RESEARCH DEGREES WITH PLYMOUTH UNIVERSITY

ARTISTIC MODULATION OF CONSCIOUSNESS BY BIOELECTROMAGNETIC STIMULATION

by

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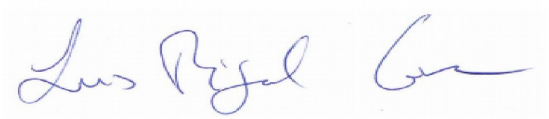
Signed 

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Abstract

Luis Miguel Girão

Artistic Modulation of Consciousness by Bioelectromagnetic Stimulation

The thesis demonstrates why the application of bioelectromagnetic stimulation as a medium of artistic expression allows for the production of new and unprecedented realisations of integrative art. Furthermore, the modulation of consciousness in human beings relating with such realisations is argued to be the core of a new practice of research resulting from the technological confluence of Philosophy, Art and Science.

The Brunelleschi Experiment is examined in order to establish the assumption that one of the fundamental characteristics of Art is to impact consciousness of those interacting with its forms. The aspects of disembodiment of the previously referred experiment, instrumental in provoking such impact, are argued to be consistent with those found in the philosophy and practice of Fernando Pessoa. The practice of the Portuguese philosopher is presented as proto-foundational grounds of the new research practice proposed. The recent findings of Olaf Blanke, specially the ones regarding the induction of out-of-body experiences by bioelectromagnetic stimulation are reassessed as previous technological foundations of the new artistic realisations proposed.

The practice of art was an instrumental part of the research and is therefore described as a methodology to access consciousness and generate knowledge, a thinking process. Research was undertaken in the context of two projects: Sensitive Spheres and Collectron. Both projects are representations of the social implications of perceiving human beings as electromagnetic manifestations. In the context of these projects, Bioelectromagnetism is understood as the study of the intersections between biological entities and the electromagnetic spectrum. Each project represents a culture of interactions between biological beings, including their spiritual dimension, in which art plays a fundamental role in creating alternative forms of communication as well as in congregating and mediating consciousnesses at a collective level.

In conclusion, Homo Conscientis, an audiovisual integrative experience applying bioelectromagnetics, is presented as the first manifestation of the new practice proposed. Both its technical aspects and the observations resulting from its application have been thoroughly described.

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Introduction

Luis Miguel Girao founder of Artshare, the NATO Art Expert, is a researcher generating support for EU and Transatlantic policy making in the field of the crossings of art, science and technology. He is a transdisciplinary artist developing applications of technology as tools for artistic expression focusing at the moment on bioelectromagnetism. He is a member of the Planetary Collegium and of the Centre for Sociology and Music Studies of Faculty of Social Sciences and Humanities of the New University of Lisbon, Portugal. In 2007, he was awarded the Bolsa Ernesto de Sousa prize, Lisbon-NYC. He collaborated with several artists and scientists and his work has been presented worldwide. He was coordinator of ICT ART CONNECT 2013 and of ICTARTCONECT.study for the European Commission. These activities gave origin to the DG CONNECT's initiative STARTS - Science, Technology and the Arts in which he is extremely involved in. He and his colleagues at Artshare are actively contributing to the VERTIGO, CREATE-IoT and BRAINHACK EC funded projects.

Motivation

The motive to do the research presented in this dissertation is rooted in an early vision by the author of a ‘machine’ that could induce changes of emotional states of humans. The research started after the author’s previous achievements on the application of computer vision techniques to create collective interactive systems. Those achievements created his basic understanding of the concept of bioelectromagnetism which was the starting point of the research. His experience in the Planetary Collegium lead him to expand the potential consequences of that

primordial vision to the field of consciousness studies. The research focus was therefore problematized in the context of consciousness studies.

Additionally, since his experience at the Biennale of Cerveira, in Portugal, in 2001, where the author met the then Minister of Science and Technology of the Portuguese Government, Jose Mariano Gago, his research practice was always intertwined with policy making, due the pioneering aspects of his activities – the integration of artists in technological research. A key aspect in this is the fact that the author's research practice was always funded by the Science and Technology sector and not by the Cultural sector. An illustrative example is the SKILLED ART project, under which a significant portion of the research here presented was done. SKILLED ART was coordinated by the author of the thesis. That project was funded by research and development funds originally dedicated to engineering. SKILLED ART was unique in the European Union because it was potentially the first ever research and development project in engineering to be coordinated by an artist.

The long-term aim of the author – to which this thesis crucially contributes to – is the integration of artistic practice as significant contribution to research and innovation in the sector of Science and Technology. The crucial contribution of this thesis in terms of policy making in the context of technological research and innovation is the new research practice proposed. By having artistic practices at its core, the new research practice proposed by the thesis allows for the integration of subjectivity in technology driven research.

Overview of the thesis

The thesis sets out to make the case for a new practice of research resulting from the technological confluence of philosophy, art and science. It is based on the hypothesis by which the practice of art based on digital technology facilitates the integration of subjective perspectives in scientific and technological research.

The dissertation articulates the thesis having as point of departure the problematization of the practice of art as a means to access consciousness and simultaneously modulating it in that process. It argues that consciousness is in the *relationship* between subjects and objects. From the point of view of the thesis, consciousness does not exist. It is not a subject as it is not an object. It is a process. That notion of *relationship* is furthermore transposed and analysed as being the core of electromagnetism. The perpendicular *relationship* between the *electric* and the *magnetic* is exposed as being the interface between physical and non-physical realities. By manipulating the *electric* one can transform the *magnetic* and vice-versa. This is described as the process of *modulation of consciousness*. The notion of artistic modulation of consciousness derives from the utilization of a set of well-defined and well-established techniques of bioelectromagnetism that allow for interaction with the nervous system of humans, including the brain and what is nowadays referred to as the second brain, located in a region above the human stomach. *Homo Conscientis*, the latest artwork resulting from the research done is a unique application of those techniques.

Lastly, the thesis is understood and built as an instrument in a global system of production of knowledge. The sub-system of that global system targeted by the

thesis is the European Union's Research Framework. In order for the proposed new practices to be implemented in that system, research policies have to be in place. The STARTS initiative of the Digital Single Market of the European Union and the NATO Arts Framework are also a result from the research done.

Thesis Structure

The thesis is divided in 5 chapters.

The first chapter looks at art practices as emerging from the urgency of expression understood as resulting from two major needs: the need to make things happen, or realisation; and the need to create beings, or manifestation. The notion of modulation of consciousness in human beings is argued to be key in the discourse, as it picks the individual or the collective at a specific point of its oscillation and transforms that oscillation by interfering with it. This interference is triggered by the interaction with forms of art.

The second chapter demonstrates why the application of bioelectromagnetic stimulation as a medium of artistic expression allows for the production of new and unprecedented realisations of integrative art.

The third chapter analyses concepts such as collective intelligence, connected intelligence, planetary consciousness as well as the notion of nonlocality of consciousness, recognising various potential definitions of consciousness, all of them pointing to notions of collectiveness and connectedness. In the light of a panpsychic approach and the bioelectromagnetism concept that this thesis builds upon, consciousness is to be found in the relationship of the parts. In this

hypothesis, consciousness does not exist *per se*. It is essentially viewed as being generated in a constant modulation process that implies action and interpretation: enaction as a way of accessing as well as creating consciousness, motion as its origin, and energy as the potential for transformation that is always dynamic and relational by nature.

The fourth chapter demonstrates why the application of bioelectromagnetic stimulation as a medium of artistic expression allows for the production of new and unprecedented realisations of integrative art. Furthermore, it establishes a model for artistic technology-based practices to be integrated into knowledge generation systems. The first is named bioelectromagnetic art and the latter executive art.

This fifth and final chapter identifies the potential invention of a new form of perspective made possible by the recent developments in bioelectromagnetic stimulation previously exposed in the text. It also demonstrates in particular how society and economy could be shaped and endowed with visions expressed and embodied by artistic practices coupled with innovative technological research.

Variable Target Methodology

The thesis is the result of a *Variable Target Methodology*.

At the core of the thesis is the integration of subjectivity in research in science and technology. Therefore, the research done consistently applied what is claimed by the hypothesis of that integration of subjectivity as an experimental research practice.

Validation of the *Variable Target Methodology* is in its concrete results. Usual validation processes in research are processes of identifying and establishing commonly agreed beliefs, as for instance, polls and questionnaires. In the specific case of this thesis, the resulting policies being implemented as a result of the research done in the thesis are proof of the validity of the research. The STARTS Initiative of the Digital Single Market of the European Union clearly validates the need of integration of artistic practices in research in science and technology. In the context of the SKILLED ART project, public workshops were the basis of further development of the system being developed.

The notion *Variable Target Methodology* is developed later in the dissertation.

Statement of Problem

The main gap in knowledge that the thesis fills in is the lack of exploratory activities in the field of science and technology. The thesis proposes a concrete approach to integrate artistic practices in research in that field. The main research question is, therefore, how can artistic practices significantly contribute to generate new knowledge in the field of science and technology? Other questions are asked in order to make a solid argument. What is consciousness and how is it relevant to artistic practices? What is bioelectromagnetism and how can it be utilized as a physical interface in the practice of art? And finally, how can the findings of the research be applied in a real-world scenario as a new research practice, including the policies needed? This research questions are directly linked with the structure of the thesis and its chapters.

Although the main contribution of the thesis is in the field of science and technology, it is driven by an artistic idea of spreading art in life through technology. The famous book of Anthony Dune, *Hertzian Tales: Electronic Products, Aesthetic Experience and Critical Design*, was already a precursor in this movement of transforming technology into an aesthetic object. However, the origin of this movement is understood by the author as being the Fluxus movement: *"Life is Art. Art is Life"*.

1. Artistic Practices

The thesis sets out to make the case for a new practice of research resulting from the technological confluence of philosophy, art and science. This first chapter looks at art practices as emerging from the urgency of expression of the one that feels it, the artist. This urgency is understood as resulting from two major needs: the need to make things happen, or *realisation*; and the need to create beings, or *manifestation*. *Realisation* is understood as **the core of the practice of art**, while *manifestation* sustains the notion of **the practice of art as a thinking process**.

This chapter aims, furthermore, at establishing the assumption that artistic urgency expresses itself by modulating consciousness both at an individual and a collective level. The notion of **modulation of consciousness in human beings** is argued to be key in the discourse, as it picks the individual or the collective at a specific point of its oscillation and transforms that oscillation by interfering with it. This interference is triggered by the **interaction with forms of art**.

The concept of **medium of artistic expression** is discussed in order to establish the **intrinsic technological foundations** of **new and unprecedented realisations of integrative art** as constitutive building blocks of the thesis.

The major claim of the thesis, therefore, is to contribute to creating new knowledge in sync with contemporary technological advancements. Its main focus, however, lies in **the fundamental role of art in creating alternative forms of communication**.

1.1 The practice of art as a thinking process

Urgency is a condition *sine qua non* in the attribution of the artistic quality to a practice. For a practice to be considered as artistic it has to originate in that primordial urgency. Karl Phillip Moritz (1756-1793), in his writings *Artistic Imitation of the Beautiful*, defined this urgency or *artistic impetus* as drive and not as idea, concept or a representation (Bernstein, 2003). This reverses the Leibniz-Wolffian hierarchy of human faculties by valuing the artistic, by considering the irrational and subconscious as the true source of human agency. Philosophers such as Schopenhauer, Nietzsche and others support that culture initiated by Moritz in which the "dark and undefined" balances with and is as relevant as the "clear and distinct". (Landgraf, 2011)

According to Landgraf, Moritz sees *urgency* as about the productivity of nature that serves as media. It links the artist and the artwork as well as it drives the creative process. Artistic creativity allows for the mediation between an undefined non-representational stimulus, i.e. *realisation*, and the artistic objectification or communication of the stimulus, i.e. *manifestation*. The notion of media is extremely important, as will be further explored in this chapter.

The term *urgency,* rather than the term *impetus*, has been chosen here because it better describes the creative drive from an artistic perspective. *Impetus* indicates a sort of continuity while *urgency* suggests an impulsive nature. Impulsiveness is more appropriate for characterising what is meant in this thesis by *artistic*. The urgency of creation in the form of love is described by the Portuguese poet Eugenio de Andrade (1923-2005) in his poem *Urgently*:

Urgently
It's urgent — love.
It's urgent — a boat upon the sea.

It's urgent to destroy certain words,
hate, solitude, and cruelty,
some moanings,
many swords.

It's urgent to invent a joyfulness,
multiply kisses and cornfields,
discover roses and rivers
and glistening mornings — it's urgent.

Silence and an impure light fall upon
our shoulders till they ache.
It's urgent — love, it's urgent
to endure.

Eugenio de Andrade, translated by Alexis Levitin (Andrade and Levitin, 2003)

Love is the ultimate form of repulsion and attraction, as expressed in this poem: "It's urgent to destroy certain words" is uttered in the same manner as: "It's urgent to invent a joyfulness". Love is of similar nature to electromagnetism. By no means does this imply that love is of electromagnetic nature. However, it is relevant to point out that both love and electromagnetism deal with attraction and repulsion. The idea of two different manifestations of the same phenomena forms

the technological foundation of the new practice of art proposed by the thesis and further developed in section 1.4.

The most relevant part of the poem for the discussion about *artistic urgency* is when it reads: “It’s urgent — love, it’s urgent to endure.” This expresses the bipolar nature of the notion of *artistic urgency* to be conveyed here: on the one hand, the need for impulses, energies of destruction and creation, attraction and repulsion; and on the other, the need for continuation, permanence, and endurance of that state of urgency. The two sides do not entail a division, an alternate ambivalence or a duality. They are simultaneous, juxtaposed, as a quantum.

The bipolarity of *urgency* expressed by Eugenio de Andrade inspires the definition of what is meant in the thesis by *artistic*. *Artistic* is that that is created by an artistic practice, and that distinguishes it from any other knowledge generation practice, such as scientific practice. The core of artistic practice is the *urgency* for creation, composed of two poles: *realisation* and *manifestation*. They are the indivisible components of *artistic urgency*. *Realisation* is the need to make things happen while *manifestation* is the need to create beings.

Realisation is the core of practice itself. It is the action of making. It is movement, the energy of exteriorization. It is embodying in an outward form.

Manifestation is the core of creation. It is openness to revelation. It is recognising a being, the energy of interiorization. It is embodying in an inward form.

The notions of embodiment and disembodiment will be further explored later in the thesis and from different points of view: artistic – *the Brunelleschi*

Experiment; consciousness studies; anthropological - *the International Academy of Consciousness*; and from a neurobiological point of view, in association with bioelectromagnetic induction.

While de Andrade's poem *Urgently* reinforces the expression of *Realisation*, another Portuguese poet, Helder, expresses an extraordinary image of *Manifestation*:

> *I now dive and ascend as a glass.*
> *I bring up that image of internal water.*
> *- Poem pen dissolved in the primordial direction of the poem.*
> *Or the poem going up the pen,*
> *passing through its own impulse,*
> *poem returning.*

Extract from *Sumula* (sum and substance), by Herberto Helder translated by Luis Miguel Girao (not published).

Herberto Helder (1930–2015), in the excerpt above, describes the bipolar coexistence of *Realisation* and *Manifestation* with a special focus on the latter. He describes the inwards embodiment of the pen by a poem. The "primordial direction of the poem" is towards the pen and the poet himself. "The poem going up the pen, passing through its own impulse" represents the impulsive nature of the need of making of the poet, *Realisation.* By "passing through its own impulse", the poem embodies the pen and reveals itself to the poem which, in

turn, writes it on the paper. *Manifestation* nurtures *Realisation,* which in turn nurtures *Manifestation*, in a non-starting and non-ending cycle of urgency.

Helder understands the artwork, the poem, as a being. The poem has its own life and manifests itself through the poet, the pen and the paper: “poem returning”. The return of the poem is the process of *Manifestation* that, however, is dependent on the poet's need for objectification : *Realisation*, his need to make things happen, in order to materialise as a form.

In a particular way, Helder expresses how “Nietzsche saw thinking itself: as a dance of concepts and the pen”, as pointed out by Roy Ascott (1934 –) in *Telematic Embrace* (Ascott and Shanken, 2007), when describing telematic networks as a “planetary field for the dance of data”. Telematics, as envisioned by Ascott, allows for the disappearance of “senders” and “receivers”, so that they all become “users”, creative participants. He established the concept of “distributed authorship” in digital networks following up on the ideas of Barthes' “dispersed authorship” in his *Le Plaisir du Text* (Barthes, 1973) and Derrida’s free play of sense. But it is in Christopher Norris’ *Deconstruction, Theory and Practice* that Ascott found this particular link between Nietzsche, Barthes and Derrida:

> *Nietzsche, like Barthes and Derrida, deploys every means of resisting this drift toward interpretation in its various traditional forms. His plurality of styles and cultivation of paradox are strategies intended to arrest understanding, as far as possible, at the level of the text where signification has not yet congealed into meaning or concept. His image of writing as a ‘dance of the pen’ is one to which Derrida often reverts in order to suggest this free play of sense.* (Norris, 2002)

Helder and Nietzsche have expressed, with different images, a process that is common both to the practice of art and thinking. *Artistic practice* can be a thinking process, and the reverse can also be true. However, *artistic* can simply be an expression or action without need for clarification of the reasoning behind it, not even for the artist who produces it. That is why art is art, as no justifications are needed, while thinking can be part of many other practices.

However, in order for an *artistic practice* to become a *thinking process* integrated in a system of generation of knowledge — a new research practice as claimed in this thesis — it has to entail a process of reasoning behind the thinking process. In chapter 5, the idea that *artistic practices* based on technology prototyping, especially digital technologies, allow for reasoning of the thinking process through reverse engineering, or deduction, will be looked at in depth. The technological result can be understood without disturbing or trying to change the process of artistic creation, and by trying to interfere with the creative process, destroying all of its artistry and substituting it with simplified creativity.

Seconding the notion of thinking of culture as started by Moritz and followed by Nietzsche is Agostinho da Silva (1906–1994). The Portuguese philosopher stated in one episode of the TV series C*onversas Vadias*, broadcast by the Portuguese national broadcaster, RTP, between 8th March and 31st May 1990:

> *We could carry on our shoulders a machine that thinks, or rather a machine that detects ideas that roam around the world.*

Agostinho da Silva, 1990.[1]

[1] https://arquivos.rtp.pt/conteudos/conversa-com-baptista-bastos/ from minute 22 onwards. (last accessed on 13/08/2017) Translated by Luis Miguel Girao.

This statement by da Silva is not an affirmation, but rather a proclamation of doubt. It was made after the interviewer, the writer Armando Baptista-Bastos (1933–2017), asked Professor da Silva why he normally advised his students not to think. His answer was the above quoted proclamation of doubt. According to da Silva, “we still don’t know” whether we produce thoughts or whether thoughts come to our minds. In case of doubt, his choice was not to think.

Da Silva, in a communicative way aimed at addressing the masses, pointed out, as Morris did, that ‘detecting ideas’ is also valid for the generation of knowledge. He was trying to bring to the general public a discussion that has been going on for centuries about *noumena* and *phenomena*.

> *Other interpreters have introduced an almost unending stream of varying suggestions as to how these terms ought to be used. A handful of examples will be sufficient to make this point clear, without any claim to represent an exhaustive overview. Perhaps the most commonly accepted view is expressed by Paulsen, who equates 'thing-in-itself' and 'noumenon', equates 'appearance' and 'phenomenon', distinguishes 'positive noumenon' and 'negative noumenon', and treats 'negative noumenon' as equivalent to 'transcendental object' [pp. 4:148-50, 154-5, 192]. Al-Azm and Wolff also seem satisfied to equate 'phenomenon' and 'appearance', though they both carefully distinguish 'thing-in-itself' from 'negative noumenon' and 'positive noumenon' [A4:520; W21:165, 313–5; s.a. W9:162]. Gotterbarn similarly equates the former pair, as well as 'thing-in-itself' and 'positive noumenon', but distinguishes between 'transcendental object', 'negative noumenon' and 'thing-in-itself' [G11: 201]. By contrast, Bird and George both distinguish between 'appearance' and 'phenomenon', but not between 'thing-in-itself' and 'noumenon' [B20:18,19, 53–7; G7:513-4n]; and Bird sometimes blurs the distinction between 'thing-in-itself' and 'transcendental object' as well.[2] Gram equates 'thing-in-itself' not with 'noumenon', but with 'phenomenon' [G13:1,5-6]. Allison cites different official meanings for each term, yet tends to equate 'thing-in-itself' at times with 'negative noumenon' and at times with 'transcendental-object', usually ignoring the role of the 'positive noumenon' [A7:94; A10:58,69]. And Buchdahl responds to the fact that the thing-in-itself seems to be connected with each of the other object-terms by regarding it as 'Kant's umbrella term'.[3]*

[2] B20:47-51; but cf. 79-80. Buchdahl rejects Bird's tendency to regard the transcendental object as 'a logical myth' [B27:64], exclaiming 'nothing could be further from the truth.'

[3] B27:51; s.a. 69. The thing-in-itself could safely be regarded in this way, but only in the sense that it 'covers' all the other object-terms by transcending them, not by being somehow identified with each of them-a point which Buchdahl does not make sufficiently clear. [2]

It is clear that there is still controversy on the matter, and a number of different approaches remain. One of the high points of the discussion about *noumena* and *phenomena* is the critique by Arthur Schopenhauer (1788-1860) of Immanuel Kant's (1724-1804) use of the word *noumena*:

But it was just this distinction between abstract knowledge and knowledge of perception, entirely overlooked by Kant, which the ancient philosophers denoted by noumena and phenomena. (See Sextus Empiricus, Outlines of Pyrrhonism, Book I, Chapter 13, ' What is thought (noumena) is opposed to what appears or is perceived (phenomena).') This contrast and utter disproportion greatly occupied these philosophers in the philosophemes of the Eleatics, in Plato's doctrine of the Ideas, in the dialectic of the Megarics, and later the scholastics in the dispute between nominalism and realism, whose seed, so late in developing, was already contained in the opposite mental tendencies of Plato and Aristotle. But Kant who, in an unwarrantable manner, entirely neglected the thing for the expression of which those words phenomena and noumena had already been taken, now takes possession of the words, as if they were still unclaimed, in order to denote by them his things-in-themselves and his phenomena." (Schopenhauer, 1969)

Schopenhauer again makes a clear distinction between "what is thought" and "what appears or is perceived". This distinction has been fundamental to the discussion on the *practice of art as a thinking process* and its potential

[2] http://staffweb.hkbu.edu.hk/ppp/ksp1/KSP6A.html (last accessed on 14/08/2017)

contributions for knowledge-generation systems[3]. It is relevant to understand and recognise the opposed concepts of *nomena* and *phenomena* in order to understand the uniqueness of the practice of art in making both concepts coexist simultaneously, as expressed above in the definition of *artistic urgency*.

Robert Pepperell, author of *Post Human Condition* (Pepperell, 1995), has resumed the discussion on *nomena* and *phenomena* by proposing the concept of *phenoumenon*. This thesis takes the notion of *phenoumenon* as the basic assumption for understanding the practice of art as a thinking process that "includes (all) our thoughts about reality which are part of a continuous *phenoumenon*". (Pepperell and Ascott, 2000).

The great contribution of the practice of art for the generation of knowledge is transforming *noumena* into *phenomena* through *Realisation* and *Manifestation* by being both simultaneously: a *phenoumenon.* In other words, art is simultaneously embodingy inwards and outwards simultaneously. This means transforming "abstract knowledge" into "knowledge of perception" by producing technology-based artworks whose reasoning can be reversed. That is, making things happen and creating beings.

[3] Knowledge-generation systems refers to organisms that bring together contributions from different fields of study to research a specific subject. The overall vision is that the integration of the practice of art in these interdisciplinary, multidisciplinary or transdisciplinary groups of researchers is crucial for the development of research. www.starts.eu (last accessed on 14/08/2017)

1.2 Abstraction or spirituality in art

> *"The ability to produce art was an indication that humans had begun to think in more abstract terms. It's a thought process that enabled us to come up with the science and technology that enabled our species to become so successful."*
>
> BBC article by Pallab Gosh, Oct. 2014[4]

This quote comes from BBC Science correspondent Pallab Gosh, who was reporting on recent discoveries in a rural area on the Indonesian island of Sulawesi where cave art from 40,000 years ago was found. The discoveries are the first ones of their kind outside the European continent, thus putting into question the positioning of Europe, and Western culture for that matter, as pioneering human development. (Aubert et al., 2014)

"The emergence of art marks the beginning of a surge in the development of human intelligence. The people who produce art are able to reflect their thoughts in the form of pictures and symbols", reports Gosh. Indeed, the ability to transform "abstract knowledge" into "knowledge of perception" is a unique characteristic of human intelligence. This ability fulfils the human need for making sense of what happens/happened by creating narratives. There is also a need to freeze moments in time: the need for creating images one can grasp and hold on to, the need for making sense of life, the need for giving meaning to life —meaningfulness.

