RESEARCH PROJECT

José María Díaz Nafría & *Francisco Salto Alemany*

CONTENTS

1. INTRODUCTION

The evolution from the industrial society to the information era is a crucial juncture of our times and a usual concern in classrooms, offices and streets. However, the very concept of information puts forward deep and challenging questions. Just one binary digit may tell us if the universe is about to collapse, therefore being very informative, and all millions of terabits on the web (measured in a shannonesque sense) may also be generated by whim of electrons in a rheostat, therefore being uninformative.

Mathematical Communication Theory makes it possible to measure the capacity of channels and to understand information in its syntactical aspects, as a physical magnitude. Information is measured on average and messages are result of combinations of objects selected from a predetermined set. However, the informational content of typical human messages seems to have semantic properties of its own (not on average) that are not apprehensible in bits. This preliminary project asks: which are the difficulties both theoretical and technical, both conceptual and technological to be found in defining a useful unified information concept, valid for cables and organisms, for antennas and societies, for robots and mental states?

This project is essentially interdisciplinary, beyond any rhetoric. It crosses different scientific, academic and social disciplines, as methodologically reflected in this writing and with the purpose of:

a) Elucidating the notion of information in a scientifically fertile way, including the clarification of the limits and means of the informational metaphors commonly used (as it is also proposed by Krippendorf).

b) Set up an effective interdisciplinary work, creating tools for mutual comprehension and criticism.

c) Give place to social interest in the vision of information.

d) Clarify the role of information technologies at personal and social levels.

e) Obtain a global stance toward problems related to information in contemporary plural societies.

2. OBJECTIVES

In synthesis, the aim of this project is *finding an interdisciplinary useful notion of information or in its absence a minimal number of irreducible elementary notions, such that a maximal number of different interests on information are covered, without functionality loss*. In order to make mutual understanding and discussion possible, an interdisciplinary setting is proposed, where criteria, procedures and tools are discussed and evaluated in two dimensions, by all participants and by specific working groups. This general objective unfolds in the following more definite aims:

1) Search for a maximally general and useful notion, or by default a minimal quantity of irreducible concepts.

2) Complement the general notions to prove their applicability in particular fields or disciplines.

3) Explain and classify all proposed notions.

4) Evaluate the nature and reach of defined notions to uncover new scientific or social interests

5) Elaborate a common transversal terminology conceived as crossing different points of view (information glossary).

6) Use the elucidated notions to eventually restate related problems: knowledge, communication, information society and pluralism.

7) Propose useful models of quantification of information alternative to the standard.

8) Write a guide of results including: a) clarified notions; b) future research projects; c) interdisciplinary communication channels; d) pedagogical, scientific and divulgative dissemination.

3. INTERDISCIPLINARY METHODOLOGY

Diachronic scheme

From a methodological stance, the project presents two dimensions: one is *global* and concerns the project as a whole, and the other dimension is articulated in *specialized subprojects*. A number of critical moments concern globally all participants, while other objectives are in hands of specific teams in charge of subprojects. Channels of communication are foreseen within and between groups.

Taking into account the conceptual difficulties involved in working together people from extremely different academic, professional and scientific backgrounds, the figure of a responsible is introduced. Each working group has a responsible person available, who is in charge of the relationship with other teams. Hence, there are three distinct working levels: 1) the *specialist level*, within each team; 2) the *responsibility level*; and 3) *global interdisciplinary level*, open to all participants.

Both for the diachronic development and for the integration of the aforementioned levels, the following temporal distribution suggest itself:

1. **Subject Fixation**. This phase should fix specific objectives and methods for the global dimension of the project. It should be not only common to all participants, but also open to new actors with different sorts of commitment. In a common debate, the notion of information is to be discussed, accounting for the different sensibilities and interests present in the participants. Preliminary statements on basic questions should be obtained according to the following schema:
    a) General discussion among all participants to specify preliminary objectives.
    b) General critical debate on such problems and corresponding working methods.
    c) Redefinition of objectives and terminology.
2. **Planning**. From the objectives fixed in the previous phase, specific working groups deal with specialized objectives, autonomously stating their methods and work plan. Schemes from each team are critically exposed to all participants from other groups in the project, enriching in this way the proposals or all groups.
    a) Job division in specialized projects –as the elaboration of conceptual models of information from certain points of view- and formation of disciplinary groups.
    b) Specification of landmarks in partial projects.
    c) Specialized projects design.

d) Mutual exposition of projects between groups.

3. **Development**: In this phase, work plans of each team should be developed. Each specialized group is in charge of the main core of their specific objectives. By means of a data base, a window containing working documents is opened among the different teams. Once concluded, results should be presented to the rest of groups. Hence, the development phase presents two parts:

   a) Development of specialized projects.

   b) Mutual critical approach among the different groups.

4. **Integration and evaluation**: Here it is to be first gathered all results of specialized groups agreed by all other teams. With respect to the expected objectives, both global and special results are to be critically evaluated, including the glossary. Finally, conclusions are reviewed and summarized, looking for lines of further future investigation. Hence, three basic moments are:

   a) Integration of all parts of the project into a coherent whole.

   b) Evaluation of results: description of achievements and shortcomings.

   c) Proposals for ulterior work.

The following diagram shows the proposed methodology in its three levels (*specific*, *coordinative*, *global*) and four temporal phases (object fixation, planning, development and integration-evaluation).

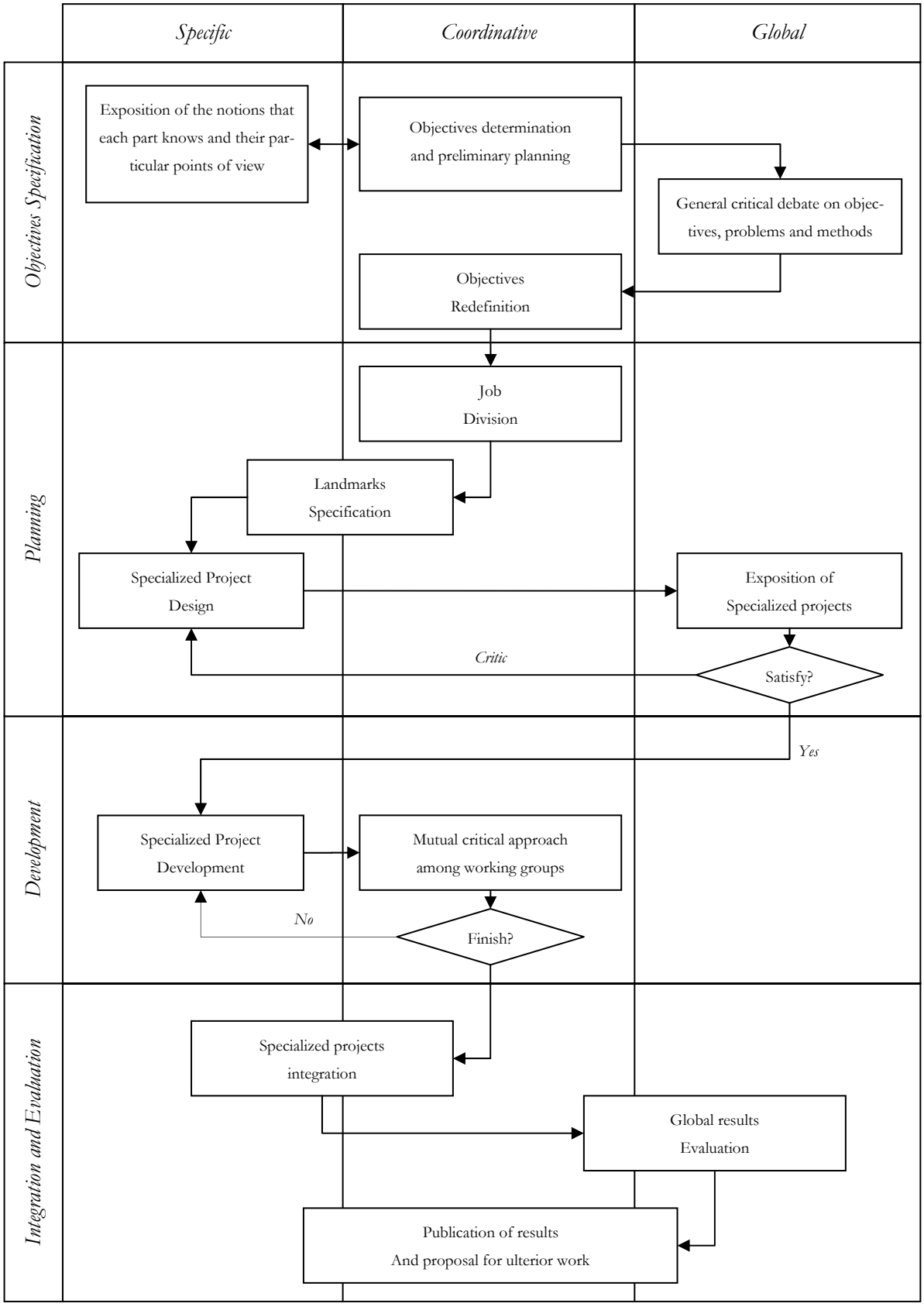

Figure 1. Scheme for diachronic development.

Research guide for participants

A research guide will be developed aiming to preserve the global perspective of the project as well as to help the interaction among its parts. This guide should include: objectives, methodology and planning, exposition and reference of the main point of view regarding *information*, common and specialised terminology, fundamental problems.

Working meetings

It will be established, to facilitate the fluent and planned course of the job, a planning scheme of the meetings (sites and times) that should be taken place, as well as the way in which the interchanges, communication channels and discussions should be held.

Shared Job Tools

To enable the access for every participant to all the developments within the project, making possible the communication and the interdisciplinary work, it would be worth having the following resources available:

— Data base being accessible to all the participants (documentation sources, developments and publications).

— Standard methodology for discussion, disciplinary work exposition, proposal contributions and critic review.

— Reviewed and shared terminology for the common work.

— Publication channels for internal results (toward participants) and for external dissemination (toward general audience).

The **glossary** further drafted could constitute an outstanding tool for the interdisciplinary work covering some of these functionalities. As it will be later shown, this tool can be understood as a two-fold approach: on the one hand, the clarification of the term used by each point of view involved and, on the other hand, the analysis of the main problems regarding information from each approach. In addition, the final stage of this glossary can substitute one of the material products of the project.

Supervision and coordination of the common work

As it was previously stated, due to the interdisciplinary character of the project in which specialised and global working is combined, it is key worth to establish *figures of responsibility* (especially if the group were large or locally disperse). These should guarantee: the efficient development of the project, the results publication, the availability of the necessary tools. Furthermore every working team should elaborate reports in which the critical working points, which should also be previously determined, regarding objectives and results.

4. ALTERNATIVES AND PROBLEMS

4.1 Main points of view

The current controversy regarding "what we call information" reflects both its etymological sense, i.e. that of "forming" (whether in a corporal or intangible manner), and the most popular of its meanings (the one that can be found in the street or in the first lines of the dictionary), which approximately refers to "the act or fact of informing", or, in other words, "to find out about something". Moreover, the course of "what has been called 'information' throughout history" shows, on the one hand, the persistence of the most remote roots and, on the other hand, the constant tension to reflect the uses and interests demanded by everyday life (whether ordinary or that of a specialised group, e.g. a group that works in a specific field of scientific research) in the meaning itself. This means that through metonymies and metaphors the term has gradually adapted itself, as far as possible, to various and collective uses and interests. However, since approximately 60 years ago, the scientific use of the notion of information has categorised the term to a large extent, making its sense much more precise[1] but also unrulier, which has created further tension when struggling to make certain points of view clear. This tension is especially obvious among those theories that, according to the delimitation of their universe of reference, have been axiomatised –turning themselves into mathematical theories– and those others that, in order not to diminish the reality they conceive, are restricted to open models, whose formalisation has not been mathematised, or its mathematical form has resulted in impractical complexity.

