Introduction
On sensing...

Theories of media art have often concentrated on the intersection between science, technology and aesthetics. There are also those that have lauded the ephemeral nature of media itself and media art as a niche in contemporary art.[1] Regardless of whether one's perspective on media art is the most up-to-date or old-fashioned,[2] one cannot neglect the knowledge produced under the umbrella of both media and media art studies programs, nor the specificities of their cross-disciplinary scope.

In a basic and simplified form, media art is considered here as the poetic, aesthetic and symbolic uses of materials and media devices in such ways that the artworks themselves generate other media and communication processes. In order to establish a common understanding of media, Sean Cubitt's (1953-) definition is here appropriate. We understand media as *"the physical processes – matter, energy dimension, and form – in which all human communication takes place, (…). Before we can communicate, we mediate"*[3]. Equally relevant is Cubitt's comments on Merleau-Ponty's (1968) proposition concerning the reciprocal nature of mediation, the condition that everything that mediates is mediated in turn. As Cubitt remarks:

> Mediation is the ground of relationship, the relationship that precedes and constructs subjects and objects. Media matter, both in the sense of giving material specificity to our descriptions of such abstract concepts as society and environment, and in the sense of the active verb: mediation comes into being as matter,

1 Daniels, Dieter. Whatever happened to Media Art? originally "Was war die Medienkunst? In: Pias, Claus (Ed.) *Was waren Medien?* Zürich/Berlin: Diaphanes, 2011. pp. 57– 80.

2 I had long taken it for granted that in the European context the segregation of media art from contemporary art no longer existed. However, after visiting *Documenta 14* in Kassel I was surprised to realize that it is still strongly present, depending on the background of the curators and organizing teams. The experience of various exhibitions in Berlin visited between 2013 and 2018 at *Haus der Kulturen der Welt* and *Akademie der Künste*, or even the *Skulptur Projekt Münster* in 2017, for instance, had given me a completely opposite impression.

3 Cubitt, Sean. *The practice of light: a genealogy of visual technologies from Prints to Pixels.* Cambridge, Massachussetts/London, England: MIT Press, 2014. p. 2.

> its mattering constitutes the knowable, experienceable world, making possible all sensing and being sensed, knowing and being known.[4]

The adoption of the term 'media' in the scope of this research also relates to how it encompasses the characteristics of a cultural production whose origin coincides with the beginning of the automation of image and sound production by means of machinic apparatuses. This cultural paradigmatic change coincides with the emergence of the notion of media within artistic and communication contexts[5] and, therefore, with the beginning of its historiography. They are part of the broader context of industrialization, which gave birth to the philosophy of technology, marked by works such as August Koelle's *System der Technik* (1822) and Ernst Kapp's *Grundlinien einer Philosophie der Technik* (1877)[6].

In the interest of including a more ecological and contemporary perspective on media, the exchanges and physical processes occurring among non-human living organisms and matter activity per se, as addressed by cybernetics and more recently post-humanist and new materialist theories, are also considered here.[7] While searching for an object of analysis able to unfold crucial issues of the intermediate agencies in media artworks, the gap between sensing and making sense particularly attracted my attention, leading me to center the investigation around a genealogy of photosensitive materials and devices in relation to media history and art.

As one of the basic and essential conditions to establish communication processes among living organisms and machinic and hybrid systems, sensorial structures are crucial for enabling inside-outside exchanges. Moreover, since media art is regarded as a dynamic and essentially process-based artistic expression, analyzing sensitive materialities in media artworks is a direct way to address their relational characteristic.

Sensitive materials and devices also proved to be a promising object of analysis for addressing concerns stemming from preliminary research and observations made during my praxis in the field as media artist, curator and lecturer. One of these concerns was the frequent neglect of the materiality of electronic and digital

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4 Ibid.

5 According to the Online Etymology Dictionary, the term as a noun 'medium', plural 'media', has its origin in the late 16th century, denoting intermediate agency, channel of communication. Its Latin root means literally "middle, midst, center; interval". The specific meaning related to communication media was first observed in the mid-19th Century. <https://www.etymonline.com/word/medium> Accessed May 21st 2018.

6 Fohler, Susanne. *Technikтheorien: Der Platz der Dinge in der Welt des Menschen*. München: Wilhelm Fink Verlag, 2003.

7 Latour 1996; Barad 2003; Bennett 2010; Schäffner 2015.

media[8] and its specificities. The implicit material-immaterial correlation between the processes of sensing and making sense involved in media artworks could be examined through any kind of physicochemical phenomenon. Nevertheless, while observing the historical importance of photosensitive materials in the origin of audio-visual media as well as the increasing variety of uses attributed to photosensors in artistic installations and performances, the prospect of unboxing photosensitivity presented itself as an intriguing way to deepen the discussion on the (im)materiality of media art.