[4] http://www.bbc.com/news/science-environment-29415716 (last accessed on 14/08/2017) The quote is a transcription of the video of the article and not from its text.

Art works can put meaning and values into physical form.

Olafur Eliasson, June 2014.

Addressing the issue of spirituality in art in this dissertation does not aim at reiterating the obvious. The spiritual aspect of the practice of art is widely recognised, from studies of cave art to the contemporary art world. Even Olafur Elliasson (1967–), one of the most recognised producers of art commodities in the world of artwork monetisation, referred to the potential of artworks to convey meaning. The statement quoted above was made during a visit to his studio in the context of the ICTARTCONNECT study.[5] The study revealed evidence to the European Commission allowing for the creation of new policies for the integration of artists in the Horizon 2020 research framework, the biggest knowledge-generation system in the world. The STARTS[6] – Science, Technology and the Arts Initiative of the European Commission – will be described further in chapter 4.

It is however relevant to point out that, by integrating the practice of art in knowledge-generation systems, the spiritual aspects of art practice are also inherently integrated in those systems. Consequently, subjective and qualitative aspects of observation resulting from the practice of art in technology research contexts can also be integrated in those systems, as further elaborated in this dissertation. Chapters 3 and 5 reveal how this integration can be a solution for the

[5] https://ec.europa.eu/digital-single-market/en/news/innovation-about-starts-when-ict-and-art-connect (last accessed on 16/08/2017)

[6] http://www.starts.eu/ (last accessed on 21/08/2017)

study of what David Chalmers (1966 –) coined the *Hard Problem of Consciousness.* (Chalmers, 1997)

The fundamental role of abstraction in the practice of art and its relationship with the spiritual aspect of the practice of art is crucial for the foundation of this thesis in defining the notion of *artistic modulation of consciousness*. Again, this involves the ability to transform "abstract knowledge" into "knowledge of perception". Historically, Wassily Kandinsky (1866–1944), "one of the pioneers of abstract art, connects abstraction with the spiritual". (Van der Veer, 2009)

> *In each manifestation is the seed of a striving towards the abstract, the non-material. Consciously or unconsciously they are obeying Socrates' command- Know thyself. Consciously or unconsciously artists are studying and proving their material, setting in the balance the spiritual value of those elements, with which it is their several privilege to work.*
>
> in *Concerning The Spiritual In Art,* Wassily Kandinsky. (Kandinsky, 2008)

Kandinsky defines the spiritual aspect of the practice of art as a process of abstraction towards the personal balance of spiritual values. He refers to Plato's dialogue *Phaedrus*, when Socrates uses the maxim to explain to Phaedrus why he sees no convenience in attempting to rationally explain mythology: "But I have no leisure for them at all; and the reason, my friend, is this: I am not yet able, as the Delphic inscription has it, to know myself; so it seems to me ridiculous, when I do not yet know that, to investigate irrelevant things." (Plato and Rowe, 2005)

The reference to Socrates, besides supporting the "spiritual revolution" that Kandinsky and his fellow artists intended to start against the establishments of religion, science and morality, clearly expresses an assumption that is relevant

for the thesis, namely the spiritual component of the practice of art as the process of knowing thyself.

> *The spiritual life, to which art belongs and of which she is one of the mightiest elements, is a complicated but definite and easily definable movement forwards and upwards. This movement is the movement of experience. It may take different forms, but is holds at bottom to the same inner thought and purpose (...). When religion, science and morality are shaken, the two last by the strong hand of Nietzsche, and when the outer supports threaten to fall, man turns his gaze from externals in on to himself.* (Kandinsky, 2008)

It is fundamental to understand that the practice of art has, among a number of aspects, a spiritual aspect nurturing processes of knowing thyself. That understanding establishes the necessary grounds to support the notion of *artistic modulation of consciousness*, in which the word *artistic* refers to a practice that originates in an *urgency* of simultaneous needs of *Realisation* and *Manifestation.* It is an artistic practice that is a thinking process, with a spiritual dimension distinguishing it from any other practices of generation of knowledge. Its uniqueness is in the openness to revelations and the capability of materializing them, as described by in Helder's poem: "*Poem pen dissolved in the primordial direction of the poem."*

1.3 Artistic modulation of consciousness

As will be elaborated on in chapter 3, this thesis builds upon one of the oldest theories in philosophy, Panpsychism. According to that theory, everything has a proto-consciousness which, in certain aggregates and under certain conditions, can generate awareness. In other terms, awareness – consciously or

unconsciously – is generated by certain specific processes. The practice of art, under the conditions specified above, is one of those processes allowing human beings to access consciousness in a particular way.

In the second half of the 20th century, the work of composers such as John Cage (1912–1992), Phill Niblock (1933–), La Mont Young (1935–) and Murray Schafer (1933–) pointed out ideas of accessing consciousness by tuning to (or being in tune with) the universe through sound. Cage in his piece 4'33'' (Cage, 1960) induces the audience to listen to silence. The piece is a statement for the non-existence of silence as well as a suggestion that there is always music to be listened to as long as one has the ability to listen to it. (De Visscher, 1989) Niblock, known as the pioneer of drone music (Glover, 2009), by playing with the loud juxtaposition of subtle variations of micro-tones, aims at modulating the audience's collective state of mind. La Mont Young, sometimes described as the grandfather of minimalism in music, who is influenced by many ethnic traditions from the philosophy and music of India to the Mormons, refers to the "eternally playing music". (Nicholls, 1996)

Schafer takes us a step further from the notion of synchronising with the universe by listening to its "eternally playing music". The inventor of the concept of *soundscape*, responding to his own concerns about environmental acoustics, proposes a concrete interference with acoustic environments of the world. He has promoted research on the subject matter in projects such as *The World Soundscape Project*. (Schafer, 1977)

Since the work of these composers, the act of listening has become an act of creation. It is in the relationship between the artist and its object that artistic experience is conveyed. The creative act occurs when contemplation happens, actively. Both the artist and the one who contemplates art transform the object of art.

Guto Nóbrega (1965–), a Brazilian artist and researcher with prominent work in the field of art and technology, established the notion of the artwork as a field phenomena. He devised "an aesthetic principle built upon the notions of resonance, coherence and field models, rooted in an integrative view of living organisms based on the theory of biophotons." (Da Nóbrega, 2009) Again here, an analogy with electromagnetism can be established, and already in the work of Nóbrega the inclusion of bioorganisms is relevant. Biophotonic communication is made through the emission/reception of light. (Van Wijk, 2001) In electromagnetism, which visible light is part of and by which biological entities can be described—as further developed in chapter 2— interaction is a crucial. An electromagnetic field can only be detected by another electromagnetic field. Therefore, an electromagnetic field that receives a light emission is also emitting in order to be able to receive. Nóbrega developed this notion further by understanding that certain conditions, such as resonance and coherence, have to be met in order for more significant forms of interaction, such as coupling, to occur.

From this point of view, interaction with artworks – fruition, contemplation – manifests in the interference with the oscillatory patterns of the artworks. Recent

ideas in the field of synchronicity of macroscopic vibrational systems suggest that synchronization (or coupling) of two distinct vibrational systems (electromagnetic fields) somehow results from a negotiation process. This conclusion arises from empirical evidence in a pendulum experiment with two electromagnets. When one of the fields is controlled electrically to change its vibrational pattern, disturbing a previously established equilibrium, both tend to readapt their own vibrational pattern until another moment of equilibrium is reached. The same sort of dialogue between the two fields happens every time their coupling is disrupted. (Doubochinski and Tennenbaum, 2007)

David Bohm (1917–1992) has conceptualised the creative act in a similar way. He referred to dialogue as being at the origin of creativity:

> *Yes, dialogue is necessary for creativity in the socio-cultural sphere; that is, this creativity cannot be sustained without dialogue. We may get a burst of creativity but it will not be sustained.* (Bohm and Pylkkanen, 1989)

The idea conveyed by Bohm can also be expressed by the difference between *vibration* and *oscillation*. The latter implies a certain regularity pattern while the former can simply be an occasional burst. For example, when analysing classical music compositions techniques, it becomes clear how to extend a burst of creativity in time. The technique of expansion in time is an illustrative example – the same melody rhythmically doubled. Ludwig van Beethoven (1770–1827), in his 5th Symphony, masters almost all possibilities of reworking the exact same musical idea. (Beethoven, 2009) The best example of exploring every single

possible technique to expand a musical motif is *The Art of Fugue* BWV 1080 (Bach and Overduin, 2001) by Johann Sebastian Bach (1685–1750).

Bach was a devoted composer, mastering composition techniques over prescribed religious melodies. However, the real creative moments where new musical themes were created was during improvisation sessions. After Bach, Wolfgang Amadeus Mozart (1756–1791) developed a fertile creativity for new melodies or themes due to his improvisational skills. Improvisation was a way of triggering creative bursts and composition as a creative work, transforming those bursts or occasional vibrations into more consistent oscillatory patterns. It was also a way of discovering new ideas in the subjective realm and composition by making sense of creative bursts and objectifying them by attributing meaning to them. This meant transforming them into a sort of language that can be explained and understood rationally and therefore sustained.

Improvisation, not just in musical terms but in general, is a key artistic process to access consciousness by allowing small vibrations, bursts, to interfere with the consistent oscillation of form.

> *You see, creativity requires a free play of thought to move in any direction which creation calls for. If the mind is rigid it cannot be creative. So any fixed position means the end of creativity.* (Bohm and Pylkkanen, 1989)

Improvisation in music, seen from the point of view suggested above, is indeed a process of dialogue. A solo improvisation is a dialogue with oneself and the

environment. A collective improvisation is a dialogue with oneself and the environment with interferences of other similar dialogues performed by others. What this thesis suggests and assumes is that this 'environment' is *consciousness.* In other words, consciousness does not exist. It is an immaterial environment that allows dialogues between the *conscious* and the *unconscious* to happen. Creative acts such as improvisation allow simultaneous 'downloads' and 'uploads' to this immaterial environment. That simultaneity is the process of *accessing* consciousness.

> *What actually has value would be to have a constantly creative culture. Now I suggest that such creativity is related to a constant discovery of new meanings. Generally speaking we start from old meanings and commonly make small changes in them. Sometimes we may, however, perceive a big change of meaning. An idea changes in a fundamental way although, of course, some old features are still carried along, no matter how big the change is.* (Bohm and Pylkkanen, 1989)

As the above quote states, *modulation of consciousness* manifests when "we start from old meanings and commonly make small changes in them". Bursts of subjective perception interfere and transform an oscillation. An oscillation however exists only in relationship with an 'environment', i.e. a number of other oscillations and vibrations of any scale. The overriding approach here is the concept of *relationship*, which brings us closer to the notion of simply being, without any need to attribute any meaning to the fact or act of being. In other words, it is simply oscillating in synchronisation with consciousness.

1.4 Alternative forms of communication

Ideas such as a "constantly creative culture" or "constant discovery of new meaning" reveal the need for a certain regularity in creative or artistic practices. In the words of the poem cited above by de Andrade, "It's urgent — love, it's urgent to endure". In other words, it is urgent to transform oscillation. It is artistically urgent to *modulate consciousness*. It is urgent to pick the individual or the collective at a specific point of its oscillation and to transform that oscillation by interfering with it with small bursts. That is one of the most relevant contributions of artistic intervention for human development in society, in economy or in any other form of human congregation. The role of the artist then is to create, in the object of art, the support to guide the experience of contemplation:

> *The artist's role at the larger planetary level of self-organising, self-aware systems, will be to plant, grow and cultivate new forms, new structures and new meanings.* (Ascott, 2000)

The main purpose of the object of art – in all its possible manifestations – is to guide the process of contemplation, or better, of *modulation of consciousness* for all involved in the creative process, from the artist to the one who enjoys art. At this stage, fruition becomes an instrumental concept. When interpreted as realisation rather than appropriation, like in usufruct — in other words, seen as the act of generation of a fruit — fruition marks the start of *embodied action* in contemplation.

In the seminal book *Embodied Mind — Cognitive Science and Human Experience*, co-authored by F.J. Varela, E. Thompson and Eleonor Rosch, the concept of Embodied Mind is explained by Evan Thompson in his introduction to the revised edition as follows:

> *The title of the book came from one of our guiding ideas, the philosophical idea of groundlessness. In Buddhist philosophy, groundlessness means that phenomena lack any inherent and independent being; they are said to be 'empty' of 'own being'. In Western philosophy, groundlessness means that knowledge and meaning lack any absolute foundation. Biology and cognitive science were arriving at the same idea — that human cognition is not the grasping of an independent, outside world by a separate mind of self, but instead the bringing forth or enacting of a dependent world of relevance in and through embodied action.* (Varela et al., 2016)

From the perspective of cognition as embodied action, the body is a medium to access consciousness. This concept is further explored in chapter 4 where the audiovisual interactive system *Collectron* is described. In *Collectron*, it is through the body and through its actions that dialogue is established. However, action does not necessarily mean motion. It can mean achieving maximum steadiness, as described in chapter 3, as a technique to trigger out-of-body experiences. Maximum steadiness reveals that there are always oscillations. John Cage discovered that silence does not exist by understanding that in an anechoic chamber one will always hear one's own heart and the flux of blood in the body. (Smith, 2013)

Even in disembodiment experiences, the body is always the reference. The *Brunelleschi Experiment* is described in detail in Chapter 5 in order to conclude

that one of the fundamental characteristics of art is to impact on the consciousness of those interacting with its forms.

In his famous experiment, Brunelleschi used the then-recent discoveries about linear perspective to take the notion of *projection* further. The experiment included a small painting with a pinhole through which one should look through in order to see the painting reflected in a mirror. The objective of the experiment was to symmetrically reverse the point of view of the observer. In a way, it was an out-of-body (disembodiment) experience.

The capability of artists to create alternative forms of communication is a unique characteristic making the case for their integration in knowledge-generation systems or research frameworks. Artistic work often precedes scientific discoveries and triggers discussions around scientific theories. For example, recent studies on visual perception, such as *Does visual perception of object afford action? Evidence from a Neuroimagining study* (Grèzes and Decety, 2002) and *Art and Illusion: A Study in the Psychology of Pictoral Representation* (Gombrich et al., 1960), building on the work of vanguard and pioneering artists such as M. C. Escher, have revealed that the human perceptual system is far from being accurate: simple tricks can both fool it as well as obfuscate the understanding of an external ecology or ecosystem.

Yet, there is also another perspective to approach this subject from: instead of assuming senses are not accurate enough to perceive reality, one could assume that the agency of the observer has an impact on the nature of the subject.

Experience is omnisensory. One cannot experience an external ecology as being dissociated from one's own internal ecology. Although it is possible to 'isolate' a sensory input or to focus on a specific stimulus, one cannot perceive that stimulus separately from other stimuli, but as something that is always integrated in a wider spectrum. It can then be reiterated here, as quoted above from the *Embodied Mind* book, that "groundlessness means that knowledge and meaning lack any absolute foundation". The notion of relationship between subject and object or, better, between bipolar congregations of object/subject, is key, as previously stated.

Karlheinz Stockhausen (1928–2007), in one of his most famous interviews, claims:

> *As a matter of fact, what we can see through the eyes is very limited, much more limited than what we can hear. Just the range of what we can perceive is far more developed in acoustics, and the precision of identifying the vibrations and the proportions, all the intervals, all the relationships between the vibrations of a spectrum. We musicians know much more. We are almost a thousand years ahead of the visual artist, because we have a very precise language of vibrations, proportions of vibrations, and all our measurements of rhythms and relationships between slow vibrations and fast vibrations in 20,000 cycles per second range are very developed in music. I think in the long run listening will become more important.* [7]

However, in his later performances of "Hymnen" (Duckworth, 1975), Stockhausen felt the need to create a visual reference to the audience in order for them to better perceive the quadrophonic effect of the composition and to be able to better focus on the development of the composition. This fact of course reveals

[7] http://www.furious.com/perfect/stockhauseninterview.html (last accessed on 26/08/2017)

a contradiction in his statements, but is also a strong reinforcement of the notion that experience is always omnisensory.

The concept of shamanistic and syncretic aspects of the artistic practices claimed by Roy Ascott in many of his writings becomes of foundational nature here:

> *The syncretic process is not in any way to be confused with synthesis, in which disparate things melt into a homogeneous whole, thereby losing their individual distinction. Nor is it mere eclecticism, which usually signals a wavering course of thought of only probable worth. In the syncretic context, extreme differences are upheld but aligned such that likeness is found amongst unlike things, the power of each element enriching the power of all others within the array of their differences. Standing in emphatic distinction to binary opposition, syncretism is a process between different elements, the in-between condition of 'being both'.* (Ascott, 2005)

The syncretic condition of being simultaneously in many dimensions is indispensable for understanding the omnisensory nature of every art form, even if very specialised, such as traditional oil painting. Even the experience of consciousness modulation that a specialised artwork guides is always omnisensory.

When it comes to more technologically advanced art forms, such as telematic art (Ascott, 1991), multidimensional aspects extrapolate from the sensorial real to the authorship realm, reinforcing what this chapter has already (re)defined as fruition. The significant perceptual action is to shift from the point of view of the artist to the perspective of the real creator, the contemplator. In this context, a possible approach would be to focus mainly on the artist as a creative force of expression, a medium of communication from and with consciousness.

In fact, artists have a function of mediation in society. In the field of performing arts, the notion of facilitation as the core of practice is relevant.

> *The human need to express the abstract through the concrete is deeply rooted, and theatre and storytelling have long been central media for learning, communication, and social development.* (Armstrong and Fukami, 2009)

Artists have been moving towards actions related to the notion of community work. They position themselves as coordinators of creative participation. (Gehlhaar et al., 2011) With his creation SOUND=SPACE (Reynolds et al., 2001), Rolf Gehlhaar (1943 –) realised a paradigm shift regarding the role of the composer in Western society. The idea of a composer as the creator of compositional principles as a set of rules for both musicians and machines, which in turn communicate via sound to the audience, has become outdated. Gehlhaar transformed this hierarchical approach to music into something completely different: "into SOUND=SPACE, where the audience becomes the performers."[8] When playing together in this multi-user environment, each participating musician is aware of both him/herself and the others while producing sound.

As a matter of fact, SOUND=SPACE triggered the shift, which is also foundational to this thesis: the firm belief in the relational nature of the artistic act as a creative practice of the audience. This leads to the notion of contemplation, fruition or *artistic modulation of consciousness* being the common ground for both those making or creating artistic experiences and those

[8] http://artshare.pt/conhecimento/fabrica/fabrica.php (last accessed on 26/08/2017)

enjoying them. SOUND=SPACE is an excellent example of the concretion of the famous statement of Marshall McLuhan: "The medium is the message" (McLuhan, 1994).

In SOUND=SPACE, the medium itself is the message. The new type of composition devised by electronic musical instruments, *musical topologies* (Almeida, 2015), in which the position of participants triggers specific sequences of sounds, is intrinsically dependent on the technological apparatus specifically developed for it, the *medium*. The medium/message of SOUND=SPACE allows participants to realise that complex musical structures are accessible to all. The days of composers such as Stockhausen, considering themselves to be the only ones able to access consciousness (in his own words “cosmos’), ended when SOUND=SPACE was created.

1.5 Art is life (Integration)

"Art is Life, Life is Art" Wolf Vostell (1932 – 1998)

Vostell was a German painter and sculptor and is considered a pioneer of *happening* and Fluxus. Fluxus was an international and interdisciplinary group of artists that in the late 1960s produced performance "events", *happenings*, including concrete poetry, visual art, urban planning, architecture, design, literature, and publishing. Fluxus has sometimes been described as intermedia, a category into which composers such as Niblock fall under. The ideas and practices of John Cage influenced Fluxus, especially his understanding of the work as a site of interaction between artist and audience. (Almeida, 2007)

For Vostell, a human's physical *action*, the handling of things, was already considered to be art. What happens, the *happening*, is already art if only one wants it to be and one affirms it. Artworks no longer need an envelope or frame. Art steps out of its frame, normally the gallery, and melts immediately into the stream of life. The dilution of the boundaries between daily life and the places determined for art was one of the main objectives of the Fluxus movement. This was partially achieved, especially at the beginning of the movement. Yet, arguably, the institutionalisation of art has been unavoidable, and it naturally took advantage of this sort of movement to expand its area of action. Nonetheless, nowadays we can experience very interesting forms of art practice, such as street theatre, viral theatre, pop-rock bands and performances, and even

some fashion industry-related events, happenings or products such as flashmobs, which somehow integrate art in daily life contexts.

One of the most common Fluxus happenings is the hammering of a piano as symbol of the destruction of the institutionalisation of the arts. This thesis builds upon a further development of this act, which is the destruction of desktop or laptop computers, as a symbol of the institutionalization of digital technologies. It is also the expression of the idea that ubiquity, in the form of the Internet of Things, amongst others, could allow the spread of artistic ideas, works or concepts embedded in new technologies themselves. Similarly to SOUND-SPACE, such a movement would allow for a worldwide dissemination of artistic ideas impregnated in society and economy via technological innovation. This idea is further developed in chapter 4, in relation to artistic interventions in the European Commission *STARTS Initiative* and the *Internet of Things Large Scale Pilots.*

Those interventions will be an expansion of some activities already happening in the field of arts and ubiquity. In that context, it has become common practice to organise workshops in which ideas to be congregated in public participation are developed.

> *Contextualising digital practices within architectural spaces, and exploring the opportunities of experiencing and perceiving domestic environments with the use of media and computing technologies have been used as methods for the design of reflexive and intimate interiors that provide informational, communicational, affective, emotional and supportive properties according to embedded sensorial interfaces and processing systems. To properly investigate these concepts, a fundamental criterion is magnified and dissected: dwelling, as an important ingredient*

> *in this relationship entails the magical power to merge physical environment with the psyche of inhabitants. For this reason, a number of views providing necessary conditions to include matters of affectivity, ubiquity and layering complexity of interior space have been highlighted.* (Phillips and Didakis, 2013)

Integrative art is the integration of artistic practice into daily life. The way it is envisaged in this thesis is through the technology described above. Nowadays, integrative art is not a common practice amongst artists in the sense that is envisaged here. Turkish artist Elif Ayter developed methodologies of integrative art education in virtual learning environments, based upon the critical examination of real life. (Ayiter, 2008) Most of the practices that involve the notion of integrative art concern the field of therapy through the arts. (Malchiodi, 2012)

Again, it was Ascott who created a concept, which can be seen as foundational for the notion of integrative art, *behaviourist art*. He also created CAiiA, the Centre for Advanced Inquiry in Integrative Arts, in the context of which this thesis has been elaborated. In behaviourist art, "the artist, the artifact, and the spectator are all involved in a more behavioural context". (Ascott, 2002)

However, the notion of integrative art that this thesis reveals and that is completely dependent of a specific technology, bioelectromagnetic stimulation, is one that is better described by the following. Spaniard Alvaro Pascual-Leone (1961–) is a Professor of Neurology at Harvard Medical School who has been investigating the use of Transcranial Magnetic Stimulation (TMS) in many applications, including treating Parkinson's disease. When Pascual-Leone applies a specific type of TMS (that will be further described in chapter 2) to some of his

clients, the effects prevail and become part of their real life. For example, one of his clients was not able to walk normally, but after that specific stimulation, he could walk normally for 20 minutes. That experience was part of his real life. It was neither a dream nor a hallucination.

This kind of bioelectromagnetic induction is the major claim of this thesis. If used as a medium of artistic expression, it will allow for the production of new and unprecedented realisations of integrative art. However, it is not just about a technology transfer from one field of practice to another. The specificities of bioelectromagnetic induction become intrinsic technological foundations of the specific practice of art exposed. And those intrinsic technological foundations are also those that allow for the integration of that specific artistic practice as a research practice in the context of knowledge-generation systems.