In short, when it comes to illustrate the different approaches to the term *information*, one must take into account two considerations: on the one hand, the term to its most remote roots –including the different meanings it has acquired until the present day– and, on the other hand, the plurality of meanings that different scientific disciplines (including socio-cultural groups of different nature) have given to the concept of information.

a) Historical roots

As mentioned above, the Latin term *informatio*, which extended, to varying degrees, to other European languages –including obviously the Romance ones– derives at the same time from the verb *informare*, which primarily meant "to form" and was used both in a *tangible* sense (*corporaliter*),

---

[1] However, it has also been branded as dark and distant from its usual meaning (*cf.* SEGAL, J., *Le Zéro et le Un. Histoire de la notion scientifique d'information*, Paris: Syllepse, 2003; CAPURRO, R., HJØRLAND, B., "The Concept of Information", *Annual Review of Information Science and Technology*, Ed. B. Cronin, Vol. 37, 2003, Chapter 8, pp. 343-411; FLORIDI, L. "Information" en MITCHAM, C. (ed.), *Encyclopedia of Science, Technology and Ethics,* Macmillan Reference, 2005).

i.e. the effect on something material, and in an *intangible* or spiritual sense, i.e. linked to moral and pedagogical uses[2]. In its tangible meaning, the use of the term "information" is referred to both artisan (or technical) contexts, as in Virgil[3], and biological contexts, as in Varro[4].

In both meanings, but more especially in the tangible one, the Latin concept fed on a Greek-rooted ontology and epistemology –entirely natural given the influence of Greek culture on Roman culture–, which entailed the frequent translation into Latin of Greek concepts, such as *eidos*, *idea*, *morphe* or *typos*. This can be found in Latin and Christian authors, such as Cicero, St. Augustine and, in general, medieval scholasticism –who were especially involved in the intellectual field and used this term to refer to pedagogical, moral and biological issues–, as well as in an epistemological and ontological sense –sometimes very well-developed–, as in the case of St. Augustine or St. Thomas, who will greatly influence the future meaning of the concept[5].

In short and in general, the plurality of meanings that foreshadows the current conflict can already be observed in antiquity. However, these meanings were full of an ontology that will gradually disappear due to the emergence and course of modernity, as shown by Peters[6], which is essential to understand the formalisation of this concept by the mathematical theory of information in the 20th century.

In fact, the old *cosmos*, ordered and structured –according to suprasensory forms that remain despite the passage of time and with regard to which such cosmos is intellectually apprehensible– gives way, with modernity, to a world of corpuscular movements, in which *consciousness* is responsible for this dynamics –from fragmentary, fluctuant and even hazardous units of feeling that must be

---

[2] A detailed explanation of the historical uses of the Latin term and its derivatives can be found in CAPURRO, R. *Information. Ein Beitrag zur etymologischen und ideengeschichtlichen Begründung des Informationsbegriffs*. Munich: Saur, 1978.

[3] *Aeneid*, VIII, v. 426, 447.

[4] In a sense that can be considered as "partially rescued" in the context of the biological morphogenesis from the late 18th century with authors, such as Oken and Saint-Hillaire (*cf.* MASON, *Historia de la ciencia,* Madrid: Alianza, Vol. III, pp. 149ss.)

[5] According to CAPURRO (in *"The concept of…"*, p.355), the 20th century gives rise to the "renaissance of the ontological dimension of the Greek roots of *informatio* beyond a restrictive humanistic view". Yet, one can also allege a deep continuity of old ontology into the modern one, e.g. in terms of a gradual transformation of the classical "chain of being" into the modern theory of biological evolution (*cf.* BOWLER, *Historia Fontana de las ciencias ambientales*, México: Fondo de Cultura Económica, 1998, pp. 112-139).

[6] PETERS, J. D., "Information: Notes toward a critical history". *Journal of Communication Inquiry,* v. 12, pp. 10-24, 1988.

ordered by consciousness itself. Thus, "under the tutelage of empiricism, information gradually moves from *structure* to *matter*, from *form* to *substance* and from *intellectual* order to *sensory impulses*".

In the course of this radical transformation, it is entirely natural that the Greek *hylemorphism* –embraced by medieval scholasticism both ontologically and epistemically– was gradually disappearing and that meaning of "form" was supplanted by a sense considered of greater consistency –i.e. that of *consciousness*[7], so that the consistency and *objectivity* of the "form" is followed by a radical dependence on the subject that fundamentally *subjectivised* it. Likewise, the *atomisation* of the external world is associated with the atomisation at the level of ideas, whose interrelation with the world is the problem (due to the restrictions on sensitive mechanisms), through which consciousness –according to empiricist epistemology– can *get information* about the world. In short, ontologically, form and structural unit lose importance and both world and consciousness become *analytical* as separate elements, but epistemically truth becomes also analytical.

Yet, in the crisis of the Enlightenment cosmology across the 19th century, which will entail the superseding of mechanism in natural sciences –especially in physics and biology–, this supposed that analyticity will be partially superseded by a more structured conception of reality, creating a considerable tension with previous ontology and epistemology that has continued to the present day. In fact, the theory of relativity, and those of quantum mechanics, statistical physics and biological evolution are strictly incompatible with the assumptions of a cosmos of corpuscular interactions and analytical consciousness. Nevertheless, in the gap that separates both conceptions, and, especially in the development of the conception of information –that will be translated into Shannon's theory, as shown by Segal[8]–, it occurs a curious and even surreptitious transformation from illustrated and empiricist epistemology into the contemporary one, executed by thermodynamics (Smoluchowsky, Szilard, Lewis), quantum physics (Von Newman) and statistics (Fisher). This process is paradigmatically illustrated in the theoretical role played by *Maxwell's demon*, whose perception allows him to "get informed", with the aim of achieving an order that cannot be explained without his intervention.

Thus, and with the subsequent quantitative adjustment, according to which entropy and information are at the same level, information rescues a classical reversibility that was questioned by the new conceptions of the world[9]. However, in turn, a new model of knowledge and even of cos-

---

[7] In some way, the Enlightenment could be considered, from a modern approach, as a vast effort to form consciousnesses or even to transmit the correct forms among them, which has been created from "clear and different ideas".

[8] Op. cit.

[9] The contradictory reduction of entropy that would entail the intervention of the Maxwellian demon, leaving the system more ordered than before (in a flagrant violation of the second law of thermodynamics, which

mos –both compatible- are forged, in which the information that can be extracted from this 'cosmos' and its inevitable uncertainty become key issues of the own vision of the world.

Thus, two contradictory movements occur at the moment of the crystallization of the information concept:

— The analytical and mechanistic ideal of rationalism is taken as a model of the measurability of information, including the own informative process[10].

— The own uncertainty, i.e. limiting oneself to the purely observable as a criterion of reality, becomes the cornerstone of the idea and measurement of information.

It is especially paradoxical that this confusion occurred, as previously mentioned[11], from the matrix of statistical physics, as its conception of the world is beyond the first of the movements. However, as stated by Danchin and Segal, this cannot be understood without the development of telecommunications engineering in the context of the post-war[12] and that of rationalisation of economic exchanges, whose models of rationality were purely classical and, to a large extent, direct heirs of the 19th positivism.

---

could be used, among other things, to obtain energy), is compensated with the contribution of information by the own demon according to its enquiries (up to a point in which from the own demon's observation, it is not possible to obtain new information so as to increase even more the order of the system). According to BIDÓN-CHANAL (in "Tratamiento científico de la información", *Convivium,* nº 34, pp. 79-92, 1971), this exorcism of the demon represents the combination of an idea of information as acquisition of knowledge– which intrinsically entails an increase of entropy–with that Aristotelian of information as order, which would allow knowledge to reconstruct order. Hence, deterministic reversibility would result from supposing the exact adjustment of both quantities. Yet, if one considers an additional restriction regarding the acquisition of knowledge, the process would be irreversible and, therefore, more coherent with contemporary physical budgets.

[10] In "Tecnologías del Ostracismo o de la pseudocomunicación" (DÍAZ NAFRÍA, J. M., *Le Monde Diplomatique edición española,* No. 135, enero 2007), we made reference to the Lockean root of Shannon's model of communication, highlighting its insufficiency with regard to the pragmatic point of view. If this were the case –and according to the persistence pointed out by Floridi of Shannon's communication model in the alternatives to his theory of information– this would be an important conceptual burden that should be overcome (FLORIDI, L., "Semantic Conceptions of Information", in *Stanford Encyclopedia of Philisophy,* Online edition, 2005, http://plato.stanford.edu/entries/information-semantic/).

[11] Cf. SEGAL, op. cit.

[12] Shannon himself worked in this field, as previously done by Nyquist and Hartley, whose contributions were essential for the Shannonian theory, as pointed out by the own Shannon (*see* SHANNON, C., "A Mathematical Theory of Communication". *Bell System Technical Journal* 27, pp. 379-423, 623-656, 1948).

Hence, one can say that the imperatives of technological development –both in communication and in computing–, and even the prestige of its brilliant career, have caused a theoretical eclipse that, as in other fields, was discussed in terms of *technocracy*[13] by Frankfurtian critics and, especially, by Habermas. From this narrow technical and economic point of view, the most relevant aspects of information for the Mathematical Theory of Communication (MTC) would be: a) to compress it –i.e. to use a minimum number of resources to express it–; b) to transmit the maximum possible amount for certain resources; and c) to count its volume –in this way predicting the necessary resources and, as a result, the costs.

Nevertheless, beyond the formalisations of the own MTC, the reality depicted by evolutionist biology and quantum mechanics involved a world of interrelations that were impossible to be reduced to classical mechanicism. As a result, given that information focuses on these new disciplines, it is normal that they encountered important tensions when adopting the notion of information coined by the MTC. However, the tensions encountered in social sciences, after the initial euphoria of applying this new mathematical concept, were also very significant, as the semantic and pragmatic dimensions of information –supported by their linguistic use– were essential to clarify the studied problems, but not related to the MTC, as stated by the own Shannon on repeated occasions[14]. Thus, in the context of these controversies, the concept of information has intended to limit itself to the uses and interests of each theoretical field, sometimes with the intention of completing the MTC, sometimes openly contradicting some of its points (especially, as general theory of information) and sometimes with the aim of superseding it.

b) Current points of view on information

As generally highlighted, the MTC, when focusing its efforts on the quantitative determination of information, makes its qualitative nature indistinguishable, referring therefore exclusively to the *syntactical* aspects of *information*[15] (even though it is difficult for the information concept to be exclusively associated with this aspect, no matter the meaning given to the term, unless it is limited to the

---

[13] According to Danchin (*see* SEGAL, *op. cit.*), "the development of these theories [of information – rom physics, statistics and telecommunications engineering-] occurs in a world strongly influenced by an ideology of degradation. Hence, assimilating entropy and disorder, and placing information in this context is not obviously innocent". On the other hand, as pointed out by several authors, the inherent confusion for Shannon to put information and entropy on the same level was the main argument of von Newman to recommend its use (*cf.* FLORIDI, L. "Information" in MITCHAM, C. (ed.), *Encyclopedia of Science, Technology and Ethics,* Macmillan Reference, 2005).

[14] E.g. SHANNON, op. cit.

[15] *Cf.* FLORIDI, *op. cit.*; SEGAL, *op. cit.*; CAPURRO, *op. cit.*

quantification of the MTC, which, in turn is referred to the uncertainty values of the signals used in the communicative process. A qualitative approach shows the importance of both its *semantic* component (according to which, the signals or symbols considered by the MTC are necessarily referred to something) and its *pragmatic* one (according to which, information is the foundation for action, whether by intentional actors, living beings or automatic systems). This does not mean to simply extend the attributes or the detail of the reference, but also an important negative limitation that forces us to exclude anything that one could not be discriminated at a merely syntactical level.[16]

As pointed out by Machlup and Mansfield[17], this negative nature can be illustrated by considering the exigencies that normally human contexts impose on the legitimate meaning of information, i.e. need for truth, value, innovation, surprise or reduction of uncertainty. This would classify as non-informative those messages that, even meeting all the exigencies of the syntactical level, were false, incorrect, useless, redundant, expected or promoters of uncertainty, against which the MTC could not object anything.

Hence, from the previously mentioned theoretical coherence or the conceptual extension demanded from different approaches, a whole array of alternatives and criticism has arisen –since the MTC was formulated– that must be taken into account in order to distinguish "what is called information" and to consider "what will be possibly called information", so that the interests at stake are reflected and we can understand each other, which is our intention.

With the aim of addressing the different approaches in a systematic way, as well as increasing the perception of the relationships among such approaches, a three-fold classification is proposed, as follows:

1. According to the ontological and epistemological categories involved, i.e. with regard to fundamental questions, such as is it something *objective* or *subjective*? Does it make reference to an *independent* or *dependent* ontological category? Does it require an *abstract*, *general* or *human* subjectivity? Does it depend on its *truth value*, *relevance* (social, political or psychological), *meaning* or *interpretation* (in theoretical or cultural contexts)?
2. According to the considered aspects of the qualitative content (syntactical, semantic, pragmatic, etc.).

