Herein are some notes and discussions which complement the manuscript:

TOWARDS AN ONTOLOGY OF THE INTERFACE: IDENTIFYING THE INTERFACE AS A MEDIATION ENTITY

They are organized in the exact same sections as the main paper.

Notes on the frontispiece illustration

This image is taken from the artwork Osmose, by Char Davies [1]. It is a complex piece, whose space, time and matter illustrate the interface's space-time-matter such as we conceive it. A space of perception, action and desire, particle-based and where adjacency is key for experiencing events. Its time is of well-balanced exposition, iterative and with a harmonized rhythm adjusted to "exploring the perceptual interplay between self and world" [1]. Its matter is dynamic, both in composition and in shape.

1. Introduction

Notes and examples based on the preliminary definition of interface

The interface is a system or a device through which non-related entities can interact. We chose this preliminary definition because it is a broad one, therefore accepted in different fields of knowledge, such as: Physics and Art [2], Informatics [3] or Human Computer Interaction [4]. It also respects the Interface's Etymology [5] and History [6].

On one hand this definition accounts for the three types of characteristics the interface holds: the ones inherited from the entities it connects; the ones that emerge from interaction; and its own constitutive characteristics. On the other hand, this definition indicates that an interface may be something as diverse as a Graphic User Interface (connecting human and computer); a public transportation hub (connecting subway and railway, for instance) or an institution (connecting public with a governmental department).

The example of a transportation hub is helpful to expose the types of characteristics of the interface and their importance in molding the experience. We can picture a train station that is simultaneously a subway station – it is an interface between the railway system and the subway system. This station/hub inherits characteristics from the subway system (the height of platforms, the ticket validation machines, etc.) because it must accommodate subways vehicles. It also inherits characteristics from the railway system (the type of platforms, the placards showing the destination of a train, etc.) for the same reason. It is, therefore, a relational system. This hub has other set of characteristics that emerge from the type of actions performed on its space (running, waiting, trains arriving and departing, etc.). Finally, it has characteristics that are its own (it is gray, it is cold, for instance) and those are responsible for the differentiated experience we have of that interface. Because there might be another hub connecting the same entities (subway and railway), with the same inherited and emerged characteristics, but with different constitutive features (colorful, warm, historical, for instance) which we experience differently.

Notes on Framework and Scope

We chose a multidisciplinary theoretic perspective to study the interface. This stems from the conviction that a study on the interface must be more comprehensive than the perspective of a single discipline. This

ontology is not divorced from practice, though: it is conceived to be put in action, to be experimented with, and to learn from its practice in return. Our proposal is to study the interface theoretically, and to do so using diverse fields of knowledge, from cultural studies to quantum physics. This concept of interface has practical repercussions, meaning it may lead to changes in Interface Design practices, for instance. Iteratively, these design changes will contribute to a more robust definition of interface.

The interface is defined within the theoretic framework of mediation and experience. Creating a framework which can enclose the interface and make it central, implies its inscription in space-time-matter. The theoretic framework emerges precisely from the space-time inscription: considering that experience (which occurs in space-time) is mediated, then the interface is the basic condition for each medium and simultaneously its inscription in space-time. Or, in other words, it is this inscription is space-time that connects the interface to experience. Simultaneously, experience is associated with mediation, resulting in a twofold movement: framing the interface in a mediation theory, through experience; and the anchorage of media in space-time, through the interface. And that's how *the world as interface* is formed:

> "Within a Lacanian context, where the real is exactly what withdraws itself from our grasp and therefore poses a limit to ourselves, we cannot confront or reach the real except through a medium. As Weibel states, technologies are indeed media to bridge the gap that separates us from the real: teletechnologies that seek to overcome distances, immersive technologies that seek to close the distinction between the virtual and the real environment." [7]

Describing the interface's mode of existence is also to describe how it relates to other entities. Given the interface relational essence, this could be mistaken for a redundancy. Activating the concept of interface is thinking its relation to others - a relation within the relational. The guidelines to this study are the operations performed by any interface - namely transferring, transmitting, translating, synthesizing and representing (in a word: mediating). This activation implies leaving the abstract sphere and concentrate on an instance of the interface - the Human Computer Interface. We chose this instance because it serves as a gateway to digital culture, where aesthetic computing has a leading role (both as a digital culture construct and constructer). By analyzing the operations performed by human computer interfaces we achieve a clearer view of how the interface relates to its bounding entities - in the case, humans and computers.