The intrinsicality is the notion of electromagnetism itself, which is present in all the dimensions of the conceptualisation of such a practice. It is a true transdisciplinary concept that, depending on the point of view taken, can be denominated in different ways while keeping its nature in all of the denominations. In this thesis, it is approached from the perspectives of: classical physics; electromagnetism; bioelectromagnetics; consciousness studies; and most relevantly, the artistic perspective. The technological grounds are indispensable to the artistic practice described here. Similarly, the artistic grounds of such practice are also indispensable because of the intrinsic dialogue between the unconscious and conscious in artistic practices. Again, electromagnetism is the best analogy to describe this bipolarity between technology and art.

The way the Oxford Dictionary defines magnetism[9], namely through electricity, is a good example of what is trying to be conveyed here:

A physical phenomenon produced by the motion of electric charge, which results in attractive and repulsive forces between objects

The "physical phenomenon produced by the motion of electric charge*"* is the phenomenon of electricity. In other words, it is the electric manifestation of magnetism. The only way to materialise or measure magnetism is through its indissociable partner, electricity. Magnetism can therefore best be described as the "attractive and repulsive forces" not "between objects" but between other *electromagnetic* fields that are embodied by objects.

Electromagnetism, from this perspective, is a *phenoumenon* in which magnetism is *noumena* and electricity is *phenomena*.

Magnetism is a pure concept. It does not exist, and it is not an object. Rather, it is a conceptualisation of relationship. The second definition of magnetism in the Oxford Dictionary is:

"The ability to attract and charm people."

Interesting enough, in this definition the repulsive characteristic of magnetism is omitted. The ability to repulse and repel people is equally a characteristic of magnetism in a social perspective. Perhaps it is appropriate here to cite Eugenio de Andrade's poem once again:

> *"It's urgent — love.*
> *[...]*

[9] https://en.oxforddictionaries.com/definition/magnetism (last accessed on 25/08/2017)

It's urgent to destroy certain words,
[...]
It's urgent to invent a joyfulness,"

This first chapter looked at art practices as emerging from the urgency of expression of the one that feels it, the artist. This urgency is understood as resulting from two major needs: on the one hand, the need to make things happen, *realisation*; and on the other, the need to create beings, *manifestation*. *Realisation* is understood as the core of the practice of art, while *manifestation* sustains the notion of the practice of art as a thinking process.

Artistic urgency expresses itself by modulating consciousness both at an individual and a collective level. It has been highlighted that the notion of modulation of consciousness in human beings is key.

Yet, it has been argued that consciousness, as such, does not exist. It is immaterial and undefinable. Consciousness is not electromagnetic. Electromagnetism is only one manifestation of consciousness. However, electromagnetism is a manifestation of consciousness that in itself is bipolar in many ways, and therefore very close to the notion of *conscious-unconscious* dialogue. In electromagnetism, electricity and magnetism always relate perpendicularly. They never reach each other but they are indissociable. In electromagnetism, electricity is material and magnetism is immaterial.

Chapter 2, on biolectromagnetics, will explore and demonstrate why the application of bioelectromagnetic stimulation as a medium of artistic expression

allows for the production of new and unprecedented realisations of integrative art.

2 Bioelectromagnetics

This second chapter sets out to demonstrate why the application of bioelectromagnetic stimulation as a medium of artistic expression allows for the production of new and unprecedented realisations of integrative art.

Bioelectromagnetism, in this thesis, is understood as the study of the intersections between biological entities and the electromagnetic spectrum. In the context of this research, it results from the interference of two or more manifestations occurring within the spectrum of electromagnetic phenomena, and one of the entities involved in these processes is a human entity.

In this context, it is pivotal to highlight the electromagnetic nature of the human body. The body as interface to consciousness.

The emphasis of this thesis has also been to include arts in the equation: expansion of body/mind and consciousness through the interface and mutual cross-fertilisation of the arts and the newest technologies.

The recent findings of Olaf Blanke, especially the ones regarding the induction of OBEs (out-of-body experiences) by bioelectromagnetic stimulation are reassessed and presented as previous technological foundations of the proposed new artistic realisations.

Both projects – Collectron and Sensitive Spheres – are designed and presented as representations of the social implications of perceiving human beings as electromagnetic manifestations.

In the context of these two projects as well as in essence, Bioelectromagnetism is therefore understood as the study of the intersections between biological entities and the electromagnetic spectrum.

Each project represents, moreover, a culture of interactions between biological beings, including their spiritual dimension, in which art plays a fundamental role in creating alternative forms of communication as well as in congregating and mediating consciousnesses at a collective level.

2.1. Biological entities and the electromagnetic spectrum

A general definition of bioelectromagnetics can be found in the book *Basic Introduction To Bioelectromagnetics* by Cynthia Furse, Douglas A. Christensen and Carl H. Durney. It reads as follows:

> *Bioelectromagnetics — the study of how electric and magnetic fields interact with the body — is a tremendously exciting field. Electromagnetic fields are all around us: radio and television signals, cellular telephones, fields from power lines and electrical appliances, radar, and more. They are even within our bodies in the endogenous fields that keep our hearts beating, brains thinking, and muscles moving. Electromagnetic fields can see inside of us to diagnose illness sometimes before we feel it ourselves. […] The promise of bioelectromagnetics seems limited only by our imagination. However, the promise of bioelectromagnetics is very much limited by the physical nature of the fields themselves and how they can be made to interact with the body.* (Furse et al., 2009)

Furse's definition makes it clear that electromagnetic fields are everywhere. They interact with human bodies and have several different applications. The engineering practice of bioelectromagnetics is a very promising field but the limitations presented by their physical natures reduce the potential for more applications. The most interesting aspect of the interaction of electromagnetic fields with bodies is noise.

> *Living cells exist in an electrically noisy environment. This has led to the so-called "signal-to-noise" problem whereby cells are observed to respond to extremely-low-frequency (ELF) exogenous fields that are several orders of magnitude weaker than local endogenous fields associated with thermal fluctuations.* (Litovitz et al., 1994)

The extremely-low-frequency fields that biological bodies produce makes it extremely difficult to distinguish the origin of the field as well as to make sense of the signals produced in order to detect patterns. Pattern recognition is

fundamental in the characterization and interaction between electromagnetic fields of biological bodies, electronic devices and other sources. As exposed by Furse, the world environment is fully populated with electromagnetic fields. Probably all material manifestations have an electromagnetic field associated with them. The implications of the regulation of the electromagnetic spectrum are highly relevant in ecological and environmental terms. Those issues do not condition the discussion on bioelectromagnetism pertinent to this study. Nonetheless, it is important to point them out here. Other approaches to bioelectromagnetism fuel the discussion in a significant manner, however.

> *Bioelectromagnetism is a discipline that examines the electric, electromagnetic, and magnetic phenomena which arise in biological tissues. These phenomena include: the behaviour of excitable tissue (the sources), the electric currents and potentials in the volume conductor, the magnetic field at and beyond the body, the response of excitable cells to electric and magnetic field stimulation, and the intrinsic electric and magnetic properties of the tissue. […] By definition, bioelectromagnetism is interdisciplinary since it involves the association of the life sciences with the physical and engineering sciences.* (Malmivuo and Plonsey, 1995)

This vision of bioelectromagnetism tries to clearly separate subject matters of study in order to establish the notion that bioelectromagnetism is an interdisciplinary practice. It also focuses on the biological component as the main focus, the source of the electromagnetic fields to be studied.

The first concept of bioelectromagnetism presented focuses on the electromagnetic environment, while the second one focuses on the biological entity[10] that produces an electromagnetic field and therefore can be stimulated by

[10] Biological entity in this study refers to all bodies that can be described as living biological bodies of any scale and type.

other external electromagnetic fields. A third concept of bioelectromagnetism is devised in this study. Bioelectromagnetism is understood here as the study of the intersections between biological entities and the electromagnetic spectrum. The concept of bioelectromagnetism proposed by the thesis focuses on the electromagnetic relationships of biological entities and other electromagnetic manifestations.

The adopted conceptualization of bioelectromagnetism is consistent with the philosophical notions expressed before. The concept is conditioned to the existence of a minimum of two poles, where one pole can only be described by another. It is based on two basic assumptions. In electromagnetism, magnetism and electricity are indissociable and one can only be studied experimentally by observation of variations in the other. An electromagnetic field can only be detected in relationship with another electromagnetic field.

> *When a magnetic field **H** has been generated in a medium by a current, in accordance with Ampères's law, the response of the medium is its magnetic inductor **B**, and sometimes called flux density. All media will respond with some induction (...)* (Jiles, 2015)

This notion of indissociability of electricity and magnetism will be explored further in the next section of this chapter. Yet, it lays the foundations for bioelectromagnetism to be considered in the context of this study as the result of the interaction between two or more manifestations occurring within the spectrum of electromagnetic phenomena, with one of the entities involved in these processes being a human being. The presence of a human being is extremely relevant because the main subject of discussion of the thesis is the

modulation of consciousness as accessed by human beings. Not that consciousness is assumed to be uniquely accessible to human beings neither it is assumed to be of electromagnetic nature.

Bioelectromagnetic induction in human beings allows, for example, the experiencing of visual illusions or altered states of mind: the type of phenomena within the bioelectromagnetic spectrum that leads to the production of multi-sensory experiences combining traditional audiovisuals with bioelectromagnetic induction.

The process of generating an electrical current, which in its turn generates a magnetic field, which in its turn interferes with the magnetic field of a human cell, such as a neuron, and alters its electric properties, is the typical chain of interaction in this study. Interaction, as a form of reciprocity, is a very important word here. As described by Jiles, all media will respond *with* some induction. However, all media will respond *to* some induction.

Tod Machover (1953-) a prominent artist and researcher, runs the Opera of The Future research group at the MIT's MediaLab, in Cambridge, USA. The major interest of the research team is to explore interfaces based on high resistivity circuits. This type of resistivity circuits allows human interference with electronic systems. When positioning a human body between two of these high resistivity circuits, variations in the electromagnetic fields of these devices can be detected and measured. The combination of the variations of both results represents the variation of the electromagnetic field of the human body itself. The

research group explored, furthermore, forms of utilising these circuits as interfaces for the hyper-instruments they were developing.[11]

The *Sensor Chair*, one of Machover's hyper-instruments had its public debut at the Digital Expression symposium in Kresge Auditorium at MIT on October 20, 1994. It was used afterwards in several different musical performances, mapping the motion of hands and feet of the person sitting in it into various musical effects that trigger, modify, and conduct electronic sound sources.

[11] The need to develop new interfaces for expression has become patent in some communities of artists in the last couple of decades. Even the name of some of newly emerging organisations have been reflecting this need, such as the series of conferences coined *New Interfaces for Musical Expression* or the *New Interfaces for Performance* organisation.

The International Conference on New Interfaces for Musical Expression (NIME) – http://www.nime2017.org/ (last accessed on 31/08/2017) – gathers researchers and musicians from all over the world to share their knowledge and late-breaking work on new musical interface design. The conference started out as a workshop at the Conference on Human Factors in Computing Systems (CHI) in 2001. Since then, an annual series of international conferences has been held around the world, hosted by research groups dedicated to interface design, human-computer interaction, and computer music.

The University of Sussex organised the latest New Interfaces for Performance biennial conference (June, 2016 - http://www.liveinterfaces.org/, last accessed on 31/08/2017), which gathered people working with live interfaces in the performing arts, including music, the visual arts, dance, puppetry, robotics or games. The scope of the conference was highly interdisciplinary but with a focus on interface technologies of expression in the area of performance. Topics of liveness, immediacy, presence (and tele-presence), mediation, collaboration and timing or flow were engaged with and questioned in order to gain a deeper understanding of the role which contemporary media technologies play in human expression. The interfaces were conceptual or material objects, and their making was concerned with the design of openings, resistance, fluidity, affordances, constraints, and expressive scope.

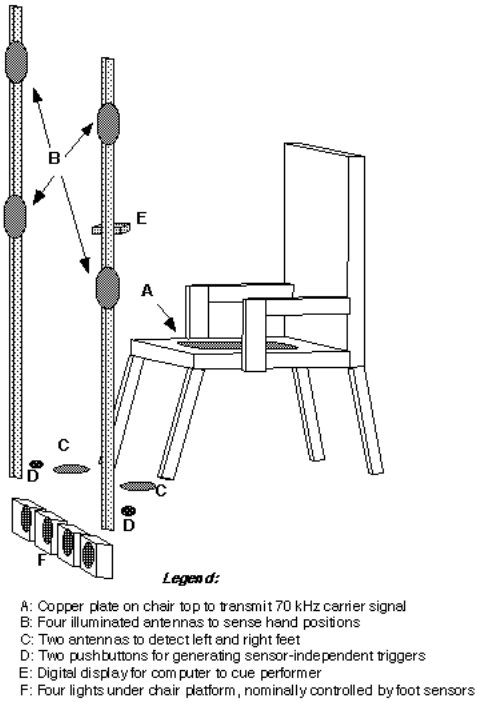

Figure 1 The chair layout diagram.

As labelled on the chair layout diagram, above, the copper plate (A) affixed to the top of the chair cushion is a transmitting antenna being driven at roughly 70 kHz. When a person is seated in the chair, they effectively become an extension of this antenna; their body acts as a conductor which is capacitively coupled into the transmitter plate.

Four receiving antennas (B) are mounted at the vertices of a square, on poles placed in front of the chair. These pickups receive the transmitted signal with a strength that is determined by the capacitance between the performer's body and the sensor antenna. As the seated performer moves his hand forward, the intensities of these signals are thus a function of the distances between the hand and corresponding pickups. The pickup signal strengths are digitized and sent to a Macintosh computer, which estimates the hand position. A pair of pickup antennas are also mounted on the floor of the chair platform, and are used to similarly measure the proximity of left and right feet, providing a set of pedal controllers. In order for a performer to use these sensors, he must be seated in the chair, and thus coupled to the transmitting antenna. Other performers may also inject a signal into the pickup antennas if they are touching the skin of the seated individual, thus becoming part of the extended antenna system.[12]

12 http://web.media.mit.edu/~joep/TTT.BO/chair.html (last accessed on 31/08/2017)

The image of humans as antennas and of a chains of humans touching each other and therefore creating an antenna system is an interesting description, and quite pertinent to the next section of this chapter.

Interfaces of the type such as the *Sensor Chair* are considered to be particularly useful in applications for people with special needs. This area of applications is actually a very recent development, and is still a research area that deserves a special attention. The use of what Anthony Brooks and Eva Peterson describe as "non-invasive gesture control" interfaces (Petersson and Brooks, 2007) has been the basis of the development of new tools for the rehabilitation of people with special needs. The relevance of this new kind of interfaces is that they extend the possibilities of communication between disabled and non-disabled people.

Historically, Léon Theremin (1896 –1993) was the pioneer of these type of interfaces (Glinsky, 1992). The instrument he created in 1928 and patented with his own name *Theremin* become extremely popular when it was invented. Recently, new modern versions have been developed to adapt it to digital music systems and to overcome its musical limitations, mainly in terms of tonality. The original instrument was confined to one single tonality.

Figure 2 - Theremin.

The relevant aspect of the *Theremin* musical instrument is that, although it works very similarly to the *Sensor Chair* the person does not need to touch it to make it play. This means that the instrument does not work because of electrical skin conductivity. Yet, it works due to the interaction of two magnetic fields: the one electrically generated by the musical device and the one of the human being.

Although still somewhat incipient, there is an emergent area of research that is worth mentioning here. It studies the capability of human beings to control the intensity of their electromagnetic fields. For example, a group of Japanese scientists has reported the difficulties involved in producing reliable measurements of Anomalous Bio-Magnetic Fields. In the article, they reviewed a number of studies reporting "that some Zen or qigong masters/students can generate nT to 100nT order magnetic fields under their control" (Kokubo et al., 1999). Their review concluded that the order of magnitude reported in those studies differed remarkably. The reasons for these variations are exposed in order to improve the quality of measurement conditions and of the detection sensors.

The development of better sensors is a key aspect in bioelectromagnetics. The early history of bioelectromagnetics is actually characterized with reference to the invention of a specific sensor, the SQUID.

> *The PRESQUID PERIOD (1963-69) began with the first valid bioelectromagnetic recording by Baule and McFee (Baule, 1963), in Syracuse, NY. This was a measurement of the magnetic field of the human heart (the first magnetocardiogram, or MCG); this was recorded outdoors in an open field, far from urban magnetic disturbances.* (Cohen, 2004)

It is important to notice here again the issue of noise in electromagnetic measurements since its beginning. That is the reason why the first recording was made in an open field. After the first experiments on electromagnetic measurements, Faraday cages were used as a conditioned environment of measurement. Nowadays, high quality sensors allow reliable measurements to be performed virtually everywhere.

Since that first valid bioelectromagnetic recording, a great number of systems for remote magnetic sensing of people were developed: Superconducting Quantum Interference Devices (SQUID); Giant magneto-resistance (GMR) and Giant magneto-impedance (GMI) (Mahdi et al., 2003).

With great applications in medicine – such as in Magnetic Resonance Imaging (MRI) – bioelectromagnetics has become a subject of increasing interest in the research world. After the invention of the SQUID magnetometer, monitoring and measuring of the magnetic fields of the human body became much more reliable. All the more so since magnetocardiography (MCG) has presented clearer

information than electrocardiography (ECG). It is in the realm of magnetic effects that better results have been more successful (Azanza et al., 2007).

Recently, the aspect of magnetism in bioelectromagnetism became more relevant because it the one characteristic to operate at a distance from the targeted living cell. That is the reason why the invention of the SQUID is so relevant. The SQUID was invented in 1964 by Robert Jaklevic, John J. Lambe, James Mercereau and Arnold Silver of Ford Research Labs. (Jaklevic et al., 1964) A SQUID is a very sensitive magnetometer used to measure extremely subtle magnetic fields as low as 5 aT (5×10^{-18} T) with a few days of averaged measurements (Ran, 2004). Their noise levels are as low as 3 $fT\cdot Hz^{-½}$ (Drung et al., 2007). As a reference, it is worth noting that some processes in animals produce very small magnetic fields between 10^{-9} T and 10^{-6} T, while a refrigerator magnet produces 0.01 tesla (10^{-2} T).

SQUIDs can be used as sensors but they can also be used as actuators. Bioelectromagnetic induction is key in this study because it is the technique which allows for direct sensory interference with humans and, consequently with their consciousness. The application of controlled induction techniques allows for refined artistic expression as further developed in the dissertation. SQUIDs compete with induction coils in delivering better results in magnetic induction.[13]

An induction coil is a type of electrical transformer used to produce high-voltage pulses from a low-voltage direct current (DC) supply. To create the flux changes

[13] The notion of magnetic induction is used here because it is what is standardized in the fields of research that use or develop the technique. The word magnetic is used to make clear that the magnetic properties of induction are the most relevant ones. However, as previously stated, electricity and magnetism are indissociable and if applied in a tissue or cell, the biological component is also not dissociable. Therefore, magnetic induction is in reality bioelectromagnetic induction.

necessary to induce voltage in the secondary coil, the direct current in the primary coil is repeatedly interrupted by a mechanical vibration. It was invented in 1836 by Nicholas Callan, Charles Page and others. It was widely used in medical electrotherapy devices from the 1880s to the 1920s (Britannica, 1994). The induction coil forms the technological basis of techniques such as Transcranial Magnetic Stimulation developed further in the following section *Neuromodulation*.

The induction of physical changes in the human body through magnetic field-based techniques has been described in several studies. A good example is the one presented by Emilio del Giudice, in which a specific magnetic stimulation of blood cells generates clots in the human circulatory system. (Del Giudice et al., 1985)

Furthermore, intermolecular interactions within living organisms have been found to occur not as individual independent events but as a part of a collective array of interconnected events. The issue of the emergence of this collective dynamic and of the correlated biocommunication therefore arises. In recent times and within the paradigm of modern molecular biology and those given by some holistic approaches to biology, the collective behaviour of ensembles of microscopic units (atoms/molecules) has been addressed in the conceptual framework of Quantum Field Theory (QFT).[14]

The possibility of producing physical states where all the components of the ensemble move in unison has been recognized. In such cases, electromagnetic

[14] QFT is the theoretical framework for constructing quantum mechanical models of subatomic particles in particle physics. QFT treats particles as excited states of the underlying field, so these are called field quanta. In QFT, quantum mechanical interactions among particles are described by interaction terms among the corresponding underlying quantum fields. (Itzykson and Zuber, 2006)

fields trapped within the ensemble appear. In their joint paper, Emilio del Giudice and Marco Bischof (2013) presented a scheme based on QFT where molecules are able to move in phase-correlated unison among themselves and with a self-produced electromagnetic field (Bischof and Del Giudice, 2013).

This part of the research highlighting the interaction of biological entities and the electromagnetic spectrum gave not only an overview of the ever-growing interest in the human interference and interface with electronic devices, but also allowed a better understanding of the inherent collective aspect of bioelectromagnetism.

2.2 Inherent Collective

Bioelectromagnetism is also understood in this study as the culture of interactions between biological beings, including their spiritual dimension, in which art plays a fundamental role in creating alternative forms of communication. Human culture relates to nature – biology, genetics and nurture – environment and surroundings that also shape identities. The multitude of interactions between culture and biology are reflected in the form of our societies, norms, rituals, languages and other representations of culture. Here the notion of culture is understood as the interaction between humans and environments, very similar to Del Giudice's understanding of the formation of blood clots as resulting from the collective behaviour of ensembles of microscopic units. Similarly to what happens with microscopic units, human collective dynamics are based on communication processes, such as dialogue, as defined by Bohm. Artworks, as understood by Nobrega, are fields for interaction and therefore alternative forms of communication.

Similar to the image of a chain of human antennas as suggested by Machover, is the idea that a viscous mass transformed by a group of dancers is an analogy that can also represent bioelectromagnetism as an inherently collective form. Isabelle Choinière is a Canadian choreographer and researcher the notion of collective body and its intersection with technology. She created a performance in which the dancers never lose contact with each other. They are always a collective body.

Figure 3 Embryonic Body.

> *This "embryonic body" I am developing is of the resonant collective genre, using somatic practices strategies in order to make room for the renewing of proprio- and exterioception.* (Choinière, 2009)

It can be interpreted that Choinière understands the human body as a medium to modulate consciousness, in accordance with what this thesis conveys as well. However, her approach is focused on somatic aspects of the body while this study is focused on describing the body as a bioelectromagnetic medium.

As previously stated, an electromagnetic field can only be detected by another electromagnetic field. Electromagnetic field measurements are performed using particular sensors or probes, such as electromagnetic field meters. These probes can be generally considered as antennae. (Grudzinski and Trzaska, 2001)

Knowing that an electromagnetic field is in theory infinite, i.e. it never reaches 0 energy intensity (Sutton, 1994), it can be suggested that, in theory, all electromagnetic fields are in constant interaction. Assuming this 'viscous mass' as a representative image – the viscous mass being a representation of the electromagnetic spectrum – transformations in the context are induced by agency of individuals in constant interaction with each other and the environment. From

this perspective, biological entities are bioelectromagnetic entities and, as such, are a product of the interaction with both the context, other entities and within themselves. A relational network of ‘antennae’ in continuous interaction. Consciousness, therefore, can be considered as the result of the constant (re-)interpretation of information, encompassing awareness as well as knowledge. Likewise, bioelectromagnetism can be viewed as the subtle manifestation of consciousness.

Studies on perception have also shown that we are used to continuously creating an image of the surrounding world, as further developed in section *2.4 The cognitive approach*. This image is 'synthesised' by the brain using the information gathered by our senses. In this reciprocal process of interaction with the surroundings, the perceiver might perceive what he/she wants to perceive, or even might perceive what he/she knows. H. D. Zeh (2000) states in this regard:

> *There is even convincing evidence supporting the idea that all states of awareness reflect physico-chemical processes in the brain.* (Zeh, 2000)

Zeh seems to point to a physico-chemical causality of awareness. This thesis is, however, based on the notion of non-causality: physico-chemical processes can also in their turn reflect awareness, as electromagnetism electricity is a perpendicular reflection of magnetism and vice-versa. It is nonetheless an undeniable fact that human beings seem to have agreed on an infinite number of perceptual and measurable truths. This can also be explained by and derived from the Multi-Consciousness Interpretation (MCI): it might be possible that principles similar to quantum decoherence create a sort of entanglement of

human beings. These correlations, in turn, generate a common image of reality. Zeh highlighted this MCI extensively in the same article by discussing epistemological consequences of quantum non-locality (entanglement) under the assumption of a universally valid Schrödinger equation and the absence of hidden variables. This inevitably led to a *many-minds interpretation*. Zeh concludes:

> *The recent foundation of quasi-classical neuronal states in the brain (based on environmental decoherence) permits in principle a formal description of the whole chain of measurement interactions, including the behavior of a conscious observer, without introducing any intermediate classical concepts (for macroscopic "pointer states") or "observables" (for microscopic particle positions and the like)—thus consistently formalizing Einstein's ganzer langer Weg from the observed to the observer in quantum mechanical terms.* (Zeh, 2000)

If this hypothesis could be followed up, a large-scale entanglement of human beings would not be that far from being proved as one might think.

