ANTHROPOLOGY AND INFOAUTOPOIESIS

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ABSTRACT: A resemanticization of Anthropology, the scientific study of human culture, is needed as, since the mid-twentieth century, we live in the Information Age. An epoch prioritizing the primacy of information, on a par with matter and/or energy. A new anthropological understanding of the impact of information entails sidestepping the influence on society of particular scientific and technological developments, such as those considered in the Anthropology of Cyberculture or Technology. The goal is to discover the fundamental role of information in anthropology, in its origins and development, as well as in its present-day local and global manifestations. *Infoautopoiesis* is at the centre of resolving the fundamental problem of information of how we become what we become. This reconceptualization of information, making it accessible to our daily experience, allows its naturalization. Requiring, in our unavoidable homeorhetic recursive interactions with our environment, the finding of individuated meaning in all that surrounds us and of which we are a part. Necessitating all organisms-in-their-environment to labour to satisfy their physiological and relational needs. Elucidating how their interactions with their environment, from an anthropological perspective, are constitutive of information self-creation, information exchange, information relations and life.

KEYWORDS: Information; infoautopoiesis; Gregory Bateson; anthropology; Culture; Nature

1 INTRODUCTION

Anthropology has a long and complicated history[1] that is concerned with the scientific study of human culture. Not a small task given that culture may be defined as "… a complex instrumental system of means of all kinds (materials,

[1] A. L. Kroeber and Kluckhohn Clyde, *Culture: A Critical Review of Concepts and Definitions*, Cambridge, Massachusetts, Peabody Museum Press, 1952, p. 7.

habits, desires, ideas and institutions) progressively created by man and used by him in his individual and social struggle with the environment, for the satisfaction of his growing needs."[2] Or, in a similar vein "… culture is the word we give to the plurality and contradictions of meanings, feelings and practices that circulate in the world and, crucially, to their orchestration."[3] This includes the notion of "intermeshed transculturations" and "complex transmutations of culture" that puts in the right perspective societies that exist at the crossroads of history.[4]

Several elements implicit is these definitions of culture need highlighting to emphasize the intricacy of its constituent elements. The most important is the recognition that each human being, as an individual and in society, coexists with her environment in order to satisfy her needs, where the human social being is the central element in the progressive, systematic, and integral creation of culture. The individual in her social environment with all relevant ramifications is at the centre in the development and impact of culture. This includes the rules of a social nature to achieve the integration of the group. Culture is cooperation, in its production and as its product.[5]

Below, we present a brief compilation of relevant manifestations that define culture in its various dimensions. Although in a given social group there is a universal culture, each individual cultivates his own version because of his individual history, partially shared with his social group. The individuation of culture is a fact with the consequent diversity of expressions, given in space and time. Cultural development is constant, sometimes slow with little variability because it requires widespread acceptance; sometimes brisk with constant enrichment, brought about by favourable circumstances. Communication plays an important role in cultural development, relying on its infinite manifestations and ways to promote change to influence more individuals to develop a common purpose. Language, writing, printing, and communication have played a determining role in cultural development over time and space, increasingly influencing the universalization of culture.

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[2] Fernando Ortiz, 'El concepto de cultura', *Catauro – Revista Cubana de Antropología*, vol. 12, no. 23, 2011, pp. 127-42, p. 134.
[3] Ben Highmore, *Culture*, 1st ed., London and New York, Routledge - Taylor & Francis Group, 2016, p. viii.
[4] Fernando Ortiz, *Cuban Counterpoint: Tobacco and Sugar*, New York, A. A. Knoff, 1947, p. 127.
[5] Ortiz, 'El concepto de cultura', p. 127.

"Cultures vary. Culture is essentially dynamic."[6] The endless sequence of cultural expressions that are shared in a multiplicity of formats and forms requires adapting to their rhythm so as not to be left behind. "Culture is progressive" with the aim of always seeking to "survive more and better."[7] Although it is not clear in all instances the unexpected way in which culture advances, the truth is that it advances. It is a constant learning and teaching that is based initially on oral culture and now on written culture, in its analogue and digital versions.

"All culture is factual; not natural or genetically inherited by man, but artificial, created by him and socially transmitted by a system that is also part of that creation."[8] Culture is an invention that responds to the needs of a living-being-in-its-environment. Everything that surrounds us in the artificial environment of our own making is our creation. We need not overlook our most impressive creations in the macroscopic world which brought about the digital age, nor our most subtle creations in the nanoscopic world that have brought about biological breakthroughs which impact our daily lives. The changes we have brought about, in space and time, impact our customs, dress, foods, languages, leisure activities, sports, our ideals, and our dreams. Changes are also reflected in our ever-evolving institutions, which are created for reasons corresponding to our ever-developing needs, whether expressed or not.

In short, "Culture is a structure of the relationship between the individual and the environment"[9] that has the ability to grow to the apparent complexity that we observe today. Without much imagination we can project ourselves towards a future of challenges and opportunities that we have no inkling as to how they will be resolved. These include global warming, the COVID-19 pandemic - a possible harbinger of new pandemics- and the recent wars in Ukraine and the Gaza Strip, the advent of ChatGPT and the potential benefits and harm that might ensue, among many other circumstances. Within this context it is possible to envision the inclusion of "How other kinds of beings see us matters. That other kinds of beings see us changes things."[10] Additionally, to envision "an integrated

[6] Ibid., p. 129.
[7] Ibid.
[8] Ibid., p. 136.
[9] Ibid., p. 141.
[10] Eduardo Kohn, *How Forests Think - Toward an Anthropology Beyond the Human*, 1 ed., University of California Press, 2013, p. 1.

anthropology combined with a niche-construction approach (that) can be beneficial."[11,12] And even the arrival of Cyberculture.[13,14]

Culture and information share the quality of being difficult to define. "'Culture' is said to be one of the two or three most complex words in the English language, and the term which is sometimes considered to be its opposite – nature – is commonly awarded the accolade of being the most complex of all. Yet though it is fashionable these days to see nature as a derivative of culture, culture, etymologically speaking, is a concept derived from nature. One of its original meanings is 'husbandry', or the tending of natural growth."[15]

The long history of information does not seem to dissipate the patina of mystery and elusiveness associated with the word information.[16,17,18,19,20,21,22,23,24,25]

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[11] Agustín Fuentes, 'Integrative Anthropology and the Human Niche: Toward a Contemporary Approach to Human Evolution', *American Anthropologist*, vol. 117, no. 2, 2015, pp. 302-15, p. 309.

[12] Agustin Fuentes, 'The Extended Evolutionary Synthesis, Ethnography, and the Human Niche: Toward an Integrated Anthropology', *Current Anthropology*, vol. 57, no. S13, 2016, pp. S13-S26.

[13] Arturo Escobar, 'Anthropology and the future: New technologies and the reinvention of culture', *Futures*, vol. 27, no. 4, 1995, pp. 409-21.

[14] Arturo Escobar, *et al.*, 'Welcome to Cyberia: Notes on the Anthropology of Cyberculture [and Comments and Reply]', *Current Anthropology*, vol. 35, no. 3, 1994, pp. 211-31.

[15] Terry Eagleton, *The Idea of Culture*, Oxford, Blackwell Publishing, 2000, p. 7.

[16] Rafael Capurro, Peter Fleissner and Wolfgang Hofkirchner, 'Is a unified theory of information feasible? A trialogue', *Informatik Forum*, vol. 1, 1997, pp. 36-45.

[17] Rafael Capurro and Birger Hjørland, 'The concept of information', *Annual Review of Information Science and Technology*, vol. 37, no. 1, 2003, pp. 343-411.

[18] Rafael Capurro, 'Past, present, and future of the concept of information', *tripleC*, vol. 7, no. 2, 2009, pp. 125-41.