2. What is an Interface

Notes on other definitions of Interface

From the preliminary definition, we concluded that the interface has three types of characteristics: relational, emerged and constitutive. The relational characteristics were associated with the space of the interface, meaning that they exist because of its in-betweeness. The emerged characteristics we related to time because they depended on the actions that were performed through and by the interface. Finally, the constitutive characteristics were associated with the matter of the interface, they are its own characteristics, the ones that mold our experience.
The interface has been studied by different fields and with different approaches, resulting in definitions more or less complete, when considering by this perspective of space-time-matter.

Interface definitions often include words such as border, surface or membrane, which leads to an incomplete conception of the interface as a geometric plane or even a point without dimensions --- a purely relational instance. Such is the case of Bureaud's definition, which is extremely clear in remarking the space of interface (its relational aspect), but does not explicitly acknowledge the time or matter of the interface itself:

> "In Physics, an interface is the point of encounter of two foreign bodies who do not dissolve in each other. Oil and vinegar have an interface, sugar and water don't. Humans and computers, because they don't fuse in one another, need evidently an interface between them." [8]

Fisher inscribes the interface in a line through which information may pass, thus considering not only the space, but also the time of the interface (through actions of passage and transition):

> "[the interface] is situated on the fracture or discontinuity line between these two worlds and it allows the passage, the transition between this two ontologically opposite worlds." [9]

For Mcluhan interface is a place of meeting and metamorphosis. McLuhan's definition accounts for the space and time of the interface:

> "Two cultures or technologies can, like astronomical galaxies, pass through one another without collision; but not without change of configuration. In modern physics there is, similarly, the concept of 'interface' or the meeting and metamorphosis of two structures." [10]

Other authors extend the space of interface to a zone or a threshold. Such is the case of Hookway, who also attributes the interface the capacity to determine and mold the information that passes through it, thus acknowledging the inherited, emerged and constitutive characteristics of the interface:

> "In its occupation of the threshold, the interface is both the conduit through the threshold and the judge sitting upon the threshold to determine what may pass through and the manner of its passing" [11]

Schaefer considers the interface a place of connection and an entity in itself. The author identifies the inherited characteristics of the interface, recognizes the action of connection and considers the interface distinct from the entities it connects, opening the possibility for the interface to have characteristics of its own:

> "An interface is a place of overlap and connection, but it is also a space of in-between, simultaneously a part of two things yet distinct in his own right" [12]

Notes on methodology

The standing point to explore the interface as an entity is to acknowledge that it is not a directly observable one; some parts can only be studied through its effects. By its operational definition, there is a part of the interface that is only apprehensible by one of the entities and out of the sensible sphere of the other. Even considering an interface connecting humans with any other entity, there is always a part of the interface that we, as humans, cannot apprehend. Therefore, we must at some point leave the human experiential level and understand the interface indirectly, by analyzing its effects. Studying the interface abstractly implies a direct work on the complex of reality [13]: by analyzing old and new conceptions of space, time and matter; and by looking for the interface on their ever-existing discontinuities.

2.1. Interface and Space: between, discontinuous, adjacent

Notes on Space of Interface

Between

The notion of being "in between" and how that affects the interface's existence is described through Plato's Timaeus dialogue (360 BC) [14] in which Space is elevated to a precise category, forming a genesis trilogy along with Being and Becoming. For Plato, each one of these categories is a differentiated reality. Being corresponds to forms or ideas: perfect, immutable and imperceptible by our senses. Becoming is perceptible and constantly mutating. Space is in between them:

> "And there is a third nature, which is space, and is eternal, and admits not of destruction and provides a home for all created things, and is apprehended without the help of sense, by a kind of spurious reason, and is hardly real; which we beholding as in a dream, say of all existence that it must of necessity be in some place and occupy a space, but that what is neither in heaven nor in earth has no existence." [15]

Being "between" allows the interface to become simultaneously a space of perception of the other world and of action in the other world, a Bergsonian redundancy. Moreover, it is also a dream place, a place of desire and fantasy. Nusselder articulates perception and desire through fantasy:

> "Much more than we are aware of, fantasy organizes our perception of the world. And technologies actually seem to embody this psychological level. Lacanian theory depicts fantasy as a medium that supports our reality by making it an attractive or engaging process (beyond our "instrumental" involvement)" [16]

This might justify why we are so easily caught in a narcissist cycle with the interface: it is simultaneously a window and our perfect mirror [17].