This thesis clearly expresses artistic intuition, which allows for explorations not possible in other fields of knowledge generation. It has, therefore, included the arts in the equation: expansion of body/mind and consciousness through the interface and mutual cross-fertilisation of the arts and bioelectromagentic technologies. Once again, the core of this study is to highlight that physical artworks dealing with electromagnetic induction have the potential to expand interaction with consciousness, using the body as a medium. In other words, through the interaction between artwork and new technologies, not only is a body-mind expansion triggered but an expansion of consciousness also comes into being.

2.3 Neuromodulation

Nowadays, the most often used form of bioelectromagnetic induction is neuromodulation: to transform electromagnetic fields found in neurons by the presence of another electromagnetic field artificially generated by electronic means. Neuromodulation is a specific application of functional stimulation.

Functional stimulation is one of the most fascinating applications of bioelectromagnetism. It deals with the stimulation of excitable biological tissues, as e.g. brain cells, by electromagnetic fields. Functional electric or magnetic stimulation consists of stimulating either muscle or the nervous system through the creation of an external electric or magnetic field in excitable tissues:

> *Electricity can have various effects on living tissues or cells. The possibility of exciting the action potential in a neural cell appears to be very attractive. The stimulus then propagates along ramified pathways of the nervous system. In this way, almost any organ of the human body can be influenced by electric pulses. (...) This has opened the way to a field of modern rehabilitation known as functional electrical stimulation (FES). In 1967, FES was described as "electrical stimulation of muscle deprived of nervous control with a view of providing muscular contraction and producing a functionally useful movement.* (Kralj and Bajd, 1989)

Functional stimulation is nowadays applied to many body parts, most frequently with medical applications in mind. A relevant type of functional stimulation is Deep Brain Stimulation (DBS). Electric properties of biological tissues such as permittivity and conductivity are important in applied problems of electrical stimulation in studying human electromagnetic field interactions and development of diagnostic and therapeutic procedures:

> *Over the last decade deep brain stimulation (DBS) has become the major growth area for the treatment of severe Parkinson's disease, tremors, and*

> *dystonia. More recently interest has begun to focus on the clinical application of deep brain stimulation to psychiatric disorders, particularly obsessive compulsive disorders and depression. The increasing therapeutic use of DBS has created opportunities to study the pathophysiology of these diseases, by allowing intra-cerebral recordings to be made from patients and permitting stimulation of various regions within the brain to be undertaken.* (Bain, 2009)

Deep Brain Stimulation is considered to be invasive as opposed to the others – such as Transcranial Magnetic Stimulation – that do not imply the direct contact between electrodes and brain tissue. Transcranial Magnetic Stimulation (TMS) has, without a doubt, been the sort of non-invasive stimulation that has an ever-growing research investment as well as an ensuing number of scientific articles published. The main reason behind it is the apparent characteristic of a narrower focus on the area to be stimulated, in comparison with the pre-existing technique, Transcranial Current Stimulation – tCs.

tCs is divided into two different techniques: Transcranial Direct Current Stimulation – tDCs, and Transcranial Alternate Current Stimulation – tACs. The obvious difference between the two of them is the type of current they utilize. The most often used is tDCs due to its portability: a couple of electrodes and a 9-Volt battery are the components needed. tACs applies circuitry for the modulation of the signal produced that is a little bit more complex. Both techniques can be divided into Anodal and Cathodal according to the positioning on the scalp of both electrodes and the consequent direction of the current flow.

TMS is usually applied to different parts of the brain as well as some points of the spinal cord. The focality of this sort of stimulation results from the technique applied: an electric current flowing through two adjacent coils (an induction coil

as described before), albeit in opposite directions, generates a differential magnetic field with its intensity centre at a considerable distance from the coils. The assembly of the coils as well as its shape are activated within several models so as to modulate the deepness and intensity of the resulting magnetic field.

A very detailed description of the different types of neurostimulation techniques can be found in the *Review of the state-of-the-art in human stimulation (Riera et al., n.d.),* a document produced in the context of the Future and Emerging Technologies funded by the HIVE Project (2008-2012).[15]

> *About HIVE*
>
> *Could computers someday interact directly with the human brain? The vision of this four-year project is that in the next 50 years we will witness the coming of age of technologies for fluent brain-computer and computer-mediated brain-to-brain interaction. While recent research has delivered important breakthroughs in brain-to-computer transmission, little has been achieved in the other direction: computer-controlled brain stimulation. The project's goal is to research stimulation paradigms to design, develop and test a new generation of more powerful and controllable non-invasive brain stimulation technologies. Starting from current distribution and multi-scale neuron-current interaction modeling and stimulation experiments using tDCS, TMS, EEG and fMRI in different scenarios, the project will develop multisite transcranial current stimulation technologies implementing real time EEG monitoring and feedback. It will explore high-level communication using stimulation, stimulation during different states of consciousness, stimulation and therapy, as well as sense synthesis, that is, the construction of new perceptions deriving from sensors interacting directly with brains through stimulation systems—all with the goal of probing the limits of non-invasive computer-to-brain interfaces. The project will develop biophysical models for multisite stimulation, carry out stimulation experiments with animals and humans, and integrate the results to develop and test new multisite technologies for interaction. Given the fundamental role of interaction in human experience, advances in this area can deliver breakthrough information society technologies of great value in addition to advancing the state-of-the-art in fundamental neuroscience research, neurology diagnosis and therapy*. (Miranda et al., n.d.)

[15] http://hive-eu.org/ (last accessed on 31/08/2017)

The summary of techniques of human brain stimulation presented in this dissertation only contains the information considerable relevant for the argumentation of the thesis. However, a considerable effort during the study was put into understanding the technological dimension of the thesis. It is extremely relevant to note that this thesis is not an isolated effort. Its integrated into a global and significant area of research on human brain stimulation and beyond, of which the HIVE Project is a relevant example.

In a further developed H-shaped coil by the Israeli company BrainsWay,[16] the depth of the magnetic field is such that it has been classified as Deep Transcranial Brain Stimulation – dTMS. These coils are connected to an electronic device that generates electric currents of such intensity and voltage that they are able to deliver the produced field at a maximum intensity of 3 Tesla. The intensity of the field needs to be of this magnitude due to the electromagnetic shielding provided by the human skull and bones (Roth et al., 2007).

The signal applied in TMS can mainly be modulated in 3 different ways. First, a single burst is the basic one and has no pervasive effects. This means that the effects only occur while the cause is active. Second, repetitive Transcranial Magnetic Stimulation – rTMS – is the repetition of single peaks in a constant frequency that can be of approximately 1Hz, Low Frequency, or 5Hz, High Frequency. This sort of modulation is applied for about 2 seconds with pauses of variable duration, but always constant in each treatment. Third, TBS – Theta Burst Stimulation – is a second order modulation that applies LF or HF bursts in sequences of 3 bursts separated by a small pause (micro-seconds). This sort of

16 http://www.brainsway.com/ (last accessed on 31/08/2017)

stimulation is applied continuously, for about 40 seconds, or intermittently, 2 seconds of stimulation followed by 'silent' intervals of 8 seconds and so forth. A combined technique of TMS and a slow-rate repetitive low-frequency median nerve stimulation, for instance to the nerves of the hand, compose Paired Associative Stimulation – PAS. All of the types described above, from rTMS to PAS, have pervasive effects that have been reported in different studies of durations from 20 minutes to 24 hours.

Dr Anthony Barker, the eminent neuroscientist who realised the first TMS experiment (1985), very clearly highlighted the widespread range of stimulation of TMS in his opening keynote (June 29, 2010) of the Magstim/University of Oxford TMS Summer. Although the intensity of the stimulating electromagnetic field is much smaller than previous techniques, the whole nervous system is engaged during the stimulation. This idea corroborates the great interest in transsynaptic phenomena asserted by Alvaro Pacual-Leone at the HIVE Workshop in Barcelona, on June 11, 2010. Transsynaptic means the travelling of nerve impulses resulting from stimulation in-between neurons through synapses. This phenomenon generated the study of brain pathways indicating the nonlocality of brain activity. The given topological combinations can now explain certain observations that used to be thought to be specifically related to certain effects. At this point, the relevance of the study of brain pathways – departing from the basic deduction that these sorts of experiments are based on an electromagnetic technique – is questionable. The types of stimulation that have been described above are perpetrated by electromagnetic fields. Almost all of the scientific studies in this field have dismissed the electromagnetic

characteristics of the brain. From the moment the stimulation acts on the neurons, phenomena have been described as being merely electric, as if it were possible to dissociate magnetism and electricity. This idea has been corroborated by recent studies on robotics showing that magnetic broadcasting happens along the nervous system and is stochastically interpreted by part of the body, such as muscle sarcomeres (Ueda et al., 2007).

Alvaro Pascual-Leone, a Spanish professor of neurology at Harvard Medical School, recently received a prize from the Michael J. Fox Foundation for having researched the potential of rTMS to improve motor as well as mood symptoms in Parkinson's disease. On a determined occasion, after a stimulative treatment of 20 minutes, the client was able to walk normally, whereas before the treatment he could only make a couple of steps at a time (Ziemann et al., 2008).

MIT neuroscientists led by Rebecca Saxe demonstrated the decreasing role of beliefs in moral judgements caused by the disruptions created by neuromodulation of the right temporoparietal junction of the brain. Clients would make radically different moral judgements of the same case before and after stimulation of that specific part of the brain (Young et al., 2010). Saxe has highlighted the relevance of this area of the brain as directly related to moral judgements. Furthermore, her study has tried to establish what is believed still to be an assumption: that the brain is the origin of moral judgement. The fact that the inhibition of a specific area of the brain provokes changes in the way some subjects produce moral judgements does not necessarily mean that it can be considered as the origin of judgement. Maybe it is just the medium through which mental activity is conveyed.

In 2002, Professor of cognitive neuroscience, Olaf Blanke announced that the part of the brain that can induce out-of-body experiences had been located.

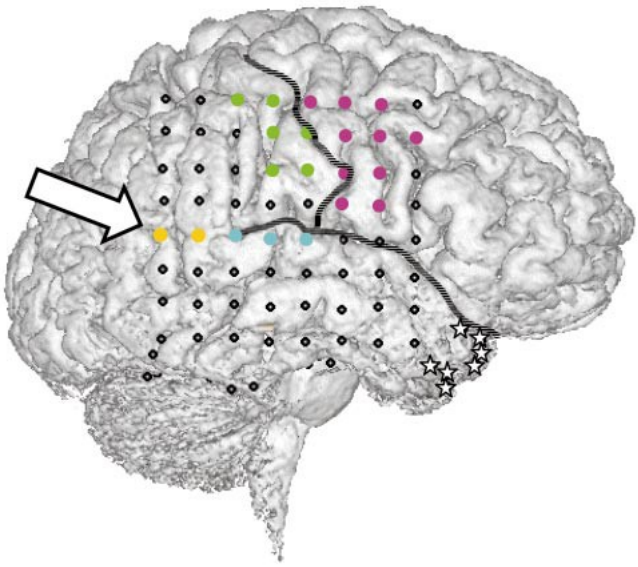

Figure 4 - 'Out-of-body' experiences (OBEs).

> *'Out-of-body' experiences (OBEs) are curious, usually brief sensations in which a person's consciousness seems to become detached from the body and take up a remote viewing position. Here we describe the repeated induction of this experience by focal electrical stimulation of the brain's right angular gyrus in a patient who was undergoing evaluation for epilepsy treatment.* (Blanke et al., 2002)

Neuromodulation has great potential not only for the study of the functioning of the brain, the direct communication between electronic devices and the human brain but more importantly to better study consciousness.

The main problem currently is accessibility of the technologies described for artistic practices. Not only they are extremely expensive but they under complete control of the scientific and medical community. Several approaches were made to institutions during the study and none of then allowed the utilisation of devices of bioelectromagnetic induction for purposes of artistic experiments.

Nonetheless, new products closer to consumer are becoming available that will allow artists to research in the field. Furthermore, as described later in this dissertation, in the context of this study, two major policies leading to the integration of artists in technology-based research were created and implemented.

2.4 The cognitive approach

Disembodiment is a crucial concept in this thesis. In particular, disembodiment provoked by bioelectromagnetic stimulation is historically as significant as the invention of linear perspective in the Renaissance, as argued in the last chapter of this dissertation. The reason why the bioelectromagnetic component is extremely relevant is because of the possibility of variation control of the process of embodiment/disembodiment via the manipulation of the electrical signal giving rise to the induction. This is demonstrated in *2.6 Embodiment and induced OBE*.

It is important, however, to refer other possible types of embodiment techniques that do not imply bioelectromagnetic induction. These alternative techniques have been applied for artistic purposes. However, these practices do not belong directly to the realm of the thesis because they do not manipulate consciousness by bioelectromagnetic stimulation or induction. They do it by inducing somatic stimuli. *Homo Conscientis* is indeed one of the only, if not the only, artwork known at the time of these writings to integrate bioelectromagnetic stimulation in its technical system.

As demonstrated by cognitive neuroscientist Henrik Ehrsson, humans have the capability to 'embody' external entities. This has already been widely described by gamers, (Gee, 2008) but it has now been put out more consistently by these recent studies. Ehrsson and his team have induced a certain kind of OBE using phantom limb-related techniques, and hence taking advantage of human variable body ownership and multi-sensory integration (Ehrsson, 2009):

> *How do we come to feel that we own our body? What is the relationship between our body and our sense of self? Questions like these have been*

> *discussed in philosophy and psychology for centuries but what advances have been made in understanding how the brain actually distinguishes between parts of one's own body and objects in the external world? We address this issue from the perspective of cognitive neuroscience, paying particular attention to multisensory integration. (…) Recently, body ownership has become a lively topic in cognitive neuroscience. This development has been made possible by an experimental paradigm that allows the controlled manipulation of limb ownership in the laboratory setting: the rubber-hand illusion. In this illusion, synchronous touches, applied to a rubber hand, in full view of the participant, and the real hand, hidden behind a screen, produce the sensation that the touches felt originate from the rubber hand, and a feeling of ownership of the artificial hand rapidly develops.* (Ehrsson, 2012)

The rubber hand illusion has been described before (Botvinick and Cohen, 1998). The newness of Ehrsson's experiments is that he brings a second order effect into play. The effect is mainly achieved due to a stereoscopic video system that allows for a better immersion of the rubber hand effect. The person sees in reality not a rubber hand but the body of the person that is being stimulated in reality. Ehrsson found out that after a certain period of time, the person is 'embodied' in the other and when threatened with a sudden movement reacts as the threat was to his own body.

> *Body ownership and embodiment are two fundamental mechanisms of self-consciousness.* (Lopez et al., 2008)

It is important to note here again the role of the body in disembodiment/embodiment. One's own body is always the reference.

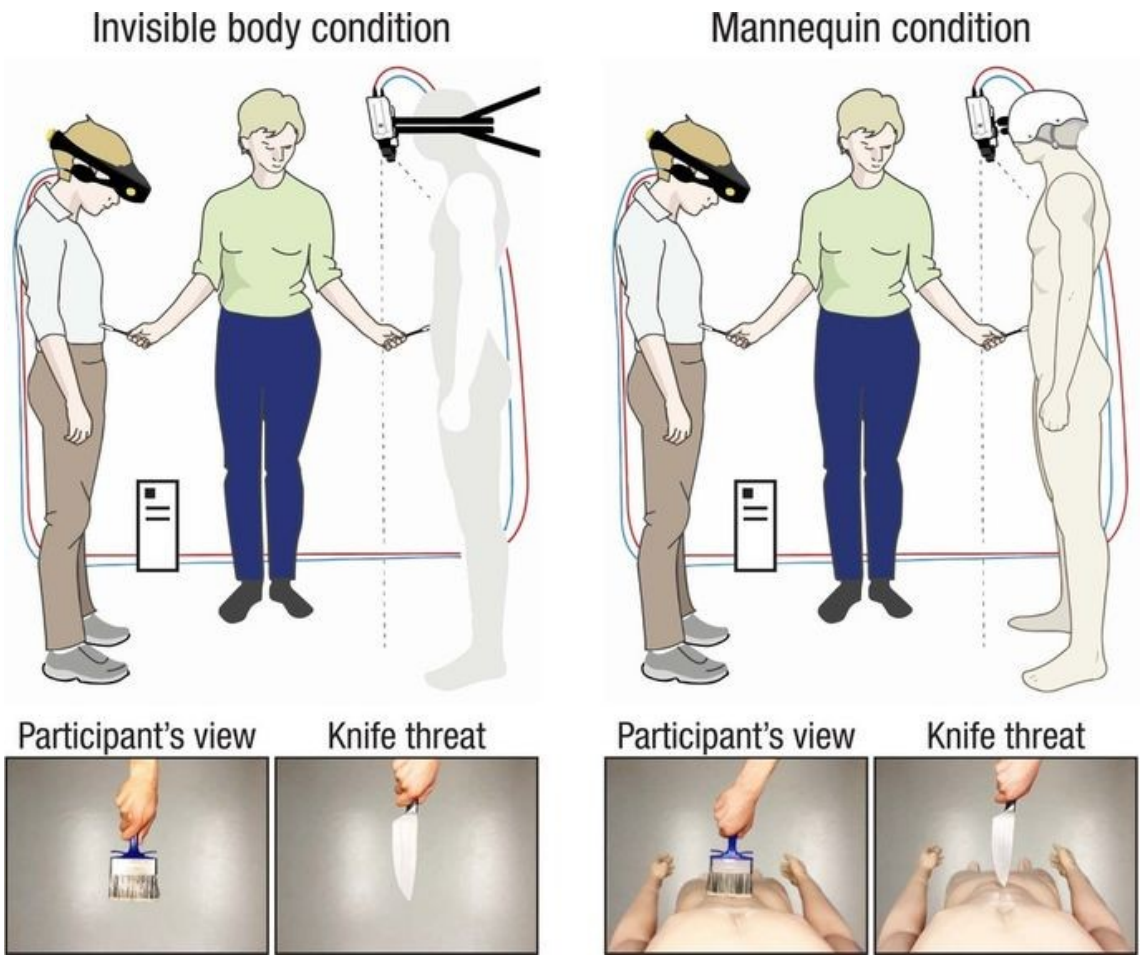

Figure 5 - Body in disembodiment/embodiment.

Ehrsson developed his experiences to the point of studying their social implications.

> *To address these questions, we developed a perceptual illusion of having an entire invisible body. Through a series of experiments, we characterized the multisensory rules that govern the elicitation of the illusion and show that the experience of having an invisible body reduces the social anxiety response to standing in front of an audience.* (Guterstam et al., 2015)

Others also explore the social dimension of body swapping but from an artistic perspective.

> *More than individuals, we are part of a social collective called humanity. As members of this collective, the perception of our own identity is based on our relation with other people and our social environment: how people see us, how we do act and interact with them, and what self image we project to this society and to ourselves. As part of this collective society, the importance of understanding the 'Other' and 'Each Other' to better understand ourselves is clear. This multidisciplinary artistic investigation plans to use the recent neuroscience approach of 'embodiment' and apply it to investigate the perception and comprehension about the Self based on the comprehension of the "Other".*[17]

The Machine to Be Another experiment by the BeAnotherLab builds on Ehrsson's research. It was performed in Rio de Janeiro, where people could swap bodies with other people living in the *favelas*. That specific experiment was awarded in 2017 with a STARTS Prize Honorary Mention, at Ars Electronica.[18]

[17] http://www.themachinetobeanother.org/?page_id=818 (last accessed on 31/08/2017)

[18] https://starts-prize.aec.at/en/ (last accessed on 31/08/2017)

2.6 Embodiment and induced out-of-body (OBE)

‘Out-of-body' experiences (OBEs) are curious, usually brief sensations in which a person's consciousness seems to become detached from the body and take up a remote viewing position. What is considered by some to be an extremely enlightening spiritual experience is classified in the scientific context as potentially reflecting “a failure by the brain to integrate complex somatosensory and vestibular information” (Blanke et al., 2002).

It is interesting to realise the multitude of interpretations towards OBEs. Yet, the technological possibility of inducing them makes that multitude not conditional to the discussion in this thesis. In other words, one does not have to agree with one or another interpretation of the phenomenon to continue the discussion of the thesis. The point is that the ability to induce them allows simply experiments with OBEs. Furthermore, other sensations of disembodiment can be induced by bioelectromagnetic stimulation.

> *The present article reviews neurological data about paroxysmal illusions during which body ownership and embodiment are affected differentially: autoscopic phenomena (out-of-body experience, heautoscopy, autoscopic hallucination, feeling-of-a-presence) and the room tilt illusion.* (Lopez et al., 2008)

Heautoscopy is seeing one's own body at a distance. Autoscopic hallucinations refers to phenomena involving out-of-body experiences, sudden conscious awareness from a viewpoint above or behind the body, or complete loss of self-attribution. The feeling-of-a-presence is self-explanatory, it means feeling the presence of somebody that is in principle not present. The most interesting thing is that all these bioelectromagnetically induced experiences can be manipulated.

> *We also review the possibilities of manipulating body ownership and embodiment in healthy subjects through exposition to weightlessness as well as caloric and galvanic stimulation of the peripheral vestibular apparatus.* (Lopez et al., 2008)

These induced experiences are not specifically guided by one sense only, but are perceived as a total phenomenon called multisensory or omnisensory experiences.

> *Studies in which subjects receive ambiguous multisensory information about the location and appearance of their own body have shown that these brain areas reflect the conscious experience of identifying with the body (self-identification (also known as body-ownership))* (Blanke, 2012)

In the framework of this thesis, these findings are revealed as the prior technological foundations not only of the proposed new artistic realisations but of a new practice of research as shown in chapters 4 and 5.

2.7 My brain is all over my body

During the Hong Kong Conference (2009) *Toward a Science of Consciousness – Investigating Inner Experience, Brain, Mind, Technology*, the author of this thesis presented a poster entitled *My Brain is all over my Body*. The communication was a follow up of an artistic intuition based on the assumption that if the nervous system is connected all over the body until it reaches the skin, it could simply be interpreted that the brain is in reality all over the body.

This idea also relates to the work of Antonio Damasio. Firstly, the famous neuroscientist associated somatic markers with decision-making.

> *The marker signals arise in bioregulatory processes, including those which express themselves in emotions and feelings, but are not necessarily confined to those alone. This is the reason why the markers are termed somatic: they relate to body-state structure and regulation even when they do not arise in the body proper but rather in the brain's representation of the body.* (Damasio et al., 1996)

In other words, somatic markers which are a direct causation of bodily sensations, including emotions, either in real-time or as a memory, are the ones conducting the decision-making process in human beings. This means that one decides first and rationalizes after. This discovery was popularized in his best-selling book *Descartes' Error: Emotion, Reason and the Human Brain* (Damasio, 2005).

In one part of another book, *The Feeling of What Happens: Body and Emotion in the Making of Consciousness,* Damasio describes an experiment he did with the famous pianist Maria Joao Pires. She claimed to be able to play *with* emotion or emotionless. The experiment consisted of measuring her galvanic skin response

while she claimed to play emotionally or emotionlessly. The experiment confirmed that there was indeed a different electromagnetic activity in her body that distinguished the two states of musical playing (Damasio, 2000).

More recently, another study went further and mapped the location of different emotions in the human body.