---

[16] In his analysis of the qualitative nature of information, W. GITT distinguishes two other levels –the *statistical* level and the *apobetic* level (referred to purposes and objectives)– that would be situated below and over the other three levels, respectively ("Information, Science and Biology", *Technical Journal*, Vol. 10, No. 2, pp. 181-187, August 1996).

[17] MACHLUP, F., MANSFIELD, U. (Eds.) (1983). *The Study of Information. Interdisciplinary Messages*. New York: Wiley.

3. According to the disciplines, from which it is proposed or elaborated.

i. According to ontological and epistemological categories

The main difference here is related to what is understood by i*nformation* –i.e. if it is considered *objective* and, therefore, as independent from mental states or user's intentions, or if it is considered *subjective*, which depends on the interpretation of a cognitive or intentional agent[18]. Between both extremes, an intermediate approach could be adopted, according to which it is not necessary to consider information as something having its own entity or something belonging to subjectivity, but rather in terms of a *relationship* that enables an action to be executed, an order to be obeyed, a structure to be established or simply allows a behaviour, adaptation or an interpretation (even though it can be referred to any type of intentionality).

In the most extremist case of objectivist categorisation, information is considered as a third metaphysical principle, in the sense expressed in the popular maxim formulated by Wiener: "Information is information, not matter or energy"[19]. This principle is sometimes associated with a teleological description of the universe as it happens in Teilhard de Chardin's "noosphere", to which Stonier makes reference, or in an openly teleological "cosmovision", as Gitt's. With regard to the MTC, it remains unclear if, for authors, this theory is objective, substantial (as sometimes interpreted) or if it makes reference to the quality of the signals used in the process of communication, in which uncertainty is something concerning the identification of the signals received (which is closer to the interest frame, in which the theory was developed).

Figure 2 shows a great number of theoretical points of view –despite not including all proposals, these models are grouped into theories named under a title that, not in all cases, is the one adopted by authors, but that makes reference to any of their key elements– that develop the concept of information according to its greater or lesser subjective nature. On the left, the most objectivist theories, on the right, the most subjectivist ones and, in the centre, a range of intermediate theories that normally adopt a two-fold approach –as it happens with Weizsäcker's dual concept of his objectivised semantics, in which the information is defined as a) "form that can be potentially known" (even if it is on the part of an abstract intentionality) and b) "that which generates information"[20]. In the case of the *Unified Theory of Information*, which is frequently presented as a mediator of

[18] CAPURRO considers it this way, *v. op. cit.,* p. 396.

[19] WIENER, N. (1961) *Cybernetics or Control and Communication in the Animal and the Machine.* Cambridge, Mass.: MIT Press, p. 132.

[20] WEIZSÄCKER, C.F. von. *Die Einheit der Natur.* Munich: Deutscher Taschenbuch Verlag, 1974, p. 351.

all points of views (without falling into reductionism or holism[21]), it must attain certain degree of intentionality –not necessarily human– called *general*, whose complexity may present different degrees depending on the process this theory refers to (adaptation to systems of greater or lesser complexity). Nevertheless, when it comes to encompass all processes and to explain their self-generation, this theory also contains the organisation of physical systems that do not include intentionality. The *Unified Theory of Information* would be included in the field of the most complex systems (normally human or social) that intend to be compatible with diachronic structuration and organisation, from the most simple elements –without using a strictly casual explanation (from bottom to top) or its exclusively projectionist counterpart (from top to bottom).

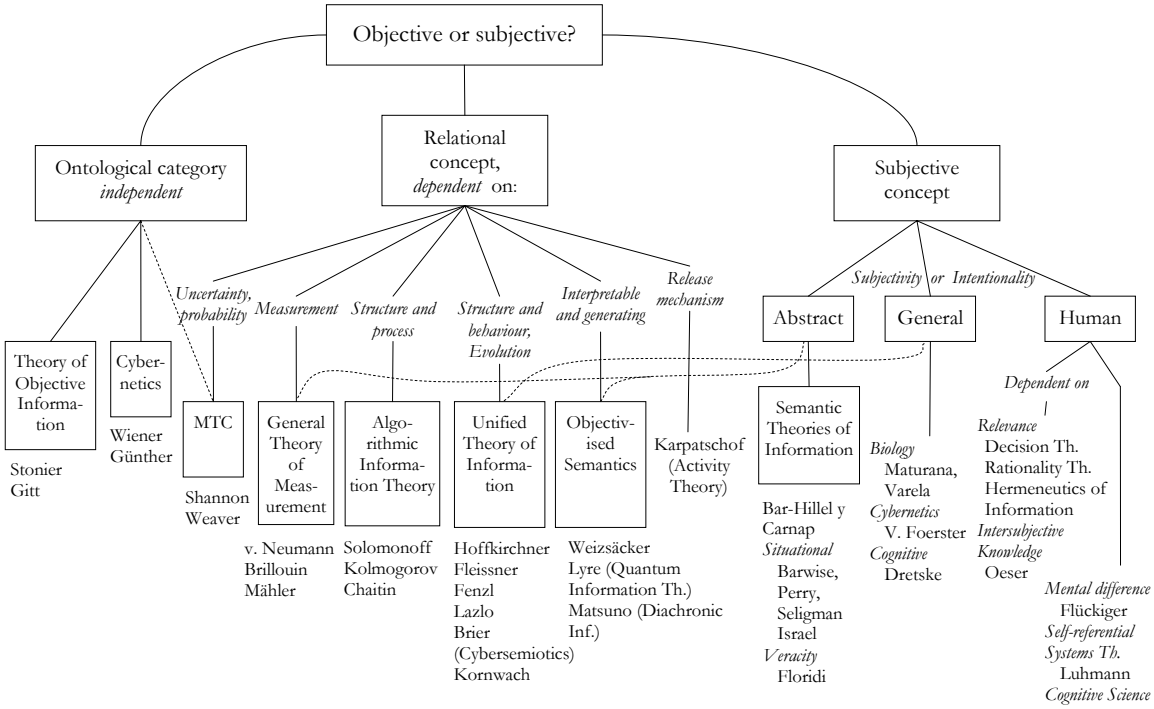

Figure 2. Taxonomy of theories depending on information is considered as something objective, relational or subjective.

If one considers information from a *subjectivist* point of view, the objective qualities of signals are of less importance, focusing on those considered relevant by the subject (the interpreter). However, this does not mean that information is only interpreted from an anthropocentric point of view (or something just occurring inside minds), but that subjectivity may be referred to an intentionality that can be: a) *abstract* (or formal, in the sense of a series of general conditions of representation and intellection of reality), as it happens in the majority of semantic theories of information; b) *general*, in

[21] FENZL , N. & HOFKIRCHNER, W. "Information Processing in Evolutionary Systems. An Outline Conceptual Framework for a Unified Information Theory". En SCHWEITZER, F. (Ed.), *Self-Organization of Complex Structures: From Individual to Collective Dynamics*, London: Gordon and Breach, pp. 59-70, 1997.

the case of information as an observer's construct (whether human or not), which encounters differences in its circumstance (as suggested by Maturana and Varela from a biological approach, or by Von Foerster from a cybernetic perspective); or *human* (in this case, the consideration of language, cognitive mechanisms or social systems becomes essential and issues of *relevance* (social or individual), *veracity* or relationship with *knowledge* turn into focal points.

With regard to the epistemic value of each point of view, it is logically neutral for objectivist conceptions (the value of information lies in itself and it is not possible to talk about truth) and can be or not considered subjectivist for those conceptions in which intentionality is necessary, especially for those theories linked to knowledge or semantic issues. Thus, the attention paid to syntactical, semantic and pragmatic aspects is essential with regard to epistemological issues.

ii. According to the qualitative content approach

The adopted perspective regarding its qualitative content is also a clarifying aspect of the scope and intention of the different concepts of information and, as previously mentioned, epistemological and ontological consequences result from this approach.

Hence, when only considering the syntactical level, the question about the truth of the content makes no sense, whereas the way toward the objectivisation of information is extremely feasible[22]. On the other hand, when the highlighted dimension is pragmatics, the question about truth is substituted by others, such as value or utility.

In short, the three mentioned aspects could be characterised as follows: according to the syntactical content, "How is it expressed?"; according to the semantic content, "What does it represent and with which truth value?"; and, according to the pragmatic content, "What value and utility has?". Even if in communicative or information-transmission processes it is fairly obvious that without expression it is not possible to talk about the transmission of semantic contents and that these are necessary to identify the pragmatic contents, it is still unclear to what extent each question determines the other two. And for that, different opinions are accepted, because although normally the three aspects are considered in a hierarchical manner (the syntactical aspect being at the lowest level and the pragmatic content at the highest one), the degree of freedom on each aspect which is allowed by the other levels will depend on the point of view adopted, and even the fact that in some cases some of the mentioned levels are not considered at all, or the levelism is avoided.

---

[22] According to ZOGLAUER, the naturalisation of the concept of information is only possible at a syntactical level, even if it is already related to semantic units mentally dependent or to any type of functional information that could be interpreted by a Turing machine (*see* "Can information be naturalized?" In KORNWACHS, K., & Jacoby, K. (Eds.), *Information. New questions to a multidisciplinary concept*. Berlin: Akademie Verlag, 1996, pp.187-207).

Thus, whereas the MTC is linked to the syntactical level, as it considers inappropriate the other two levels, some points of view regarding the semantic issue consider it as strongly restricted by Shannon's information –such as in Weaver's case– and others consider it as a weak restriction that allows a large margin of freedom, such in Sloman's case[23].

In Figure 3, without trying to exhaust the subject, the extent to which each concept answers to the questions about the qualitative content of information is again represented. It must be observed that syntactical perspective is situated both on the left and on the right, with the aim of including and avoiding each of the three aspects that have intentionally not been represented in a hierarchical manner. As it can be seen, Shannon's information and the reformulations that cover the incompatibilities of the MTC, with regard to the epistemology of modern physics, are situated at the syntactical level (quantum theory of information or information according to the holographic principle). These last ones, as shown in Figure 3, are partially situated at the semantic level, since, contrary to the classical conception of the MTC, there is a certain degree of indecision when reality is described by data, which entails that information is necessarily measured by theory. However, this consideration rather belongs to an epistemological level regarding the observation and measurement of reality and does not make reference to the commonly understood as semantic aspects of information. It is rather an additional limitation at the syntactical level with regard to the assumptions of the MTC; in fact, Von Neumann's entropy, relating to quantum states, is normally smaller than Shannon's one →*qubit.*

[23]*See* FLORIDI*, op. cit.* In this respect, it is important to highlight that there are good reasons to consider that a mere sound, to which the MTC would give the maximum value of information, does not meet the elements commonly attributed to information. However, a single bit may tell us if the Ptolemaic universe is or not the case or if war has begun, which completely changes our representation of the world or our expectations for the future.

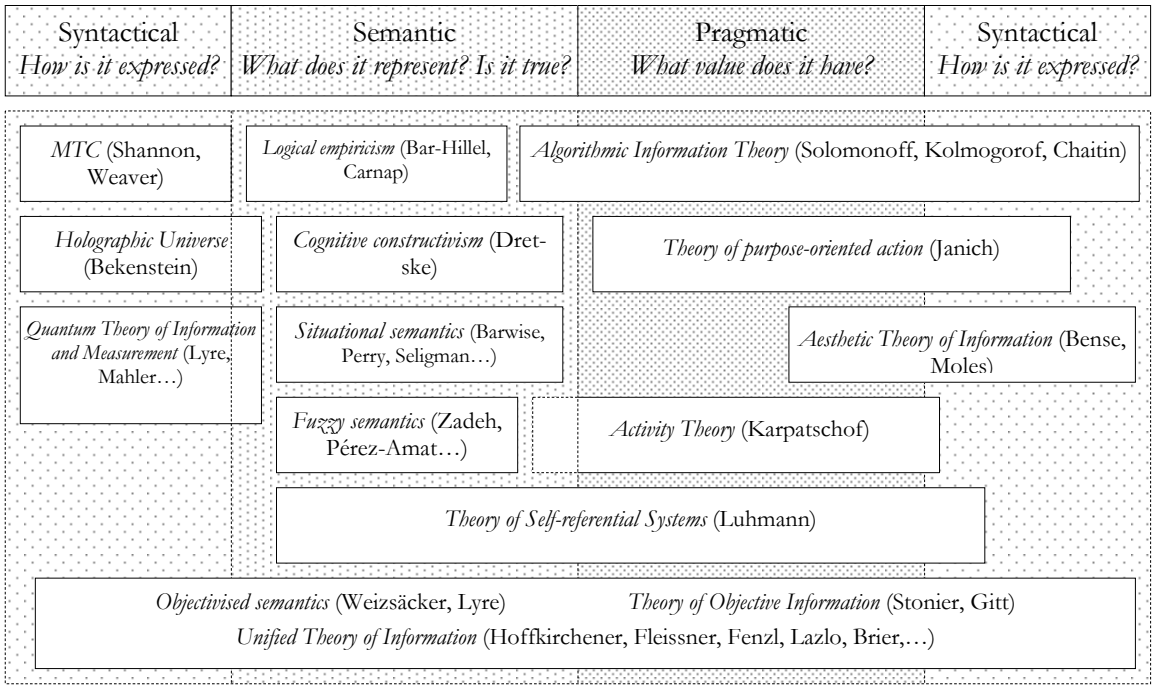

Figure 3. Perspectives of the qualitative content according to different concepts of information.