[19] Wolfgang Hofkirchner, 'How to achieve a unified theory of information', in José María Díaz Nafría and Francisco Salto Alemany, *What is Information? Proceedings of the First International Meeting of Experts in Information, November 6th-8th*, Leon, Spain, Universidad de León, 2008.

[20] Wolfgang Hofkirchner, 'Chapter 1: The Dawn of a Science of Information', in Wolfgang Hofkirchner (ed.), *Emergent Information — A Unified Theory of Information Framework*, Singapore, World Scientific Publishing Co. Pte. Ltd., 2013a, pp. 3-34.

[21] Wolfgang Hofkirchner, 'Emergent Information. When a Difference Makes a Difference…', *tripleC*, vol. 11, no. 1, 2013b, pp. 6-12.

[22] Robert K. Logan, 'What Is Information?: Why Is It Relativistic and What Is Its Relationship to Materiality, Meaning and Organization', *Information*, vol. 3, no. 1, 2012, pp. 68-91.

[23] James Gleick, *The Information - A History, A Theory, A Flood*, New York, NY, Pantheon Books, a division of Random House, Inc., 2011.

[24] Howard H. Pattee, 'Epistemic, Evolutionary, and Physical Conditions for Biological Information', *Biosemiotics*, vol. 6, no. 1, 2013, pp. 9-31.

[25] Tim Ingold, 'Evolution without Inheritance: Steps to an Ecology of Learning', *Current Anthropology*, vol. 63, no. S25, 2022, pp. S32-S55.

Symptomatic of this is the prominent quote by Norbert Wiener stating that, "Information is information, not matter or energy. No materialism, which does not admit this, can survive at the present day."[26] This phrase achieves two things: for one, it defines information in terms of itself perhaps with the intent of giving information prominence; for another, it postulates information on the same fundamental and objective level as matter and/or energy. This baseless postulate has led to its wide acceptance in numerous influential works and precludes the search for alternative definitions that are more amenable to understanding how information originates and relates to our daily experience.[27,28,29,30,31,32,33,34,35]

The goal in this work is to uncover how culture, nature and information relate to each other. To expose the elements that allow an analysis of the individual-in-its-environment and the role of information in the development of culture and the study of anthropology. This approach sidesteps the baseless postulate of pre-existing information either in the environment or as a fundamental element in the Universe. This approach avoids putting technology and its development as a crucial element influencing cultural development. Rather, it promotes the view of technology as an inevitable consequence of the embodiment of information in our tools, machines, and other human creations. For this purpose, this paper is divided into six sections. First, the concept of information is naturalized so as to

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[26] Norbert Wiener, Cybernetics: or Control and Communication in the Animal and the Machine, New York, John Wiley, 1948, p. 132.

[27] John Archibald Wheeler, 'Sakharov revisited: "It from Bit"', in M Man'ko, *Proceedings of the First International A D Sakharov Memorial Conference on Physics, May 27-31*, Moscow, USSR, Nova Science Publishers, Commack, NY, 1991.

[28] Tom Stonier, *Information and Meaning - An Evolutionary Perspective*, Berlin Heidelberg New York, Springer-Verlag, 1997.

[29] Hubert P. Yockey, *Information theory, evolution, and the origin of life*, Cambridge, UK, Cambridge University press, 2005.

[30] Seth Lloyd, *Programming the Universe*, New York, NY, Alfred A. Knopf, 2006.

[31] Stuart A. Umpleby, 'Physical Relationships among Matter, Energy and Information', *Systems Research and Behavioral Science*, vol. 24, no. 3, 2007, pp. 369-72.

[32] Mark Burgin, *Theory of Information - Fundamentality, Diversity and Unification*, Singapore, World Scientific Publishing Co. Pte. Ltd., 2010.

[33] Luciano Floridi, *Information: A Very Short Introduction*, Oxford University Press, 2010.

[34] Vlatko Vedral, *Decoding Reality - The Universe as Quantum Information*, Oxford, UK, Oxford University Press, 2010.

[35] Cesar A. Hidalgo, Why information grows : the evolution of order, from atoms to economies, New York, Basic Books, 2015.

apply it to all human actions. Second, infoautopoiesis (information self-creation/production) is introduced by considering the fundamental problem of the science of information presented in the context of the individual-in-its-environment. Third, how the infoautopoietic homeorhetic human-organism-in-its-environment influences the communication process including considerations of semantic and syntactic information. Fourth, discussion of infoautopoiesis and its potential impact on anthropology. Last, a summary and some conclusions are presented.

2 THE NATURALIZATION OF INFORMATION

There is a surprising inability to define what information is, either because of its variety or because of the myriad criteria used to categorize it.[36,37,38,39,40] The following quote is an example,

> My skepticism about a definitive analysis of information acknowledges the infamous versatility of information. The notion of information has been taken to characterize a measure of physical organization (or decrease in entropy), a pattern of communication between source and receiver, a form of control and feedback, the probability of a message being transmitted over a communication channel, the content of a cognitive state, the meaning of a linguistic form, or the reduction of an uncertainty. These concepts of information are defined in various theories such as physics, thermodynamics, communication theory, cybernetics, statistical information theory, psychology, inductive logic, and so on. There seems to be no unique idea of information upon which these various concepts converge and hence no proprietary theory of information. [41]

The approach to information presented in this work permits, what Bogdan does not see as possible, the convergence toward a unique idea of information.

If we are to include the concept of information in the field of anthropology,

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[36] Capurro and Hjørland, 'The concept of information'.

[37] David Bawden and Lyn Robinson, *Introduction to Information Science*, 2nd ed., London, Facet Publishing, 2022.

[38] Mark Burgin and Wolfgang Hofkirchner (eds.), *Information Studies and the Quest for Transdisciplinarity - Unity Through Diversity*, New Jersey, World Scientific Publishing Company, 2017.

[39] Claude E. Shannon, N. J. A. Sloane and Aaron D. Wyner, 'Claude Elwood Shannon: Collected Papers', 1993.

[40] Ingold, 'Evolution without Inheritance: Steps to an Ecology of Learning'.

[41] Radu J. Bogdan, Grounds for Cognition: How Goal-guided Behavior Shapes the Mind (1st ed.), Psychology Press, 1994, p. 53.

we need to naturalize the definition of information to make it applicable to our daily experience. A fruitful beginning relies on examining the etymology of the word information. We find its root originates from the Latin *informatio*, which arises from the verb *informare* (to inform) in the sense of giving shape to something material, as well as from the act of communicating knowledge to another person.[42,43,44,45,46] A common factor in these two notions of information is the implied dynamic outlook involved in shaping matter as well as the minds of other similar individuals. In an analogous dynamic vein, Gregory Bateson defines information as "a difference which makes a difference."[47] If both of these conceptions of information are examined together they define the self-referential, interactive, recursive, evolving, and never-ending virtuous dynamic spiral of sensation-information-action by living-beings-in-their-environment. Living beings, in their continuous spatial and temporal interactions with the environment through their sensory organs, assess information as "difference(s) which make a difference." This leads to actions that reflect their capacity to relate to their environment by acting on matter in nature and on their fellow beings, motivated by the necessity to satisfy physiological and/or relational needs. Bateson illustrated this dynamism by describing the actions of a lumberjack with a tree:

> Consider a tree and a man and an axe. We observe that the axe flies through the air and makes certain sorts of gashes in a pre-existing cut in the side of the tree. If now we want to explain this set of phenomena, we shall be concerned with differences in the cut face of the free, differences in the retina of the man, differences in his central nervous system, differences in his efferent neural messages, differences in the behavior of his muscles, differences in how the axe flies, to the differences which the axe then makes on the face of the tree. Our explanation (for

[42] Capurro and Hjørland, 'The concept of information'.