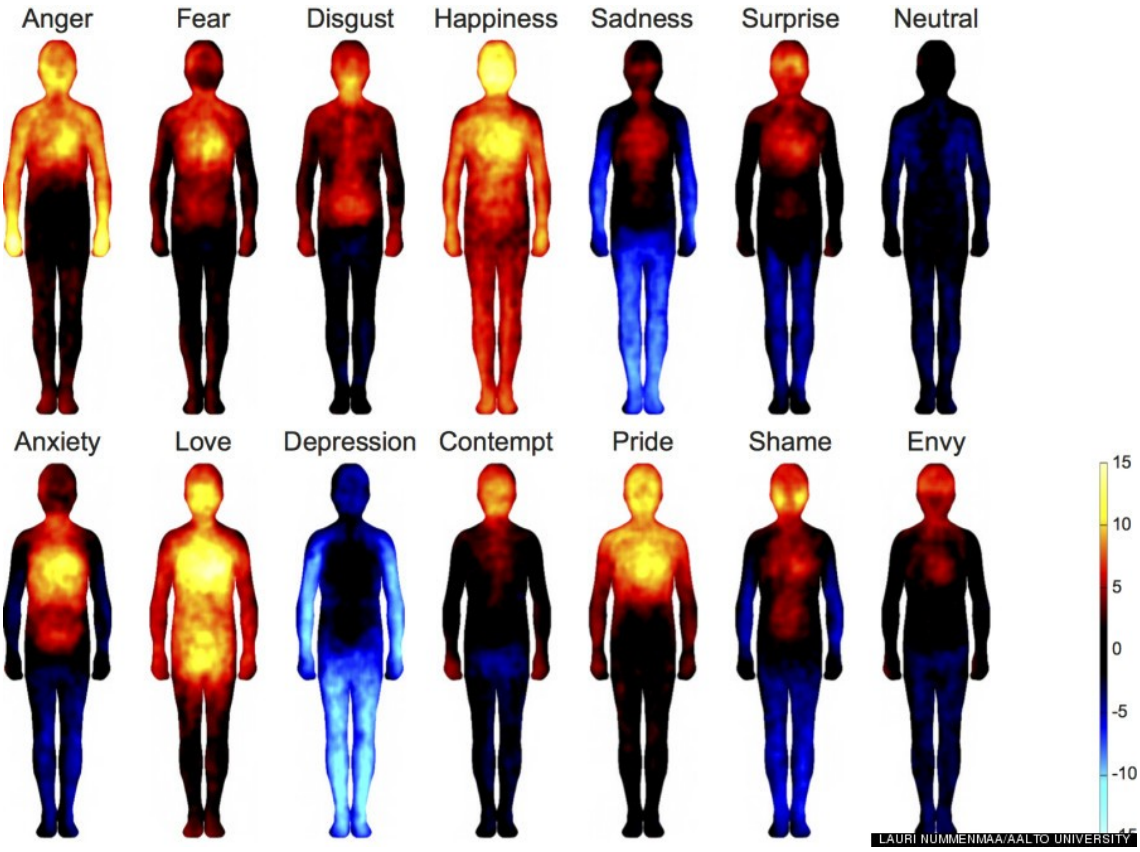

Figure 6 - Mapping Emotions On The Body.

Lauri Nummenmaa from Aalto University in Finland takes further the suggestions by Damasio that emotions might be bodily functions that manifest significantly in the body. It is relevant to point out that Damasio, in his above-mentioned studies, also proved that if a body is not present or is in a sleeping state, the brain simulates bodily sensations.

> *Emotions coordinate our behavior and physiological states during survival-salient events and pleasurable interactions. Even though we are*

> *often consciously aware of our current emotional state, such as anger or happiness, the mechanisms giving rise to these subjective sensations have remained unresolved. Here we used a topographical self-report tool to reveal that different emotional states are associated with topographically distinct and culturally universal bodily sensations; these sensations could underlie our conscious emotional experiences. Monitoring the topography of emotion-triggered bodily sensations brings forth a unique tool for emotion research and could even provide a biomarker for emotional disorders.* (Nummenmaa et al., 2014)

This study has become very relevant in several fields of inquiry, including neuroscience and is an indication that there is indeed a new area of research in this idea that the brain can be all over the body. This and the fact that more sophisticated bioelectromagnetic stimulation technologies as yet unreachable during the study led to the decision to integrate direct current stimulation in specific parts of the body in the integrative artwork *Homo Conscientis,* described in chapter 4. Furthermore, the recent discussion about the discovery of a *second brain* in the stomach of humans led that specific part of the body to be stimulated through bioelectromagnetic induction.

> *Once dismissed as a simple collection of relay ganglia, the enteric nervous system is now recognized as a complex, integrative brain in its own right. Although we still are unable to relate complex behaviors such as gut motility and secretion to the activity of individual neurons, work in that area is proceeding briskly.* (Gershon, 1999)

The enteric nervous system, or the second brain, as it has been popularized, seems to have a considerable role in a person's mood and well-being (Hadhazy and others, 2010).

The theme became also part of an artistic work entitled *Second Brain*. The artistic project is led by Michael Straeubig, currently a research fellow at Plymouth University in the context of the CogNovo project.

> *Research has identified various microorganisms in the gut that interact with the brain regulating our mood and behavior. Starting from a speculative design perspective, the Second Brain Project explores this wider form of cognition that goes on in our bodies. In order to visualize the brain-gut interaction, the team developed a Second Brain installation during Hack the Brain Amsterdam. For the installation, a brain-computer-interface was used to detect signals produced simultaneously by the brain and the gut. The team used machine learning to distinguish between these signals and forwarded them to an Arduino, which modulated the power of two pumps. The pumps inflated a bunch of plastic bags alternatively, according to the strength of the brain and gut signals. The plastic bags sustained two transparent plastic spheres containing liquids including saliva from the team. The two spheres are lifted and lowered in synchrony with the gut-brain signals, exchanging their liquids through transparent plastic tubes.*

Second Brain uses brain sensing technology to understand the potential synchronisation between the brain and enteric nervous system. No stimulation technology is involved in this artwork.

The application of bioelectromagnetic stimulation is fundamental in this study. Moreover, the integration of such stimulations for the controlled manipulating of sensations as a process of *modulation of consciousness* is relevant to the thesis.

At this point, it is important to endorse the Tokyo 99 Declaration presented at Toward a Science of Consciousness Fundamental Approaches, at the United Nations University, in Tokyo, in 1999. The passage reads as follows:

> *Today, we have the intellectual, physical and financial resources to master the power of the brain itself, and to develop devices to touch the mind and even control or erase consciousness. We wish to profess our*

> *hope that such a pursuit of knowledge serves peace and welfare.* (Pickering, 1999)

Surely, new developments in the entrainment of bioelectromagnetic capabilities will enhance human survival capabilities directly related with the growth of agency. The debate on free will and agency has been a very lively one. Brain implants, such as Deep Brain Stimulation (DBS), are a good example to illustrate this. DBS was designed to improve motor, mood and behavioural pathology, and presents unique challenges to our understanding of identity, agency and free will. Indeed, these devices can have visible effects on persons' physical and psychological properties. Yet, they are essentially undetectable when operating correctly. They can supplement and compensate for one's inherent abilities and faculties when they are compromised by neuropsychiatric disorders:

> *Further, unlike talk therapy or pharmacological treatments, patients need not 'do' anything for the treatment to take effect. If one accepts, as we argue here, that brain implants are unique among implantable types of devices, then this can have significant implications for what it means to persist as the same person and be the source of one's thoughts and actions. By examining two of the most common indications for DBS in current use, namely in the motor (Parkinson's Disease) and psychiatric (Major Depression) domains, we further argue that although DBS, as it is currently applied, does not necessarily represent a unique threat to personal identity and agency per se, it introduces an unprecedented 'third party' into the debate on these concepts.In this way, DBS can be used as a tool to begin probing, both conceptually and empirically, some of philosophy's most perennial metaphysical questions.* (Lipsman and Glannon, 2013)

The underlying artistic premise in this thesis is that of bioelectromagnetism being the primary stage of the extra-physical existence of the human being. This means that in the dichotomy *electro* and *magnetic*, electro is linked to the body whilst

magnetic is linked to the mind. In other words: from electro to magnetic, an expansion of consciousness from material to immaterial occurs. Perception is multisensory by nature at any given time since consciousness appears not to be unidimensional. Even when focusing on the stimulation of a specific sense, the final result always involves the sum of all the senses. The proposed induction techniques, therefore, do not imply any change in perceptual given states, but allow for a better efficacy in interfering with the constant transformation of perception, resulting in processes of continuous modulation: a bioelectromagnetic interface is a technical tool for the modulation of the different states of mind. This constitutes a whole new area for artistic expression in itself. The production of this kind of experiences is still far from realising its full potential. Yet, and for the first time, it is clearly expressed in *Homo Conscientis*. Once again, the core of this thesis, and by the same token that of an artwork, is that continuous modulation of the human being through bioelectromagnetism allows for an artistic modulation of consciousness.

The function of this short update on bioelectromagnetism is to re-illustrate the electromagnetic nature of the human body. The body as interface to consciousness.

There is no such thing as electromagnetic nature. There is something we might agree on to define as natural phenomena that can be partially described and characterised through the view of electromagnetic theory. This special perspective on nature is one that incorporates interaction as a basic principle. It also constitutes the basis for the conceptualisation of the practice of art as a

process of mediation amongst and between human beings. A field-based reality, as Roy Ascott would put it.

The proof that these ideas have not been utopian, but have resulted from contemporary technological circumstances, is to be found in the number of emerging applications of bioelectromagnetics, that also include the military e.g. (ANNEX I) These sort of applications have been omitted here since the ones in the area of health are much more constructive for a world where well-being is the relevant target. Nonetheless, it is worthwhile to reiterate that bioelectromagnetics is inherently interactive. This again brings the mind into focus as a very powerful tool against any sort of top-down enforcement. In the light of these ideas, it does not make sense any more to use binomials such as subject-object or input-output. Everything is interaction in a continuum. Non-dual approaches proposing alternatives such as interference, resonance and those, in the words of Linus Lancaster, an American artist, "yet-to-come" are needed in order to fully conceive of realities from such a perspective (Lancaster and Young, 2012).

3. Consciousness and Research

In the last few decades, concepts such as collective intelligence, connected intelligence, planetary consciousness as well as the notion nonlocality of consciousness have been developed, recognising various potential definitions of consciousness, all of them pointing to notions of collectiveness and connectedness. The key word that seems to come out of all this is interconnectedness. This aspect is fully in agreement with the concept of bioelectromagnetism adopted in this thesis, as laid out in the previous chapter.

In one of the oldest theories of philosophy of mind, panpsychism, consciousness is regarded as a non-reducible feature of each and every physical field and particle of fundamental physics. According to that theory, everything that exists has a "proto-consciousness" which, in certain aggregates and under certain conditions, can generate inner awareness.

In the light of a panpsychic approach and the bioelectromagnetism concept that this thesis builds upon, consciousness is to be found in the relationship of the parts. In this hypothesis, consciousness does not exist *per se*. It is essentially viewed as being generated in a constant modulation process that implies action and interpretation: *enaction* as a way of accessing as well as creating consciousness, *motion* as its origin, and *energy* as the potential for transformation that is always dynamic and relational by nature. This is the reason why the composition or manipulation of the electromagnetic spectrum is only a medium for true artistic expression, as a practice of accessing consciousness for knowledge generation. Consciousness is not of bioelectromagnetic origin, but it manifests itself in the primary instance in the electromagnetic spectrum.

Assuming the notion of artwork as field phenomena, as expressed in the first chapter of this dissertation, the accomplishment of artistic practice only occurs when the transformation of consciousness of the collective involved in its generation is transformed. Modulation is understood as a process of transformation of consciousness.

It is further posited in this chapter that artistic practices leading to concrete technological applications allow for the integration of subjectiveness in research. Processes of artistic creation imply non-objective dimensions such as the spiritual or unconscious. These processes allow the artist to access consciousness in a unique manner. Accessing consciousness is described as a relational process by the individual who is affected by consciousness but can also influence consciousness. During those processes, which in some cases can be compared with trance states, the production of technology materialises ideas that could not otherwise be produced by rationalised engineering processes. But because they have been materialised, a number of deductive processes can be applied, for example reverse engineering, in order to rationalise the results and make them reproducible. Reproducibility of technology is a condition sine qua non for the validation of research results and potential applicability.

Modulation of consciousness in human beings is argued to be the core of a new practice of research resulting from the technological confluence of philosophy, art and science. This third chapter also points out the potential of bioelectromagnetic stimulation as a medium of artistic expression, integrated in knowledge generation systems. Aspects of disembodiment, peculiar to artistic practices, are understood to be crucial in a new potential *modus operandi* in

research, as shown in Chapter 5. An anthropological case study is analysed in this third chapter and further associated with the technological induction of autoscopy experiences as a potential future practice in research in general and in knowledge generation systems (institutionalized research) in particular.

3.1 Consciousness

Several approaches to the notions of consciousness are presented in this chapter and the adoption of a preferred one is justified. The term consciousness means different things to different people, and no universal core meaning is agreed upon. Max Velmans, Emeritus Professor at the Goldsmiths University of London, exposes the problem as follows:

> *This uncertainty about how to define consciousness is partly brought about by the way global theories about consciousness (or even about the nature of the universe) have intruded into definitions. Normally we point to some thing that we observe or experience. The term consciousness however refers to experience itself. Rather than being exemplified by a particular thing that we observe or experience, it is exemplified by all the things that we observe or experience. Something happens when we are conscious that does not happen when we are not conscious and something happens when we are conscious of something that does not happen when we are not conscious of that thing. We know what it is like to be conscious when we are awake as opposed to not being conscious when in dreamless sleep. We also know what it is like to be conscious of something (when awake or dreaming) as opposed to not being conscious of that thing.* (Velmans, 2009)

This uncertainty is mostly due to the nature of an individual experience. Nonetheless, the basic assumption that consciousness is experience is pertinent to the thesis. Artistic practices normally imply the creations of experiences and experimentation as a process. Maybe because of that uncertainty, due to the subjective nature of consciousness, science did not dedicate itself to the study of consciousness. But in the latest few decades that has changed.

> *For decades now, the evidence has been mounting in quantity and quality. The scientific community has responded with rising interest. Consciousness has become a major focus for research. Each month new findings appear in leading journals. In the coming century this new ferment is likely to reshape our understanding of mind and brain in the most basic way.* (Baars et al., 2003)

The growing interest in consciousness studies gave origin to a considerable number of different approaches which are summarized here.

3.1.1 A definition of consciousness

Inherent collective, interconnectedness and non-locality.

The idea of a global network has been presented by several authors: Pierre Levy and Derrick de Kerckhove, to name just two. In 1994, Levy published *L'Intelligence Collective*, and in 1997, de Kerckhove published *Connected Intelligence*. In his most recent book *The Architecture of Intelligence (1997),* de Kerckhove highlights an architecture of intelligence that brings together three main spatial environments that we live in and with today: mind, world and networks. Telecommunication-based art helps perceive that the human kind is becoming larger. Looking at planet Earth from space shows that the real size of collective body of humans is the planet itself. Interactive arts and the proliferation of sensory interfaces can make human beings realize their extended minds and bodies as tuning mechanisms to monitor the state of health of the Earth. Proprioception is therefore changed to extend their point of being (rather than their point of view) from wherever they are to wherever their technically extended senses can allow them to reach. Roy Ascott, in his article *Planetary Technoetics: Art, Technology and Consciousness* introduced the concept of Planetary Consciousness. Ascott considers the value of the idea of planetary consciousness as follows:

> *Where consciousness evolves at the planetary level, a new sensibility arises, a new way of valuing ourselves, our attitudes and actions. It has*

> *begun to arise from our understanding of the dynamics of living processes, the flux and flow of nature, the transformative continuum of energies at both quantum and cosmic levels, which condition both our material states and our sense of being. (…) The emergence of mixed-reality technology marks a further step in our quest to control our own evolution, to redefine what it is to be human and to become actively responsible for the construction of our own realities. (Ascott, 2004)*

Thomas W. Malone, the Patrick J. Mc Govern Professor of Management at the MIT Sloan School of Management, and also the founder and director of the MIT Centre for Collective Intelligence, uses the following definition:

> *Collective intelligence is groups of individuals doing things collectively that seem intelligent. (Malone, 2008)*

He further argues that:

> *With new information technologies—especially the Internet—it is now possible to harness the intelligence of huge numbers of people, connected in very different ways and on a much larger scale than has ever been possible before. In order to take advantage of these possibilities, however, we need to understand what the possibilities are in a much deeper way than we do so far. (Malone, 2008)*

Pierre Lévy, Canada Research Chair in Collective Intelligence, has termed Collective Intelligence as follows:

> *Collective Intelligence (CI) is the capacity of human collectives to engage in intellectual cooperation in order to create, innovate and invent. It can be applied at any scale, from work teams to huge networks or even to our whole species. Collective Intelligence is a determining factor in competitiveness, creativity and human development in a knowledge based economy, or in an information economy. The more our society depends on the creative management of knowledge, the more this capacity becomes of fundamental importance. There is a growing feeling that there exists a strong correlation between communities collective intelligence and the degree of their human development. CI can be seen as a driving force of human development and within this conceptual framework, conversely, human development provides CI with an environment for growth. As digital technologies give us more and more powerful tools to augment personal and collective cognitive processes, it becomes essential to understand how the collective intelligence processes can be multiplied by digital networks. (Lévy, 2009)*

Connectivity is undoubtedly the buzzword of the new millennium. A significant number of people are connected to many different networks almost around the clock. The architecture of intelligence is the architecture of connectivity. It is the architecture that brings together the three main spatial environments that we live in and with today: mind, world and networks.

Derrick de Kerckhove makes an interesting distinction between collective and connective intelligence:

> *I adopted the term connective as a sub category of collective intelligence to indicate cognitive relationships that include specific configurations and proper attribution to individual participants. The assumption is that all forms of group intelligence are subsumed by the term collective. But it isn't so. At best collective may signify the overall cognitive achievement of a community over a given period of time. Connective, however, reflects the form, duration and outcome of specific cognitive activities performed by groups of individually identifiable persons working together. It applies in particular to social relations and interactions that are carried by networks. The Internet is an emotional as well as cognitive environment. It offers and stimulates different levels of involvement from simple collaborative practices to emotional engagement in social movements. (Kerckhove, 2014)*

Continuing his reasoning, he defines connected intelligence as follows:

> *Connected Intelligence is the active personal and collective cognitive environment that electronic technologies have weaved in and around us via the Internet in particular and electricity in general. It functions both as an extended memory and a processing intelligence for each one of the users of electronic technologies from the telegraph to "cloud computing" and Twitter. It brings people together instead of separating them as alphabetic literacy did and it allows for any number of individual entries in a fluid information space definable for individual as well as collective and connective needs. It can take many forms whether pooling individual resources in services such as Google, Wikipedia and social bookmarking or externalizing and objectifying imagination in fictional but live 3D environments such as Second Life. (Kerckhove, 2014)*

The above-mentioned authors have recognised various modes of consciousness pointing to collectiveness and connectedness. Although collective intelligence is not the same as consciousness it brings the notion of contemporary

interconnectedness as a tendency of development of the human kind. The sort of interconnectivity of collective intelligence and connected intelligence has a considerable practical approach: the phenomena made possible by digital networks. The notion of Planetary Consciousness brings forward the hypothesis of these tendencies of being a reflection of a consciousness-related aspect – a manifestation of consciousness in contemporary times that highlights the inherent collective of consciousness, similar to the inherent collective of electromagnetism pointed out in the previous chapter.

In that perspective, the possibility of consciousness being a non-local phenomenon becomes relevant. A pertinent argument for the nonlocality of consciousness is made by de Kerckhove when referring to an interesting viewpoint developed by Ascott:

> *Another angle on the meaning of intelligence comes from Roy Ascott's suggestion that the brain is not an organ that produces consciousness, but one that perceives it, just as the eye does not produce vision but perceives the visual object. This bold and interesting hypothesis implies that consciousness is not internal to the body but available everywhere and that different types of bodies are equipped with different types of cognitive apparatuses. Of course there is no scientific proof of that hypothesis and it may not even have an immediate bearing on the nature of intelligence. However it begins to be useful when it is related to technology. Taking the example of the eye, glasses help to refine the precision of vision. In the same way, ICT technologies might be deemed to help improve and share access to matter and awareness. (Kerckhove, 2014)*

Ascott suggests that the brain is an organ to access consciousness. American physicist Russell Targ in his book *Limitless Mind: A Guide to remote viewing and transformation of consciousness* clearly presents, based on two decades of research at the Stanford Research Institute, some support for the notion of accessing consciousness in the context of the phenomenon of nonlocality. Together with other scientists in the consciousness research field, Targ has

demonstrated that our minds have extraordinary abilities we are just only beginning to scientifically grasp and comprehend. Targ pinpoints nonlocality as follows:

> *We live in a 'nonlocal' reality, which is to say that we can be affected by events that are distant from our ordinary awareness. (...) All of space-time is available to your consciousness, right where you are. You are always on the edge. (...) Nonlocality is a property of both time and space. The physics of nonlocality is fundamental to quantum theory. The most exciting research in physics today is the investigation of what physicist David Bohm calls "quantum interconnectedness" of nonlocal correlations. How does consciousness access this nonlocal space? We believe it does so through the process of intentionality, which is fundamental to any goal-oriented process including retrieval of memory. In fact, the universality of nonlocality is simply there, existing as the fundamental nature of space and time. That is, it is not a physical thing, but it is available to be accessed at will. (Targ, 2010)*

The notion of an interconnected intelligence that might be a manifestation of consciousness is a very relevant hypothesis for the thesis. Furthermore, the possibility of consciousness being of an inherent collective nature expressed in its non-locality is also a relevant notion.

Diverse approaches on consciousness

David Chalmers coined the famous "hard problem" of consciousness. John Searle has shed new light on the interlinkages between computers, mind and consciousness. Rodney Brooks advocates that consciousness can be created in non-biological media. Warren Brown highlighted "embodied cognition, embodied consciousness". According to Christof Koch, consciousness is the foundation of everything. Giulio Tononi developed his new information integration theory of consciousness. Roger Penrose claims that consciousness is non-computable and that on a non-computational physical body could explain

consciousness. Ray Kurzweil believes that a point will be reached where computers will evidence the rich array of emotionally subtle behaviours that we see in human beings.

NYU philosopher David Chalmers famously described the “hard problem” of consciousness as follows:

> *Conscious experience is at once the most familiar thing in the world and the most mysterious. There is nothing we know about more directly than consciousness, but it is extraordinarily hard to reconcile it with everything else we know. Why does it exist? What does it do? How could it possibly arise from neural processes in the brain? These questions are among the most intriguing in all of science. (...) Researchers use the word "consciousness" in many different ways. To clarify the issues, we first have to separate the problems that are often clustered together under the name. For this purpose, I find it useful to distinguish between the "easy problems" and the "hard problem" of consciousness. The easy problems are by no means trivial – they are actually as challenging as most in psychology and biology – but it is with the hard problem that the central mystery lies. The easy problems of consciousness include the following: How can a human subject discriminate sensory stimuli and react to them appropriately? How does the brain integrate information from many different sources and use this information to control behaviour? How is it that subjects can verbalize their internal states? Although all these questions are associated with consciousness, they all concern the objective mechanisms of the cognitive system. Consequently, we have every reason to expect that continued work in cognitive psychology and neuroscience will answer them. The hard problem, in contrast, is the question of how physical processes in the brain give rise to subjective experience. This puzzle involves the inner aspect of thought and perception: the way things feel for the subject. (Chalmers, 1995)*

As extensively described in Chapter 1, it is the core of this thesis that physical processes in the brain do not give rise to subjective experience. Experience is not a consequence of brain activity. Experience or consciousness, as put forwards by this thesis, is the interplay of physical processes with non-physical processes. Physical processes that exist in the brain, the second brain and in the infinite bioelectromagnetic ‘network’ which *manifests* non-physical (non-existing) processes and *realizes* physical processes.

- Poem pen dissolved in the primordial direction of the poem. (Herberto Helder, 2001)

Berkeley philosopher John Searle has shed new light on the interlinkages between computers, mind and consciousness. He believes that computer programs can never have a mind or be conscious in the human sense, even if they give rise to equivalent behaviours and interactions with the external world. It's appropriate to ask the question whether it will ever be possible, with hyper-advanced technology, for non-biological intelligences to be conscious in the same sense that we are conscious. In other words, can computers have "inner experience"? Searle argues:

> *Only a machine could think, and indeed only very special kinds of machines, namely brains and machines that had the same causal powers as brains. And that is the main reason why strong AI has had little to tell us about thinking, since it has nothing to tell us about machines. By its own definition, it is about programs, and programs are not machines. Whatever else intentionality is, it is a biological phenomenon, and it is as likely to be as causally dependent on the specific biochemistry of its origins as lactation, photosynthesis, or any other biological phenomena. No one would suppose that we could produce milk and sugar by running a computer simulation of the formal sequences in lactation and photosynthesis, but where the mind is concerned many people are willing to believe in such a miracle because of a deep and abiding dualism: the mind they suppose is a matter of formal processes and is independent of quite specific material causes in the way that milk and sugar are not. (Searle, 1980)*

Robotics entrepreneur and MIT professor emeritus Rodney Brooks agrees that consciousness can be created in non-biological media, but disagrees on the nature of consciousness itself. Brooks' view is a natural consequence of his beliefs that the universe is mechanistic and that consciousness which seems special, is an illusion. He claims that, because the external behaviours of a human, animal or

even a robot can be similar, we fool ourselves into thinking our internal feelings are so unique (Brooks, 2001).