If one only takes semantic questions into account, there are a great number of proposals that, in turn, present important internal differences that are not easily compatible, as they start from atavistically opposed assumptions, such as those of the empiricist, constructivist or rationalist approaches. Thus, although in most proposals the semantic value of a supposedly informative assumption intends to refer to probabilistic calculations, inspired by Shannon's quantification, a different probability can be found in each case: in Bar-Hillel's and Carnap's *logical empiricism*, it is based on the result of a logical construction of atomic propositions in a formal language; in Dretske's *cognitive constructivism*, in the probability of the states of the observed facts; in Barwise's or Perry's *situational semantics*, in the probability of the space of states and the consistency from a certain contextual situation; and in Zadeh's *fuzzy semantics*, the categories used in the descriptors are associated to elastic restrictions and fuzzy quantifiers.

With regard to pragmatic questions, the *algorithmic information theory* defines it in terms of the informative resources to generate something, whether a mere binary structure, an object or the development of a certain operation. Thus, its approach is essentially practical, but as long as it refers to the expressive resources required to perform something, its approach is also syntactical and this theoretical field is therefore an extremely active place for the development of codes[24]. In an ex-

[24] In the sense that *algorithmic information theory* also deals with an optimal representation of something, the theory can also be understood as a semantic and syntactical approach. So is considered by LYRE, H. *Informationstheorie*, Wilhelm Fink Verlag (UTB), Munich, 2002.

pressly pragmatic sense of Janich's theory of information, it is referred to purpose-oriented human actions and searches the possibility of reproducing such actions through artificial anthropomorphic devices articulated by standard interrogative dialogues that are qualified by information. As a result, one also finds this two-fold attention to pragmatic and syntactical dimensions. However, in a higher degree of abstraction regarding informative pragmatics, *Karpatschof's activity theory* reduces the syntactical field to that of qualities of signals with regard to a "release mechanism"', which is, so to speak, the one that calls the shots. Hence, this study focuses on the characteristics of this mechanism which consists of a system containing potential and stored energy that is capable of being released in a specific manner when activated by a signal that meets certain conditions[25].

In an integrating perspective of the different aspects of information, Luhmann's theory of self-referential systems considers information as a mediator between the "meaning offer" (typical of the cultural circumstance) and "understanding". Thus, semantic and pragmatic dimensions are in this case closely related, whereas social systems can be considered as meaning worlds or as problem-solving worlds. This interrelation of pragmatic and semantic dimensions constitutes in Lyre's or Weizsäcker's semantic theory the condition for the possibility of the objectivisation of semantics, achieving the unification of the three fundamental levels of information, solving for the syntactical one the already mentioned epistemological defects of the MTC, especially in relation to the certitudes of quantum theory.

In the hierarchical sense of the three informational contents, the *unified theory of information* intends to cover all problems relating to information, such as phenomena merely physical, organic or social, according to the self-generative paradigm. In this case, the constitution of the syntactical level is the condition and substratum for the articulation of the semantic level, and this one is, in turn, the condition and substratum for the self-generation of the pragmatic level. This organisation is also applied to Stonier's and Gitt's objectivised information: Gitt considers two additional levels below and over the other three ones, respectively, the statistical level being below the syntactical one and the apobetic level (or purpose) being over the pragmatic one.

---

[25] One of the interests that this theory could contain for the main purpose of our project is the lability of the conditions of signals and the release mechanism. It must be pointed out that if the conditions imposed by the release mechanism were the satisfaction of certain truth or veracity conditions, this could be linked to the problem of knowledge or, in general, to the semantic problem. However, if the conditions were of an aesthetic nature, the release mechanism could be linked to the problem of artistic information, although similarly it could be also adapt to problems of biological adaptability or social coexistence. *See* KARPATSCHOF, B. *Human activity - contributions to the anthropological sciences from a perspective of activity theory.* InformationR.net, 2007.

iii. According to the theoretical disciplines involved in the definition and use of the concept of information

Other perspective that allows us to distinguish the scope and interests reflected in the different conceptions of information are the theoretical disciplines involved in their definition. If these conceptions come from telecommunications, biology or sociology, it is obvious that "information" will be use in a different sense. The first one intends not to get involved in questions of meaning or relevance and the second one avoids intentionality, which cannot be avoided by sociology. Despite that, one of the most outstanding characteristics of information theories is maybe that these ones have intended to embrace very different points of view, even in the case of theories without an obvious intention of exhaustiveness.

This is, for example, the case of the MCT, which is mainly constituted within the field of telecommunications and mathematics, even if, as widely shown by Segal, its concepts arise from physics (thermodynamics and quantum), statistics (with certain link to eugenic projects) and telecommunications.)

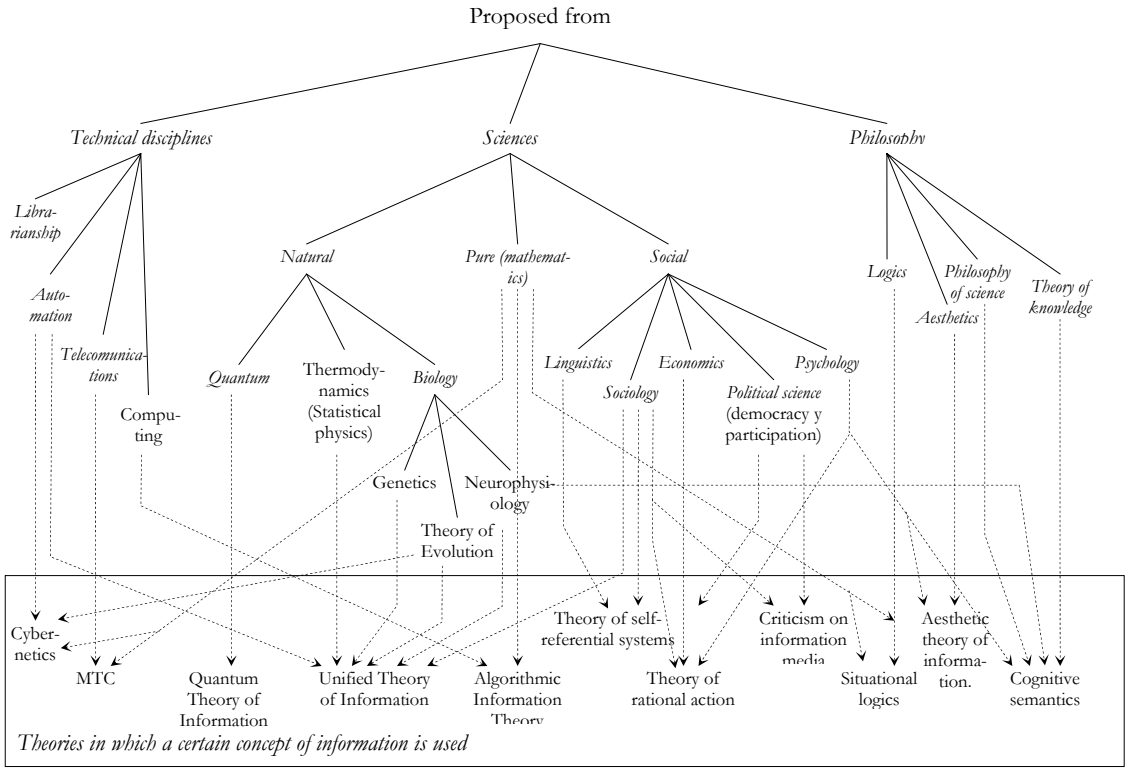

Figure 4. Relationship among theories of information and technical and scientific disciplines.

In any case, this practically interdisciplinary nature is especially observed from the constitution of classical cybernetics in 1940 and from the contributions derived from physics, biology, psychology, automation, neurophysiology or psychiatrics. This interrelation is also observed in the unified theory of information and in cognitive theories.

However, despite this background of relationships between scientific and technical specialities, some theories have been developed from not so open contexts, such as the *algorithmic information theory*, mainly linked (especially in its genesis) to mathematics and computing; the *aesthetic theory of information*, linked to the theory of art, mathematics and psychology; the theories of rational action or self-referential systems, developed in the field of social sciences –such as the *theory of self-referential systems* or the *criticism on information media*– and, finally, the *semantic theories*, of a more philosophical and, especially, logical nature.

Again not so thoroughly, Figure 4 shows the relationships between scientific and technical disciplines, ordered in a taxonomic manner, as participants in the definition of the concept of information. It must be observed, on the one hand, the deep interrelation among academic disciplines, and, on the other hand, the fact of situating natural sciences on the left and social or human sciences on the right means that on the left, the prevailing theories are the most syntactical and objectivist ones, and on the right, the semantic, pragmatic and subjectivist theories are predominant.

4.2 Problems of reductibility and agreement

In short, some of the posed problems when it comes to achieve the intended generalisation of the objective of the projects are:

1) Is there a single notion that is useful for all disciplines? In other words, can all the used notions be reduced into a single and fundamental one from the different scientific points of view?

2) Is there any concept that is at the same time useful and of a relevant "informational content" which is capable of unifying intentional contents and those that leave the question of intentionality apart, or even those for whom this question must be avoided?

3) Could a general meaning be accepted and agreed by all disciplines?

4) Would this general meaning be useful and, as a result, abstract?

5) What ontological, epistemological and methodological consequences would entail the supposed validity of this type of notion?

6) Can the question of information be separated from those of knowledge, communication, reproduction or self-regulation?

4.3 Neglected aspects that can be important for the notion of information

It has been previously highlighted that there are shortcomings in some concepts of information with regard to others. Thus, for example, the canonical definition of the MTC comes into conflict with the irreversibility of the theory of measurement, which is more related to the approach of quantum mechanics, as the merely syntactical approach avoids the irreducible semantic aspects. In

this sense, veracity can or not be taken into account, as well as contradictions or ontologies, whereas relevance would be excluded in non-contextualist approaches.

4.4 Relationship with other scientific and social problems

We will mention some problems that have already been considered in this paper, such as measurement, stability, control, adaptive efficiency, maximum storable data capacity, maximum efficiency of a code, communication, knowledge, veracity, truth, contradiction, socialisation (cohabitation, coexistence, etc.) in plural societies or political organisation.

4.5 Preliminary terminology

It would be useful to have a primitive terminology, including a minimum number of the most accepted terms, used in a coherent manner by all participants, as well as a terminological place, where all tensions referred to certain aspects causing divergences among different points of view were collected. In a preliminary manner, previous to the tensions that emerged during the development of the project, the ***glossary*** below reflects various points of view according to the terminology of the authors, as well as the tension that arose from a specific problem, such as that of knowledge, context or contradiction.

GLOSSARY

In the following glossary (only developed for a short number of entries as an example of what-it-could-be) the main voices are highlighted with bold characters, followed by the most common used names for the same concept –or the nearest ones- in French, German and Spanish. Whenever a voice is used in other compound names the simple name is typed in uppercase before all the compounds ones, while that is referred in these using the symbol ~. Secondary voices are typed in italics, and these are also used, going along with the symbol →, to indicate that the voice (highlighted in italics) is further developed in an article of the glossary. In case a particular voice is used in a restricted field or only by a limited number of authors author, these are pointed out between square brackets.