[43] Capurro, 'Past, present, and future of the concept of information'.

[44] José María Díaz Nafría, 'What is information? A multidimensional concern', *tripleC*, vol. 8, no. 1, 2010, pp. 77-108.

[45] Aurelio Francos Lauredo and Purificación Moscoso Castro, 'Ciencias de la información e investigación antropológica: valor del documento oral en los estudios de identidad cultural', *Catauro – Revista Cubana de Antropología (in Review)*, vol. 6, no. 10, 2004, pp. 4-18.

[46] John Durham Peters, 'Information: Notes Toward a Critical History', *Journal of Communication Inquiry*, vol. 12, 1988, pp. 9–23.

[47] Gregory Bateson, Steps to an ecology of mind; collected essays in anthropology, psychiatry, evolution, and epistemology, New York, Ballantine Books, 1978, p. 453.

> certain purposes) will go round and round that circuit. In principle, if you want to explain or understand anything in human behavior, you are always dealing with total circuits, completed circuits. This is the elementary cybernetic thought. [48]

This description reflects Bateson's cybernetic perspective of the world, where identifying differences/information by a living being is key to successful interactions in the environment. The self-referencing, interactive, and recursive actions of the lumberjack help to achieve the collection of wood to meet the needs at hand. The word cybernetic is not used in the homeostatic sense of the word, i.e., leading to a return to a state of equilibrium. It is used in a homeorhetic sense since the activities of the woodcutter tend to converge towards a dynamic trajectory. The woodcutter's activity is a moving target during the activity of chopping firewood, due to the continuous sensation-information assessment of the task at hand leading to action. The repetitive nature of the activity leads to continuous improvement of the sensation-information-action cycle by the lumberjack and consequent increases in efficiency.

As part of this conceptualization of information, Bateson notes 'that the word "idea," in its most elementary sense, is synonymous with "difference."'[49] In other words, every interaction with our environment leads to noticing differences, i.e., to the conscious and/or unconscious generation of ideas. For Bateson the words information, differences and ideas are synonymous when engaged in the self-referential, interactive, recursive, evolving, and never-ending spiral of sensation-information-action.

All multifarious expressions of life share the ability to interact with their environment to satisfy their physiological and/or relational needs and make effective their unavoidable metabolic connection with the environment. This may be conceptualized as resolving the mind-body problem or how organisms coordinate the world and their images of the world to create an environment in their own self-image, to make it amenable for their development. A more nuanced account states, "Adequate explanation in any cognitive science must at some stage address the matter-mind problem, that is, the problem of symbol

[48] Ibid., pp. 458-9.
[49] Ibid., p. 453.

reference or how the world and our images of the world are coordinated."[50] In other words, how do human beings internalize their sensory perceptions of the environment around them in a correlated manner to derive meaning from their perceptions, so as to act effectively in the world? This is the problem whose outline is reflected in these lines and that needs resolution.

The sensation-information-action triad brings to the fore the necessary and unavoidable connection of human beings with nature. In other words, information mediates the detected sensorial signals from the environment and the actions/labour by humans on said environment. Indeed, the sensation-information-action triad defines the metabolic connection of human beings with nature, elaborated on by Marx,

> Labour, then, as the creator of use-values, as useful labour, is a condition of human existence which is independent of all forms of society; it is an eternal natural necessity which mediates the metabolism between man and nature, and therefore human life itself. [51]

It is in this process of the work of each human being, in an individuated form, that humanity develops its culture, necessarily subject to the society and time period in which that human being operates. That is to say, the sensation-information-action/labour process is the fundamental factor for the development of culture in society. Another way of arguing this fundamental point is to observe that 'culture is ordinary,'[52] a reflection that states that culture is a creation of each one of us and that it is inevitably voluntarily or involuntarily shared. It is the feeling of harm or help by expressions of others that do not agree with our values, but that exist and must be considered.

That is, "... however varied the useful kinds of labour, or productive activities, it is a physiological fact that they are functions of the human organism, and that each such function, whatever may be its nature or its form, is essentially the expenditure of human brain, nerves, muscles and sense organs."[53] Therefore,

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[50] Howard H. Pattee, 'Cell Psychology: An Evolutionary Approach to the Symbol-Matter Problem', *Cognition and Brain Theory*, vol. 5, no. 4, 1982, pp. 325-41, p. 325.

[51] Karl Marx, Ernest Mandel and Ben Fowkes, *Capital: A Critique of Political Economy*, London, Penguin Books Limited, 1976, p. 133.

[52] Raymond Williams, 'Culture is Ordinary', in Ben Highmore (ed.), *The Everyday Life Reader*, London and New York, Routledge, 2002, pp. 91-100, p. 92.

[53] Marx, Mandel and Fowkes, Capital: A Critique of Political Economy, p. 164.

these material-informational efforts have a direct connection with the functioning of the human body in the sensation-information-action/labour process.

In other words, labour and information are immanent.[54,55,56] Moreover, since culture arises from man's eternal action in the face of nature, the intimate intertwining of labour, information and culture is undeniable. Therefore, all products of human labour embody information that reflects their culture. This aspect of the products of human labour generally goes unnoticed. And perhaps we can say that anthropology is the science that studies culture as the result of the embodiment of information in matter due to human labour resulting from a sensation-information-action/labour process. One result of this observation is that implements manufactured by humans are easily recognizable regardless of their anthropological age;[57] as are the signs of butchery on the bones of animals that are more than 2 million years old.[58,59] And so it is with all the artifacts that humans create and that allow us to originate this artificial world that surrounds us.[60,61]

3 INFOAUTOPOIESIS

> New ideas are difficult just because they are new. Repetition has somehow plastered over the gaps and inconsistencies in the old ones, and the new cannot penetrate.
>
> Joan Robinson (Economist)

[54] Jaime F. Cárdenas-García, Bruno Soria de Mesa and Diego Romero Castro, 'The Information Process and the Labour Process in the Information Age', *tripleC*, vol. 15, no. 2, 2017, pp. 663-85.
[55] Jaime F. Cárdenas-García, Bruno Soria de Mesa and Diego Romero Castro, 'Understanding Globalized Digital Labor in the Information Age', *Perspectives on Global Development and Technology*, vol. 18, no. 3, 2019, pp. 308–26.
[56] Jaime F. Cárdenas-García, 'Labour Productivity: The Link Between Use-Value, Value, and Information', *Cosmos and History: The Journal of Natural and Social Philosophy*, vol. 19, no. 1, 2023b, pp. 327-55.
[57] Maxime Aubert, *et al.*, 'Earliest hunting scene in prehistoric art', *Nature*, 2019.
[58] Ann Gibbons, 'Lucy's Toolkit? Old Bones May Show Earliest Evidence of Tool Use', *Science*, vol. 329, no. 5993, 2010, pp. 738-9.
[59] Mohamed Sahnouni, *et al.*, '1.9-million- and 2.4-million-year-old artifacts and stone tool–cutmarked bones from Ain Boucherit, Algeria'ibid., vol. 362, no. 6420, 2018, pp. 1297-301.
[60] Jaime F. Cárdenas-García, 'The Central Dogma of Information', *Information*, vol. 13, no. 8, 2022a, pp. 365.
[61] Jaime F. Cárdenas-García, 'Info-Autopoiesis and the Limits of Artificial General Intelligence', *Computers*, vol. 12, no. 5, 2023a, pp. 102.

> The difficulty lies not so much in developing new ideas as in escaping from the old ones.
>
> John Maynard Keynes (Economist)

Although we have identified the immanence of information, labour, and culture, it is necessary to not only detail how the generation of information occurs, but also to identify the different types of information that exist and the function they fulfil.