Discontinuous

Another essential Space definition comes with Newton, who introduces the absolutism of space and time. This absolutism and separation was later questioned by Einstein who presents time as a category equivalent to the other three defining Euclidean Space [18]. Also, Einstein affirms the relativity of the four categories, abolishing the existence of an absolute referential. Space is no longer a plane; it acquires a curvature (in time) that depends on the masses of the objects that exist in it [19]. From then on understanding space-time implies considering the masses, the particles and their behavior, namely through its relation to light, something very appropriate in this digital dematerialization era:

> "Quantum theory gets its name from this property, which it attributes to all measurable physical quantities – not just to things like the amount of light, or the mass of gold, which are quantized because the entities concerned, though apparently continuous, are really made of particles. Even for quantities like distance (between two atoms, say), the notion of a continuous range of possible values turns out to be an idealization. There are no measurable continuous quantities in physics." [20]

Adjacent

Foucault, working through experience, proposed another important vision about space:

> "We are in the epoch of simultaneity: we are in the epoch of juxtaposition, the epoch of the near and far, of the side-by-side, of the dispersed. We are at a moment, I believe, when our experience of the world is less that of a long life developing through time than that of a network that connects points and intersects with its own skein." [21]

For Foucault the experiential relation of space-time is a relation of connection and weaving. The concepts of space and time are recognized as fundamental, but the experiences are lived and registered in a new way. A way where cartography does not set the rules and where chronologic distribution has another logic: associative, cyclic, symmetric or a combination of the aforementioned. Events are represented by neighborhood and connection, more than position or date.

> "Our epoch is one in which space takes for us the form of relations among sites" [22].

Sites of rest, sites of passage, utopias and heterotopias. It is interesting to see the overlapping of vocabulary when describing networks and experience [23], since it occurs on the conceptual sphere of the interface.

2.2 Interface and Time: speed, iteration, harmonization

Notes on Time of Interface

Speed and chronoscopic time
Human beings perceive movements of matter in space and not time itself [24]. Considering speed is to consider the distance covered in time by a mass. Paul Virilio studies speed through telepresence:

> "Once astrophysicists stop talking exclusively about 'space-time' and start talking about 'space-time-matter' […] introducing a third kind of interval of the 'light' type alongside of those of 'space' and 'time', they engineer the emergence of a new conception of time, which is no longer exclusively the time of classic chronological succession, but now a time of (chronoscopic) exposure of the duration of events at the speed of light" [25]

Virilio chooses light exposure as an alternative measure of time. The author makes an analogy with photography to explain the three possibilities of time: underexposed-exposed-overexposed [26]. It is also possible to make an analogy with the interface: something only exists to the other system if "exposed" in the interface. If something or an event is underexposed the other system cannot acknowledge it; if, on the contrary, it is overexposed then loses its novelty and interest (it is saturated). It is also possible to make an analogy with media coverage of an event, and it becomes quite clear the importance of dosing exposure, the importance of time.

There is no direct relation between exposure and old categories of time: past, present, future. In terms of interface and media it should be clarified that underexposure is not the past, it is the temporal suppression of an event which, having no duration of exposure, is non-existent; over-exposure is not the future of an event, it is the process of affective numbing that occurs by exposing something for too long. According to Virilio, telecommunication revolution, besides retaining space (by contracting it in a screen and keeping it in permanent commutation), annulled the transmission duration. What becomes critical is not the dimensions of space, but the fourth dimension of time, because present time no longer has a place to happen [27]. We are constantly here and there, we are in a commuting state, so there is no space for now.

Iteration
Interface should be considered in time, in action. Interface is reconceived by each action, in an iterative process, not in a cyclic one. As already stated, interface time does not endure past, present and future, as in a classic chronology: each instance of the interface is the cartography of past choices, current achievements and abstract future possibilities –all retained in its space.

2.3 Interface and Matter: transmission, plasticity

Notes on Plasticity

The unity of composite materials

Interface is made of a composite material, which means that the interface is heterogeneous by constitution. Being heterogeneous does not mean it is multiple of fragmented --- the interface remains

Uno. The interface does not unite of fuse its bounding entities, it maintains the separation, but creates unity from them:

> "The separation maintained by the interface between distinct entities or states is also the basis of the unity it produces from those entities or states." [28]

The synthesis operated by the interface, which guarantees its unity is similar to that operated by fantasy:

> "For Lacan, fantasy, or the imaginary order, both *synthesizes* the manifold stimuli originating in internal and external reality 'into a number of pre- formed frameworks,' and *anticipates* an ideal unity." [29]

The composite nature of the Interface matter serves as model to study our subjectivity matter: heterogeneous but Uno [30].