As it was previously said, the glossary has a two-fold objective: on the one hand, the clarification of the term used by each point of view involved and, on the other hand, the analysis of the main problems regarding information from each approach. This is the reason why some articles –of restricted use– may be very concise, while other –open to controversy– may exhibit a larger extension.

ACRONYMS

AIT..... *Algorithmic Information Theory*

MTC..... *Mathematical Theory of Communication*

UTI..... *Unified Theory of Information*

A

Alphabet (F. *alphabet*, G. *Alphabet,* S. *alfabeto*)**,** term commonly used in the communication model or information transmission model (especially on the syntactic level, such as in the case of MTC), in order to designate a finite set of symbols or messages that make up the →*code* used in communication and which must be known for both the emitter and receiver.

Aspects of **information** (F. *aspects de l'information*, G. *Aspekte der Information,* S. *aspectos de la información*) (also referred as *dimensions*), the designation of syntactic, semantic and pragmatic aspects proceeds from the conception of the →*sign* of *Peirce* according to a triple perspective which links them with themselves, with the object and subject. The said triadic relationship is taken by *Morris*, who links it to his study: syntax, semantics and pragmatics, respectively (→*levels*).

Autopoiesis (αυτο-ποιησις, 'auto (self)-creation'), neologism introduced in 1971 by the Chilean biologists Humberto *Maturana* and Francisco *Varela* to designate the organisation of living systems in terms of a fundamental dialectic between *structure* and *function*. Although the term emerged in biology, afterwards it came to be used in other sciences as well. Its use by the sociologist Niklas Luhmann is worth pointing out. It can be said that →the *UTI*

takes and reproduces the concept in more differentiated categories (→*self-restructuring, self-reproduction* and *self-recreation*).

For Maturana and Varela, *autopoiesis* is a fundamental condition for the existence of living beings in the continuous production of themselves. According to Maturana (*Transformation in coexistence*), "living beings are networks of molecular production in which the produced molecules generate, through their interactions, the same network that creates them". *Autopoietic* systems are those that show a network of processes or operations that characterise them and which have the capacity to create or destroy elements of the same system as a response to the disturbances of the medium. Within them, even if the system changes structurally, the network that characterises them would remain invariable during its whole existence, maintaining its identity.

For *Luhmann*, autopoiesis means a new theoretical paradigm, which, if applied to social systems, has a self-referential nature that does not restrict itself to the structural level; the nature itself constructs the elements that make it up. So, whereas in biological systems self-reference corresponds to self-reproduction, in social (or psychic) systems, it is constituted through *meaning* (Sinn), which, in its turn, is produced by the "processing differences" which permit to "select" from the "meaning offer" (*Mitteilung*). According to the Luhmannian interpretation, "communication" (*Kommunikation*) melts the difference between "information" (*Information*), the "meaning offer" (*Mitteilung*) and "understanding" (*Verstehen*) (in which each part differentiates the other two and leads them towards a unity), where the *information* is but a selection within the "meaning offer" through a connection between differences. Therefore, there would not be strictly a transmission of information between emitter and receiver; instead, the first one makes a suggestion for the selection of the second one, so that the information for both is different, although, in any case, it is constituted through communication processes.

B

Behaviour (F. *comportement,* G. *Verhalten,* S. *comportamiento*) [UTI] is generally used to refer to the set of responses of animals or humans to exogenous stimuli (from the environment) or endogenous stimuli (from the organism itself). It plays a key role in the →*UTI* as a fundamental feature of the →*macro level* (where the pragmatic aspects of information are expressed separately) as regards the manner in which the system interacts with its adjacent ones in the network. What *structure* is to the *micro level* and *state* to the *meso-level, behaviour* is here to the *macro-level*, of which external manifestations of the system (or *output*) are a part, whose possible difference must be based on a change of the state. At the same time, the state must be based on a change of the relationships or elements of the structure.

The information appears when the self-organising processes give rise to a qualitative change in any of the three levels, so that only

a portion of the entry (or stimuli) of the entrance will entail a change in its internal structure. At the same time, a part of the structural changes will involve a change of state and, finally, only one part of the changes of state will result in a change of behaviour, through which the system will respond to the environmental changes, whose severity will force the system to modify its activity, either following its own interest or that of the network to which it belongs. From this point of view, behaviour involves the highest manifestation of information, where the syntactic and semantic aspects are subsidiary, representing the precondition of behaviour.

C

Capurro's Trilemma [Fleissner]

Channel (F. *canal*, G. *Kanal,* S. *canal*), *Communication* ~, in the MTC and many other information and communication theories by extension, deals with the medium (or set of media) that allow(s) transmitting the signals generated by the transmitter to the receiver. As stated by Shannon: "merely the medium used to transmit the signal from transmitter to receiver. It may be a pair of wires, a coaxial cable, a band of radio frequencies, a beam of light, etc".

It could be said that the objective of the *transmission codifier* is to adapt the messages, send through the information source, to the characteristics of the channel (which has certain limitations and available resources, such as the bandwidth or frequency margin that can be send). In the analysis, Shannon distinguishes between *channels without noise* (which is nothing but a theoretical abstraction that can approximately correspond to a situation in which the noise is negligible with respect to the received signals) and *channels with noise* (which is the normal situation and must especially be taken into consideration when the noise is notably present with respect to the signal).

A fundamental part of Shannon's theory is aimed at finding the limits of the →*information amount* that can be sent to a channel with given resources (*Shannon's fundamental* →*theorem*).

Code (E. *código*, F. *code,* G. *Kode*) is a system of signs and rules for converting a piece of information (for example, a letter, word, or phrase) into another form or representation, not necessarily of the same type. In communication (especially, in telecommunications) and information processing, **encoding** is the process by which information is converted into symbols (usually belonging to an →*alphabet*), which are communicated, stored or processed. **Decoding** is the reverse process which reconverts code symbols into information that is understandable or useful to the receiver.

Note that from this point of view the code is supposed to be known by the sender (or source) and the receiver (or destination) simultaneously, which explains the intercomprehension between them (in case it involves intention) or interoperability (if the information is understood only at a *pragmatic* or *operational* →*level*). Therefore, we would be

dealing with a traditional perspective related to reversibility, which would explain neither the emergence nor dynamics of this code. An improvement of this perspective can be found in Foerster´s criticism of →*cybernetics* of the *first order*, which is intended to be improved in cybernetics of the *second order* in order to explain the self-referential and →*autopoietic* processes.

In *semiotics,* as regards the system of signs, a code is a system of correlations or correlation rules between the coding system (system of signifiers, syntactic space or expression space) and a codified system (system of meanings or semantic space or content space). In the words of Umberto *Eco*, the code "associates a vehicle-of-the-sign (or signifier) with some-thing that is called its meaning or sense".

CONTENT (F. *contenue*, G. *Gehalt*, S. *contenido*)

Qualitative ~ of information: generally used to distinguish it from a purely quantitative consideration on information. It is aimed at highlighting the fact that information can be viewed from different perspectives or →*aspects*. Only when the focus is limited to one of them, it is more easily abstractable, which makes its quantification more feasible (which is normally unidimensional). Nevertheless, given the limitations of the syntactic aspect (relating to a limited group of symbols and rules) regarding the eminently open character of semantics and pragmatics, it is not surprising that the goal of the quantification of information has been a success in the syntactic level and not in the other two.

Information ~ [Chaitin]: $I(x)$ of a binary sequence x is defined as "the size in bits (number of binary digits) of the smallest program for a canonical universal computer U to calculate x".

Informational ~ [Israel and Perry]. In the *situational semantic* approach of Israel and Perry, where the relationships between the contents of an information system are considered as architectural*,* the *informational content* of a fact may involve very remote objects from those involved in the particular fact and will "only be *information* when the constraints and connecting facts are actual". ("Information and architecture". In J. BARWISE, *et al.* (Eds.), *Situation theory and its applications*, 1990, pp. 147-160).

Semantic ~ or '**Semantic ~ Amount**' [Bar-Hillel, Carnap], in the probabilistic approach to the semantic information provided by a proposition p, the authors suggested a measure of content, CONT (p), which would be additive for statements with exclusive contents: $\mathrm{CONT}(p) = 1 - \mathrm{P}(p)$, where P($p$) is the so-called "absolute logical probability" of statement p build from atomic proposals (description of state) in a given formal language. This measure deviates from the Shannonian quantification, because it is not additive for inductively independent statements, and, instead, it is proposed the *informativity* INF(p), which is indeed similar to the standard measure.

Context (F. *contexte*, G. *Kontext,* S. *contexto*). Coming from the Latin verb *contextere*, meaning 'to weave' or 'interlace'; in a figurative sense, it refers to the interlacement of the meanings contained in a text or communication, in general, as well as to the circumstance in which this communication occurs (e.g. physical, pragmatic and cultural environment), which allows for the specification of the meaning of the transmitted information. Although the meaning of 'context' in relation to statements is common, by extension it is also applicable to the structure in which it is situated, and without which it would be unintelligible or less intelligible.

A distinction can be made between *situational context* (or non-expressive context) and *expressive context,* relating to the set of syntactically and semantically related expressions, which, at the same time, are articulated through *deixis* and modal indicators in the situational context. In its turn, the *situational context* can be divided into: *general* (related to the communicational situation defined by the time, place and action within which the communication is framed), *social* and *personal* (defined by the relationship between the statements, their attitudes, interests and their respective meanings of knowledge).

There is great disparity in the analysis of context from the different notions of information: from complete oblivion (in the more objectivisable meanings of information, according to which the information is entirely contained within the message), to central attention (in those perspectives for which information makes only sense in social frameworks or in the adaptation to the environment, according to which the message is a mere key to release the information contained in the context). It is ironic that, while in linguistics the consideration of context was brought to the forefront and in physics the classical conception of the outside observer was lost, at the same time the →*MTC* defined information as a characteristic typical of the information source, without making reference to its context. Something similar could be said about the founding of the "cognitive sciences" in the "symposium on information theory" of 1956, which minimized the consideration of cultural and historical contexts in which cognitive processes happen. Nevertheless, although we could talk about epistemological anachronism, there was still a discussion going on about the hidden variables in quantum theory, and also the project on the unification of sciences of Vienna´s circle was still running, whereas the so-called historicist turn, which would underline the importance of cultural contexts, was still far away.

In any case, in →*cybernetics,* the contextualization of information has been an intrinsic aspect of its theory from the very beginning, as it is in the pragmatic situation (which, in its turn, involves the environment) that information gains meaning as a fundamental means to pursue an objective. Even so, it is cybernetics of the second order which will put a bigger demand when it

comes to contextualisation, as it will make the system's regulative structure dependent of the possible changes in the environment, in order to survive.

On the other hand, from a quantum physics point of view, information is – as stated by Mahler – a "contextual concept", intrinsically linked to a "situation". This *situation* is but the dynamic scenario in which a system takes "decisions", giving place to an "information flow". Therefore, in accordance with current physical theories, one cannot say that information is encoded in physical, elementary components, but that it appears after measuring. (*v.* →*qbit*; MAHLER, G., "Quantum Information". In KORNWACHS and JACOBY (Eds.), *Information. New questions to a multidisciplinary concept*, 1996, pp. 103-118).

It is also from the analysis of the semantic aspects of information that a change has been observed in which there is more consideration for the context: from the "ideal receiver" of Bar-Hillel and Carnap (1952), capable of assessing information in terms of a structure of atomic statements (in an almost formalised language), to the *situational semantics* of Barwise, Perry, Israel… (1980s and 1990s) in which language ceases to be the property of events and comes to depend on the context and the consistency restrictions between statements (→*informational contents*). Here, it is also worth pointing out the proposal of Dretske of considering information in relation to a knowledge background and the proposal of Floridi of basing information not on terms of truth (as Dretske or the situationalists do and which, in a certain way, involves a privileged view beyond all context), but on terms of veracity, which, in its turn, entails the fallibility of the interpreter and the pertainance to a temporality and a finite knowledge.

Although, as mentioned before, many of the information theories related to cognitive sciences show a reducing trend to minimise the role of context, in other fields of social science, concepts have arisen that highlight it as an essential element. Therefore, while under the cognitive interpretation the subject extracts information from the physical-chemical properties of the sensory stimuli, in the hermeneutic, historical, critical-sociological and Luhmannian approach, the reference and meaning only appear contextualised in a cultural world.