Another concern that emerged from my previous experience was the insistently prevalent *"gap between 'two cultures' of natural sciences and the humanities"*[9], which has been deconstructed in various contexts in the thesis. To reveal the complexity of photosensitive materialities and operations in media artworks, both the cross-disciplinary practice itself and the analysis here conducted face the challenge of bridging opposing traditions, which reflect the dichotomous relationship between theory and practice. The diversity of references – ranging from highly technical to philosophical – was intentionally chosen to trigger dialogues among the various types of media art agents: artists, scientists, critics, curators, and students.

To query the dichotomous issues often present in media artworks – material-immaterial, organic-machinic, theory-practice – a genealogy of photosensitivity was constructed to stress relevant concepts and historic and contemporary examples in support of a relational material approach concerning media art. Retelling some well-known media histories from an alternative perspective related specifically to photosensitivity,[10] the examination shows where the dichotomies are located and how counterproductive it is to feed them. The purpose was to elucidate specific elements of the photosensitive qualities found in media artworks and their implications, as a metonymy to provide general and crucial guiding criteria for the production, criticism, education and diffusion of media art.

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8 When renowned authors in the field, such as Edmond Couchot, state that *"the image-making processes are no longer physical (material or energy related)"* (Couchot, 2007: 182-3), all the existent materialities that the human senses cannot perceive are ignored. Pierre Lévy in *O que é o virtual?* (1996) has precisely critiqued the problem of the misconception of the virtual and its immaterialization.

9 Daniels 2011: 5.

10 It is more frequent in the literature of media and art history the focus on the role of light and visuality, while photosensitivity is relegated to being a secondary and less discussed topic. Some examples are the aforementioned Cubitt's *The practice of light:* and Peter Weibel and Gregor Jansen (Eds.) *Lichtkunst aus Kunstlicht/Light Art from Artificial Light. Licht als Medium der Kunst im 20. und 21. Jahrhundert/Light as a Medium in 20th and 21th Century Art.* Ostfildern: Hatje Cantz, 2006.

Material-immaterial

Intertwined with abstractions and materialities, every media presents specific characteristics that express a worldview and suggest how one relates with it. Abstractions are here understood as concepts, languages, codes, symbols, software, mathematical models and operations, etc.; whereas materiality refers to the set of materials, devices, physical objects, technical ensembles, hardware, and so forth. In this sense, analysing media artworks is very close to detecting and studying the various ways of combining and implementing their materialities and techniques, their physical characteristics and their operations, respectively, in a given context.

The lack of knowledge about media art materialities and operations often produces an imprecise terminology for media art within the art world. The problem increases if one considers the complexity of each element forming media devices as technical ensembles. Ignoring the technical knowledge produced by scientists can lead to a series of misunderstandings and false premises. Light, for instance, given its dual electromagnetic nature as particle and wave, can mediate physicochemical processes as both energy and signal sources, requiring different structures for specific operations. Philosopher Peter Sloterdijk's (1947-) perspective on the concept of matter in relation to its response to light is especially pertinent here. He wrote: "*Matter is present wherever light cannot penetrate. Matter is called matter when a resistance or an opaque size, that is, a dense or impermeable size, obstructs the propagation of light*".[11] This quote can lead to a false generalisation, which is easily deconstructed if one looks deeper into the differing material reactions to light actuations, especially by observing the variations provoked in a given material's resistance. Some materials, for instance, have special characteristics that entail that light changes their resistance. As light passes through matter, there is an interaction, and light may be absorbed, reflected, scattered, dispersed, or otherwise altered. Here lies an important part of the present work, dedicated to reveal, or at least acknowledge, mankind's ability to manipulate and attribute aesthetic significance to matter that is beyond the capacity of the limited human sensorial apparatuses to perceive. In other words, the interplay between material and immaterial cannot be considered solely from the human perspective of what is visible and/or tangible.

Walter Benjamin's *The work of art in the age of mechanical reproduction* (1936), as a response to Paul Valéry's inquiry into the emerging ubiquity of representations in the *beaux arts*,[12] is a seminal study in media theory and history concerning the new

11 From the original in German: "*Materie überall dort vorliegt, wo Licht nicht durchdringen kann. Von Materie spricht man dann, wenn ein Widerstand oder eine opake Größe, das heißt, eine dichte oder undurchlässige Größe sich der Ausbreitung des Lichtes in den Weg stellt*" Sloterdijk, Peter. Licht und Widerstand. Über Materie. In: Heibach, Christiane. Rohde, Carsten. (Hg.) *Ästhetik der Materilität.* HFG Forschung Band 6. Paderborn: Wilhelm Fink, 2015. p. 43.