3.1 The fundamental problem of information

In an attempt to demystify the generation of information, it is useful to pose the Fundamental Problem of Information Science,[62] i.e., how do human beings develop, in a self-referential process, from a state in which information for the organism-in-its-environment is almost non-existent to a state in which the organism not only recognizes the existence of the environment, but also sees itself as part of the organism-in-its-environment system and is able not only to engage with and navigate through it in a self-referential way, but even to transform it in its own image? This question serves to affirm the individuated centrality of the human organism in the information process and to emphasize the social nature of human relationships in helping us achieve the essence of who we are as living beings.

3.2 The organism-in-its-environment

Figure 1 shows a representation of an organism-in-its-environment which we use to explain the resulting self-referential/interactive/recursive process of sensation-information-action. Two distinctive circuits may be identified: one internal and the other external, where black arrows show the flows relevant to the illustrated dynamics. The internal circuit within the light blue INFOAUTOPOIESIS (INFO = information; AUTO = self; POIESIS = creation/production) box is the fundamental element that implements Gregory Bateson's cybernetic definition of information as "a difference which makes a difference".

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[62] Jaime F. Cárdenas-García and Timothy Ireland, 'The Fundamental Problem of the Science of Information', *Biosemiotics*, vol. 12, no. 2, 2019, pp. 213-44.

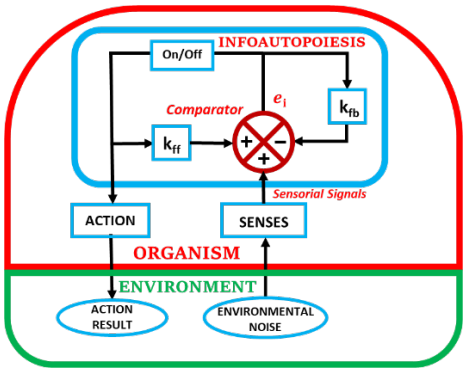

FIGURE 1 – THE ORGANISM-IN-ITS-ENVIRONMENT

We will not be presenting in detail what occurs within the light blue INFOAUTOPOIESIS box which may be found elsewhere.[63] The external circuit shows how the organism interacts with its ENVIRONMENT in a self-referential/interactive/recursive way, in consonance with the internal circuit. The flows into the external circuit start from the ENVIRONMENTAL NOISE, or environmental white noise that has been a constant since the beginning of life, are transduced in the SENSES to become "Sensorial Signals" which are admitted and processed by the organism in the INFOAUTOPOIESIS box. The "Sensorial Signals" are **not** information from the environment, but rather the result of the organism having the capability to distinguish, from all of the ENVIRONMENTAL NOISE, signals relevant to its primary motivation of satisfaction of its physiological and/or relational needs. This is akin to being able to discern the noise signals relevant to a conversation in a noisy room. The "Sensory Signals" are processed in the INFOAUTOPOIESIS blue box to self-produce information, which corresponds to the discernment of meaning from the previously distinguished noise signals of the conversation. In short the INFOAUTOPOIESIS blue box generates semantic information which is internal to the individual. The *On/Off* box shown in the diagram represents the ability of the organism to respond to the accumulation of semantic information until a threshold is reached. Surpassing this threshold results in an ACTION which the organism exerts on its environment and its effect is shown as the ACTION

[63] Mark Burgin and Jaime F. Cárdenas-García, 'A Dialogue Concerning the Essence and Role of Information in the World System', *Information*, vol. 11, no. 9, 2020, pp. 406.

RESULT in the environment. In other words, a homeorhetic ACTION occurs depending on the learning of the human organism based on the "Sensory Signals" and the satisfaction of its physiological and/or social needs, defined by the self-referential needs of the organism. The resulting homeorhetic ACTION may be likened to an organized response by the organism, which can characterize as externalized syntactic information in the form of an ACTION RESULT. This learning process allows the organism to achieve greater efficiency in spatially/temporally relating to its environment by the accumulated internalized semantic information to the corresponding syntactic information which is then externalized as needed.

Recent research illustrates this type of behaviour, where partially dehydrated cells of bacterial spores Bacillius subtitilis have the ability to analyse their environment, despite being physiologically dead for years in a lethargic state, to survive unfavourable environmental conditions. Despite their lethargic state, they continue to generate information from short-lived environmental signals, leaving their dormant condition after accumulating a certain number of signals that become information through infoautopoiesis to confirm to them that they can now become active again and return to life. This is precisely what we want to represent as occurring within the INFOAUTOPOIESIS block of Figure 1.[64,65] The authors of this cited research do not distinguish between environmental noise signals and information. We want to emphasize that there is no information in the environment. Rather, there is only noise in the environment which each organism then transforms to information motivated by satisfaction of its physiological and/or relational needs.

The "Sensorial Signals" identified in Figure 1 result from the sensory interaction of the organism with its environment and the ENVIRONMENTAL NOISE or white noise that impacts the SENSES. When we refer to SENSES, we are not only talking about the five most common senses: touch, sight, smell, hearing, and taste; but also that these SENSES have millions of sensory elements throughout our body. It should be noted that each sensory element acts in a commensurable way according to the specificity of its sensory capacity. For

[64] Kaito Kikuchi, *et al.*, 'Electrochemical potential enables dormant spores to integrate environmental signals', *Science*, vol. 378, no. 6615, 2022, pp. 43-9.
[65] Jonathan Lombardino and Briana M. Burton, 'An electric alarm clock for spores'ibid., pp. 25-6.

example, if you measure temperature, that measurement is made only with that consideration. ENVIRONMENTAL NOISE has to be of sufficient intensity and duration, apart from being of interest to the organism to become a "Sensorial Signal." The motivation that an organism has to recognize some characteristic of white noise is the satisfaction of its physiological and/or social needs. For example, an infant in its gestation phase outside the womb seeks, in particular, its mother's nipple for feeding. That does not necessarily mean that she realizes that doing so means eating, even if she manages to satisfy her hunger.

In short, the internal and external circuits described above define an asymmetrical relationship between the organism and its environment. The ENVIRONMENTAL NOISE that impacts the sensory organs of the organism is not a reflection of the organism's actions in the environment, although they are related. Our sensory organs (touch, hearing, sight, smell, and taste) are the only window that allow us to act on our environment in order to be successful in satisfying our physiological and/or relational needs. This means that there is no information in the environment and that we do not have sensory organs that identify environmental information. All this contradicts the postulate of many scientists who consider that there is information in the environment.[66,67,68,69,70,71,72,73,74]

[66] Burgin, Theory of Information - Fundamentality, Diversity and Unification.
[67] Floridi, Information: A Very Short Introduction.
[68] Hidalgo, Why information grows : the evolution of order, from atoms to economies.
[69] Lloyd, Programming the Universe.
[70] Stonier, Information and Meaning - An Evolutionary Perspective.
[71] Umpleby, 'Physical Relationships among Matter, Energy and Information'.
[72] Wheeler, 'Sakharov revisited: "It from Bit"'.
[73] Wiener, Cybernetics: or Control and Communication in the Animal and the Machine.
[74] Yockey, Information theory, evolution, and the origin of life.