In *hermeneutics*, understanding is seen as something determined by schemas of pre-understanding determined by the cultural context of the interpreter. In the *historical approximations*, information acquires the level of genuine historical phenomena (*cf.* BROWN, J. S. and DUGUIN, P. *The Social Life of Information*, 2000; BORGMAN, A., *Holding on to reality. The nature of information at the turn of the millennium*, 1999; regarding that essential temporality of information, Matsuno starts from assumptions that are strictly physical, "The Internalist Stance. A Linguistic Practice Enclosing Dynamics". *Annals of the New York Academy of Sciences*, 901, pp. 332-350, 2000). In Luhmann's →*systems theory*, there is not exactly a transmission of information, but the emitter limits him/herself to making a suggestion for the selection within the "offer

of meanings" (Mitteilung), which defines a communication process in a specific, socio-linguistic case. However, in Habermasian critical sociology, the subject (or receiver) – although framed closer to a specific vital horizon– has a reflexive faculty (or communicative competence, attained by virtue of being part of a certain social group), which allows him eventually to show the distortions, irregularities and censures that condition all factual communication processes. In this way, Habermas, in the contextual interpretation of information, makes it possible –to put it this way – to go beyond the Luhmannian "offer of meaning" or to move –by means of willpower– the hermeneutic vital horizon.

Contradiction (F. *contradiction*, G. *Widerspruch,* S. *contradicción*). Relationship between an affirmation and a negation with the same subject and predicate. It was traditionally studied under the "principle of contradiction" (or of "non-contradiction") and initially formulated and studied by Aristotle as a supreme principle of beings and of thinking; it can be formulated as follows: "It is impossible for the same attribute to belong and not belong to the same thing, *at the same time and under the same respect*".

Its interpretation can fall on two main aspects: the ontological and logical one, going so far as to become, when it comes to the ontological principle, an expression of the structure constituting what is real. However, its decline as an unquestionable principle could situate itself in Hegel's consideration of contradiction as a basis of reality's internal movement (although one must take into account that, in most cases, the philosopher refers more to opposing realities than contradicting ones). Within the dialectic tradition of Hegelian origin, Adorno considers that a link would exist between the ontological and logical aspects, according to which "reality's repressive structure" and survival's coercive character are reflected in the logical principle of contradiction. According to its negative dialectics, the possibility of transcending the said principle and the one of identity summarises the self-improving capacity of the social contradictions. Therefore, according to the dialectical tendencies, in general, the consideration of the logical principle is only subordinate to the need for improvement of reality's contradictions.

From this –so to speak– utilitarian consideration (or genetic one, according to Adorno's interpretation) of the principle of contradiction, some of the theories of information based on *self-referential* systems would participate. For example, from a *cybernetic* perspective, the logical principle of non-contradiction can be considered as being a part of the mechanism of regulation, under normal conditions, whereas its improvement would correspond to the need of readapting the said regulation to changing circumstances (→*positive* and *negative feedback*).

Although the principle of contradiction would be easily refutable in its most brief expression (deleting the part in italics of the previous formulation and without which it would be exposed to a large number of

paradoxes), it is advisable to notice that the consideration of "*at the same time and under the same respect*" makes it less vulnerable and introduces a necessary *contextualization* of the statements (to which we have referred to in the *context* article) for a correct analysis of the consistency of the semantic content of information, such as the approximations of Bar-Hillel and Carnap, Dretske and the situationalists propose (but only the lasts consider the key issue of contextualization).

In any case, the claim to consistency in what will be considered →*informational content* means that contradictions have no place and, consequently, the probability of receiving self-contradicting information would be zero (according to a naturalistic vision on information, such as the one of Dretske, the ontological version of the principle of contradiction would say that reality cannot emanate from contradictory information, because reality proper rejects it). Therefore, in case of considering the semantic content of an informative statement –according to the *inverse relationship principle* of Barwise– as opposite to its probability, one would come to the paradox that one contradiction would give us a maximum amount of information. Floridi calls this the →*Bar-Hillel-Carnap Paradox* and the most common point in most of semantic approximations is to get rid –one way or another– of the said contradictions. Nevertheless, if a dialectical point of view were to be adopted (for example, the critical theory of the Frankfurtians), then contradiction is not something to which to turn a deaf ear, but, on the contrary, the possibility of updating the vision of reality with less contradictions. That is to say, somehow it could be that contradictions would announce a new world to us –to call it this way– a new way of seeing things (Weltanschaung) in which perhaps, when achieved, new things could be seen while the things seen before would dissolve along with past errors. An example of this is the abandonment of classical physics and the birth of contemporary physics according to the contradictions which piled up from the reading of experiments of a very diverse nature –optical, electrical, astronomical … (*v.* POINTCARÉ, "The principles of mathematical physics (1904)", in EINSTEIN *et al.*, *The theory of relativity*, 1995).

Nevertheless, it should be pointed out, on the one hand, that in few cases the so-called contradictions follow the clause of "*at the same time and under the same respect*" and, on the other hand, that in a normal situation –or what Kuhn would call, concerning research work, "normal science"– the contradictions serve to detect false information, wrong interpretations… and, in this way, the principle of contradiction becomes an essential tool to receive information, as well as for the incorporation of it in a knowledge system.

CYBERNETICS (E. *cibernética,* F. *cybernétique*, G. *Kybernetik*) comes from the Greek Word *Κυβερνήτης*, meaning the art of steering a ship, used by Plato in the sense of guiding or governing men. Nowadays, it refers to the study of the control and communication of complex systems, whether

they are living organisms, machines or organisations, paying special attention to the →*feedback* as the main way of regulation. It is usually considered that it has been properly formulated in a work of Norbert *Wiener* of 1948 (*Cybernetics, or control and communication in the animal and machine*, 1948), for whom cybernetics is a science that studies control systems, especially, self-control systems, whether in living organisms or machines, where this "control is the sending of messages that truly change the behaviour of the receiving system". Both in its genesis in the 1940s –with contributions coming from evolutionary biology, von Uexküll, psychology, Anokhin, systems control, Wiener, neurophysiology, McCulloh and Rosenblueth, psychiatry, Ashby…– as in its last development, it has been an eminently interdisciplinary discipline.

For cyberneticist *Gregory Bateson*, cybernetics is the "branch of mathematics which deals with issues of control, resources and information", while from a more general point of view for *Stafford Beer* (who is considered to be the father of management cybernetics) it is "the science of effective organisation"

First order ~ or **classical ~** and **second order ~** (E. ~ *de primer y segundo orden,* F. ~ *de premier et deuxième ordre*, G. ~ *erster und zweiter Ordnung*). In 1958, Heinz von Foerster conducted a critical review of the cybernetic theory of Wiener, observing that although this theory was introducing significant changes regarding the previous conceptions of regulation and control, it did not involve an epistemological break with the traditional conception of science, because a model continued to be applied in which the observer contemplates the object or the system from outside without influencing it and achieving to study it objectively. Von Foerster believed that cybernetics should overcome this epistemological anachronism, so that the observer would be part of the system, asserting his own goals and his own role within the system. Since then, there is a distinction between *traditional cybernetics* or *cybernetics of the first order* and *cybernetics of the second order*, also named *complexity theory*. While cybernetics of the fist order is formulated in a fundamental way: What and how are the mechanisms of feedback of the studied system? Cybernetics of the second order would raise a question: How are we able to control, maintain and generate this system through feedback?

Cybersemiotics [Søren Brier]. By means of connecting Peirce's semiotics (→*sign*) with the →*cybernetics of the second order*, Brier defines *cybersemiotics* in terms of a dynamic and contextually adaptive relationship between a sign, an object and an interpreter. According to Capurro it is conceived as a "hermeneutics of the second order that extends the concept of interpretation beyond human knowledge, relating it to all kinds of selective processes".

D

DATA (F. *donnée*, G. *Angabe, Daten*, S. *dato*)

Diaphoric definition of ~ [Floridi]

Primary ~

Secondary ~

Operational ~

Derivative ~

Meta-~

Decoder →*Encoder*

Dialogic *vs* **Discursive**.

Difference

Virtual ~

Actual ~

Domain Analysis

E

Encoder (E. *codificador,* F. *codificateur*, G. *Kodierer*) is a device for converting data or signals by using a specific *code*. It is normally used with four clearly differentiated purposes: 1) To remove redundancy or anything that is not going to be perceived by the information receiver or remain beyond the quality objectives of the received signal, in which case we talk about a *source encoder*; 2) To increase the redundancy so that the decoder can eventually detect and correct the errors that have occurred during the reception of signals or symbols; in this case we talk about a *channel encoder*. 3) To make the coded data unreadable, except when the code is known, by using the *encryptors or ciphers*; 4) *To allow* the transmission of data through a channel with certain resources and limitations that would correspond (in a model used in the MTC) to the *transmitter-encoder,* which, especially in telecommunications, is called *modulator*.

The **decoder** (E. *decodificador,* F. *decodificateur*, G. *Dekodierer*) would be a device that performs the inverse operation, whatever the purpose of the code: the *source* decoder would try to restore the eliminated redundancy; the *channel* decoder would remove the redundancy that has been introduced by the corresponding encoder, and correct the errors that can be detected; the *decryptor* would make the data readable; and the *demodulator* or receiver/decoder would identify the symbol transmitted through the channel –normally according to a maximum likelihood criterion– and restate the data into the form that it had before the modulator.

Element (system) [Fenzl]

Emergentism [Fenzl]

Entropy →*Information Amount*.

Erotetic Analysis [Floridi] (from Greek ἐρωτάω, 'to ask') refers to asking questions in order to determine what the source is communicating. If all questions accept a binary response (yes, no), the number of questions and answers corresponds to the information given by the source (in bits). This interpretation of the →*information amount,* which is Shannonian and compatible with its conception of information in terms of the receptor's uncertainty, is possibly the one most closely linked to the common notion of information as "that which allows us to know about something" and which is naturally linked to the fact we are uncertain about what has happened. One logical way of remedying this ignorance would be through questions. Note that if the uncertainty would

be reduced to only $N = 2^k$ states of equiprobable things, $p = 1/N$ (for example, picking a card out of a deck of 32), the most economic way of knowing what is the case through binary answers would be through $\log_2 N = k$ questions.

It can also easily be guessed that if any of the cases were to be more probable (for example, in half of the cases the same card would be picked) then the questions could be asked in such a way that, on average, they would require less questions and answers. In short, one can observe that the Shannonian expression $-\log_2 p$ (for a message) has a certain naturalness or coherence with one of the basic intuitions related to information.

As Floridi points out, an erotetic analysis allows us to separate data from semantic content, reducing them to binary answers, which are represented by their corresponding questions. In a Carnapian sense, the questions would correspond to the intensity and the responses to the extension, which in Fregean terminology could be linked to sense and reference, respectively.

Following Floridi, "semantic content is unsaturated information", whereas data may be considered as "a key to unlock [semantic] information contained in the query". The Shannonian entropy, which is characteristic of the data, would, therefore, represent the average "amount of details… to saturate the informee's unsaturated information", which can also be interpreted as a "measurement of the freedom of choice" when it comes to answering.

Error

Estructuralism

Estructure [UIT]

EVOLUTION

~ phases [UIT] physical phase (Reflexion, self-restructuring systems), biotic phase (Representation, self-reproducing), cultural phase (Anticipation, self-re-creating).

Evolutionary System [UIT]

F

FEEDBACK (F. *rétroaction* ,G. *Rückkopplung*, S. *realimentación*, *retroacción*)

Positive ~

Negative ~

Bipolar ~

H

Hermeneutic

I

Inaccuracy [Floridi]

INFORMATION

Environmental ~ [Floridi]

Common or **Mutual ~** of two strings, $I(x:y)$ [Chaitin]

Conditional or **Relative ~** of a string x given y, $I(x|y)$ [Chaitin]

Dis-~

Joint ~ of two strings, $I(x,y)$ [Chaitin]

Cultural ~ [Borgmann]

Effective or **Useful ~** [UTI, Floridi]

Factual ~ [Floridi]

Functional or **Kinetic ~** [UTI]

Incremental ~ [Israel y Perry]

Instructional or **Operational ~**

Para-~ [Chmielecki]

Mis-~ (misinformation)

Mutual ~ [Chaitin] →*Common*

Natural ~ [Borgmann]

Pure ~ [Israel y Perry] radiografía

Saturated and **unsaturated ~** [Frege] →*Erotetic Analysis*.