12 Valéry, Paul. La conquête de l'ubiquité. In : Tremblay, Jean-Marie (Ed.) *Les classiques des sciences sociales.* Chicoutimi, Québec, 2003. Electronic edition from Valéry's text originally published

challenges brought by new materials and methodologies. Curiously, while technological development frequently forces standardization, it also provides a potential increase of variability, fostered essentially by the invention, combination and recombination of new information and materials. In this sense, media art production is a propulsive force toward the generation of disruptive forms of media, in other words, of new means to communicate. Photography is an accessible example of what is meant here. The photo camera is a complex machine based on different fields of knowledge. Principles from physical optics, chemistry, geometry and perspective were joined in an ensemble that is able to capture and store images, which later, with the assistance of another machine and devices, can be reproduced. The camera itself is a media (mean) to make an image possible and concrete: the negative, the print, a data file, all of which are media (means) themselves. One cannot conceive photography without the set of apparatuses that are used to produce it, which are still now being constantly reinvented.

The development or enhancement of a technology provokes paradigm changes in its aesthetic appropriations in similar proportion. What photography inaugurated has been considered as the liberation of the hands of the artist and, ironically, as the beginning of a dependence on machines. Nevertheless, instead of judging how free from or attached to the tool the artist is, it is relevant to recognize the increasing distance between mind and hand, a space that has become filled with numerous inter*media*te elements. Since the advent of photography, the supposed talent required from an artist to produce an image became coupled with the potential and limitations of a series of industrial products: photosensitive emulsions applied to celluloid, the cameras, the developing chemicals and print machinery. Thenceforth, artistic expression was also able to be executed by digits[13]: a shot[14],

in 1928, in Œuvres, tome II, Pièces sur l'art, Nrf, Gallimard, Bibl. de la Pléiade, 1960. pp. 1283-1287. Available at <http://classiques.uqac.ca/classiques/Valery_paul/conquete_ubiguite/conquete_ubiquite.html> Accessed: May 30th 2016.

13 The term 'digit' refers simultaneously to a finger and a numeral. This is a special example to draw attention to the role of metaphors in media development, which also embodies the material and immaterial aspects at the same time.

14 Numerous theoreticians have discussed the historical connections between cameras and guns in ways that go beyond the language domain (with the verb 'to shoot') to encompass their technical developments. For more information concerning this topic, I suggest reading Paul S. Landau's *Empires of the Visual: Photography and Colonial Administration in Africa*, published in Landau, Paul S.; Kaspin, Deborah D. *Images and Empires: Visuality in Colonial and Postcolonial Africa*. Berkeley: University of California Press, 2002. pp. 146-49. A classic media artwork on the topic is *World Skin: a Photo Safari in the Land of War,* by the French artist Maurice Benayoun. More details at his official webpage: <http://www.benayoun.com/projet.php?id=16> Accessed March 15th 2016.

a bang, a trigger, a number. This represents an escalation of abstraction[15], as has been suggested by media philosopher Vilém Flusser (1920-1991), who in his *Filosofia da caixa preta: Ensaios para uma futura filosofia da fotografia* (1983)[16] suggested one to deplete the apparatus' possibilities. Nevertheless, the higher the degree of abstraction the more combinations between the immaterial and the material world tend towards infinity through the continuous invention of apparatuses. As known from traditional media history, what was learned from photography was later incorporated in techniques to develop machines for producing, storing and distributing moving images, which gave birth to another seminal media: cinema. However, it also took time to assimilate the dimension of time to film itself and to subsequently explore cinema's own expressive language. There is no way to ignore that film development and editing used to be a very material praxis. Material issues also emerged when sound and colour were added to film technology.[17] Therefore, to understand and explore media-specificity in both terminological and practical instances, it is crucial to think about media's materiality.

In the aesthetic domain, the liaison between an idea to be communicated and the materiality to be used is mediated by the sensing phenomena. Outlining a genealogy of light-sensitive elements in relation to media art is also a strategy to highlight the expanded creative possibilities of today, beyond the disciplinary boxes that institutions normally impose, so that thinking about the possibilities of dealing with images (and per extension the imaginary) can move far beyond verisimilitude.[18]

Substantial changes in relation to the material-immaterial relationship were triggered by Modernism[19] during late 19th and early 20th centuries during the in-

15 Flusser, Vilém. *Universo das imagens técnicas: Elogio da superficialidade.* São Paulo: Annablume, 2008.

16 Flusser 2011.

17 Kittler, Friedrich. *Optical media: Berlin Lectures 1999.* Translated by Anthony Enns. Cambridge, UK/Malden, USA: Polity Press, 2010 (first published as *Optische Medien/Berliner Vorlesung 1999*. Berlin: Merve Verlag, 2002).

18 In the history of art, the sense of sight has been paramount in the production and perception of an artwork, and this tradition continues today in art museums due to preservation and security issues through the imperative, "do not touch". Furthermore, the mixture of modern artistic experiences with media development pushes both the history of art and the philosophy of images to transcend the limits of art, as shown by *Theorie des Bildakts.* The theorists of this movement base their work largely on Ernst Cassirer's philosophy of symbolic forms, stretching the idea of materialized symbols and their embodied forms, as well as a form of animism. An excellent introduction to this perspective can be found in: Bredekamp, Horst. The Picture Act: Tradition, Horizon, Philosophy. In: *Actus et Imago – Bildakt at Warburg Institut*. Berlin/Boston: De Gruyter, 2014, pp. 3-32.