3.3 Shannon's communication theory

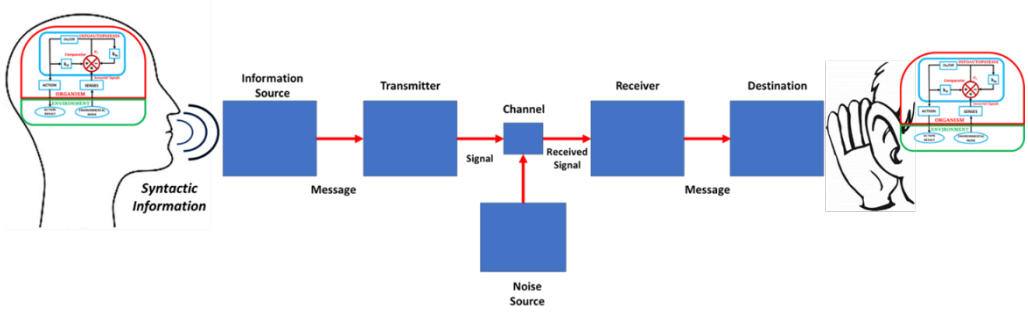

FIGURE 2 – THE COMMUNICATION PROCESS [ADAPTED FROM SHANNON[75]]

Figure 2 shows at the centre of the figure a block diagram of the of the general communication system underlying the Mathematical Theory of Communication, central to the establishment of 'Information Theory' as a discipline. The Information Source may be likened to a microphone into which a message is spoken to start the communication process. The Transmitter is an encoding device that makes the electrical Signal generated by the microphone amenable to transmission over a wired or wireless Channel. The Channel is subject to accumulation of Noise from multiple Noise Sources. The Receiver is a decoding device that reconstructs the original message from the Signal. Finally, the Destination is the speaker that blares out the arriving Message.

Shannon defines the fundamental problem of communication as 'that of reproducing at one point either exactly or approximately a message selected at another point.'[76] This engineering analysis was devised to understand and solve the problem of communication, emphasizing the syntactical aspects of communication, i.e., the ordering of the transmitted messages according to the rules of syntax or syntactics.

If we are to naturalize the process of communication, we might ask if there are missing elements that would merit inclusion for a more comprehensive

[75] Claude E. Shannon, 'A Mathematical Theory of Communication', *The Bell System Technical Journal*, vol. 27, 1948, pp. 379–423, 623–56, p. 379.
[76] Ibid.

analysis. For example, how does the sender of the message at the left end of Figure 2 produce the message that is to be coded for transmission? What is the historical and technical process that allows humans to develop the technology, design, build and use the apparatus that allows communication to take place? More fundamentally, how do humans come to be in a position not only to produce advanced technological developments, but to be able to express themselves to take advantage of their use? Phylogenetically, it is not too long ago that we were living a hand-to-mouth existence where communication was at best by signs and/or direct oral communication. Ontogenetically, we develop from a state in which we can hardly communicate to a state in which oral communication is second nature to us. These questions seem relevant if we are to understand information from a more general perspective. Not having ready answers to these questions suggests that we may suffer from alienation, or an inability to recognize our handiwork in the products of our labour. It is easy to forget that our handiwork created the described communication system that we are describing. Further, there is a human being at the left-end and right-end of the communication system in Figure 2 in whose head we have inserted the organism-in-its-environment illustration of Figure 1. Recall that within the INFOAUTOPOIETIC blue box semantic information is generated, while the resulting ACTION and related ACTION RESULT encompass syntactic information. Thus, the human being at the left-end in generating a message, as the result of an internal or endogenous process of creation of semantic information or information that has meaning for her, codes it as external or exogenous syntactic information in the form of speech. The communication apparatus subsequently digitally codes the message as syntactic information and sends it to the human being at the right-end. After the digitized message acquires noise in the channel, it is denoised and decoded in the receiver to become synthesized speech, which reaches the ears of the human being at the right-end. That individual must then decode the synthesized syntactic speech and decode/interpret the message based on prior experience and knowledge. This process leads to recognized syntactic information and interpretation as semantic or meaningful information for the recipient. The same message might have different meanings to different individuals.

In this process of communication we seem to suffer from fetishism, or an

attribution of inherent value, or powers, to the messages that we code and decode. We seem to have the power to effortlessly speak into a communication system and then listen to a response and effortlessly decode what we hear. The postulate that information is a fundamental quantity of the Universe in addition to matter/energy[77,78,79,80] appears to be true since the information in coding and decoding messages is effortless and readily accessible. No explanation needs to be given as to why we might be able to code a message at the left end of Figure 2, and then understand the decoded message that we become privy to after receiving it at the right end of Figure 2.

3.4 Semantic and Syntactic information

In Figure 2 above, we identify the language being spoken by the individual on the left-side as syntactic information, which is the result of the accumulated internalized semantic information which the individual chooses to externalize. All expressed syntactic information does not imply that there is meaning attached to it. Meaning is the result of interpretation of a syntactic construction by an individual that cares to interpret the syntactic expression. In this particular case, the syntactic information externalization that takes place is in the form of spoken language which has a particular syntax depending on the spoken language. It could easily be written syntax if a message is texted on a mobile phone; an artistic expression such as a painting or sculpture; and, even a manufactured product using machines (another syntactic creation) that has utility for a user, such as eating utensils, plates, and cups. Conceptually, syntactic information can be any organized creation that a human being can conceive and realize by her ability to labour. So we are back to where we started in our naturalization of information where the etymological and Bateson definitions of information allow us to describe our interactions with nature as a creative cycle of sensation-information-action.

In summary, infoautopoiesis results in the generation of semantic (internal or endogenous) and syntactic (external or exogenous) information relevant to

[77] Stonier, Information and Meaning - An Evolutionary Perspective.
[78] Donald M. MacKay, *Information, Mechanism and Meaning*, Cambridge, MA, MIT Press, 1969.
[79] Fred I. Dretske, *Knowledge and The Flow of Information*, Cambridge, MA, The MIT Press, 1981.
[80] Luciano Floridi, *The philosophy of information*, Oxford ; New York, Oxford University Press, 2011.

humans in their environment. Internal or semantic information generation is motivated by the individuated satisfaction of physiological (internal and external) and relational needs, where sensorial precepts play an important role and make the external environment meaningful. One characteristic of internal information is its inaccessibility, which may be remedied if an individual is willing to share its contents through external expressions using language, gestures, pictographs, musical instruments, sculptures, writing, computer coding, etc., which is syntactic in nature and corresponds to Shannon information. This means that Shannon/syntactic information is a metaphor for everything that is produced by all living beings. In the case of human beings, this includes all our artificial creations in the arts and sciences and all human artifacts which surround us.

In this regard, recent research[81,82,83,84,85] shows that,

> Humanity has reached a new milestone in its dominance of the planet: human-made objects may now outweigh all of the living beings on Earth.
>
> Roads, houses, shopping malls, fishing vessels, printer paper, coffee mugs, smartphones, and all the other infrastructure of daily life now weigh in at approximately 1.1 trillion metric tons—equal to the combined dry weight of all plants, animals, fungi, bacteria, archaea, and protists on the planet. The creation of this human-made mass has rapidly accelerated over the past 120 years: Artificial objects have gone from just three percent of the world's biomass in 1900 to on par with it today. In addition, the amount of new stuff being produced every week is equivalent to the average body weight of all 7.7 billion people." [86]

The implication is that there is no information in the environment or in the Universe independent of humans.

To gain a measure of what we mean when we refer to syntactic elements in nature, we quote Pattee when he states, "For my argument here, I will mean by matter and energy those aspects of our experience that are normally associated

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[81] Emily Elhacham, *et al.*, 'Global human-made mass exceeds all living biomass', *Nature*, vol. 588, no. 7838, 2020, pp. 442-4.

[82] Stephanie Pappas, 'Human-Made Stuff Now Outweighs All Life on Earth', *Scientific American*, December 9, 2020.

[83] A. Thompson, 'Taking Stock of Life'ibid., vol. 319, no. 2, 2018, pp. 16.

[84] Lior Greenspoon, *et al.*, 'The global biomass of wild mammals', *Proceedings of the National Academy of Sciences*, vol. 120, no. 10, 2023, pp. e2204892120.