Plasticity of Osmose's Interface

Char Davies' Osmose [1] (Fig.1 and frontispiece of the main document) exemplifies what is meant by this approach of comparing plastic characteristics to the interface's matter. Osmose's physical interface consists of a head-mounted display (HMD) and a real-time motion tracking based on breathing (vest) and balance. The immersant breaths in to float upward, breathes out to fall and changes the body's centre of balance to change direction in the virtual world.

Osmose's interface is malleable since it adapts to both human body's and computer's mode of communication. It is, therefore, molded by them. But it molds them back in the sense that it configures their communicational limits within Osmose.

This interface coats the human body (through motion tracking) so that the computer can receive its signs; and covers the computer (with the HMD), so that the user can see the digital world. This interface is natural and artificial: e.g. the vest is natural to humans insofar as it moves to thoracic movements; and it is artificial insofar as it transmits digital data.

Synthesis occurs in response to every movement made by the immersant and to any data processed by the computer, thus synthesizing something new in the HMD.

Osmose's interface material is a composite generated by different materials: analogue and digital, for instance. It is heterogeneous but Uno.

In each transmission, the interface material gains both a different composition (e.g. more digital or more analogue) and a different shape (e.g. the vest changes shape and the graphics change in the HMD).

3. How does the interface relate to other entities?

Notes on framework

Interfaces exist where, when and because there is a need for interaction. How interaction occurs --- the processes and operations it involves --- is therefore critical to describe what an interface is. Mediation becomes the supporting theory for activating the interface concept and to understand some of its relationships.

As stated before, interface is the "experiential arm" of media, which means that it is through the interface that media are experienced (and are inscribed in space-time-matter). If we are to work the interface on a humanly experiential level, it is necessary to leave the abstract sphere (in which the concept of interface

had been studied on the previous point) and concretize it in one of its instances: the human-computer interface. In other words, the idea is to project the multidimensional concept of interface on the human computer interface plane. This will allow for considerations on interface design, conception and use --- analyzing its mediation energy.

3.1. Human Computer Interface: articulating intelligible with sensible while actualizing the virtual

Plato's definition of space applied to the interface led to the conclusion that to know and recognize the interface itself we need to use a hybrid reason. In the case of human computer interfaces that reason has to be simultaneously mathematic and sensible. According to Alain Renaud [31], it is the interface as device that has the means for actualizing the virtual and for making the transfer between intelligible and sensible, therefore adjusting the relation between real and possible. The author goes on by explaining that realizing the possible implies the setting in motion of a thought organically articulating intelligible and sensible, authorizing and making the free passage from one to the other, in both senses, and even in all senses [32].

Combining this central operation of the interface, as engendered by Renaud, with the need for a hybrid reason, derived from Plato's dialogue, it becomes clear that our mode of experience of human computer interfaces is already far from pure (neither purely cognitive, nor purely sensible; neither purely virtual, nor purely actual).

3.2. Human Computer Interfaces: Trans-appearance through bio-digital rhythmic harmonization

According to Virilio, telecommunication revolution, besides retaining space (by contracting it in a screen and keeping it in permanent commutation), annulled the transmission duration. Telepresence implies a persistent commutative movement that occurs on the interface and which generates apparent continuous hybridization, when in fact there is a constant materialization and dematerialization of the interface, gaining visible and invisible matter in apparent simultaneity (trans-apparent matter), constant shaping and reshaping (plasticity).

To achieve trans-appearance there is a need to harmonize the bio-digital rhythm. Historically, only when transparency became important did harmonization become a goal. Following John Walker's computer generations [33] becomes clear that on the first computer generation there was a pseudo-harmonization: the user would accompany the computer in all its tasks. On the second generation, no attempt was made to harmonize: the computer would "retire to think" leaving the user waiting. From then on, there had been a systematic program to harmonize time in the interface. At first the attention was centered on masking the computer's delay, now there is also a need to go on the opposite direction and mask a "too-fast" processing. For instance, in many interactive systems, there is an attempt to provide temporary feedback while the computer is still processing; and in other interactive systems or operations, the results are delayed on the interface layer because the process might seem to fast (therefore unreliable, for example) by the user.

REFERENCES

[1] Osmose is an artwork from 1995 consisting of an immersive interactive virtual reality environment installation. 17 March 2017 http://www.immersence.com/osmose/

[2] Annick Bureaud, "Pour Une Typologie Des Interfaces Artistiques" in Louise Poissant, Ed. *Interfaces et Sensorialité: Esthétique des Arts Mediatiques*, (Saint-Foy Québec: Presses de l'Université du Québec, 2003. pp.19--35) p.19;

[3] Mary Campione, Kathy Walrath, Alison Huml, *Java Tutorial, The: a short course on the basics,* 3rd edition, (Boston, MA: Addison-Wesley Professional, 2004) p.54;

[4] Brenda Laurel, *The Art of Human-Computer Interface Design*. (Boston, MA: Addison-Wesley, 1990) p.xii).