19 Argan, Giulio Carlo. *Arte Moderna: do Iluminismo aos movimentos contemporâneos.* São Paulo: Companhia das Letras, 1992.

dustrial revolution. Along with the wide-scale transformations of Western society emerged artworks emphasizing the crisis of representation in the visual arts, whose further development lead to the neglect of the art object itself and a simultaneous emphasis on artistic processes and situations. Artists increasingly proposed artworks in which the role of the audience was necessary for the artwork to occur and, therefore, to be experienced.[20] These sort of initiatives also contributed to reviews of the exhibition spaces themselves.[21]

Simultaneously, art history recorded examples of technical and material primacy[22]. The tension between the abstraction of concepts and the concreteness of materials is unavoidable. In media artworks, whose materials and technical means are mostly dependent on industrial artefacts, this tension increases in complexity and influences the core of the creative experience. Remembering the Platonic definition of '*techné*', often translated as 'art', 'craft', 'skill', 'technical knowledge', 'expertise', and even 'science'[23], helps to explain why media art historians and critics structure their arguments around the fruitful intersections between art, science and their common technological apparatuses.

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20 Popper, Frank. *Le déclin de l'objet - art action participation 1*. Chêne, Paris, 1975. A more critical perspective can be found in Bishop, Claire. *Artificial Hells: Participatory Art and the Politics of Spectatorship.* London: Verso, 2012.

21 In 1942, for instance, in the exhibition *First papers of surrealism* Marcel Duchamp (1887-1968) proposed the *Twine* installation. As he was also contributing to the exhibition design, he filled the whole space with twines, in such a way that the visitors needed to pass through the materiality of the work to experience it as well as to reach the others artists' artworks. There are several possible interpretations of this artwork, however, the intention here is to show the beginning of the trend to physically include the audience in the artwork. Within this context, as states art critic Vick John, "*Duchamp himself, also tended to stress more his twine's functional value than its symbolic meaning*"[21]. John, Vick. 2008. *A New Look: Marcel Duchamp, his twine, and the 1942 First Papers of Surrealism Exhibition*. Available at <http://www.toutfait.com/online_journal_details.php?postid=47245> Accessed March 14th 2016. A later significant example in this trend is the *Relational Objects* series by the Brazilian artist Lygia Clark (1920-1988), who largely contributed to what in art history is called Participatory Art, mainly in the 1960s and 1970s. In this series of works she used objects to engage people in situations of exchange. The objects themselves had no meaning. The same phenomenon is observed in optical and kinetic artwork, developed in the same period by artists such as Yaacov Agam, Jesús Rafael Soto and others.

22 As contemporary examples there are the colour and paint patent cases, such as the International Klein Blue, a deep blue hue first mixed by artist Yves Klein (1928-1962) in the 1960s, and more recently the Vantablack, the blackest and therefore least light reflecting pigment ever produced, developed by the British Company NanoSystems and patented by Anish Kapoor (1954-) for artistic applications.

23 Roochnik, David. *Of art and wisdom: Plato's understanding of techne.* Pennsylvania State Univ. Press, 1996.

Furthermore, these cases do not merely exemplify the interplay between material-immaterial, visible-invisible, tangible-intangible, they also reflect the link between psychic and social systems, which are frequently divided in art theory and criticism. Entangled within the operationalities of art, psychic and social systems integrate what the cyberneticist sociologist Niklas Luhmann (1927-1998) named 'art system'.[24] From this perspective, analysing photosensitivity in artistic dynamics strategically addresses the continuity, mutual influence and communication among humans and other organisms and wo_man-made and artificial objects.

Organic-machinic

For the philosopher of technology Gilbert Simondon (1924-1989), organisms and technological artefacts emerge from distinct evolutionary processes of individuation.[25] Nevertheless, there are plenty of examples of how the understanding of the natural world and the human ability to create and construct media and machines mutually influence one another. Although clearly distinguishing the borders between biological and technological beings, Simondon believed that human-machine coupling can exist when a common code to the memories of both can be discovered, so that through the convertibility from one system to another one can achieve a possible synergy.[26] Flusser's notion of the zero-dimension of electronic and digital media will be used to support this thesis' argumentation on the possibilities and implications of the convertibility mentioned by Simondon. The current technological context is materially and technologically enhancing the possibilities of merging the evolutionary principles of organic and cultural objects, thereby leading towards the emergence of hybrid systems.