Warren S. Brown, a psychologist at Fuller Theological Seminary and a member of UCLA's Brain Research Institute, highlighted "embodied cognition, embodied consciousness". According to Brown, biological beings are the richest substrate for embodying consciousness. However, he didn't rule out that consciousness might be embodied in something non-biological. Brown also speculated that:

> *Consciousness may be a particular kind of organisation of the world that just cannot be replicated in a non-biological system. (Brown et al., 1997)*

Neuroscientist Christof Koch, President and CEO of the Allen Institute for Brain Science, takes a strong philosophical stance based on his work as a neuroscientist:

> *Without consciousness there is nothing. The only way you experience your body and the world of mountains and people, trees and dogs, stars and music is through your subjective experiences, thoughts, and memories. You act and move, see and hear, love and hate, remember the past and imagine the future. But ultimately, you only encounter the world in all of its manifestations via consciousness. And when consciousness ceases, the world ceases as well. To understand consciousness, we must understand the brain. But there's the rub. How the brain converts bioelectrical activity into subjective states, how photons reflected off water are magically transformed into the percept of an iridescent aquamarine mountain tarn is a puzzle. The nature of the relationship between the nervous system and consciousness remains elusive and the subject of heated and interminable debates. (Koch, 2012)*

Giulio Tononi, neuroscientist and professor at the University of Wisconsin, developed his new integrated information theory of consciousness (IIT). Tononi argues that:

> *Consciousness has to do with the capacity to integrate information. This claim may not seem self-evident, perhaps because, being endowed with consciousness for most of our existence, we take it for granted. To gain some perspective, it is useful to resort to some thought experiments that illustrate key properties of subjective experience: its informativeness, its unity, and its spatio-temporal scale. (Tononi, 2004)*

According to IIT, consciousness corresponds to the capacity of a system to integrate information:

> *This claim is motivated by two key phenomenological properties of consciousness: differentiation – the availability of a very large number of conscious experiences; and integration – the unity of each such experience. The information integration theory accounts, in a principled manner, for several neurobiological observations concerning consciousness. These include the association of consciousness with certain neural systems rather than with others; the fact that neural processes underlying consciousness can influence or be influenced by neural processes that remain unconscious; the reduction of consciousness during dreamless sleep and generalized seizures; and the time requirements on neural interactions that support consciousness. (Tononi, 2004)*

Summing up the core insights of ITT, it can be stated that ITT accounts for several aspects of the relationship between consciousness and the brain. ITT starts from the essential properties of phenomenal experience, from which it derives the requirements for the physical substrate of consciousness. Furthermore, ITT argues that the physical substrate of consciousness must be a maximum of intrinsic cause–effect power, thus providing a means to determine the quality and quantity of experience. ITT, therefore, leads to some counter-intuitive predictions and can be used to develop new tools for assessing consciousness in non-communicative patients.

Mathematician Roger Penrose claims that consciousness is non-computable and that on a non-computational physical body could explain consciousness:

> *Consciousness implies awareness: subjective experience of internal and external phenomenal worlds. Consciousness is central also to understanding, meaning and volitional choice with the experience of free will. Our views of reality, of the universe, of ourselves depend on consciousness. Consciousness defines our existence. The nature of consciousness, its occurrence in the brain, and its ultimate place in the universe are unknown. We proposed in the mid 1990's that consciousness depends on biologically 'orchestrated' quantum computations in collections of microtubules within brain neurons, that these quantum computations correlate with and regulate neuronal activity. (Penrose and Hameroff, 2011)*

Inventor and futurist extraordinaire Ray Kurzweil believes that we will get to a point where computers will evidence the rich array of emotionally subtle behaviours that we see in human beings. They will be very intelligent, and they will claim to be conscious. They will act in ways that are conscious. They will talk about their own consciousness and argue about it just the way you and I do. And so the philosophical debate will be whether or not they really are conscious – and they will be participating in the debate. He puts it this way:

> *Can the pace of technological progress continue to speed up indefinitely? Is there not a point where humans are unable to think fast enough to keep up with it? With regard to unenhanced humans, clearly so. But what would a thousand scientists, each a thousand times more intelligent than human scientists today, and each operating a thousand times faster than contemporary humans (because the information processing in their primarily nonbiological brains is faster) accomplish? One year would be like a millennium. What would they come up with? Well, for one thing, they would come up with technology to become even more intelligent (because their intelligence is no longer of fixed capacity). They would change their own thought processes to think even faster. When the scientists evolve to be a million times more intelligent and operate a million times faster, then an hour would result in a century of progress (in today's terms). This, then, is the Singularity. The Singularity is technological change so rapid and so profound that it represents a*

> *rupture in the fabric of human history. Some would say that we cannot comprehend the Singularity, at least with our current level of understanding, and that it is impossible, therefore, to look past its "event horizon" and make sense of what lies beyond. (Kurzweil, 2004)*

In a recent article in Nature, *A Giant Neuron Has Been Found Wrapped Around the Entire Circumference of the Brain* (Reardon and others, 2017) the Allen Institute for Brain Science has pointed, for the first time, to possible new origins of consciousness. For the first time indeed, scientists have detected a giant neuron wrapped around the entire circumference of a mouse's brain that is so densely connected across both hemispheres, it could eventually even explain the origins of consciousness. Using a new imaging technique, the team detected the giant neuron emanating from one of the best-connected regions in the brain, and advanced it could be coordinating signals from different areas to create conscious thought. At a recent meeting of the *Brain Research through Advancing Innovative Neurotechnologies* initiative in Bethesda, Maryland on February 15 2017, a team from the Allen Institute for Brain Science, led by Christoph Koch, President of the Allen Institute, described how all three neurons stretch across both hemispheres of the brain, but the largest one wraps around the organ's circumference like a “crown of thorns”. The discovery is an intriguing piece of the puzzle that could help up make sense of this crucial, but enigmatic region of the brain, and how it could relate to the human experience of conscious thought.

The diversity of approaches in the field of consciousness studies clearly demonstrates that there is no unified approach to what consciousness is or what its nature is. It is interesting, however, to observe that, because consciousness studies are relevant in many different specialities of scientific research, the different approaches on consciousness tend to reflect the speciality of the author.

This fact makes the case for truly transdisciplinary research to be the future of consciousness studies. Only holistic perspectives that are able to disembody and see from above and many other different angles can help find conceptual commonalties between all the diverse approaches to consciousness studies. This study tries to be a contribution in this direction of thinking.

Philosophical currents in consciousness studies

From the perspective of Physicalism or Materialism, consciousness is entirely physical, solely the product of biological brains, and all mental states can be fully reduced to physical states – which, at their deepest levels, are the fields and particles of fundamental physics. Overwhelmingly for scientists, physicalism or materialism has perhaps become the prevailing theory of consciousness. For this current of thinking, the utter physicality of consciousness is an assumed premise, strongly supported by incontrovertible evidence. Though the terms "materialism" and "physicalism" are generally interchangeable, materialism connotes a more metaphysical or ontological meaning, whereas physicalism conveys a more methodological or linguistic usage:

> *The word 'physicalism' was introduced into philosophy in the 1930s by Otto Neurath and Rudolf Carnap, both of whom were key members of the Vienna circle, a group of philosophers, scientists, and mathematicians active in Vienna prior to World War II. On the other hand, 'materialism' is traditionally construed as denoting, not a linguistic thesis, but a metaphysical one, i.e. it tells us about the nature of the world as such. (Stoljar, 2010)*

In the approach of Epiphenomenalism, consciousness has also been viewed as entirely physical, thus solely the product of biological brains, yet mental states cannot entirely be reduced to physical states, though mental states have no powers. Here, mind is entirely inert. Awareness of consciousness is real but the sense of mental causation is not. There is no top-down causation. Feelings that thoughts can cause things are an illusion. In the Stanford Encyclopedia of Philosophy, William Robinson termed it as follows:

> *Epiphenomenalism is the view that mental events are caused by physical events in the brain, but have no effects upon any physical events. Behaviour is caused by muscles that contract upon receiving neural impulses, and neural impulses are generated by input from other neurons or from sense organs. On the epiphenomenalist view, mental events play no causal role in this process. (Blöser and Stahl, 2017)*

Non-reductive physicalism (NRP) is the metaphysical thesis that claims that all entities of the world constitute an ontological and causal network that is fundamentally physical and, however, cannot be reduced to nor fully explained by the laws, properties, and concepts that the basic physical science can discover and articulate. NRP is, therefore, the view that mental properties form a separate ontological class to physical properties: mental states (such as qualia) are not reducible to physical states. The ontological stance towards qualia in the case of non-reductive physicalism does not imply that qualia are causally inert; this is what distinguishes it from epiphenomenalism. According to this theory, while mental states are generated entirely by physical states (of the brain), they are truly other than physical. Mental states are ontologically different. The prime feature of non-reductive physicalism is “top-down causation”, where the content of consciousness is causally efficacious. The mechanism of non-reductive

physicalism is emergence. American philosopher Donald Davidson was one of the first to attempt to formulate such a NRP:

> *When one runs across what are traditionally seen as absurdities of Reason, such as akrasia or self-deception, the personal psychology framework is not to be given up in favour of the subpersonal one, but rather must be enlarged or extended so that the rationality set out by the principle of charity can be found elsewhere. Mental states supervene on physical states, but are not reducible to them. Supervenience therefore describes a functional dependence: there can be no change in the mental without some change in the physical–causal reducibility between the mental and physical without ontological reducibility. (Davidson, 2005)*

Quantum consciousness (sometimes called quantum mind) is the idea that consciousness requires quantum processes, as opposed to the view of mainstream neurobiology in which the function of the brain is wholly classical, and quantum processes play no computational role. Consciousness is non-computational and relates to or resides in the fundamental gap between the quantum and the classical worlds. Consciousness is still explained by the physics of neurons, but a physics enlarged from that which we currently know. Though dismissed by most scientists, the claim is that these two great mysteries, consciousness and quantum theory, can be solved simultaneously. Roger Penrose, quoted before, is the most famous proponent of this theory.

In the Qualia Force approach, qualia are individual instances of subjective, conscious experience. Tim Crane, when analysing the contemporary mind-body problem, traces back the origins of qualia:

> *While sense-data are largely a British invention, it is American philosophy which can lay claim to the invention of qualia. The first philosopher to use terms 'quale' and'qualia' in something like its modern sense was C.S. Peirce. When Peirce wrote in 1866 that there is a distinctive quale to every combination of sensation...a peculiar quale to*

> *every day and every week—a peculiar quale to my whole personal consciousness, he was talking about what experience is like in a general sense, not restricted to the qualia of experience in the sense in which it is normally meant today. (Crane and Patterson, 2012)*

According to the Qualia Force Theory, consciousness is an independent, non-reducible feature of physical reality that exists in addition to – and probably not derived from – the fields and particles of fundamental physics. This unknown aspect of the world may take the form of a new, independent, fundamental physical law or force. Franco Orsucci refers in his article "Mind Force Theory" (Orsucci, 2009) to Douglas Hofstadter, who in his book *I Am A Strange Loop* coined the concept Qualia Force Theory of Mind Force Theory. (Hofstadter, 2008)

In Qualia Space, consciousness is an independent, non-reducible feature of physical reality that exists in addition to the mass-energy and space-time of fundamental physics. This unknown aspect of the world may take the form of a radically new structure or organisation of reality, perhaps a different dimension of reality (e.g., "qualia space" as postulated by the "integrated information theory"). The concept Qualia Space has been introduced and explained by Giulio Tononi in his article "The Integrated Information Theory of Consciousness: An Updated Account" (Tononi, 2011).

Panpsychism is one of the oldest theories in the philosophy of mind, according to which, consciousness is a non-reducible feature of each and every physical field and particle of fundamental physics. Everything that exists has a "proto-

consciousness" which, in certain aggregates and under certain conditions, can generate inner awareness.

Panpsychism is the doctrine that mind is a fundamental feature of the world which exists throughout the universe. Since panpsychism is, by definition, the doctrine that *mind*, in some sense of the term, is *everywhere*, in some sense of that term, it is worth mentioning a complication which is a possible source of confusion at the outset. Clear indications of panpsychist doctrines are already evident in early Greek thought. Greek philosophers supporting panpsychism are Thales, Anaximenes, Heraclitus, Anaxagoras, Empedocles and Plato (Stanford Encyclopedia of Philosophy, 2010). Of greater interest is the role of ancient panpsychism in the much wider debate between panpsychism and emergentism. It was the modern "mechanistic" picture of the world inaugurated by Galileo, Descartes and Newton which put the problem of the mind centre stage while paradoxically sweeping it under the rug. The nineteenth century was the heyday of panpsychism. Notable panpsychist thinkers of this period include Arthur Schopenhauer and William James, to name just a couple. The most significant development and defence of a panpsychist philosophy in the twentieth century was undoubtedly that of Alfred North Whitehead. The current burst of scientific and philosophical studies of mind sparked by the "cognitive revolution" has rekindled debate about the perennial dilemma of emergentism versus panpsychism. The recently renewed and once again influential claim of some philosophers, especially David Chalmers, that the explanation of consciousness presents a uniquely difficult problem for science has forced the re-examination of the metaphysical foundations of the scientific world view (Chalmers, 1997).

Chalmers calls this problem the “hard problem of consciousness”; it is also sometimes called the “explanatory gap” or the “generation problem”. The key difficulty is how to explain in naturalistic terms the generation of consciousness by “mere matter”. Once again it seems imperative to decide whether and how mind *emerges* upon, or exists only under, some specifiable and non-universal natural and non-mentalistic conditions or whether mind itself forms a part of the fundamental structure of the world, perhaps in some of the ways panpsychists have suggested.

Dualism postulates that consciousness requires a radically separate, non-physical substance that is not only independent of the physical brain but also apart from the physical world. This would mean that reality consists of two, ontologically distinct parts – physical and non-physical substances, divisions, dimensions or planes of existence. The two distinctive parts account for the origin of the term *dualism*. René Descartes (1596-1650) originally claimed that consciousness requires an immaterial soul, which interacts with the body via the pineal gland of the brain. Under dualism, human consciousness would require both a physical brain and a non-physical substance (somehow working together), and following the death of the body and the dissolution of the brain, this non-physical substance by itself could maintain some kind of conscious existence.

It was the Descartes’s definition of consciousness that was the starting point for Daniel Dennet to postulate the most controversial definition of consciousness.

> *Cartesian materialism is the view that there is a crucial finish line or boundary somewhere in the brain, marking a place where the order of arrival equals the order of "presentation" in experience because what happens there is what you are conscious of. [...] Many theorists would insist that they have explicitly rejected such an obviously bad idea. But*

> *[...] the persuasive imagery of the Cartesian Theater keeps coming back to haunt us—laypeople and scientists alike—even after its ghostly dualism has been denounced and exorcized. (Dennett and Weiner, 1991)*

To put it simply, for Dennet consciousness is a process of the brain only. Dennett says that, when the dualism is removed, what remains of Descartes' original model amounts to imagining a tiny theater in the brain where a (small person), now physical, performs the task of observing all the sensory data projected on a screen. Dennett's more controversial claim is that qualia do not exit because their properties — qualia are supposed to be incorrigible, ineffable, private, directly accessible and so on— are incompatible, therefore the notion of qualia is incoherent. The non-existence of qualia would mean that there is no hard problem of consciousness. For Dennett, human beings are without any additional non-material aspects. This thesis is clearly opposed to Dennet's "multiple drafts" model. Even the simple understanding of bioelectromagnetism as described in this study demonstrates the unavoidable physical as well as non-physical nature of the human being.

In diametrical opposition to Dennet's materialism is the age-old claim, rooted in some traditionalwisdom, that the only thing that is genuinely real is consciousness – everything else, especially the entire physical world and all it contains (including physical brains), is derived from an all-encompassing "cosmic consciousness". Each individual instance of consciousness – human, animal, robotic or otherwise – is a part of this cosmic consciousness. Eastern religions, in general, espouse this view. In contemporary thinking, Deepak Chopra in particular has endorsed consciousness as ultimate reality.

I believe the soul is an expression of an underlying universal field of consciousness (Chopra, 2002)

From all the available definitions of consciousness, this thesis builds upon the one of panpsychism. The notion of "proto-consciousness" is key. However, its understood in a slightly different manner than originally. Everything that exists has a "proto-consciousness" but it does not 'have' it, as a property or an addition. Consciousness is constantly being generated. It is in constant creation. Consciousness has no beginning and no ending as there is no space, time or any other dimensions. They are constructions, not just of matter or of ether yet of the perpendicularity of both as manifested in electromagnetism. Always together, always separated. Consciousness is, however, "proto", primordial because it is life and death simultaneously. Therefore, it does not exist. It is constant creation. Ephemeral. It is artistic by nature.

The other important aspect of panpsychism for the thesis is that certain conditions are to be met in order for inner awareness to be generated. Inner awareness is understood here as knowledge. Therefore, in order for knowledge to be generated, certain conditions have to be met. In those conditions, the conscious is highlighted. In other conditions, the unconscious prevails and knowledge gives place to wisdom and awareness becomes occult. It is the interplay between the conscious and unconscious that artistic practices master.

3.1.2 Accessing consciousness for knowledge generation

A relevant part of the approach in this thesis relates to modulation. This is an extremely important concept, not only in scientific terms, but also in artistic ones: modulation as a basis for the explanation of physical systems and the understanding of the communicative aspects of art practice. Some analogies of modulation are interesting metaphors. For example, sound as a traditional carrier of music, and religious rituals as a traditional carrier of spiritual energy. Or light as an alternative carrier of music, in a more direct relationship with the human nervous system. Yet, not all rituals are conducive to spirit, as not all the produced sounds carry music in them. Specific conditions need to be accomplished and achieved first in order for these phenomena to occur. When these conditions have been achieved, then the elements involved in the realisation of the modulation can be considered to exist in a coherent domain.

In electronics and telecommunications, modulation is the process of varying one or more properties of a periodic waveform, called the carrier signal, with a modulating signal that typically contains information to be transmitted. Most radio systems in the 20th century used frequency modulation (FM) or amplitude modulation (AM) to make the carrier carry the radio broadcast. In music, modulation is most commonly the act or process of changing from one key (tonic, or tonal centre) to another. This may or may not be accompanied by a change in key signature. Modulations articulate or create the structure or form of many pieces, as well as adding interest. As regards consciousness, modulation has been defined in various ways in the scientific literature.

In his article (2001), Michael V. Anthony defined modulation as follows:

> *I argue that the purportedly distinct senses of 'consciousness' within the consciousness literature are interpretable as modulations of a single sense of 'consciousness', thus making the univocality view a serious contender alongside the ambiguity view. For modulation to explain the relevant semantic phenomena, however, it must be antecedently plausible that there is some single meaning of 'consciousness' that gets modulated across contexts. It seems, however, that there is a general sense of the term that is widely used among researchers—a sense, incidentally, that is acknowledged by many adherents of the ambiguity view. It is that sense, or something close to it, that I believe plausibly gets modulated across contexts. (...) To show that modulation can explain the semantic phenomena others take to support the ambiguity view, it must be shown for each alleged sense of 'consciousness' that modulation indeed accounts for the relevant phenomena. (Anthony, 2001)*

> *From a quite different approach angle, Anthony Hudetz and Robert Peirce (2010) presented the original results as well as overviews of the current state of knowledge as regards anaesthetic modulation of both consciousness and memory. They argue and make a stand that:*
>
> *Understanding the neurobiological bases of consciousness and memory are arguably two of the greatest challenges for neuroscience. The possible impact of such discoveries for science, and society is enormous. Knowing what makes people consciously perceive and behave as they do, and how and why they learn, remember, and forget, not only would revolutionize fields of medicine such as neurobiology, psychology, and anesthesiology but would have far-reaching implications for morality, ethics, law, and education. We believe that anesthetic research can make major contributions in these research endeavors. Anesthetic agents represent an exclusive class of psychoactive drugs that can be used to modulate the states of consciousness and memory in a safe and reversible manner. A century of experience with anaesthetic drugs, and the rapidly expanding knowledge of their molecular, cellular, neurophysiological, and psychological actions, make them unique and useful tools to study the neurobiological bases of consciousness and memory. As anesthesiologists remove and restore human consciousness and memory daily, their methods and experience should arguably be a foundation par excellence for a scientific understanding of the nature and modulation of the states of consciousness and memory. (PEARCE, 2010)*

It is interesting to note at this stage that anaesthetics are the antonym of aesthetics. Which can make us understand aesthetics as bringing things to life, in line with the notion of *manifestation* as presented in Chapter 1. David Chalmers (1998) has also been analysing the matter of consciousness modulation by introducing the concept of consciousness module:

> *Now, I do not think this is a full explanation for consciousness. One can always ask why these processes of availability should give rise to consciousness in the first place. As yet we cannot explain why they do so, and it may well be that full details about the processes of availability will still fail to answer this question. Certainly, nothing in the standard methodology I have outlined answers the question; that methodology assumes a relation between availability and consciousness, and therefore does nothing to explain it. The relationship between the two is instead taken as something of a primitive. So the hard problem remains. But who knows: Somewhere along the line we may be led to the relevant insights that show why the link is there, and the hard problem may then be solved. In the meantime, whether or not we have solved the hard problem, we may nevertheless have isolated the basis. We just have to keep in mind the distinction between correlation and explanation. (...) This way of thinking about things allows one to make sense of an idea that is sometimes floated: that of a consciousness module. Sometimes this notion is disparaged; sometimes it is embraced. But the methodology in the search for an NCC [Neural Correlate of Consciousness] suggests that it is at least possible that there could turn out to be such a module. What would it take? It would require some sort of functionally localizable, internally integrated area, through which all global availability runs. It need not be anatomically localizable, but to qualify as a module it would need to be localizable in some broader sense. For example, the parts of the module would have to have high-bandwidth communication among themselves, compared to the relatively low-bandwidth communication that they have with other areas. Such a thing could turn out to exist. (Chalmers, Hameroff et al., 1998)*

If such a module existed and could be localized then neuromodulation would be of extreme relevance in modulation of consciousness.

> *The term neuromodulation has been used loosely to describe a number of very difficult kinds of phenomena. (...) In a more restrictive way, it can be defined as the ability of neurons to alter their electrical properties in*

response to intracellular biochemical changes resulting from synaptic or hormonal stimulation. Defined this way, neuromodulation is one of the most important intrinsic properties of individual neurons. This property not only allows the nervous system to adapt its control of physiological functions to a continually changing environment, but it is also the basis for many long-lasting changes in animal behaviour. (Levitan and Kaczmarek, 1987)

3.2 Art practice as a thinking process

Here once again, artistic practice as thinking process seems to be the crucial missing link towards opening up to new ways of development in the field of knowledge generation, mainly because of its transdisciplinary nature. Artistic practice, indeed, calls for a wider view on these latest scientific achievements. Artistic freedom allows experiment first and rationalisation later. As previously argued, artistic practices are based on urgency and the creative act needs no justification in order to happen. Contrary to that, scientific and engineering processes are constrained by (apparently) rational decisions (according to Damasio's somatic markers).

This insight can be translated into a theoretical term ranging between holism and reductionism. A theoretical term neither regarding the whole as a result of the different parts nor the parts as a mere reaction to a latent energy spreading out in the cosmos. Or, from theory of time perspective, an alternative term relating also to something between absolute time, as defended by many including Albert Einstein (1879-1955), and durational time, as proposed by Henri Bergson (1859-1941): Relational Time, for instance. This insight as been inspired by the theories of Doubochinski and Tennenbaum, such as Argumental Interaction.

> *The work reported here originates in the discovery, four decades ago, of a previously unknown type of self-organizing interaction among oscillating systems -- so-called argumental interactions -- and of "quantized" modes of behavior in macroscopic argumentally-coupled oscillators, having no equivalent in the classical theory of oscillations. Recently the present authors have been jointly pursuing new lines of investigation into argumental interactions and their possible significance for the foundations of physics. Among other things, the study of argumentally-coupled oscillators suggested to the authors a new general way of looking at physical objects, their interactions and their aggregative, "social"*

> *behavior as manifested on all scales of observation. (Doubochinski and Tennenbaum, 2008)*

Argumental coupling implies the capability of electromagnetics to establish a sort of dialogue and self-regulate.