Structural ~ [UTI].

~ Aesthetics or **~ Aesthetics Theory** (F. *Esthétique informationelle*, G. *Informations-Aesthetik*, S. *Estética de la informacion*)

~ Amount or **Entropy** (E. *cantidad de información, entropía,* F. *quantité d'information, entropie*, G. *Informations-gehalt, -entropie*) [Shannon], from a discreet information source, characterised by the probability p_j of producing each of its symbols *j*, the *entropy* of such a source of information:

$$H = -\sum_j p_j \log_2 p_j \text{ (bits)}$$

Which is delimited by $0 \le H \le \log_2 N$, where *N* is the number of symbols.

In case the source shows various states *i,* with *Pi* being the probability of the state, and each of them being characterized by a probability $p_i(j)$ of producing symbols *j*, then the *entropy* is defined as the average of the entropies of each state:

$$H = \sum_i P_i H_i = -\sum_{i,j} P_i p_i(j) \log_2 p_i(j) \text{ (bits)}.$$

In accordance with Floridi (→*Erotetic Analysis*), *entropy H* can designate, in the ideal case in which a channel has no noise, three equivalent quantities: 1) average of the information generated by the informing agent (by each symbol); 2) average of the deficit quantity of data (Shannonian uncertainty) by the part of the informed agent before he inspects the output of the informing agent; 3) informative potentiality.

Given the fact the first two interpretations assume that a defined uncertainty corresponds to each symbol (whether it is in the input or output), at the same time this involves a certain tactical agreement of the alphabet or informational game in which the agents are immersed. In both cases, the information can be quantified under the condition that the distribution of probability can be specified.

According to the third sense, one could understand entropy in terms of a physical magnitude related to the amount of disorder in processes or systems that carry energy or information.

The bigger the entropy, the bigger the number of physical states in which the system can find itself and, consequently, the more information it can refer to or, differently said, the specification of the state in which a certain system finds itself will require more information as its entropy increases, which will be numerically equivalent to the amount of information or

data that has to be brought in order to specify the state.

~ Processing [UIT]

~ Retrieval

~ Sciences (F. *sciences de l'information,* G. *Informationswissen-schaften,* S. *ciencias de la información*) →*Library Science.* Although in Spain it tended to be considered a synonym of *Communication Sciences,* with special emphasis on the field of journalism, in other Spanish-speaking countries it was used in the English sense of *Information Science* (→*Library Science*). However, also in the Spanish academic field the English discipline is framed within the *Information Sciences*, as it teaches *Library Science* in many of its faculties.

Informativeness or **Amount of Semantic Information** [Bar Hillel, Carnap]

Input *vs* **Output** (input –system) [Fenzl] Action *vs* Reaction [Karpatschof]

Intelligibility

Intentionality

Interpretation [Capurro]

K

Knowledge (F. *connaissance*, G. *Erkenntniss*, *Wissen,* S. *conocimiento*). From the majority of viewpoints regarding information and knowledge, the relationships between these two concepts is close, especially as far as the common use of both terms is concerned. As a rule, the position of information is lower than that of knowledge, with information somehow 'nourishing' knowledge. Nevertheless, this connection is ignored in cases of a *syntactic radical* vision, where the problem of the relationship is avoided to address only its technical dimension (as in the →*MTC*) from a *radical pragmatic* point of view in which only what-is-being-done is called into question, so that the information is considered as a mere instrument of the action and, therefore, the problem of whether the information refers to objects (be it in terms of whether we are dealing with a correct perception or if it is known that *p* be the case) is ignored.

Although conceptions of knowledge are and have been very different, such as for the opinions regarding its *definition*, *possibility*, *basis* or its *modes*, we can say that two fundamental models have prevailed: the *iconic* one, according to which knowledge is an accurate picture (of mental nature) of the object of knowledge, and the *propositional* model, whereby knowledge is a real proposition. The problems of the *iconic* model, where perception and apprehension play a key role, lies in the specification of the limits between object and subject, as well as in the explanation of non-iconic knowledge (such as logical, mathematical and relational "truths"). However, in the *propositional* model, where the scientific statement plays an exemplary role, the inevitable circle, which comprises the justification of knowledge, becomes problematic (→*Gödel's incompleteness theorem*). But, whatever the model of representation, there would be a difference between knowledge and a *true opinion,* insofar as only that one knows how to justify himself

(although its justification is only partial or problematic).

According to what is said, it is clear that in all those ideas on information in which semantic dimension is considered, its link with knowledge must appear. Normally, a more analytic concept for information is adopted and a more synthetic one for knowledge, as well as a bigger proximity to the object on the part of the information and to the subject on the part of knowledge.

For Dretske "knowledge is belief produced by information", and belief always relates to a background of knowledge. From a naturalistic perspective, in which a casual dependence occurs among the internal states of a living being and external conditions, information for Dretske creates experience (sensory representations) and causes beliefs (cognitive experiences), which underlie the sedimentation of knowledge.

According to Floridi´s semantic approach, *knowledge* is constituted in terms of justifiable *semantic information*, i.e. information constitutes the elements for further inquiry. In its turn, *information* is the result of a *data* modelling process, which –unlike the Dretske's naturalistic assumption– does not necessarily represent the intrinsic nature of the studied system (or is not necessarily directly linked to it by a causal chain), instead, it will depend on the development of the data by knowledge. In turn, the data are conceived as resources and restrictions that allow for the construction of information. Therefore, one can say that Floridi proposes an architectural relationship between knowledge, information and data, where the first one is situated on the summit and the data on the base. At the same time, and as a result of this interrelationship, he replaces the requirement of *truth* of Dretske (who also endorses the situational semantic theory) by a requirement of *truthfulness*, so that instead of searching for a correspondence between the statement and the content of the information, a correspondence is rather being sought between what is reported and the informant.

In the →*UTI, knowledge* is constituted by means of interpreting the *data* (or assigning meaning), which, in turn, is the basis for decision-making that makes up "practical wisdom". In this case, we are talking about different levels of information rather than a dependency relationship, so that information is gradually processed: first, at the syntactic or structural level, then at the semantic or state level, and, finally, at the pragmatic or behavioural level. The information processing is performed by means of interrelationship between the adjacent strata and not in terms of a casual progression (as in Dretske's naturalism).

L

LEVEL or **Aspect** of information

Abstraction ~ [Floridi]

Apobetic ~ [Gitt]

Macro-~ (UTI)

Meso-~ (UTI)

Micro-~ (UTI)

Pragmatic ~

Semantic ~

Statistical ~

Syntactic ~

Library Science and **Special Librarianship** (F. s*ciences des bibliothèques*, *bibliothéconomie*, G. *Bibliotheks-, Dokumentations- wissenschaft,* S. *biblioteconomía,* –Amer.– *bibliotecología*). At the beginning of the 20th century, the term 'information' was frequently linked to *Special Librarianship* in the English speaking world. After a period of time in which this activity had been associated to *Documentation*, in the 1960s it came to emerge with what came to be called **Information Science** (which in some Latin-American countries has been translated into "Ciencia de la Información", which is close to the English meaning). According to Capurro and Hjørland, this was caused by the growing interest in computer applications, the influence of the Shannonian theory and the current information processing paradigm in the cognitive sciences. When it comes to the academic disciplines regarding librarians and documentalists, two clear trends have been distinguished in Library Science: the *general* one, which, in a certain way, is aimed at public libraries and which highlights general education and is widely separated from the knowledge it serves, and the *specialised* one, aimed at specific subjects. However, although this second stand was relatively dominant until the 1970s, from that moment on it came to lose its dominant position as education tended to become more general and inclined towards psychology, subjective idealism and methodological individualism. At the same time, it can be spoken about the emergence of an intermediate way which could be branded as a neutral specialisation (even formal or abstract), the *domain analytic approach* (which, in its turn, is related to hermeneutics, semiotics and social constructivism).

According to Griffith's definition (*Key papers in information science*, 1980), "Information Science is concerned with the generation, collection, organisation, interpretation, storage, retrieval, dissemination, transformation and use of *information*, with particular emphasis on the applications of modern technologies in these areas". The objective of its disciplinary framework is "to create and structure a body of scientific, technological and system knowledge related to information transfer". That is to say, – despite the problematic or contingent link Griffith makes with respect to the used tools– one can say that we are dealing with a science which contains elements that are *theoretical* (except for its specific application) and *applied* (aimed at services and products).

Regarding the conceptualisation of information that is carried out in this field, it could be said that special focus is put on two opposing meanings: 1) the information as an object in documents and 2) its radical subjectivisation, i.e. information as everything "that can be informative to someone".

LOGIC

Fuzzy ~

Modal ~

Situational ~

M

Meaning

Measurement [Mähler]

N

Net or **Network** (of systems) [Maturana, UIT]

Noise

Negentropie [although the concept was introduced by Erwin *Schrödinger* in 1943 the term was first used by Léon *Brillouin* in 1953…]

O

Output [UIT]

P

Bar-Hillel-Carnap Paradox (**BCP**).

Plurivocity *vs* **univocity** [Weizsächer]

Holographical Principle [Proposed by Gerard 't Hooft in 1993 and developed by Leonard Susskind

Q

Qubit (from *quantum bit*)

R

Receptor

Release Mechanism [Karpatschof]

Rightness [Habermas]

Redundancy [→*MTC*]

Repertoire

Reversibility (and Irreversibility)

S

Selection

Self-re-creation [used in the *Unified Theory of Information* as one of the three basic capacities of information systems –the most advanced]: capacity of the **self-re-creating systems** to create the necessary conditions, not only for their reproduction, but also to create themselves according to the objectives that they have established themselves. In their capacity to change the environment for their own settlement, they show an even bigger capacity to adapt than the systems that are merely biotic (→*self-reproducing*) of which they are a part and which involve the most advanced evolutionary stage (or *stage of cultural* →*evolution*).

They can be classed as self-determining in so far as their self-organising capacities offer, under certain circumstances, a set of possibilities, which they can choose themselves. Given the fact that such a choice takes the form of a decision adopted under the condition of freedom of choice, which cannot be reduced, the pragmatic and semantic levels are separated. Consequently, in the stage of social, self-recreating and self-determining systems, the semiotic relationship spreads in its three speech production levels, which can be described in terms of the creation of ideas. Such creation happens in three stages: 1st) the perception of signals from outside the system causes the

appearance of a sign, which is a modification of the system's structure; 2nd) the interpretation of the perceptions by which the system's state is modified and another sign –meaning something– emerges, which is given to the system as its objective; 3th) the evaluation of the interpretations that cause another sign to emerge, by means of which the system, as subject, completes its meaning, considering the object as an initial state to reach the end and affects the behaviour of the system in a way that it can be modified.

The sign, in each of these three levels, is called (in UTI) *data*, *knowledge* and **wisdom** (or **practical wisdom**), respectively, each one corresponding to the field of the perceptive, cognitive and evaluative capacities, which together make up the characteristics of *conscience*, which appears in systems. In each stage, a break in the self-organisation occurs, which is a starting point for another one to occur (or not occur) afterwards.

Self-regulation (or *automatic regulation*) used in systems theory and cybernetics in the sense of *homeostasis* (→*feedback*), that is to say, the capacity of a system to maintain itself in a situation of balance. Automatic regulation is mainly found within the field of electronic systems and control engineering.

Self-reproduction [used in the *Unified Theory of Information* as the intermediate capacity of information systems]: the capacity of **self-reproducing systems,** which do not only change their structure into another one more or less chosen by themselves, but they also insert these modified structures into a wider context, that of making them to help to keep their own existence. Here, a functional structure is not a simple pattern anymore, but a 'thing' that has meaning, and this 'thing' will be called here a symbol, so that the production of signs in this evolutionary stage of living systems changes from creating patterns to creating symbols.

The *self-reproducing* systems are considered an evolutionary stage (called *biotic*) among the →*self-restructuring* and the →*self-recreating* ones, so that they involve a special case of *self-restructuring* systems, as well as a case more general than the *self-recreating* ones, which encompasses them.