An implementation of this framework of thinking can be found, for instance, in the biological notes of the conceptual machines described in *Vehicles – Experiments in synthetic Psychology* (1984) by the cyberneticist Valentino Braitenberg (1926-2011), who blurred the traditional borders between nature and culture in relation to neuroscience and computer science.[27] Referring explicitly to the McCulloch-Pitts neuron model, Braitenberg modeled his vehicles on the electrical properties and function of neural cell membranes, following the fundamental operations of calculus and logic propositions: conjunction (AND), disjunction (OR) and negation (NOT). Those operations coincide with the elements of logic used by Greek philosophers

24 Luhmann, Niklas. *Art as social system*. Stanford, CA: Stanford University Press: 2000.

25 Simondon, Gilbert. *Du mode d'existence des objets techniques*. Domont/Roubaix, France : Éditions Aubier, 1958/2012. p. 82.

26 From the original in French : "*Le couplage de l'homme à la machine commence à exister à partir du moment où un codage commun aux deux mémoires peut être découvert, afin que l'on puisse réalizer une convertibilité partielle de l'une en l'autre, pour qu'une synergie soit possible*". (Simondon 1958: 173)

27 Braitenberg 1984: 109.

in antiquity and by programmers today. In the arts, such coincidences have allowed artists to use mathematical models of complex natural phenomena to create generative and self-organizing audio-visual artworks, such as autonomous light and robotics sculptures and video and sound art, which frequently use biological matter as well.[28]

Looking at these kinds of possibilities and focusing on the intersection between photobiology and sensor engineering, the thesis addresses how photosensitivity (light-matter interaction) plays an essential role in both life and media development through the relationship between sensorial/material limits and human endeavors to play with them, enhancing, altering and extending their characteristics.

Theory and practice

The insertion of machinic apparatuses in the production of art mirrored the pre-existent division based on the dichotomy between theory and practice, which separates those who think about and conceptualize from those who execute and master the material and technical aspects. This separation began far before modernity and industrialization with the history of culture, which coincides with the history of abstraction.[29] Contemporary media art likewise stems from this historically and culturally constructed gap between the world of thinkers and the world of makers. In association with the concept of process-based artworks and the immateriality this concept suggests, related terms and roles like 'participant', 'interactor' and, more recently, the 'maker'[30] have emerged and carried over to the idealism of Do-It-Yourself (DIY) and hacking cultures. However, while in art history discourses the art object has lost its significance, the commoditization of the artwork is (and always has been) a constant requirement of the art market. To fit these requirements, process-based artworks are either shrunken to take place in exhibition spaces, or artists find alternative spaces more adequate to their ideas. To a certain extent, banal views of interactive art are associated with this phenomenon. Often the word 'interactive' has been used to refer to any use of digital media in art exhibitions, undermining the aesthetic movement towards the potential openness of

28 A recent example is the cybernetic synthesizer CellF, created by Guy Ben-Ary. CellF is an autonomous instrument made from evolving networked biological matter. More information about the project at <http://guybenary.com/work/cellf/> Accessed May 9th 2017.

29 Flusser 2008:16-19.

30 The Critical Media Lab (Swiss Institute of Experimental Design and Media Cultures), at the Transmediale Festival 2016 – conversation pieces, critically addressed the maker culture by presenting the intervention Unmaking_Kits. The curatorial program of the festival was divided into four parts of the contemporary anxieties related to the digital media: Anxious to act/Anxious to make/Anxious to share/Anxious to secure. More information about the intervention available at <http://www.ixdm.ch/portfolio/unmaking-5-anxieties/> Accessed July 31st 2016.

artworks.[31] Instead of freeing objects from deterministic statements and forms, so-called interactive media artworks often constituted mere reactive systems, with little margin for uncertainty and indeterminacy.

One can hardly say that there is a difference between thinking and acting in media art practice. Nevertheless, one notices that the levels of intimacy with media materialities diverge at the same pace as that of the antagonism between the developers and the users logics.[32] In the history of electronic and digital culture, the emergence of the graphic user interface (GUI) is a classic example of this dissociation and the increasing number of intermediate layers between artists' minds and hands. Other facilitators for media artists and designers in relation to software and hardware tools (e.g., the development of Processing, Arduino and Raspberry Pi boards as well as many other visual programming platforms such as Isadora, Max/msp and Pure Data) are also manifestations of these intermediate layers that have emerged in the creative industry of human-machine communication.

Human history, memory and culture are essentially developed through relationships with objects. Electronics and digital objects have the special feature of being programmable. The increasing miniaturization of devices and the encapsulation of calculation and algorithmic processes on a scale that human senses cannot perceive have brought with them a sort of media device fetishism. Seduced by their external appearance and ignoring the internal operational processes, one easily renounces learning and understanding when dealing with electronic and digital objects. This is one of the possible driving forces behind the dichotomous relation between theory and practice in media art as well. However, Vico's[33] axiom seems to be still valid: *"man is able to understand only that which he himself has produced"*,[34] and, from a complementary viewpoint, that which one has oneself experienced. Coming closer to the materiality of things and acknowledging the role of the observer when observing a system are essential conditions for participating in processes of knowledge production.[35] While refraining from the nostalgia for pre-industrial times, it is necessary to recognize the craftsmanship values behind media artworks, reducing the theory-practice dichotomy.