[85] Agustín Fuentes, 'Distinctively human? Meaning-making and world shaping as core processes of the human niche', *Zygon®*, vol. 58, no. 2, 2023, pp. 425-42.

[86] Pappas, 'Human-Made Stuff Now Outweighs All Life on Earth'.

with physical laws."[87] In other words, when we observe nature and apply science and the scientific method to make sense of what we observe, we build an understanding that is based on our syntactic conceptualizations. We observe, experiment, and theorize using our syntactic creations in fields that include mathematics, physics, chemistry, biology and even anthropology to gain access to the world that surrounds us so that we can change it in our own image to serve our needs. What this means is that all of what we discover and build is subject to interpretation by someone, so we have to teach every new generation how to understand and interpret our scientific creations. All these findings have a common and fundamental basis, i.e., that information does not exist in the environment; rather, information is self-produced by living beings through sensorial interactions with the environment motivated by the need to satisfy physiological and/or relational needs. Info-autopoiesis is a new information paradigm that we can use to think about the world in which we live to determine what is possible within the bounds of syntactic information creation.

If for some reason this chain gets broken, for example when we were unable to decipher Egyptian hieroglyphic script, it was only because of the Rosetta Stone, the first Ancient Egyptian bilingual text recovered in modern times, that we were able to gain access to the inscribed syntactic knowledge. The explanations and practical achievements of science need to be reevaluated since they all are the result of syntactic creation. In short, syntactic creation is only able to explain other syntactic elements in our environment. It cannot explain nor create life, an element in nature that is capable of semantic interpretation for its own benefit as well as syntactic creation to close the circle of its metabolic connection with nature.

4 DISCUSSION

Previously we mentioned that Bogdan does not see the possibility of the convergence toward a unique idea of information.[88] Specifically Bogdan mentions that "The notion of information has been taken to characterize (1) a

[87] Howard H. Pattee, 'Evolving Self-reference: Matter, Symbols, and Semantic Closure', in Howard H. Pattee and Joanna Rączaszek-Leonardi (eds.), *Laws, Language and Life - Howard Pattee's classic papers on the physics of symbols with contemporary commentary*, Dordrecht, Springer, 2012, pp. 211-26, p. 213.

[88] Bogdan, Grounds for Cognition: How Goal-guided Behavior Shapes the Mind (1st ed.), p. 53.

measure of physical organization (or decrease in entropy), (2) a pattern of communication between source and receiver, (3) a form of control and feedback, (4) the probability of a message being transmitted over a communication channel, (5) the content of a cognitive state, (6) the meaning of a linguistic form, or (7) the reduction of an uncertainty." Reference numbers are added to differentiate between characterizations of information. Numbers 1, 2, 4 and 7 are linked to Shannon's mathematical theory of communication; while numbers 3, 5 and 6 are more attuned to Bateson's "difference which makes a difference." But both can be considered to be linked by infoautopoiesis and communication as represented in Figure 2. Taking this approach puts in perspective the self-generation of internalized semantic information by the human-organism-in-its-environment that results in externalized syntactic information that is communicated through a syntactical creation that allows communication to occur over large distances between individuals, though personal communication also falls within the constraints of the solution devised by Shannon. This characterization of seven types of information are really the various forms in which information appears and is labelled in the communication process that includes infoautopoiesis. This is similar to the story of blind individuals trying to describe an elephant by touching different portions of its body.

The process of communication has existed since cognitive and sentient cellular life begun 3.8 billion years ago.[89,90,91,92,93] But it is not until Shannon defined the problem of communication, due to the digitization needs of the information age, that a measure of the physical organization of the message, the identification of a source and receiver, the nature and analysis of syntactic information, and increasing the probability of receiving the same message as it was sent, needed to be examined in developing "Information Theory." In a

[89] František Baluška, Arthur S. Reber and William B. Miller, Jr., 'Cellular sentience as the primary source of biological order and evolution', *Biosystems*, vol. 218, 2022, pp. 104694.
[90] František Baluška, William B. Miller, Jr. and Arthur S. Reber, 'Cellular and evolutionary perspectives on organismal cognition: from unicellular to multicellular organisms', *Biological Journal of the Linnean Society*, vol. 139, no. 4, 2023, pp. 503-13.
[91] William B. Miller, Jr., 'The Microcosm within the Microcosm within Evolution and Extinction in the Hologenome', 2013.
[92] William B. Miller, Jr. and John S. Torday, 'Four domains: The fundamental unicell and Post-Darwinian Cognition-Based Evolution', *Progress in Biophysics and Molecular Biology*, vol. 140, 2018, pp. 49-73.
[93] Arthur S. Reber and František Baluška, 'Cognition in some surprising places', *Biochemical and Biophysical Research Communications*, vol. 564, 2021, pp. 150-7.

similar way, Bateson concerned himself with a more general theory of information that sought to characterize information as something fundamentally tied to our actions and interactions in our environment. Infoautopoiesis completes the circuit by considering how both conceptions of information can be used to explain how living beings become what they become by means of the sensation-information-action cycle. The same cycle of the woodsman previously mentioned has the same dynamics of Figure 2, if a substitution is made of the individual on the right side of the figure with the tree that the woodsman is cutting down. Again showing that externalized syntactic information results from the actions of humans based on self-produced/created internalized semantic information.

The infoautopoietic sensation-information-action cycle is the most fundamental way to realize the metabolic connection that exists between humans and nature. Indeed, to discover how labour, information, nature, and culture connect. Where we can say, in the most rudimentary way that "In this case all that need be said is quite simply that we are dealing with ***techniques of the body.*** The body is man's first and most natural instrument. Or more accurately, not to speak of instruments, man's first and most natural technical object, and at the same time technical means, is his body."[94] Our body is what gives us access to our environment sensorially through our actions, in our efforts to mould the individuated human niche to satisfy our physiological and/or relational needs. Indeed, "Technology, defined anthropologically, is not material culture but rather a total social phenomenon in the sense used by Mauss, a phenomenon that marries the material, the social and the symbolic in a complex web of associations."[95] Technology and the process of technological development is an infoautopoietic sensation-information-action process that is used to discover new and better ways of imparting syntactic information into matter, in an endless cycle of improvement, not only affecting the matter subject to human actions but also the engaged human actor. It is a syntactic information embodying process involving "the expenditure of human brain, nerves, muscles and sense organs"[96]

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[94] Marcel Mauss, 'Techniques of the body', *Economy and Society*, vol. 2, 1973, pp. 70-88, p. 75.

[95] Bryan Pfaffenberger, 'Fetishised Objects and Humanised Nature: Towards an Anthropology of Technology', 1988, p. 249.

[96] Marx, Mandel and Fowkes, Capital: A Critique of Political Economy, p. 164.

that goes unnoticed by the actors that engage in its development due to their focus on creating products that are useful, but it is neither a somnambulist nor a deterministic process.[97] This creative syntactic information embodying process proceeds gradually but inexorably, from time to time engaging in abductive creation and qualitative jumps, based on the developing skill of its practitioners.

