confines the use of an algebraic element, and the present conceptualization holds that all the entities in the world are permanent possibilities of information and I can draw the final conclusion:

Any object is a signifier if it is distinct with respect to an observer. [1.9]

This statement agrees with the position of several commentators who share the idea that every object in the physical world is a potential form of information. Umberto Eco (1979) extends the notion of sign to anything material which can be seen, heard, touched, smelt or tasted. Inequality (1.31) spells out that each object or event which makes a difference with respect to an observer is a potential information item. E.g. the beer you are drinking, your hat, a tree in the garden and the Moon are signifiers since you can discern them from something else.

Not only is everything in the world considered information, moreover – I underline – *natural* information ensures the essentials for the survival of an individual. A man/woman is capable of staying alive thanks to what he/she sees, listens to, smells and touches in the real world. Basically people are able to subsist because of the support of spontaneous signifiers. Men/women eat, work, live etc. with the primary aid of natural signs sometimes called *sense data* in literature.

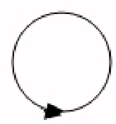
A spontaneous signifier has the possibility of representing anything and conforming to the types of signs devised by Peirce, for example a lion symbolizes power, and smoke is the index of fire. In addition each natural signifier is capable of making a special sense namely people recognize that the object or the event E is the counterpart of itself: the Sun represents the Sun, a chair signifies a chair; a table represents a table, the lamp symbolizes the lamp and so forth. All the physical items fulfill this extraordinary semantic function:

Each physical item represents itself. [1.10]

This semantic function has fundamental importance and plays an essential role in favor of the human survival. An individual can live thanks to the entities extant all around him/her, and recognizes the objects in the world because *each object symbolizes itself*. The ensuing formal expression makes explicit how the natural signifier coincides with the signified

$$E \equiv NE \tag{1.32}$$

This relationship constitutes a very special semantic relation that is said to be *reflexive* with the mathematical language. The extremes overlap and the graph (1.30) assumes the ensuing shape



$$E \equiv NE \tag{1.33}$$

A natural signifier has a proper and necessary meaning, and the mind *ME* recognizes this meaning without exception. Whilst *ME* can assign whatsoever *NE* to a generic signifier due to the principle of arbitrariness, *ME* behaves in a disciplined manner when it handles the semantics of natural signifiers. People systematically conform to (1.32) and one can conclude that a spontaneous signifier conveys information which is inherent to its nature.

An artificial signifier can also convey meaning (1.32). For example, an electronic engineer interprets a 3.4 mA signal as an electrical current of that magnitude, and overlooks the symbolic value that the signal can assume. Statement [1.10] is not so common for those who use artificial signifiers; instead it is systematically true for natural signifiers. The following table summarizes the popularity of the semantic functions

	Represent Themselves	Represent Something Else
Natural Signifiers	***Normally***	***Rarely***
Artificial Signifiers	***Rarely***	***Normally***

Figure 1.16.

In statistical terms the semantic property [1.10] is irrelevant to those who prepare artificial signifiers but is noticeable from the perspective of ICT experts who make a significant exception. Hardware technicians treat a signal as a physical quantity as normal practice. Practitioners apply (1.32) whenever they design and build up a device (I shall go back on this technique in the next pages). This professional habit has a cultural effect as it encourages the idea that Semantics has no importance for engineers and this myth still hangs around in the technical field.

B. Information Independent of Man's Will

Inequality (1.31) spells out the perception process with precision. The generic object *E* passes from the potential information-state to the real information-state and also R changes its state as long as R operates. The probe R lies normally in the *generic state* R_G and assumes the *observation state* R_O when the probe detects *E*. Hence one can generalize this concept in the following way:

A physical element that changes state while interacting with an object is an observer.

[1.11]

I discuss a straightforward case to show how the present account is put into effect.

The ammeter includes the sensor R (Figure 1.17) which basically consists of two magnets and a mobile coil. R detects the electric current *E*, i.e. the component R registers the difference between *E* and the ground value which is the comparison term *E**. The energy *E* moves the sensor itself which is independent of human awareness in harmony with [1.10]. Whether a man is willing or unwilling to receive the response from R, a physical law determines the appropriate reaction of the ammeter. If a human agent is involved in the task achieved by R, than the ammeter serves this agent and communicates the readout to him by means of the needle S. If nobody pays attention to the ammeter, R detects information anyway.

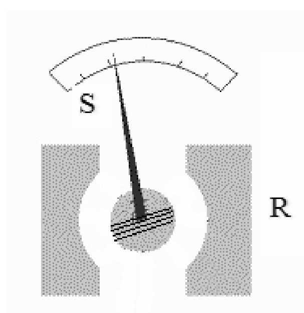


Figure 1.17. An ammeter.