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31 Eco, Umberto. *A obra aberta: Forma e Indeterminação nas Poéticas Contemporâneas.* São Paulo: Perspectiva, 2003.

32 Krippendorff, Klaus. Discourse and the materiality of its artifacts. In: T. R. Khun (Ed.) *Matters of communication: Political, cultural, and technological challenges to communication theorizing*. New York, NY: Hampton Press, 2011. pp. 23-46.

33 Expressed by the Enlightenment polymath Giambattista Vico (1668-1744).

34 Bredekamp, Horst. The Picture act: Tradition, horizon, philosophy. In Marienberg, Sabine; Trabant, Jürgen. *Bildakt at the Warburg Institute. Band XII Actus et imago*. Berlin/Boston: De Gruyter, 2014. p. 9-10.

35 In a historical and comparative study of work skills Richard Sennett reviews and updates Vico's idea in terms of the current technological cultural environment. Sennett, Richard. The craftsman. New Haven, Connecticut: Yale University Press, 2008.

One can certainly find few examples of artists and groups that have been successful in bridging the gap between theory and praxis in the cross-disciplinary field of media art. However, artists do frequently rely on the knowledge of engineers to solve problems on the material level and, albeit rarely, let a media artwork evolve as a collaborative process by means of knowledge exchange. This reproduces the pre-established work division between conceptualization and handicraft. This problem results, on the one hand, from the lack of integration between scientific and aesthetic knowledge and, on the other, from how educational systems are organized. In this sense, the Simondonian perspective on the chasm between technical and intellectual knowledge is very actual.[36] According to Yuk Hui, *"for Simondon, the divergence of knowledge production between science and technology, theory and practice, leads to the opposition between culture and technics, and so we need a new philosophical thought to bring society together, hence the technics can be re-inscribed in culture"*[37]. This is one of the assumptions and endeavours of the present thesis as well in light of the technological advances being experienced by the current generation of artists and the difficulties of dissolving this dichotomy in highly specialized environments.

The above inquiries into media art were incited by a hands-on approach with photosensitive elements. By means of resisting and counter-acting upon the established and embodied ways of doing, the research process has been an attempt to use critique and self-reflection as a means to emancipate of artists from unrecognized dependencies.[38]

The conceptualization and execution of an aesthetic experiment re-informed the aforementioned material-immaterial, organic-machinic and theory-practice issues, leading to the formulation of a general research question: *How do photosensitive elements support a reflection on the (im)materiality of media art that provides a basis to discuss its aesthetics, specificities and adaptability to each media artwork context?*

To address each dichotomy directly, the thesis poses specific research questions in each of its three chapters.

Methodology

The research methodology combined historical and analytical approaches, including cultural techniques, media archaeology, new materialism and second-order cybernetics. The articulation of this conceptual toolbox indirectly mirrors the triadic structure often implemented in formal and informal levels of art education:

36 Simondon 1958.

37 Hui, Yuk. *On the existence of digital objects.* Minneapolis, London: University of Minnesota Press, 2016. p. 5

38 Habermas, Jürgen. *Theory and praxis.* Boston, USA: Beacon Press, 1973. pp. 1-40.

to read, to make and to contextualize, as systematized by art educator Ana Mae Barbosa (1936-)[39] based on Paulo Freire's (1921-1997) pedagogic theory.[40]

Cultural techniques

Frequently implemented in media studies, cultural techniques encompasses practices and methods of producing culture located at the interface between the humanities and the technological and natural sciences, and it constitutes a condition of the possibility of culture per se.[41] In practice, the approach of this thesis consisted in opening the black boxes of knowledge embedded within photosensitive biological models, technological artefacts and their operations. The procedures form a framework that allows comparisons among the analysed elements, enabling a historical and a critical genealogy to emerge.

Implicit in this process is the mutual influence between body and media technology, as also suggested by the cultural studies scholar Harun Maye.[42] This perspective structured the development of a genealogy of photosensitivity in relation to media art, starting with the analysis of basic elements and followed by various combinations among them and their surroundings, forming, in Simondon's terms, technical ensembles and their milieu.

Furthermore, cultural techniques are an effective theoretical framework to deal with cyclic translation chains between characters, persons and things. As a cultural practice closely related to the human sensorial-cognitive system and the invention of technical apparatuses, media artworks' complexity can hardly be grasped if not through such an approach. Understanding its translation dynamics is essential for media artists to enhance their own awareness and production concerning the relationship 'form-function-content'.