> *The ability of argumental interactions to efficiently "translate" oscillational energy over such a large range of frequencies, is inseparably connected with the role of fluctuations and self-regulating behavior. In the classical (Newtonian) mode of interaction, a system being acted upon by an external force is virtually the "slave" of that force; the Newtonian concept of force leaves no room for a true mutual interaction and mutual adaptation of the interacting systems to each other. The argumental pendulum, by contrast, remains "its own master": by shifting the phase of entry into the interaction zone, it can self-regulate its exchange of energy with the electromagnet. (Doubochinski and Tennenbaum, 2010)*

From an argumental coupling perspective, the relationship between two electromagnetic forces is self-regulated by each of the components but simultaneously maintains interaction: argumental interaction.

Since bioelectromagnetism is the main focus of this research, and in the light of the ideas presented above, it becomes therefore almost inevitable to be directed towards a variation of the panpsychic approach: an approach where consciousness is to be found in the relations of the parts. In this hypothesis, consciousness is essentially viewed as a modulation process that implies action and interpretation: *enaction* as a way of accessing as well as creating consciousness, *motion* as its origin, and *energy* as the potential for transformation that is always dynamic and relational by nature. Enactivism argues that

> *cognition arises through a dynamic interaction between an acting organism and its environment. (Thompson, 2010)*

It is exactly here that the proposed *artistic modulation of consciousness by bioelectromagnetic stimulation* gains place. The key element is the possibility of external control of the electromagnetic field the biological entity interacts with. This possibility allows the registration of a history, a continuous record of different subjective experiences of the biological entity, a human being for instance in correlation with a specific type of electric signal. Here, the modulation process is being triggered by bioelectromagnetic argumental coupling.

From this point of view, bioelectromagnetic entities are harmonic structures, in relationship with the infinitely big and small, yet, not the product, but the constitutive parts. The way to interact with these bioelectromagnetic entities is through bioelectromagnetism, which in itself is a form of art, because it is a transformation of consciousness. Therefore, there is no difference between artistic experience, scientific experience or life experience. They are all – always – integrated into a single experience. Today, an emergent form art could be named bioelectromagnetic art and could be understood as the most evolved form of expression of integrative art, where *Art is Life and Life is Art*.

In this thesis, artistic practice is defined as a series of infinite loops of trial and assessment of hypothesis. A good example is the practice of painting as a truly enactive activity. The continuous assessment of coherence of a painting emerging in front of its author has been the leitmotiv for its development, up to the point its consistency has been allowing for potentially infinite possibilities of visions of

constructed realities: instantaneously open for re-interpretation and therefore constantly open for re-construction.

As already referred to above, *enaction* is a key concept here:

> *A living organism enacts the world it lives in; its effective, embodied action in the world actually constitutes its perception and thereby grounds its cognition. (Stewart et al., 2010)*

Art practice, thus, means the creation and analysis of human experiences through creative research in art. In making art, the aim is to expand the boundaries of cultures and the limits of perceptions through rigorous experimentation with and in the mediums. Considering human experiences from an experiential standpoint, experimentation leads to questioning beliefs, rituals, and philosophies as well as social, economic, and institutional structures. Yes, art is a form of communication. What separates it from other forms of communication is that the information comes from a subjective source, and is then created (or interpreted in classical terms) in a subjective way by the viewer (or listener, or reader, or participant). In conclusion, art practice, in this thesis, serves as a communication model based on *enaction*.

3.3 Art vs Science in knowledge generation

The still massive uncertainty regarding research into Art versus Science in knowledge generation has contributed to levelling out the position of the artist and that of the scientist when it comes to the production of knowledge. This thesis argues that art practice as research methodology is instrumental to the integration of subjectivity in the production of scientific, reproducible knowledge.

Relevantly, Joe Davis (1951-) was one of the first artists in residence at MIT, and subsequently a number of institutions integrated artists in their research teams. Nowadays, Davis is a research affiliate in the Department of Biology at MIT.

Roy Ascott at the First Consciousness Reframed Conference, University of Wales (1997) set the tone by stating:

> *Interactions between art, science and technology are leading to the emergence of new cultural forms, behaviours and values. It is within the field of Consciousness that this is most marked, and, at the same time, least understood. Technology, creatively and wisely applied, assists us in creating new ideas of self and society, just as the physical and biological sciences provide us with new models and metaphors of being, or as we might prefer to say, becoming. Telematic connectivity, the associative structures of hypermedia, virtual reality and artificial life, are just some of the environments in which art and mind are explored and extended; We call this momentum post-biological, not to deny Nature its status but to signal the potency of these new technologies of mediation, construction and transformation in our understanding and perception of reality. (Ascott, 1997)*

The most useful contribution from Art to Science is the introduction of what is defined here as *Variable Target Methodology*.[19] Essentially, artistic practices are

[19] The methodology described here was coined by the author of the thesis as *variable target methodology* in a non-published internal communication, in 2014, to the Assistant for cultural matters of the President of European Commission. The methodology has been previously referred to orally in the conference *Presence in the Mindfield*, in Lisbon, December 2011.

revelation processes. Consequently, the initial target of an artistic driven research process might be shifting and a completely opposite target might be envisioned. Actually, in some cases, such target might not exist as such *a priori*. It will reveal itself in the course of the research. By means of this methodology, genuine novelty might then be achieved: the outcome resulting from a kind of 'freedom' of artistic thinking. Of course, the implications of such processes are not without risk, mainly when it comes to funding and project management. However, controlled risk is the basis for innovation.

Patricia Leavy (2016) has stressed the increasing importance of arts-based research (ABR):

> *Arts-based research (ABR) practices emerged from the 1970s to 1990s and now constitute a significant methodological genre. (...) Technology has further propelled advances in ABR via innovations including digital imaging, digital cameras, the Internet, PhotoShop, sound files and so forth. (...) ABR has so developed in a transdisciplinary methods context involving the crossing of disciplinary borders as well as cross-disciplinary collaborations. (...) For social researchers the appeal of the arts is in their ability to transform consciousness, refine the senses, promote autonomy, raise awareness, and express the complex feeling-based aspects of social life. ABR also draws on the oppositional, subversive, transformational, and otherwise resistive capabilities of the arts. (Leavy and others, 2016)*

The Planetary Collegium is the most relevant example of how artistic driven contributions are essential for research. The Planetary Collegium – first established as the *Centre for Advanced Inquiry in the Interactive Arts* (CAiiA) by Roy Ascott in 1994 – was relocated to Plymouth University and renamed The Planetary Collegium in 2003.

The Collegium's aim consists of producing new knowledge in the context of the arts, through transdisciplinary inquiry and critical discourse, with special reference to technoetic research and to advances in science and technology. Furthermore, the Collegium seeks to reflect the social, technological and spiritual aspirations of an emerging planetary society, while sustaining a critical awareness of the retrograde forces and fields that inhibit social and cultural development. It has been coalescing the face-to-face association of individuals with the transcultural unity of telematic communities, while at the same time focusing on developing a network of research nodes strategically located across the planet, each with a distinctive cultural ethos. For more than a decade now, the Collegium has been seeking outcomes that involve new language, systems, structures, and behaviours, and insights into the nature of mind, matter and human identity.

In sync with the groundbreaking insights of the Collegium, this thesis endorses the view that artists dealing with new technologies play a potentially extremely relevant role in the creation and production of new knowledge, especially in the field of consciousness studies.

The interface of Art and Science in knowledge generation has, however, been pursued before.

The most beautiful experience we can have is the mysterious — the fundamental emotion which stands at the cradle of true art and true science. (Einstein, n.d.)

Increasingly, artists and scientists have been eager to explore creative art practices emerging at the intersection of their two fields. The dialogue between

disciplines – in particular between the sciences and the visual arts – has been intensifying and thriving for many years. Science institutions have discovered art as a medium to both intelligibly communicate their specialised knowledge to a broader public and thus generate new knowledge. This knowledge generation in Art and Science revolves around two key questions: what scientific methods are used by artists, and what artistic approaches are used by scientists?

Both artists and scientists have been motivated by how these intersection ties can spur vibrant new economies. Another focal interest has been the way and means to foster creativity through changes in curricula and outreach to schools and in public spaces. Furthermore, a shared motivation has become increasingly stronger: their contribution to humanity's persistent urge to pursue beauty and meaning. Countless novel terms emerged to describe this new and fertile terrain existing outside the confines of traditional discipline silos, like, for example, "art/science hybridity," "interdisciplinary," "transdisciplinary" and even "anti-disciplinary". The platforms for both the investigation and expression of these new modes range from theatres, museums and other traditional performance spaces to research labs, personal computers, health facilities, public squares, hacker spaces, processing software, Maker Faires and cyberspace.

There is a transformative impact from art, though not easy to define and even trickier to prove. Recent neuroscientific advances by Nobel Prize winner Eric Kandel and others have shown that the brain constantly rewires itself depending on how people experience the world from one moment to the next. Even our oldest memories and experiences are being re-created every time they are called

forward, constantly being reshaped in ways large and small by new intellectual and emotional contexts.

What an intriguing and challenging prospect: to unlock what really happens at the molecular level when our brain is "on art": a sensation enhancing our awareness of both ourselves, each other and the world; a radical alteration of the perceptions of the person experiencing it, infusing them with new insight and understanding. Great moments of scientific discovery can produce similar revelations and breakthroughs.

Since time immemorial, the drive and passion for both artists and scientists have been twofold: the quest for the exhilaration of "knowing" something new and important and the urge to share this new knowledge with others.

The paths taken by artists and scientists on their quests for truth may seem unrelated at the surface. The scientific method on the one hand is, by definition, objective. Here, truth is typically pursued by designing experimental studies that test a potential explanation, or hypothesis. Artistic method and evaluation on the other hand seems more driven by intuition. Artistic truth is largely pursued via the creation of an art object transmitting a fresh perspective.

At their core however, the difference between artists and scientists is not so significant as it seems. Both are committed to solving humankind's greatest mysteries through the power of their imagination and creativity.

It’s our firm belief that in today’s world of unprecedented and disruptive change, both artists and scientists have the potential to co-creatively harness emerging knowledge in meaningful and impacting ways.

Richard R. Ernst, awarded the Nobel Prize in Chemistry in 1991, highlighted the interface between the Arts and Science with the following statement:

> *Here in the union of arts, humanity, and science, finally we find the true origin of all encompassing wisdom. Wisdom is often transitory. It may be experienced just as brief glimpses or flashes of revelations that reveal external insight and lead to moments of comprehension. Such mental experiences have enormously stimulated the development of all human activities from the arts to religion, and to science. (cited in Patricia Leavy (2011) see supra)*

Enabled by the rise of digitally-linked network cultures, a re-organisation of creative practices forced by new forms of information, attended by new possibilities of communication, connectivity, accessibility and interactivity, can be observed over the last couple of decades. These shifts have taken heterogenic effects on societies and fomented transformations of abstraction models and production processes. Artistic projects dealing with these issues have become the forefront to explore ideas and invent prototypical test-runs, questioning these shifts on a level which marks an unprecedented and unequalled position under the circumstances of increasingly complex media realities. Countless artistic developments and projects based on experimental interventions have brought forward the thinking outside the box of standardised forms of cultural self-organisation and self-design. In this sense, ability-profiles like “playfulness”, “problem sensibility”, “open-ended learning”, “hackability” and “error-friendly behaviour” have gained ground in unstable and disrupted media integrated delineation environments. These complexities have, in turn, enabled artists to explore projects within different communities and cultures which cannot be generalised with the term creative industrialisation. Operating in proto-mode of

dynamic adaption, artistic communities have been developing qualifications and framesets to apply uncertain and critical perspectives to established forms of organisation and representation. Within these scopes, the outcomes of artistic project cultures dealing with these multi-factorial issues can be questioned concerning their patterns of configuration, formalising methods and assembly models. Artistic creative practices have, therefore, to be contextualised within different aspects and references of delineation to explain these combinations under the conditions of exploring creative emergences and their codes and cultures.

Ars Electronica,[20] in Linz, Austria is a concrete and iconic example of artistic driven research. Since 1979, Ars Electronica has sought out interlinkages and congruities, causes and effects between art, technology, and society. The ideas circulating at the centre are innovative, radical and eccentric in the best sense of that term. They influence everyday life – lifestyle, way of life, every single day. Ars Electronica's four major pillars – the festival, the prix, the centre and the futurelab – provide it with a well-balanced structure that is conducive to its international orientation, while still enabling it to meet the needs of the local community. Thus, more than any other institution, Ars Electronica represents a comprehensive approach to confronting techno-cultural phenomena. Ars Electronica Futurelab focuses on the future at the nexus of art, technology and society. It considers it works as sketches of possible future scenarios in art-based, experimental forms. In this way, it is aiming to develop contributions through methods and strategies of applied science, the results of which reveal new

[20] https://www.aec.at (last accessed on 31/08/2017)

knowledge and experiences of societal relevance in art and science. Since 1996, the Ars Electronica Futurelab has constituted the research and development motor of Ars Electronica. This section has been conceptualized as an artistic-scientific think tank and as a studio-lab. Its projects are as prototypical future sketches on innovation to discuss and reflect on future concepts and their meaning for our society. The Ars Electronica Center is the architectural expression of what Ars Electronica is about: a place of inquiry and discovery, experimentation and exploration, a place that has taken the world of tomorrow as its stage, and that assembles and presents influences from many different ways of thinking and of seeing things.

Transcending oneself is a peculiar aspect of artistic practices that can be extremely important for research purposes if properly integrated into knowledge generation systems.

> *When an artist is alive to the spiritual domains, he or she can depict and convey those domains in artistic rendering. Such an artwork then reminds us of our own higher possibilities, our own deepest nature, our own most profound ground, which we all are invited to rediscover. The purpose of truly transcendent art is to express something you are not yet, but that you can become. It is a direct invitation to recognize and realize a deeper dimension of our very own being. (Grey and Wilber, 2001)*

Again, *urgency* as exposed in Chapter 1 as being the core of artistic practices comes into play in the discourse. Expressing "something you are not yet, but that you can become" is another form of putting *manifestation*. But the need for *realisation*, for making things happen, goes beyond the individual self.

> *The current cultural situation is calling for individuals to transcend the fractured vision of postmodernism and awaken to some transpersonal and collective spiritual basis for truth and conscience. At this transitional time it is inevitable that artists will reflect regressions into romantic mythic fantasies and nihilist nightmares. Yet can we use the wisdom gained from*

> *each stage of consciousness and artistic epoch and transfigure our minds and our art into a new integral vision, honoring the truths of both objective and subjective worlds, and save the planet while we're at it? When artists give form to revelation, their art can advance, deepen, and potentially transform the consciousness of their community. The creativity of artists is nothing other than universal creativity manifesting through us on a microlevel. The trick for most artists is to get themselves out of the way and let the spirit do its work. Art can be a spiritual practice. A spiritual practice is an activity that enables you to develop the qualities of mental clarity, mindfulness of the moment, wisdom, compassion, and access to revelations of higher states of awareness. (Grey and Wilber, 2001)*

The artistic modulation of consciousness is pointed out here as "honoring the truths of both objective and subjective worlds", previously referred as *phenoumenon*. The notion that artists can "potentially transform the consciousness of their community." is extremely relevant, as is the notion of a sort of synchronisation of the overall process, as in coupled argumental interaction.

> *A special case of alignment is synchronization. In a live performance, the performer is not just seeking to align the brain states of members of the audience, but is doing so in synchrony. Furthermore, the members of a performance ensemble are seeking to align the brain states of not just the audience but also of each other. In addition to the experiences aligned by music, the synchrony itself can produce powerful experiences, as anyone who has played in a string quartet, or sung in a choir, can attest. Music promotes group cohesion" (Rebuschat, 2012)*

The ability of artists to transcend themselves and congregate and mediate consciousness at a collective level is a unique contribution to the process of knowledge generation. The artistic process of transcendence, as addressed in Chapter 5, especially in the reference to Fernando Pessoa, can be understood as kind of disembodiment. As previously stated, embodiment/disembodiment can have a crucial role as mode of artistic modulation of consciousness.

3.4 OBE practice as research methodology – anthropological case study

Aspects of disembodiment, such as induced Out-of-Body Experiences (OBEs), serve as an example to highlight the potentialities of such techniques in the modulation of consciousness. The sole purpose of the incursion into the practice of auto-induced OBE is to understand the preferable ambient conditions in which these phenomena tend to occur as well as to comprehend alternative practices of modulation of consciousness for research purposes. The combination of both electromagnetic induction and favourable environment conditions is the target and purpose of this approach. Homoeostasis is considered to be a preferable condition in the auto-induction of OBE. In these practices, the body has a very important role as a grounding mechanism. Yet, subjectivity plays a major role in all of this. The most interesting part of the proposal put forward by the reported group of people is the possibility of the integration of subjectivity in a model in which common agreement has been the validation tool. By reporting on this group of people, the intention is neither to validate their practice from a scientific point of view, nor to promote its usage for whatever other purposes. The only reason is to present and share an anthropological case study as well as a relevant form of modulation of consciousness practice in sociological and anthropological terms. The most important outcome of this incursion into OBE is, therefore, the insight that certain conditions of the environment can be propitious to inducing sensory variations that – combined with bioelectromagnetic techniques – present us with new tools for expression that were explored in the artwork that is at the core of the thesis, *Homo Conscientis.*

It is pertinent here to restate a definition of what an OBE is.

> *'Out-of-body' experiences (OBEs) are curious, usually brief sensations in which a person's consciousness seems to become detached from the body and take up a remote viewing position. (Blanke et al., 2002)*

Furthermore, it is important to remember that OBEs can be induced by bioelectromagnetic stimulation. The authors of the article describe the repeated induction of this experience by focal electrical stimulation of the brain's right angular gyrus in a patient who was undergoing evaluation for epilepsy treatment. Stimulation at this site also elicited illusory transformations of the patient's arm and legs (complex somatosensory responses) and whole-body displacements (vestibular responses), indicating that out-of-body experiences may reflect a failure by the brain to integrate complex somatosensory and vestibular information. OBE, as described by its practitioners, has nothing to do with dreams. These experiences are claimed to belong to different realities and to happen in totally different sleep circumstances.

The International Academy of Consciousness is described here. The text that follows is in combination with the text published by the IAC and that can be found online.[21]

The International Academy of Consciousness is a non-profit research and education organisation with a presence in 9 countries and 13 cities, as well as a research campus in Portugal.

The IAC's roots date back to 1981, with the founding of the Centre for Continuous Consciousness (CCC) in Rio de Janeiro, Brazil. The CCC conducted

[21] http://www.iacworld.org/ (last accessed on 31/08/2017)

experimental consciousness research and periodically staged free conferences throughout Brazil. Increased demand for these structured presentations offered by the CCC led to the founding, in January 1988, of the first Conscientiological organisation. In 1994, conscientiology expanded internationally, mainly to North America and Europe, pioneered by personnel who are, to date, actively part of the IAC's staff. That process of global expansion ultimately led to the establishment of the International Academy of Consciousness (IAC). The Academy was formally founded in 2000 to develop a research centre, but that objective expanded in 2002 when the IAC incorporated all of the conscientiological European and North American educational centres. This incorporation marked the official launch of the IAC in its current form, as an organization focused on both research, with its European research centre – the IAC Research and education Campus, via its educational centres worldwide. Today, the IAC has become a global organisation with even broader objectives in education and research, as well as a permanent presence in five continents and several countries around the world.

The IAC Research Campus, in Portugal, provides a unique combination of optimised physical infrastructure and a specially cultivated energetic atmosphere (energetic field), resulting in the ideal environment for:

- Individuals wishing to have parapsychic/psi experiences and increasing their self-awareness (especially via the self-research laboratories)
- Major scientific symposia and conferences
- Major educational events and workshops.

A key feature of the 250,000 m2 (62 acres) complex is its innovative, leading-edge set of consciential laboratories, each designed to provide an ideal environment for self-experimentation and research on a specific theme. These laboratories engage the individual as both the researcher and the object of study as they offer prime conditions for the participant to observe and analyse their personal psychic experiences. The IAC Campus supports the establishment of two condominiums for resident researchers, scholars, and volunteers. These condominiums contribute to the growing, active, and developing campus community. As part of its development policies, the IAC campus incorporates sustainable ecological practices.

The field courses dedicated to cosmoconsciousness and the expansion of mentalsoma, conscious projection, the study of the energosoma and the measurement of energosomatic control – using a multitude of angles, considering intraphysical, extraphysical, and consciential aspects, to name just a few.

The IAC's Research Paradigm is very peculiar. The organisation has not been following the traditional Newtonian-Cartesian research paradigm that is been predominant in mainstream science. According to this paradigm, reality is considered to consist solely of a physical universe operating under physical laws. Unlike this paradigm, the IAC's research is conducted based on a new paradigm or view of reality that is inclusive of the genuine multidimensional, psychic, 'spiritual,' and 'transcendent' experiences had by millions of people around the world. The added value: when these experiences are investigated in an unbiased, rational, and objective manner, they point to the conclusion that we live within a greater, multidimensional reality that, to date, has been largely ignored by

mainstream science. Indeed, the materialistic or mechanistic Newtonian-Cartesian paradigm contends that the physical world is made up of basic entities with specific properties. According to that paradigm, by reducing the physical world to its most basic entities or parts, we are able to ascertain a completely knowable, predictable, and therefore controllable physical universe (reductionism, physicalism). With the sole aim of maximising objectivity, physicalistic investigators thus limit themselves to that which is physically observable or which produces effects that can be recorded on a physical device. The IAC research team argues that the multitude of multidimensional, psychic, or 'spiritual' experiences had by people around the world does involve objective events and occurrences that can be observed. However, physical senses and physical devices alone typically do not capture the observable data, or capture only a fraction of it at best. Therefore, this practice cannot be taken as a recognized and advisable research practice. However, it is interesting as an anthropological case study that is extremely useful in understanding certain conditions and techniques to experiment in artistic modulation of consciousness.

This is why the IAC has gone beyond the scientific materialism approach. Under the materialistic or physicalistic paradigm, investigators usually limit themselves to third-person observations: they attempt to remain objective so that what they end up observing is (supposedly) not influenced by their subjective perceiving processes. Such an approach has proven its relative merits, but it has significantly limited the development of new knowledge when one excludes from study the investigator's first-hand psychic experiences. Parapsychology is a perfect example to illustrate this. For 125 years, it has been attempting to make progress

in this area while relying primarily on the objective, third-party accounts of experiencers. However, it is very hard for an investigator to deeply understand certain phenomena if he or she has never personally experienced them, or has experienced them only once or twice in his or her lifetime.

Therefore, under the new research paradigm being used by the IAC, investigators have been allowed to legitimately use as data for their research both their own psychic experiences and their psychic perceptions of the psychic or energetic experiences of others. This approach has not only enriched the debate but also established a higher baseline of knowledge. It has allowed discussion to move beyond elementary questions, such as 'is ESP (extrasensory perception) possible?', and shift it instead to questions, such as 'how can I enhance my ESP?' or 'what benefits could I derive or produce by improving my ESP?'.

According to the IAC, the problem with science for over three hundred years has been that it largely limited itself to physical objects that can be observed by multiple investigators with their physical senses and their technological extensions. This positivist or scientistic ideology led psychology away from the introspective work of William James to behaviourism which viewed humans as biological machines that respond to the environmental stimuli.

The IAC's alternative framework is called the consciential paradigm. The IAC's research and training is based on an alternative framework: the consciential paradigm. The premise of the paradigm: most scientists are having such a hard time researching OBEs because they are asking the wrong question, based on an inadequate perspective. OBEs are still perceived as the result of neurological activity, and not regarding dimensions beyond the physical reality as real. Hence,

the consciential paradigm has set out to demonstrate that OBEs can falsify the materialistic or physicalist paradigm, including a brain-based account of who and what humans are. OBEs could allow the study of psychical processes from a multidimensional perspective that might reveal processes hidden from usual awareness. Naturally in this consciential paradigm, the scientist cannot be just an observer any more. He needs to undertake hundreds of experiments to begin to understand OBEs and what this reveals about so-called anomalies and even about often-overlooked instances of our daily life. Clearly, in this new science, this new paradigm, distinct expectations and rules must apply to phenomena that go beyond physical reality. Consequently, the consciential paradigm could be seen as a multidimensional logical positivistic framework, because it is still based on the use of logical tautologies and first-person observations from experience, but without restricting the kind of experience to the physical perception.

To sum up, the IAC is an anthropological example of how the rational study and development of psychic and energetic abilities, especially the out-of-body experience (OBE) might serve as a means of understanding the multidimensional fabric of our reality and learning how to live better within it.