Mechanical implements assist researchers and professionals who acquire information unaffected by personal feeling. These valuable pieces of information – popularized as '*measures'* – are sharp as much as possible and their meanings are not influenced by individual's interpretation (Roche 1998). Literary people often see measures as the most vapid and lifeless pieces of information. This is true beyond any doubt, but this defect is compensated by the *precision, objectiveness* and *universality* of measured data: three cornerstones for scientists and mathematicians.

Statement [1.11] yields that any appliance which reacts to a solicitation is an observer. In particular, all the ICT devices play the role of R. An analog or digital device changes state when it receives the input signal and complies with [1.11]. Analog and digital equipment execute a broad variety of functions thanks to the detection process which is the preliminary step for any function to achieve.

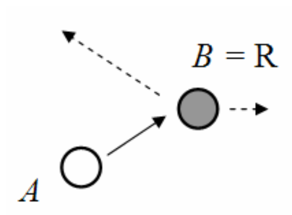


Figure 1.18.

We can extend the meaning of statement [1.11] to any material entity which is able to exchange information due to bare mutual interactions. No restriction confines the possibility that a lifeless object is capable of working as R; for instance the Sun warms up the Earth. This simple event – interpreted from the present perspective – implies that the Sun is a signifier and the Earth that changes its state under the Sun's rays acts as R. As second example suppose the body *A* bumps against the body *B* that changes position (Figure 1.18); factually *B* senses the sign *A* and plays the role of R. Note that this is not an abstract case: a group of mechanical sensors works with a principle like that.

Statements [1.9], [1.10] and [1.11] entail that a device is capable of conveying information without human intervention. Automatic systems are able to handle a signifier and a signified completely independent of Man. because the assignment of significance, which is arbitrary in principle, becomes disciplined after the property (1.32). These results offer a theoretical basis for the mechanical acquisition of information achieved by ICT appliances. Technicians could not build up robots, automatic systems, and self-controlled devices in cutting-edge technologies without the properties of *E* and R examined in this paragraph.

We find noteworthy examples in the biological realm too. Intricate regulation mechanisms ensure the survival of cells. Biological feedback and feed-forward loops take control of cell organs accordingly to the genetic code; notably living organs are regulated by means of information exchange. These informational mechanisms intervene from the birth of the cell and throughout the life-cycle of the cell beyond any human awareness.

Two groups of authors who have different intellectual origins, address the topics treated in the present section.

Peirce developed a theory of signification of non-intentional signs and his thought sustained experts who began to study the signals exchanged by biological entities. This novel field of research was named 'Biosemiotics'. Thomas Sebeok - mentioned in the preceding pages - was among the first to investigate the communication in animals. Later on, experts extended their inquiries to various forms of production, action and recognition of signs in the biological realm: from cells to bacteria, to vegetables and animals (Favareau 2007).

Eqn (1.32) is close to Stonier's view on information in a special manner. Tom Stonier concentrates on natural information, and insists on the objectivity and autonomy of information assumed as diversity of matter and/or of energy. He draws attention to the atoms and the molecules that make up the mass and movement of the universe and at the same time handle information. Stonier develops his ideas in (1994) and concludes:

> "The first and most important fact is to understand that information is a basic property of the universe, like energy, and like energy it has a reality of its own."

The present account agrees with Stonier theory and shows how physical bodies convey information due to relentless mutual interactions. The semiotic work is active in the physical universe from the first moment of the 'big-bang' after infinite chains of intrinsic causalities. Statements [1.9], [1.10] and [1.11] yield that a system – biological or artificial – is capable of handling information uninfluenced by intellectual opinions.

7. Complete Catalogue

The reflections set forth in the previous pages lead me toward a complete catalogue of signifiers. In particular the features of the matter discussed in the last paragraph suggest the classification of signifiers according to their origin. The whole set includes *spontaneous* or *natural signifiers*, like your chair, a street and a tree, and *artificial items*, like this page and the electric signals that a device generates for the special purpose of informing.

This practical criterion for grouping is typical of technical-scientific areas. The classes *natural/artificial* may be found in other disciplines: Chemistry, Mechanics etc. For example pharmacists use drugs derived from natural sources such as plants and mineral substances, and drugs produced by industrial processes. Sometime two medicaments have the same active elements but are considered different because of their origins, natural and artificial.

I use the table in Figure 1.16. Broken down according to their provenance, signs have the following properties:

Natural information - *The signifier and the signified usually coincide*:

$$E \equiv NE$$

Artificial information - *The signifier and the signified usually do not coincide:*

$$E \neq NE \qquad [1.12]$$

This description covers all the objects and events that exist in Nature that are potential information carriers. This view of Semantics appears exhaustive and is scarcely influenced by subjective feelings; it should become a good premise in the study of analog and digital appliances.