Media archaeology

Looking carefully at media theory and history, one can notice that, despite a movement toward innovation, inventors and artists are not driven by a linear progression of technology. They are rather driven by the friction between traditions and the discovery of new techniques. Media are constructed by complex relationships that constantly and dynamically overlap, adapt and reorganize elements.[43] In this

39 Barbosa, Ana Mae; Cunha, Fernanda Pereira (Orgs.) *A abordagem triangular no ensino das artes e culturas visuais.* São Paulo: Cortez, 2010.

40 Freire, Paulo; Illich, Iván. *La educación: Una Autocrítica.* Búsqueda: Buenos Aires, 2002.

41 Maye, Harun. Was ist eine Kulturtechnik? In: Engell, Lorenz; Siegert, Bernhard (Ed.) *ZMK Zeitschrift für Medien- und Kulturforschung.* Band 1. Hamburg: Felix Meiner Verlag für Philosophie. 2010. p. 121.

42 Ibid 123.

43 The German Media Theory school elucidated the architecture of knowledge by clarifying the existence of abstract operations of media technologies over time: processing, transmitting

sense, media-archaeological approaches relativize media obsolescence and present alternative and unexplored paths to explain why, for instance, film did not make books obsolete, television did not make cinema theatres disappear, or Youtube has not incited the disappearance of both. The history of stereoscopic image devices, which have experienced several waves of popularity since the end of the 19th century, is another didactic and interesting example to demystify the disruptive character marketed together with certain technological devices.[44]

Therefore, the compilation of ideas shared in the thesis was based on the combination of media archaeological excavations with sharp examinations of contemporary media art exhibitions and artworks, followed by a systematic selection of samples that present the potential to enhance the argumentation. This collection and systematization aims to clarify interrelations between photosensitive elements, media art histories and knowledge construction.

Jussi Parikka defines media archaeological approaches in general as *"digging into the background reasons why a certain object, statement, discourse or, for instance, in our case, media apparatus or use habit is able to be born and be picked up and sustain itself in a cultural situation"*[45]. However, as a relatively recently established field of study, each theoretician or artist dealing with past media has developed their own way of dealing with them. Hence, regarding the variety of media archaeological approaches, a hybrid one was adopted here, embracing on the one hand, the work of the media theorists Wolfgang Ernst, Jussi Parikka and Friedrich Kittler, who incorporate Foucault's genealogical method, not only going back in time in historical terms, but also inside machines' infrastructures[46]; and on the other hand, that of Siegfried Zielinski, who counts on *"fortuitous finds instead of searching in vain"*[47].

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and storing information, from electrons and ions to images and sounds. The works by Friedrich Kittler, Wolfgang Ernst and Wolfgang Schäffner mark the origins of this work. More specifically see: Schäffner, Wolfgang. Elemente architektonischer Medien. In *Zeitschrift für Medien und Kulturforschung*. Nr. 1. 2010, pp. 137-149. Ernst, Wolfgang. *Digital Memory and the archive*. Minneapolis: University of Minnesota Press, 2013; Kittler, Friedrich. *Aufschreibesysteme 1800/1900*, München: Fink, 1985; and from the same author *Grammophon, Film, Typewriter*. Berlin: Brinkmann & Bose, 1986.

44 Many authors are relevant in demonstrating through media-archaeological perspectives what I state here. Among them, those that most influence my thought are: Grau, Oliver. *Arte virtual: da ilusão à imersão.* São Paulo: Editora Unesp/Editora SENAC, 2007; Zielinski, Siegfried. *Deep time of media: Toward an archaeology of hearing and seeing by technical means.* Cambridge/London: MIT Press, 2006.; Crary, Jonathan. *Techniques of the observer: on vision and modernity in the nineteenth century.* Cambridge/London: MIT Press, 1990.

45 Parikka 2012: 6.

46 Parikka 2012: 81

47 Zielinski 2006: 15.

New Materialism

Another important issue is the definition of materiality, which is here understood as the constitutive nature of objects and lives, as manifestations of matter in the perceived and known (studied and modelled) physical world.

Complementarily to the media-archaeological perspective, new materialist approaches consider the agency of matter through its material-discursive practices.[48] They endorse a post-humanist worldview, in which matter (such as meaning) is dealt with as a doing, rather than as a static object. In this sense, matter is considered through its on-going historicity, as part of the continuous stabilising-destabilising activities happening in and shaping the world.

Since the creative process in media art happens in the flux between the conceptual and the concrete worlds, between purifications and translational processes[49], a new material approach is the most suitable contemporary theoretical framework to embrace the complexity of operations involving photosensitivity.

To consider a new materialist approach in relation to media art does not entail adopting deterministic viewpoints. On the contrary, it includes the problem of media-specificity and its relationship with the subject being communicated. This means that the coherence and cohesion among the elements implemented in media artworks are more relevant and insightful than merely appreciating the beauty of a final enclosed art object.