Actually, an appropriate perspective is that,

> "Anthropos and techne are inseparable when it comes to the study of humans and their societies. From its very origins as a discipline, anthropology has recorded and researched human-technology interfaces in efforts to account for and understand forms of social organisation and practice as well as systems of belief and meaning throughout the world. Whether approached in terms of the tools and dexterous capabilities that were seen to separate humans from other species or the technical systems that allowed for subsistence and the reproduction of society, human ingenuity and practice involving the development and use of various kinds of technologies has been a definitive object of ethnographic inquiry." [98]

Though now we must be careful to state that humans are unique in tool use, but not in their privileged ability to embody increasing levels of syntactical information in their creations. Indeed, it is possible to examine the capitalist production process so as to include information as an intrinsic property of labour in technological development,

> This points to a potentially intrinsic dynamic that is set free in the capitalist process of production by the inclusion of information as an intrinsic property of labour, which is evident from analysing the modified labour theory of value. RSV (Relative Surplus Value) is the result, not of a preconceived plan by the capitalist, but rather the result of labour taking an active role in the production process by adding information at every step of the production process. This is understandable since the day-in and day-out responsibility of labour is to tend the fruits of its labour and in the process to innovate on the result. This leads to process improvements as well as to tool and machinery improvements that become embodied as new technology leading to higher productivity. This is how labour unavoidably embodies information in the products of its labour in an interactive and iterative process. In short, the capitalist enterprise, intrinsically and sometimes unknowingly, due to the immanence of labour and information, is always generating RSV which serves as

[97] Pfaffenberger, 'Fetishised Objects and Humanised Nature: Towards an Anthropology of Technology', pp. 238-9.

[98] Maja Hojer Bruun, *et al.* (eds.), *The Palgrave Handbook of the Anthropology of Technology*, 1st ed. 2022., Singapore, Springer Nature Singapore : Imprint: Palgrave Macmillan, 2022, p. 2.

> an unrecognized incentive for the capitalist as the production process generates use-values and value in the form of information to pursue technological innovation. [99]

Let us further examine technology using a provisional definition of technology given by Lemonnier[100] which states that "Technology embraces all aspects of the process of action upon matter, whether it is scratching one's nose, planting sweet potatoes, or making jumbo jets." This definition, while not recognizing the role of semantic and syntactic information, does recognize the metabolic connection between humans and nature. Additionally, "to be called "technological," an action needs to involve at least some physical intervention which leads to a real transformation of matter, in terms of current scientific laws of the physical world." Identifying five related components of every technique: matter, energy, objects (artifacts, tools, or means of work), gestures ("operational sequences") and specific knowledge (related to specific skills in completing tasks).[101]

In discussing the components of a technique, information is included without a definition, but with certain specifications. For example when discussing matter emphasis is placed on the presence or absence of specific materials and their use. This is related to the sensing-information-action cycle which influences our ability to select and use what is in our individuated niche with a focus on utility or use value. The creation of "objects" (artifacts) certainly has a connection to "gestures" ("operational sequences") but this involves recognizing the role of information and its development and accumulation. An acknowledgment of the role of information surfaces in the following passage,

> Wobst (1977:32) made a fundamental remark, which is most important for our purpose, concerning the threefold nature of any technique: "material culture ... participates in and enhances exchanges of energy, matter and information in the human population that fashions it." We may pass over the distinction between matter and energy; however, the dividing line between physical aspects and informational aspects of material culture is crucial to our subject and difficult to explore. I shall come back to this point later, but it must be noted that my purpose

[99] Cárdenas-García, 'Labour Productivity: The Link Between Use-Value, Value, and Information'.
[100] Pierre Lemonnier, *Elements for an anthropology of technology*, Ann Arbor, Michigan: Museum of Anthropology, University of Michigan, 1992, p. 1.
[101] Ibid., pp. 5-6.

> here is not to identify where "function" stops and "style" begins (since style can be shown to have a function); rather, it is to investigate how, and to what extent, both physical functions and informational functions are interrelated in any technology. I maintain that informational functions may be found among the actual physical features of a technological system and not just in the so-called "stylistic" features which have little or no physical action on matter. [102]

Here there is an explicit recognition of the role of information in the "physical/functional" and "stylistic" features of technological systems. This means that technology incorporates syntactic information, which may have a functional and/or aesthetic role, implying a developing role for information, while not explicitly using a concept of information. This is also true when defining or delimiting a particular technique, where an interdependence exists between the use of various technologies. And also in addressing the "systemic aspects" of various technologies.

These accounts where the role of humans is revealed as part of the metabolic relationship with nature and where information is also considered as an explanatory element, are few and far between in the comprehensive account given in The Palgrave Handbook of the Anthropology of Technology.[103] To search for accounts that better deal with information as an important element we turn to anthropology cyberculture and also digital anthropology. In particular, cyberculture seems to respond to "Computer, information, and biological technologies … bringing about a fundamental transformation in the structure and meaning of modern society and culture."[104,105] More specifically,

> While any technology can be studied anthropologically from a variety of perspectives-the rituals it originates, the social relations it helps to create, the practices developed around them by various users, the values it fosters-"cyberculture" refers specifically to new technologies in two areas: artificial intelligence (particularly computer and information technologies) and biotechnology … While computer and information technologies are bringing about a regime of technosociality (Stone 1991), a broad process of sociocultural construction set in motion in the wake of the new technologies, biotechnologies are

[102] Ibid., p. 7.
[103] Bruun, et al. (eds.), The Palgrave Handbook of the Anthropology of Technology.
[104] Escobar, *et al.*, 'Welcome to Cyberia: Notes on the Anthropology of Cyberculture [and Comments and Reply]', p. 211.
[105] Escobar, 'Anthropology and the future: New technologies and the reinvention of culture'.

> giving rise to biosociality (Rabinow I992a), a new order for the production of life, nature, and the body through biologically based technological interventions. These two regimes form the basis for what I call cyberculture. They embody the realization that we increasingly live and make ourselves in technobiocultural environments structured by novel forms of science and technology. [106]

While guidelines are provided to engage in an anthropological cyberculture project, it is never clear what role information plays, though mention of the political economy of cyberculture involves "the information economy" and talk of profound changes in capitalism to accommodate the role of information. While the concept of information remains undefined, questions arise as to the relationship between information, capital, and labour. Noting that "As is information, science and technology have become crucial to capitalism in that the creation of value today depends largely on scientific and technological developments."[107]

The anthropological outlook in the age of information[108] seems to have overlooked the role that humanity plays in its development. The initial impact of digital technologies in anthropology focused on how digital technologies impacted humans, not how humans fundamentally impacted digital technologies. This is typical of what is found in cyborg anthropology meaning making.

The field of digital anthropology, as its name implies, primarily concerns itself with 'the human' and secondarily with 'the digital.' Specifically, "Many of the anxieties and fears about digital technologies have hinged on their implications for what it means to be human – whether in terms of the capacity of virtual platforms to disrupt or reorganise the performativity of identity, or fears that robots and artificial intelligence will displace or replace humans." Second, "on the global, networked, and infrastructural qualities of digital technologies." Third, "on the specific relationship between culture and computing by outlining anthropological research on digital technologies that has taken as its focus the experiences of people in non-Western, non-literate, and non-industrialised

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[106] Escobar, *et al.*, 'Welcome to Cyberia: Notes on the Anthropology of Cyberculture [and Comments and Reply]', p. 214.
[107] Ibid., p. 220.
[108] Manuel Castells, *The Rise of the Network Society*, Vol. I, West Sussex, United Kingdom, Wiley-Blackwell, 2010.

societies." Fourth, "at how digital anthropology is making important contributions to ongoing discussions about digital methods." Fifth, "how digital anthropology has emerged from and continues to exist in the interstices between academic anthropology and research being conducted outside academic settings."[109]

Additionally, the field of digital anthropology relies on six principles. The first principle "is that the digital itself intensifies the dialectical nature of culture. The term *digital* will be defined as all that which can be ultimately reduced to binary code but which produces a further proliferation of particularity and difference". The second principle states "humanity is not one iota more mediated by the rise of the digital." The third principle "commitment to holism, the foundation of anthropological perspectives on humanity." The fourth principle "reasserts the importance of cultural relativism and the global nature of our encounter with the digital, negating assumptions that the digital is necessarily homogenizing." The fifth principle "is concerned with the essential ambiguity of digital culture with regard to its increasing openness and closure, which emerge in matters ranging from politics and privacy to the authenticity of ambivalence." The sixth principle "acknowledges the materiality of digital worlds, which are neither more nor less material than the worlds that preceded them."[110,111]

Both of these perspectives on digital anthropology do not seem to consider how information impacts how the digital developed and the technological needs that it solved, placing emphasis on applications rather than fundamental theoretical elements that may serve to clarify its role as a technological development and its implications for humankind. Without an understanding of information and the digital it becomes difficult to study phenomena that emanate from that misunderstanding.