[5] Branden Hookway, *Interface* (Cambridge: The MIT Press, 2014) p.7

[6] Peter Daniel Schaefer, *Interface Friction: the politics of participation and the spaces between users and new media* (Unpublished dissertation: University of Iowa, 2008) pp.5 -- 8; and in Hookway [5] p.59.

[7] André Nusselder, Interface Fantasy: A Lacanian Cyborg Ontology. (Cambridge, MA: The MIT Press, 2009) p.28.

[8] Bureaud [2] p.19; Translation by author. Original: "En Physique, une interface est le point de rencontre de deux corps étrangers qui ne se dissolvent pas l'un dans l'autre. L'huile et le vinaigre ont une interface, le sucre et l'eau n'en ont pas. Les humains et les machines informatiques ne se fondant pas encore l'un dans l'autre, une interface entre les deux est – de manière évidente – nécessaire."

[9] Hervé Fisher, "Mythanalise Des Interfaces: Le Mythe De Janus." In Louise Poissant, Ed. *Interfaces Et Sensorialité: Esthétique Des Arts Mediatiques*. (Saint-Foy Québec: Presses de l'Université du Québec, 2003) pp. 317--24. p. 321; Translation by author. Original: "Elle [interface] est située sur la ligne de fracture ou de discontinuité entre ces deux mondes et permet le passage, la transition entre ces deux mondes au statut ontologique opposé."

[10] Marshall McLuhan, *The Gutenberg Galaxy: The Making of Typographic Man* (Toronto: University of Toronto Press, 1962) p.149

[11] Hookway [5] p.7.

[12] Schaefer [6] p.1

[13] Complex of reality is here understood strictly in Deutsch's terms, meaning the actual fabric of reality. David Deutsch, *The Fabric of Reality* (England: Penguin Books, 1998). pp.7--24.

[14] Plato, *Timaeus* (NA: Project Gutenberg, 2008) 27 Jul. 2016 http://www.gutenberg.org/etext/1572

[15] Plato [14] p.300

[16] Nusselder [7] p.13.

[17] See Cristina Sá, "A Travessia Do Interface Nas Artes Tecnológicas", In Aderito Marcos Ed. Artech05 2º Workshop Luso-Galaico de Artes Digitais (Vila Nova de Cerveira: Ass.CCG/ZGDV, 2005).

[18] Deutsch [13]

[19] Manuel José Lopes da Silva, "Espaços Cosmológicos." *Revista de Comunicação e Linguagens*. Espaços: nº

34-35: 157--63 (2005). p.160

[20] Deutsch [13] pp. 35—36

[21] Michel Foucault, *Of Other Spaces: Utopias and Heterotopias.* Architecture, Mouvement, Continuité 1984. **5**: p. 46--49. 27 Jul. 2016 http://foucault.info/doc/documents/heterotopia/foucault-heterotopia-en-html p. NA

[22] Foucault [21] p. NA

[23] This overlapping appears even before internet existed as such (Foucault's text is from 1967), corroborating the idea of internet as a social construct.

[24] Paul Virilio, *Open sky*. (London: Verso 2003) Reprint. ed. The author suggests this perception along the book but more explicitly on p.13.

[25] Virilio [24] p.3

[26] Virilio [24] pp. 27--28 An object underexposed to light is not captured on film; an object overexposed to light becomes saturated and impossible to read.

[27] Virilio [24] pp.9--10

[28] Hookway [5] p.4

[29] Nusselder [7] p.18:

[30] This subject was addressed in Cristina Sá, "Ainda Precisamos de Interfaces? Sobre o interface enquanto complexo mediador", *Revista de Comunicação e Linguagens* (2012), 43/44: 161 -- 176.

[31] Alain Renaud, "L'interface informationnelle ou le sensible au sens de l'intelligible" in *Interfaces et Sensorialité: Esthétique des Arts Mediatiques*, L. Poissant, Editor. Saint-Foy Québec: Presses de l'Université du Québec 2003. p.69

[32] Renaud [31] p.74

[33] John Walker, *Through the Looking Glass*, in *The Art of Human-Computer Interface Design*, B. Laurel, Editor. 1990, Addison-Wesley Massachusetts. p. 439 -- 447.