Second-order Cybernetics

Cybernetics evolved as a cross-disciplinary science in the 1940s to study control and communication in machines and living beings.[50] Highly criticized for of its use in military contexts, it has undergone substantial changes since 1974, when Heinz von Foerster distinguished first- from second-order cybernetics, *"respectively, the cybernetics of observed systems and the cybernetics of observing systems"*[51], highlighting the observer's role in the observation process. Nowadays, cybernetics remains a successful methodological tool to consider recursive movements from abstract to concrete, from beings to machines, and from nature to culture.

The inclusion of the role of the observer in the research process supported by the meta-theory of second-order cybernetics has enabled the integration of thinking and doing in media art. The second-order observer is the conceptual tool that has enabled the researcher to address as directly as possible the conflict between theory and practice. To maintain a minimum level of consistency given the critique of

48 Latour 1996; Barad 2003; Bennett 2010; Schäffner 2015.

49 Latour 1993: 11.

50 Wiener, Norbert. *Cybernetics or control and communication in the animal and the machine.* New Orleans, Lousiana: Quid Pro Books, 2016 (1958).

51 Scott 2011:30.

this specific dichotomy, the present research could not be based only on readings, technical visits and conversations with artist and specialists.

As a methodological tool for this practice-lead research[52], an aesthetic experiment in media art was developed, named *Self-portrait of an absence* (2016). The researcher's partial absence of vision was appropriated to conduct a second-order cybernetic approach. Using her own body as source of investigation and considering the eye as an epistemological object, her role as observer has been inevitably acknowledged throughout the research process. By confronting organic and machinic light-sensitive entities, namely eye and camera, a part of the research was motivated by the triad: eye-camera-black box. This constellation was assumed as a challenging epistemological and relational object, provoking reflections that structured the subjects articulated in this thesis.

Thesis structure

The thesis is divided into three chapters, which each unfold increasingly complex technical ensembles.

In chapter one, *Photosensitivity: Materialities and operations*, the protagonists are photosensitive elements from media history and media art. Developing the argumentation from individuals to technical ensembles, the chapter sketches the relationships between the discoveries of materials, the development of devices, models of understanding of biological elements, and their expressions in the aesthetic field.

The questions orienting the chapter are: *What is the technical and scientific knowledge embedded in light-sensitive matter? How does this knowledge relate to media development? What has been aesthetically integrated in media artworks?* These questions evolve into material, technical and operational explanations, showing how overlapping the material and immaterial layers of media art are. This leads to a discussion based on the notion of media art's informational aesthetics.

The second chapter, entitled *Photosensitivity shaping hybrid systems,* focuses on another dimension of photosensitivity, namely the organic-machinic dichotomy, and addresses its manifestations in media artworks. The question orienting the chapter is: *What photosensitive materialities and operations being used in media artworks can help to deconstruct the organic-machinic dichotomy?* Due to the immense variety of photosensitive elements, it was necessary to narrow the analysis down to a specific typology. Therefore, light-sensing as vision has been privileged, by means of a comparison between eye and camera. Nevertheless, guided by new materialist and

52 According to Henk Borgdorff *"embedded in artistic and academic contexts, artistic research seeks to convey and communicate content that is enclosed in aesthetic experiences, enacted in creative practices and embodied in artistic products".* (Borgdorff 2011: 45)

post-humanist approaches, the chapter also presents some examples that demonstrate the relevance of photosensitivity in relation to non-human living organisms within media art.

The first and second chapters prepare the reader by introducing the background information required for the core argumentation of the thesis, developed in chapter three *Light-to-sound translations*. Including the performance *Self-portrait of an absence* developed by the author, media devices and artworks technically based on light-to-sound translations are analyzed and compared in their specificities. The set of questions guiding the chapter are: *How do translations from light into sound occur? Can media artworks be seen as processes of the translation of materialities? How do media artists embrace their role as translators? What are the challenges for the artists underlying this endeavour?* The argumentation evolves from the definition of a sensor, which transforms a physicochemical stimulus into an electric signal[53] that together with its programmability, structures a sort of meta-language for communication between beings and things. The zero-dimensionality of electronic and digital media, as proposed by Flusser, allows media artists to translate any material into another.[54] The analysis leads into a discussion of the implications of creative processes based on the translation of materialities, drawing attention to the absent zone found in between the systems in translation.

The thesis is addressed to art students, artists, curators and theoreticians and aims to contribute to a critical perspective on the use of scientific and technological knowledge in aesthetic experimentation. It presents arguments for recognizing the bridging role of the artist, who creates empowering tools for reflecting, acting upon and triggering reflections about technocratic society and the potential freedom embedded in imaginative and poetic uses of technical objects.

53 Fraden 2004: 1.

54 In addition to Rainer Guldin's (2010) ideas about Flusser's work, the technical definition of a sensor by Jacob Fraden (2004) and insights obtained from researcher's own practice justify the use of the term 'translation'.