Previously, we have shown that humans are the creators of all existing internalized semantic and externalized syntactic information, including the information that establishes and shapes our institutions and their influence in our societies which, at the same time, recursively and interactively impacts us. This unavoidable mutual interaction, over which we may not have control, cannot but

[109] H. Geismar and H. Knox (eds.), *Digital Anthropology*, 2nd, Routledge, 2021, pp. 3-4.
[110] Ibid., pp. 21-2.
[111] H.A. Horst and D. Miller (eds.), *Digital Anthropology*, 1st ed, Routledge, 2012, pp. 3-4.

define the digital that is now pervasive in our societies, while also affecting us in sometimes consequential ways. The digital is just one more technology that creates the challenge of controlling its proliferation and impact. In some ways, it is no different from the proliferation and impact of nuclear power or fossil fuels on our environment. Though one significant difference might be its unparalleled capacity for exponential growth due to our ability to artificially in-form our environment.[112,113,114] This effect is easily identifiable in metrics such as the speed of computation, Moore's law of integrated circuits, increase in wireless transmission, sequencing the genome, 3D printing, development of mRNA vaccines, etc. It is now a pervasive element in our societies.

One of the concerns that surfaces with regard to the extensive use of the digital in a ubiquitous platform such as the world wide web is that 'The system is failing.'[115,116] These observations reflect the conflict that sometimes emerges between what seems to be public goods and services on the one hand, and the appropriation of those public goods and services by private conglomerates on the other. It is a criticism of the users and abusers of technology, but not of the technology itself. This is true of the world wide web as described above and is also true of climate change which results from the indiscriminate private appropriation and use of minerals, lands and other resources leading to indiscriminate pollution of the air, water, and oceans. Even the reasons underlying the migration of large masses of population can be traced back to the economic, military, and other interventions by countries from the northern hemisphere. Bringing to the fore the need to do something about it: 'We are at a

[112] Ray Kurzweil, How to Create a Mind: The Secret of Human Thought Revealed, Penguin Books, 2013.
[113] Aran Ali, *From Amazon to Zoom: What Happens in an Internet Minute in 2021*, Visual Capitalist, 11/10/2021 2021. Accessed 11/23 2021, Available from https://www.visualcapitalist.com/from-amazon-to-zoom-what-happens-in-an-internet-minute-in-2021/.
[114] Jean Thilmany, *5 Industries Where Big Data Brings Big Returns*, The American Society of Mechanical Engineers, 11/15/2021 2021. Accessed 11/23 2021, Available from https://www.asme.org/topics-resources/content/big-data-brings-big-returns.
[115] Olivia Solon, *Tim Berners-Lee on the future of the web: 'The system is failing'*, The Guardian, 11/15/2017 2017. Accessed 11/23 2021, Available from https://www.theguardian.com/technology/2017/nov/15/tim-berners-lee-world-wide-web-net-neutrality.
[116] BBC, 'Tim Berners-Lee on the future of the web: 'the system is failing', 11/16/2017 vols., YouTube. https://www.youtube.com/watch?v=ACQ45K_orOM, 2017.

crossroads to the future; we must go into action and take the right direction!'[117] The ultimate question is, who is in the position to act and in so doing, to decide whether public or private interests are the ultimate beneficiaries. It needs to be kept in mind that if private interests prevail, both public and private individuals will be the losers. The best recent examples of this dynamics are the COVID-19 epidemic and global climate change. In case of the former, the richest countries have abandoned to their fates the poor countries (with most of the world population) that lack the technological knowhow to produce their own vaccines. With regards to the latter, the major sources of pollution are in the rich countries, but it is the poor countries, which have no power to act on their own behalf, which must bear the negative effects of climate change. A comprehensive analysis of the origin and the impacts of information and the digital may be found in Cárdenas-García.[118,119]

5 SUMMARY AND CONCLUSIONS

Anthropology as the scientific study of human culture lacks an updated connection to the Information Age that started in the mid-twentieth century. In an effort to remedy this situation, infoautopoiesis or the process of information self-creation is assessed to uncover how culture, nature and information relate to each other, recognizing that culture and information share the quality of being difficult to define. This approach helps to falsify the held belief that information exists in the environment independent of living beings and/or is a fundamental quantity in the Universe, besides matter and/or energy. This cannot but helps us to reexamine the fundamental role of information in anthropology, in its origins and development, as well as in its present-day local and global manifestations. This approach avoids putting technology and its development as an important element influencing cultural development. Rather, it promotes the view of as an inevitable consequence of the embodiment of information in our tools, machines, and other human creations.

The naturalization of the concept of information is the first step to gaining an

[117] Hannes Werthner, *et al.*, *Vienna Manifesto on Digital Humanism*, May 2019 2019. Accessed 11/23/2021 2021, Available from https://dighum.ec.tuwien.ac.at/dighum-manifesto/.
[118] Jaime F. Cárdenas-García, 'Info-Autopoiesis and Digitalisation', *Proceedings*, vol. 81, no. 1, 2022c, pp. 82.
[119] Jaime F. Cárdenas-García, 'Info-Autopoesis and Digitalisation', *New Explorations: Studies in Culture and Communication*, vol. 2, no. 3, 2022b.

understanding of the implications of information for living beings. Its etymological origins and Gregory Bateson's conceptualization of information as "a difference which makes a difference" allow access to its dynamic characteristics for living beings-in-their-environment. Leading to asking and answering the questions of why and how living beings become what they become as a result of information self-creation. This includes reflecting on the capacity of organisms to relate to their environment by acting on matter in nature and on their fellow beings, motivated by the necessity to satisfy physiological and/or relational needs. Permitting the identification of the immanence of information, labour, and culture, which allows the detailing of how the generation of information occurs, and also identifying the different types of information that exist and the function they fulfil.

In re-examining Shannon's mathematical theory of communication it is possible to discover and generalize that the conceptualization of infoautopoiesis requires not only, in the process of the sensing-information-action cycle, the internal (endogenous) creation of meaning in the form of semantic information, but also the generation of external (exogenous) expressions as syntactic information which requires interpretation, as no meaning is attached to it. Conceptually, syntactic information can be any human creation conceived and realized by our ability to labour. These syntactic expressions are all types of artificial human creations, such as the syntax of a text message; a painting or sculpture; and manufactured products such as computers, mobile phones, machine tools, games, microscopes, scientific texts, ChatGPT, and novels. All science achievements are the result of syntactic creation. Syntactic creation is incapable of creating life, or any element in nature that is capable of semantic interpretation for its own benefit. This precludes the existence of sentient Artificial Intelligence (AI).[120,121]

The role of information in the anthropology of technology, anthropology cyberculture and digital anthropology is found to be minimal. While mention of information is made, there is no attempt to define nor to use it in an explanatory fashion. The role of information appears undiscovered in anthropology.

[120] Jaime F. Cárdenas-García, 'The Limits of Artificial General Intelligence', *Preprints.org 2023, 2023040258*, 2023c.

[121] Cárdenas-García, 'Info-Autopoiesis and the Limits of Artificial General Intelligence'.

Infoautopoiesis is suggested to be an approach in anthropology to discover anew the role of information in the history of humankind and other living beings. There is a need to recognize that all living beings are at the centre of all information creation, recognition, transmission, preservation, and utilization.

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