As far as the evolution of the semiotic relation is concerned, one can observe here a ramification in which the syntactic level is separated from the semantic-pragmatic one, the first one referring to the *sensations* of the living systems. These sensations consist of self-organised restructurings, evoked by the environmental disruptions and limited by the "offer of sensitive mechanisms" in a recursive process of symbolic production. On the semantic-pragmatic level, actions are developed according to sensations. Given that the living systems act according to what such sensations mean in terms of relevance for survival, we could talk about both meaning and action, although in an indissoluble manner: the syntactic difference means in practice a difference with regard to the objective of the survival, so that the signs now *represent* the aptitude of the system towards the environmental conditions (whereas in the self-restructuring systems one

talks about *reflection*, one could talk now about *representation*).

Self-restructuring [used in the *Unified Theory of Information* as the lowest capacity of information systems] is the most primitive type of *self-organising processes* and in which the most primitive manifestation of signs also occurs. This type of systems is also called *dissipative*, because, in thermodynamic terms, they dissipate the entropy as a sub-product of the work carried out during the restructuration, in which, at the same time that the energy degrades, the system manages to get rid of it. This is necessary for the new structure to be considered a creation of a superior order, instead of a degradation of the system. The structuring process leads to a special and/or temporal pattern.

Understood as information processing, the creation of patterns is the rudimentary way of producing signals, being the pattern the distinction carried out by the system in which the three semiotic relations can be found (→*sign*): 1st) a *syntactic* relation can be observed to the extent that the creation of the pattern is a type of recursive process which builds on the previous pattern and chooses one amongst various possible patterns; 2nd) as far as the incoming energy allows the system to change its pattern, the entrance becomes a signal that makes the new pattern arise, although it does not establish it completely. The state adopted by the system when creating a new pattern can be interpreted as a representation of the entrance, so that it can be said it is a *semantic* relationship. 3th) As long as the new pattern corresponds to the observable behaviour in which the system expresses its activity, the *pragmatic* relation remains also thematised here.

However, the three semiotic relationships coincide with the pattern and, therefore, they are not differentiated yet. It can be said that the pattern *reflects* the conditions of its environment, as the pattern depends on it. Such *reflection* of the environment constitutes a precondition for the appearance of a sphere of influence in which the behaviour of the system launches that of the adjacent ones, so that the appropriate conditions can emerge for the maintenance and improvement of the system, which will be possible in →*self-reproducing* systems.

Semiotic

Sign

Signal

State (sistem) [UIT]

Symbol

T

Tautology

Telematics

THEOREM

Gödel's incompleteness ~s: *1st GIT*) Any effectively generated theory capable of expressing elementary arithmetic cannot be both consistent and complete. In particular, for any consistent, effectively generated formal theory that proves certain basic arithme-

tic truths, there is an arithmetical statement that is true, but not provable in the theory.

2nd GTI) For any formal recursively enumerable (i.e., effectively generated) theory T including basic arithmetical truths and also certain truths about formal provability, T includes a statement of its own consistency if and only if T is inconsistent

Shannon's fundamental ~ of Noiseless Channel

Shannon fundamental ~ of Discret Channel

Turing ~

THEORY

Algorithmic Information ~ (*AIT*)

Complexity ~, also called *Second Order* →*Cybernetics*. It has also been spoken about **Algorithmic** (or **Computational**) **Complexity** to refer the most commonly called →*Algorithmic Information Theory*.

Critical ~

Mathematical ~ of Communication (*MTC*)

Systems ~ (G. *Systemtheorie*) [Cybernetics, Luhman]

Unified ~ of Information (*UTI*) (G. *Vereinheitlichte Theorie der Information,* S. *Teoría Unificada de la Información*.

Truth [Floridi, Habermas]

Truthfulness [Floridi, Habermas]

V

Vacuity [Floridi]

W

Wisdom or **Practical Wisdom** [UIT] →*self-re-creation*.

BIBLIOGRAPHICAL REFERENCES

Critical Reviews:

SEGAL, J., *Le Zéro et le Un. Histoire de la notion scientifique d'information*, Paris: Syllepse, 2003.

CAPURRO, R., HJØRLAND, B., "The Concept of Information", *Annual Review of Information Science and Technology*, Ed. B. Cronin, Vol. 37, 2003, Chapter 8, pp. 343-411.

HOFKIRCHNER, W. (Ed.), *The quest for a unified theory of information. Proceedings of the Second International Conference on the Foundations of Information Science*. Amsterdam: Gordon and Breach, 1999.

FLORIDI, L. "Information" en MITCHAM, C. (ed.), *Encyclopedia of Science, Technology and Ethics,* Macmillan Reference, 2005.

Classical Texts:

a) About the *Mathematical Theory of Communication*:

SHANNON, C. E., "A Mathematical Theory of Communication". *The Bell System Technical Journal*, Vol. 27, pp. 379–423, 623–656, July, October, 1948.

SHANNON, C. y WEAVER, W., *The mathematical theory of communication*. Urbana: The University of Illinois Press, 1949.

WIENER, N., *Cybernetics or communication and control in the animal and the machine*. Cambridge, MA: MIT Press, 1948.

b) About the *Algorithmic Information Theory*:

SOLOMONOFF, R. J., "A formal theory of inductive inference", *Inf. Control*, vol. 7, pp. 1-22 (I part), pp. 224-254 (II part), 1964.

KOLMOGOROV, A. N., "Three approaches to the quantitative definition of 'information'". *Problems of Information Transmission*, vol.1, pp. 1-7, 1965.

CHAITIN, G. J., "On the length of programs for computing finite binary sequences". *Journal of the Association for Computing Machinery*, vol. 13, pp. 547-569, 1966.

—, "On the length of programs for computing finite binary sequences: stadistical considerations", *Journal of the ACM*, vol. 16, pp. 145-159, 1969.

c) About *Information Semantics*

BAR-HILLEL, Y. y CARNAP, R., "Semantic information". *British Journal of Science*, vol.4, pp. 147-157, 1953.

DRETSKE, F.I., *Knowledge and the flow of information*. Cambridge, MA: MIT Press, 1981.

d) About *sociological perspectivas of information* and *information society*:

HABERMAS, J., *Theorie des kommunikativen Handelns*, Suhrkamp, Frankfurt a.M, 1981.

LUHMANN, N., *Soziale Systeme*. Frankfurt am Main: Suhrkamp. 1987.

CASTELLS, M., *The Information Age: Economy, Society and Culture*. (3 volumes). Malden, MA: Blackwell, 1996-1998.

Miscellaneous Focus:

a) *Algorithmic Information Theory*:

CHAITIN, G. J., "Algorithmic Information Theory", en *Encyclopedia of Statistical Sciences*, Vol. 1, New York: Wiley, 1982, pp. 38-41.

CALUDE*, Information and randomness: an algorithmic perspective*, Springer, 1995.

VITÁNYI, P., "Meaningful Information" en *IEEE Transactions on Information Theory*, Vol. 52, Num. 10, pp. 4617-4626, oct 2006.

b) From a *quantum theory* perspective and from *thermodinamics*:

GREEN, H., *Information Theory and Quantum Physics: Physical Foundations for Understanding the Conscious Process*, Springer, 2000.

MAHLER, G., "Quantum Information". En KORNWACHS, K. y JACOBY, K. (Eds.), *Information. New questions to a multidisciplinary concept*. Berlin: Akademie Verlag, pp. 103-118, 1996.

LYRE, H., *Quantentheorie der Information. Zur Naturphilosophie der Theorie der Ur-Alternativen und einer abstrakten Theorie der Information*. Viena: Springer, 1998.

GALINDO TIXAIRE, A., "Quanta e Información" *Revista española de física*, Vol. 14, Nº. 1, pp. 30-47, 2000.

BEKENSTEIN, J. D., "nformation in the Holographic Universe", in *Scientific American*, July, 2003.

c) From the point of view of *biology; cybernetics (system control)* or the *Unified Theory of Information*:

ALVARADO BALLESTER, R., *Comunicación, Información, Evolución Biológica*, Madrid: Instituto de España, 2000.

RÜTING, T., "Jakob von Uexküll — theoretical biology, biocybernetics and biosemiotics". *European Communications in Mathematical and Theoretical Biology*, Vol. 6, pp. 11-16, 2004

HAKEN, H., *Information and Self-Organization. A Macroscopic Approach to Complex Systems*. Springer Verlag, Berlin, 2000 (2nd ed.).

GITT, W., "Information, Science and Biology", *Technical Journal*, Vol. 10, No. 2, pp. 181-187, August 1996.

FENZL, N. y HOFKIRCHNER, W., "Information Processing in Evolutionary Systems. An Outline Conceptual Framework for a Unified Information Theory". En SCHWEITZER, F. (Ed.), *Self-Organization of Complex Structures: From Individual to Collective Dynamics*, London: Gordon and Breach, pp. 59-70, 1997.

HOFKIRCHNER, W. (Ed.), *op. cit.*

VV.AA., *Unified Theory of Information website* (incluye enlaces, textos y referencias a proyectos relativos a la teoría unificada de la información), http://www.uti.at/

CHMIELECKI, A., "What is information?" *The Paideia Archive, Philosophy and Cognitive Science* (disponible en Internet), 20th. World Congress of Philosophy, Boston, EE.UU.: 1998.

d) *Semantic Aproximations*:

FLORIDI, L., *op. cit.*

—, "Semantic Conceptions of Information" en *Stanford Encyclopedia of Philisophy,* Edición electrónica en internet, 2005, http://plato.stanford.edu/entries/information-semantic/

—, "Is Semantic Information Meaningful Data?" en *Philosophy and Phenomenological Research*, Vol. LXX, No. 2, pp. 351-370, March 2005.

—, "Outline of a theory of strongly semantic information", *Minds and Machines*, Vol. 14, pp. 197-221, 2004.

—, "Consciousness, Agents and the Knowledge Game", *Minds and Machines*, Vol. 15, No. 3-4, pp. 415-444, November 2005.

PÉREZ GARCÍA, R., *Información y significado: hacia una teoría semántica de la información* (Tesis dirigida por Ángel Benito). Madrid: Universidad Complutense, 1990.

BARWISE, J., SELIGMAN, J., *Information Flows: The Logic of Distributed Systems*. Cambridge, RU: Cambridge University Press, 1997.

ISRAEL, D., y PERRY, J., "What is information?" En P. HANSON (Ed.), *Information, language and cognition*. Vancouver, Canada: University of British Columbia Press, pp. 1-19, 1990.

d) From the *social sciences*:

BIDÓN-CHANAL, C., "El tratamiento científico de la información", en *Convivium,* Nº 34, pp. 77-92, 1971/II.

ESCARPIT, R., *Teoría de la información y práctica política*, México: Fondo de Cultura Económico, 1983.

BENITO, Á., *Fundamentos de teoría general de la información*. Madrid: Ed. Pirámide, 1982.

LUCAS MARÍN, A., *et al.*, *Sociología de la comunicación*, Madrid, Trotta, 2003.

KARPATSCHOF, B., *Human activity. Contributions to the anthropological sciences from a perspective of activity theory*. InformationR.net, 2007.

d) Regarding *problems related to information concept*:

SFEZ, L., (Dir.), *Dictionaire critique de la communication*, Paris: Press Universitaire de France, 1993.

MOLES, A., ZELTMAN, C. (Dir.), *La comunicación*, Bilbao: Mensajero, 1985.

SEARLE, J. R., *Intencionalidad. Un ensayo en la teoría de la mente*, Madrid: Tecnos, 1992.

ORTEGA, J., *¿Qué es conocimiento?*, Madrid: Alianza, 1984.

CHOMSKY, N., *El conocimiento del lenguaje*, Madrid: Altaya, 1997.

DÍAZ NAFRÍA, J. M., "Tecnologías del Ostracismo o de la pseudocomunicación", *Le Monde Diplomatique edición española,* No. 135, enero 2007.

MATTELART, A., *Historia de la sociedad de la información*. Barcelona: Paidós, 2007.

LÓPEZ PÉREZ, R., "Crítica de la teoría de la información"*, Cinta de Moebio,* No. 3, abril 1998.

BRUNER, J. S., *Acts of Meaning: Four Lectures on Mind and Culture (Jerusalem-Harvard Lectures)*. Harvard University Press, 1992. [*Actos de significado. Más allá de la revolución cognitiva*. Madrid: Alianza, 2006]

MACBRIDE, S. (dir.), *Many Voices, One World: Towards a New, More Just, and More Efficient World Information and Communication Order*, Rowman & Littlefield Publishers, 2003. [*Un solo mundo, voces múltiples. Comunicación e información en nuestro tiempo*. México: Fondo de Cultura Económica, 1988]