Conclusion

Semiotics provides intriguing keys for interpreting basic aspects of information, but unfortunately most semioticians follow the philosophical approach. They adopt qualitative methods of research and seem allergic to Mathematics. The present chapter can be seen as an essay on Semiotics reviewed from the technical point of view; or in other respects, it may be seen as an independent attempt to investigate ICT on the basis of semeiotic concepts. In order to reach my goal I put forward formal descriptions of the signifier and the signified that are divorced from any particular school of Semiotics and cover all the objects and events that exist in Nature that are potential signs.

Authors usually subdivide Semiotics into three branches: *Semantics*, *Syntactics* and *Pragmatics* which correspond to the levels 4, 5 and 6 of the Stamper's list cited in the first part of this chapter. Semantics is a noteworthy section of Semiotics but Shannon (1949) holds: "Semantic aspects of communication are irrelevant to the engineering problem". A large circle of writers, coming especially from the engineering and technical areas, share this statement and do not pay much attention or even rejects Semantics.

Two principal elements support this position. The linear semantic relation (1.32) that is rather common in ICT seems to encourage the formation of a generic opinion on Semantics. The meaning of signals appears trivial; but this is not exactly true as I tried to explain. Secondly, technicians claim that meanings are affected by personal interferences and cannot be considered as a reliable field of research. This present-day fashionable position may be concisely described by the following sentence:

> "Subjective factors interfere with Semantics, thus a technician should place Semantics aside".

The premise of this popular way of reasoning: "Subjective factors interfere with Semantics" is true beyond any doubt. The meanings of signs rely on the human soul and the significance stems from the unpredictable inclination of individuals. We have amply examined the principle of arbitrariness that gives strong support to the preamble of the foregoing sentence. However the conclusion: "Thus a technician should place Semantics aside" does not seem obvious to me, and some objections may be made.

Normally scientists do not retreat from a field of interest when subjective elements influence that field. I exemplify this idea of mine by quoting the following three cases.

About 1931 Bruno De Finetti and Frank P. Ramsey discovered the subjective value of probability in the mathematical calculus (Gillies 2000). They found out how the probability $p(A)$ of the single event A has no relation to the physical reality instead $p(A)$ expresses the degree of an individual's belief about the occurrence of A. This theoretical issue, which apparently seems to be disruptive, did not destroy the calculus of probability instead it triggered fertile studies which have strengthened the statistical field. Presently statisticians, doctors, managers and other decision makers adopt the *Bayesian methods* in every-day activities. The *subjective school* does not constitute a 'group of terrorists' in the scientific territory but is a well appreciated group of theorists which is currently endeavoring to improve and to disseminate the Bayesian methods.

Mechanics is the science that establishes the equations for the movements of bodies and the forces that cause interactions; although the speed does not turn out to be an absolute quantity. The magnitude of the velocity of a body depends on the observer in the sense that two observers can assign far differing values of velocity to a body in a determined situation. This subjectivism undermined confidence on the fundamentals of Mechanics and constituted a serious theoretical conundrum, but did not convince scholars to give up the question. Conversely theorists attacked the relativism of movement, Galileo and others found the way to circumvent the problem (Brown 2006) and fixed the characteristics and the role of the so called *referential system.*

A medical intervention has no predetermined effects, and the benefits coming from a cure depend on each cured subject. Two patients treated with the same protocol exhibit behaviors that sometime diverge in a drastic manner as one dies and the other survives. The subjective tolerance of drugs and of all the medical remedies did not lead experts to drop the study of medicine. The subjectivism of outcomes does not discourage doctors from taking care of ill persons, and researchers in medicine investigate ever new therapies. Perhaps the most challenging medical treatment emerges in the psychological realm and in particular in psychoanalysis. What is more personal and unrepeatable than a human sensation?

Man's psyche – intimate and profound to the extent that the same individual is amply unaware of it – constitutes the greatest challenge of subjectivism, yet Sigmund Freud discovered the *language of dreams* which offers an objective key to decipher the soul of a person down to his unconscious (Freud et al 2009).

The aforementioned scientific challenges do not constitute intellectual curiosities or tiny tesserae belonging to the scientific mosaic. The three topics played and still play a noteworthy role in the progress of science. The above mentioned areas of research are extremely important in modern society and are felt even by laymen in a way:

- Who has never doubted whether the probability of winning at the lottery is a pipe dream?
- Who has never wondered whether his friends were moving or his train was departing from the subway station?
- Who was never afraid of not being appropriately cured?

Scientists cannot destroy the subjectivism of natural phenomena, nonetheless they do not surrender and work hard to enhance the knowledge of phenomena and to delimit the effects of arbitrariness. Researchers accept the challenges of subjectivism and struggle to take their field of study under control.

I do not see reasons to dodge parallel efforts in information science, and this book represents an attempt to show how Semiotics – and Semantics in a special manner – can sustain the study of the computer technologies.

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