Some commonalties can be established with artistic practices, without the need to claim those practices are of a scientific origin. As iterated before, artistic practices do not need justification. They happen because they are urgent.

Artistic practices can serve both as research methodology and an innovative contribution to and in knowledge generation systems, especially in the artistic modulation of consciousness and in aspects that are common to this anthropological case study.

The notion that under the materialistic or physicalistic paradigm, investigators usually limit themselves to third-person observations is in reality misinterpreted by the IAC. OBEs are also third-person observations. They happen in some body but the consciousness is detached from that body. One sees oneself from above, from a third-person perspective. In a way it is the realisation of the Socratic *know thyself*, referred to in Chapter 1. As described before, it seems to be the capability to detach the self that allows artists to congregate consciousness at a collective level.

A more relevant aspect brought up by the case study is the study of psychical processes from a multidimensional perspective that might reveal processes hidden from usual awareness. This is common to the process of artistic modulation of consciousness. The difference is that in an artistic perspective, subjectivity can prevail. However, a conversion of those subjective aspects can be achieved in an artistic context if the creation or the application of a technology is involved, because when it becomes technological it is reproducible and analysable.

It from this perspective that the induction of subjective experiences by bioelectromagnetic stimulation, such as OBEs as described by Blanke, can be extremely important if properly integrated as an artistic practice in knowledge generation systems.

3.5 Integration of subjectiveness in research – art practice: a solution for the *Hard Problem*

The adoption of art practices as a research methodology is instrumental to the integration of subjectivity in the production of scientific, reproducible knowledge. This might also allow for a holistic approach to the emergence of future sciences. Defining art is surely an impossible task. After all, art can entangle many aspects. Yet, it is a demonstrable and sustained belief: artistic practice is a process of accessing knowledge. It will be further demonstrated here and in Chapter 5 of this dissertation, that artistic practices can constitute a model of integration of subjectivity into the field of consciousness studies.

Figure 7 - The author presenting the notion of the Hard Problem, in London.

Art has increasingly become an instrumental research methodology for future developments of humankind, as can be highlighted by the emergence of a number of institutional activities worldwide. This aspect will be further developed in the next chapter, where, as part of this study, new policies of integration of artists into research frameworks are described.

As a method of integration of subjectiveness in the generation of knowledge, art practice can be structurally defined as a series of infinite loops of trial and assessment of hypothesis. As stated before, a good example is the practice of painting as a truly enactive activity: instantaneously open for re-interpretation and therefore constantly open for re-construction.

Art as a hierarchy of meta-observations in a holo-cognitive structure can be a process of transformation of consciousness as the thesis demonstrates. Paradoxically, according to this model, experiencing eternity is instantaneous, while perplexity of a conscious being towards a fractal reality is endless. Dialogue – basically an exercise of free will and an instrument in an ontological language – allows, according to David Bohm (1917-1992), for a creative leap, providing a provisional resolution to this paradox of confrontation with an inherited consensus reality. It is actually within the possibilities and potentialities of the medium of expression that the new is being created and realised. A transformation of consciousness occurs precisely in the intention of resolving the paradox, inherent to this unique synthetic process. What happened to be an aleatory group of individual and collective memories before, now shifts into a provisional consensual new reality, confronting a previously inherited one. What prevails is the resulting manifestation, open to interpretation, and hence to allowing reconstruction, recreation and renewal again. Consequently, a work of art can be considered as a portal, an interface to access consciousness, as the ultimate step of meta-observation.

In this vision and approach, art practices are unique: they maintain the conscious being simultaneously receptive and active, while at the same time waiting for

eternity to return, and timelessness and utopia to manifest themselves in the countless possibilities of the medium. This creative process of synthesis, with its particular integration of multiple dimensions – and adapted to the formalities of institutional chairs – might well become an extremely valuable and irreplaceable means for the generation and production of new knowledge.

In this definition, creativity is the process of establishing dialogues between many, the context and the inner self. Moments of inspiration are nothing more than moments of intense dialogue. Feeding off these dialogues with science and technology, artists dealing with technology as their creative matter produce technology-based artworks. These artworks are crucial in communicating new ideas because they themselves are an application of the technological idea – a prototype.

This is crucial in the reasoning of this thesis: unlike the usual scientific/conceptual, this approach is experimental first and approving the methodology afterwards. The technological manifestation of artistic practices allows for reverse engineering and repeatability.

As presented in this thesis, the new artistic and research practice might be a solution to overcome the *Hard Problem of Consciousness*, not to solve it because it is unsolvable by default.

Christof Koch, in his book (2012) *Consciousness – Confessions of a Romantic Reductionist* sets the scene by stating:

> *In philosophy, the difficulty of explaining why somebody can feel anything is often referred to as the Hard Problem. The term was coined by the philosopher David Chalmers. He made his reputation in the early 1990s by a closely argued chain of reasoning, leading him to conclude that*

> *conscience experience does not follow from the physical laws that rule the universe. These laws are equally compatible with a world without consciousness or with a different form of consciousness. There will never be a reductionist, mechanistic account of how the objective world is linked to the subjective one. The term Hard Problem, with its capital H, as in "Impossible Hard", subsequently went viral. Nobody disputes that the physical and the phenomenal worlds are closely linked in billions of people every day of their lives, but why this should be so is the puzzle. (Koch, 2012)*

The notion of overcoming the problem originates in the fact that artistic practices do not need justification. Therefore, there is no need for "explaining why somebody can feel anything" to integrate those subjectives as contributions to the generation of new knowledge. Technology, as described above, is key in this aspect.

The episode with the pianist Maria João Pires as described by Damasio is worth mentioning again in order to make clear the role of technology, and most specifically of electrical signals, in the integration of subjectivity through artistic practices.

> *When she plays, under the perfect control of her will, she can either reduce or allow the flow of emotion to her body. My wife and I thought this was a wonderfully romantic idea, but Maria João insisted that she could do it, and we resisted believing it. Eventually, the stage for the empirical moment of truth was set in our laboratory. Maria João was wired to the complicated psychophysiological equipment while she listened to short musical pieces of our selection in two conditions: emotion allowed, or emotion voluntarily inhibited. Her Chopin Nocturnes had just been released, and we used some of hers and some of Daniel Barenboim's as stimuli. In the condition of "emotion allowed," her skin conductance record was full of peaks and valleys, linked intriguingly to varied passages in the pieces, and then, in the condition of "emotion reduced," the unbelievable did, in fact, happen. She could virtually flatten her skin conductance graph at will and change her heart rate, to boot. Behaviourally, she changed as well. (Damasio, 2000)*

The new artistic practice proposed in this thesis is the extension of that described by Damasio. It extends it by introducing the technique of bioelectromagnetic induction as described in the next chapter *Homo Conscientis*. This means that, as skin conductance measurements can indicate emotional variations, skin direct current stimulation can induce emotional variations. The artistic practice in itself is also extended into a research practice when properly integrated in multidisciplinary teams in knowledge generation systems, such as the European Union's Horizon 2020 Frameworks and the future FP9.

This chapter presented a review of the most prominent currents when it comes to a definition of consciousness. A variation of panpsychism is adopted in which consciousness is constantly being created. Bioelectromagnetism was presented as medium for accessing consciousness and generating knowledge by process of artistic modulation of consciousness. The induction of out-of-body experiences as 'scientific' practice was presented in an anthropological case study to reiterate the relevance of aspects of disembodiment in artistic practice for knowledge generation. Artistic thinking practices were presented in comparison with scientific practices and relevant institutions already integrating artistic thinking in research contexts were described. The specific artistic practice proposed by the thesis was presented as solution to overcome the *Hard Problem of Consciousness* but not to solve it as it is unsolvable by nature.

4. *Homo Conscientis* – artistic practice-based research model

This chapter demonstrates why the application of bioelectromagnetic stimulation as a medium of artistic expression allows for the production of new and unprecedented realisations of integrative art. Furthermore, it establishes a model for artistic technology-based practices to be integrated into knowledge generation systems. The first is named *bioelectromagnetic art* and the latter *executive art.*

Art practice was instrumental as research during the study in a transdisciplinary approach to the creation of knowledge. In such an approach, the whole is connected to all of its parts. Its aim is to integrate processes of revelation of knowledge as a result of the playfulness of artistic practice.

To this end, innovative research was undertaken in the context of two projects: *Sensitive Spheres* and *Collectron*. Both projects are representations of the social implications of perceiving human beings as electromagnetic manifestations. In the context of these projects, bioelectromagnetism – as described in detail in Chapter 2 – is understood as the study of the intersections between biological entities and the electromagnetic spectrum. Each project represents a culture of interactions between biological beings, including their spiritual dimension, in which art plays a fundamental role in creating alternative forms of communication as well as in congregating and mediating consciousnesses at a collective level.

Finally, *Homo Conscientis*, an audiovisual integrative experience applying bioelectromagnetics, is presented as the first manifestation of the new artistic artwork as apparatus for the novel research practice as well.[22]

[22] This chapter describes the artistic insight of the author and it encompasses and summarizes all the literature references provided before and after in the thesis. Therefore referencing of sources is only done when other mentions of the same source cannot be found in the text.

4.1. Artist as maker of technology

The practice of art was an instrumental part of the research undertaken. Therefore, it is described as a methodology to access knowledge, a thinking process. That practice of art was also a transdisciplinary approach to the creation of knowledge. In this approach, the whole of the study is connected to all of its parts. The description of this new practice of research, resulting from the technological *Confluence* of philosophy, art and science and its outcomes, forms the core of this thesis. Its aim is to integrate processes of revelation of knowledge as a result of the *urgency* of artistic practice.

There is, however, a practical component that is indispensable to the referred artistic practice. The hands-on component is that which allows for the concrete application of ideas of inaction. The idea of manual work as put as forward by Mahatma Gandhi as form of passive resistance also has an influence in this practice. It is important to make clear that the author of this thesis has developed all the skills to execute all his ideas and concepts. This means that all the electronics, programming, woodwork, metalwork, setting up, writing, producing and other activities that are related to the creation of the artwork were done by the author. It is in this sense that the notion of artist put forward here is of one that concretely makes and develops applications of technology.

4.2 Sensitive Spheres

Sensitive Spheres was a research project and artwork with the aim to master basic knowledge on electromagnetism as well as interaction between humans and electromagnetic fields, so-called bioelectromagnetism. This research project is based on the shared will to sense the invisible in the visible, and make it therefore 'visible'.

> *A mission of 20th century art was to make the invisible visible; in the 21st century artists may become more concerned with finding ways to allow us to sense the invisible in the visible. The ratio of the senses may shift, and new perceptual modes may be uncovered. As science develops greater sensitivity to life processes and art acquires new means of realisation, artists may work more directly with invisible forces and fields rather than simply representing them and engage more directly in their implementation rather than with their implication. (Ascott, 2006)*

It reflects, furthermore, our need as human beings to extend our senses. A simple analogy can be the amount of information carried in the electromagnetic waves surrounding us. We are only able to 'see' and decode them if we possess a proper device, like, for example, a cellphone. The similarities between a solar system and a cell, or between neural networks and human society serve as background ideas in this project. Each intermediary stage in this project was developed around concrete experimental electronics and corroborated by a corresponding literature review. The results were presented both at the Exploring Consciousness with Art Technology and Design Exhibition, and the Towards a Science of Consciousness 2009 conference, in Hong Kong (Girão, 2009).

Figure 8 - Presentation of Sensitive Spheres, in Hong Kong.

The basic plan was to build an interactive system composed of a number of spheres that would interact with each other and with a range of humans. Interactions would occur in the dimensions of the electromagnetic spectrum and would be made 'visible' through an audiovisual landscape composed by variations of sound and light of the surrounding space.

Sensitive Spheres was a transitional experimental piece in this study. Although the main aim of that wider of this study is to achieve non-representational and non-mediated art forms, as will be developed further later on, *Sensitive Spheres* represented and was inspired by a concept presented by Jonathan Tennenbaum at the Summer School of the International Institute of Biophysics, in Neuss, Germany, August 2008.

The reason why *Sensitive Spheres* is a representational art piece is because of the digital 'transduction' into the audible spectrum of the interactions occurring in the electromagnetic spectrum. It does not stay only within the electromagnetic spectrum.

Tennenbaum and Doubochinski introduced the concepts of Argumental Interaction and Macroscopic Quantum Effect (Doubochinski, 2008). Actually, the theory of Argumental Interaction has not revealed any new phenomena in the area of Experimental Physics. Yet it has highlighted a new perspective on traditionally studied phenomena. The basic example of interaction of a magnetic pendulum and a coil has been described as a system in which each element is an autonomous subsystem in itself, and not just an element with a specific electromagnetic field. Each subsystem is described by its interaction with other systems and subsystems. In the Argumental Interaction Theory, the descriptive formula of a system contains vectors representing the forces of all of the surrounding systems. This applies to all the scales. The electromagnetic field of a certain object does not consist of fixed characteristics but varies according to other electromagnetic fields around or inside it.

To be totally correct, according to Doubochinski and Tennenbaum, the Newtonian concept of field is not even valid in this new descriptive system, due to the fact that conceptualisation implies that the field is a characteristic of the object itself, not dependent on the context. According to Doubochinski and Tennenbaum, an object is a system resulting from all interactions inside and outside itself. The transition between scales is explained by the Macroscopic Quantum Effect, according to which all phenomena described by quantum mechanics 'reverberate' in the macro scale in ways that can be described as wave functions. It is in the embedment in this sociological approach to physics that *Sensitive Spheres* was born.

Previous ideas about cooperation and multidimensional existence also culminated in *Sensitive Spheres*. *Cooperation Game* (Girao, 2007) was an interactive installation aimed at making participants aware of each other's presence as well as making them cooperate towards a common result: in this case, a balanced soundscape. The participants' position in space is tracked by a video system that allows them to control their own floating object on a 3D graphics projection of a liquid surface. Interactions amongst participants are represented by ripples generated by the movement of the objects they control (Girão, 2009).

This interest in subtle interaction led to the study of quantum mechanics and the understanding of the problems of both quantum decoherence and the consequent wave function collapse, including the politics of the refusal of the Many-Worlds Interpretation, by Hugh Everett. (Byrne, 2007; Girão, 2008).

The aim of *Sensitive Spheres* was to make 'visible' the multidimensional aspect in humans by revealing and demystifying their electromagnetic dimension.

The first phase of the project looked into primal radio interference. The idea was to use human electromagnetic properties to interfere with an oscillatory electromagnetic device. This approach is technologically pure because it deals with both agents of the system in the same dimension, without any sort of transduction.

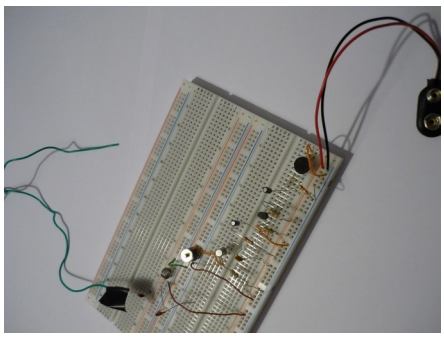

Figure 9 - The first electronic experiment of Sensitive Spheres.

In the course of mounting a basic frequency modulation radio transmitter, one of the biggest issues in electromagnetism studies was manifested as an insight: interference (Mapps, 2003). Capturing undesired electromagnetic manifestations of objects – not constituting the focus of our study – is pretty common. Those interferences are usually treated as noise. This means that all energy manifestations below a certain threshold are not taken into account. Considering the theories of interconnectedness, resulting from chaotic mathematics, or recalling the Macroscopic Quantum Effect, or even going back to the origins of all these concepts in the multidimensional theories of Huge Everett, we can understand the potential relevance of all that classified as noise, just due to the practicalities of materialisation. It is of course indispensable to treat noise as despicable for certain engineering purposes – obviously because of practical targets – but it should not be dismissed in more philosophical approaches. It should also not be forgotten that we tend to classify as noise everything else that cannot yet be characterised as a pattern. Interference can be seen as a major problem for implementing bioelectromagnetic technologies. Interference can also be understood as the recipient from which new knowledge will emerge, as soon as the recognition of very complex patterns is available.

It is extremely interesting to understand all this when experiencing it in practical experiments. When testing that simple radio device – the module to be replicated as sensor device in *Sensitive Spheres* – the positioning of the hand over the circuit would inevitably produce interference on the signal produced. Interference would happen anywhere in the circuit. This was exactly the goal of these investigations: basic human electromagnetic properties. In electromagnetic terms, a human being can be characterized as a serial circuit composed of a variable capacitor and resistor. The capacitance is of the order of 50-100 pF and resistance of about 10 KOhms. Depending on where in the circuit the human element is positioned, the interference caused would have different functions. There are two main features both based on the human electromagnetic correspondent. The first is the amplification effect: if the human element is positioned at the end of the circuit, where resonance occurs, the human body works as an antenna amplifying the emitted signal. This can be experienced in normal radio receivers and also in analogue television sets. The second, the most relevant for this project, was the substitution by the human element of the variable capacitor that modulates the carrier frequency. As capacitance is inherently dependent on the distance between the two elements generating an electrostatic field, proximity of the human element is the variable to be used as the modulator of the carriers.

It was at this stage of practice that the notion of modulation of consciousness by bioelectromagnetism started gaining shape in the study.

The Theremin (1919), a musical instrument invented by Lev Theremin, implies the same principle of capacitance and proximity measurements, but in order to improve the reliability of the response of the system, by avoiding 'residual noise',

the amount of energy it utilises is extremely high. It is above the threshold level where noise is not relevant. In general terms, the idea of *Sensitive Spheres* is meant to be an electromagnetic network of humans mediated by wireless 'Theremins'.

The complexity of the number of stages – needed to filter the signal produced by the sensor in order to make it reliable – became a problem. On top of that came the realisation that all the electromagnetic spectrum is almost viewed as property either of states or institutions in their representation. The available bandwidth for experimentation is very narrow, and the frequencies that were manipulated were not available. In order to design an operating sensing device, using bioelectromagnetism in the desired purist form would transform the making of the sensing device into an excessively complex task for that intermediate stage of the research.

As a result of these deep investigations into commercially available radio transmitters and transceivers, operating in legal bandwidths, to be coupled with simple capacitive sensors, it became clear that all of them used digital modulation techniques. This type of radios is normally used for remote control of small machines such as cars, helicopters or boats. For this type of usage, only binary states are needed.

Implementing advanced digital radio transceivers became inevitable, broadening the range of possibilities and allowing not only the reading of continuous variable parameters, but also the communication between the radios themselves in order to create a talkative network. Although moving further away from the original

purist approach, a precise materialisation of the representational system that was set to be built was manifested.

Nonetheless, a new problem comes into the equation when implementing digital systems. They are mechanical in concept. A continuously varying signal when digitally represented is transformed into a sequence of static frames, just like in cinema. Furthermore, these frames even have a limited number of values that they can consider. In any case, independently of the capacity of the machine, the process of digitising is always the same, with more or less resolution. The continuum is not possible in digital systems. The digital is always a reduction of what it represents. It is always a representation, while electromagnetic systems are inherently feedback systems. Feedback is dependent on the continuum as it is the basis for interaction. Without feedback there is no interaction.

It is obviously possible to digitally reproduce feedback processes. That is exactly what has been developed for the past ten years: interactive digital systems. But again, they will always remain simulations. They will never be truly integrated with humans. In order to produce integrative systems, we need to clearly understand these limitations of digital systems and deeply invest in the development of digitally controlled autonomous electromagnetic systems. The bionic approach of Harry Asada is a good example. His research lab was developing robots at the time that implement a control system similar to what happens in human bodies. Sarcomeres are the basic units of muscle. Motor neurons broadcast an electromagnetic signal that is received by each single sarcomere, which then somehow takes a stochastic decision either to contract or to expand (Ueda et al., 2006).

A similar approach can also be found in the final version of the wireless sensors network of *Sensitive Spheres*. The Xbee Znet 2.5 modules by Digi are used to create a wireless digital radio network that communicates with a computer. The computer processes the gathered information to produce sound output. These modules communicate between themselves in such a way that it is possible to calculate their relative position in space. They form an entity that results from this process of aggregation by communication. Proximity of humans is detected by the AD7150 sensor, from Analog Devices. This extremely small sensor has two channels, the output value of which is read by the microchip of the RF modules. Capacitance is calculated based on the discharge time of a pulsed electromagnetic signal going through a small conductive wire.

Participants of *Sensitive Spheres* could interact with its electromagnetic environment by varying the distance between their hands and the small networked spheres. They can also move the spheres around in space, modifying the structure of the aggregative network. Any action of the participants has a direct and clear influence on the sounds produced and, in some instances, on the light ambience as well.

Furthermore, potential product development resulting from the prototyping process in *Sensitive Spheres* was also explored. This type of explorations of potential industrial applications resulting from the outcomes, or partial outcomes of the research are an integral part of the model of art practice presented here as a research method. Innovation understood as a process of applying concretely new knowledge in society or economy is in high demand in knowledge generation

systems worldwide. This type of artistic practice has great potential in this field as complementary to scientific and engineering practices.

The system developed for *Sensitive Spheres* was implemented at LAMCI – CESEM, at the New University of Lisbon. There, the system was used in testing music perception in infants. The main feature of the system, in this regard, is the possibility to instantly address different sounds to each individual sphere.

The wireless sensors network of *Sensitive Spheres* was developed and implemented in the *EcoIDs* project, of the i-DAT lab, at the University of Plymouth, U.K. The main idea of that project was to distribute wireless ecological sensors all over the world and to make the data they produce available in real-time on the web. Prototypes were tested in Japan, in July, 2009 (Phillips, 2009). The *EcoIDs* were the later deployed in the *Confluence* project[23]. *Confluence* was a new arts, technology and environment project being delivered by partners Beaford Arts, University of Plymouth's i-DAT (Institute of Digital Arts and Technology), the North Devon Biosphere Foundation and Appledore Arts. It was developed across Torridge – in Dolton, Merton, Great Torrington, Bideford, East-the-Water, Appledore and Instow, in North Devon, UK. Schools and communities, alongside artists selected in a national application process, developed new work about each place. They used environmental data collected live by i-DAT's devices (the *EcoIDs*). The project also included demonstrations and workshops.

Another application of the ideas resulting from the *Sensitive Spheres* project was *Matrixz.* The realisation of electromagnetic properties of humans being a unique

[23] http://i-dat.org/*Confluence*/ (last accessed on 31-08-2017)

identification process (Brooks, 2003), originated in the idea of using capacitance as an identification method in electronic systems. This was implemented in the *Matrixz*, a musical instrument developed by the author of this thesis for people with special needs. By organising a number of objects in a box, players of *Matrixz* compose musical cyclic sequences. The identification of those objects is provided by capacitors inside them. *Matrixz* was developed for the Education Service of Casa da Música Foundation, in Portugal, in the context of the *Ao Alcance de Todos* festival (Pereira, 2009).

4.3 Collectron

The *SkilledArt*[24] project was a research and development project coordinated by the author as part of this study. *SkilledArt* was a 590,000.00 EUR project that ran between July 2009 and August 2012. The partners of the project were Artshare, the University of Porto and the University of Aveiro, all in Portugal. The Planetary Collegium – Plymouth University was the international strategic partner. *SkilledArt* was a project on interface research and development and associated strategies for the creation and maintenance of transdisciplinary communities of knowledge. Telematic communication between physical spaces, for virtual interaction in the context of E-Learning, was its main focus. Human-computer interfaces were developed targeting telematic human-human and human-avatar interactions. *Collectron* was the resulting prototype of *Skilled Art*.

Collectron is a platform both for the creation and transmission of mediated knowledge between groups of people and for the acquisition of new skills. It consists of a network of collective interfaces based on the idea of a collective computer where the body and mind of participants forms the interface. *Collectron* is basically a hybrid system that promotes interaction between humans by integrating them into the system via mechanisms of interpretation. Therefore, it is complimentary to e-learning, and aims at filling the gap between students that is created by e-learning in order to lead to nodes of self-employment and entrepreneurship.

Collectron is also a hybrid collective space allowing people both to "live" information and to create knowledge by using their own bodies as interfaces to

[24] http://www.eurekanetwork.org/project/id/4982 (last accessed on 31-08-2017)

access, manipulate and exchange information among themselves. *Collectron*, furthermore, connects people into communities of common place and interest by engaging them into 'serious games' in common space. And last but not least, *Collectron* is the venue for the creation of communities of knowledge advancing towards the development of knowledgeable citizenship.

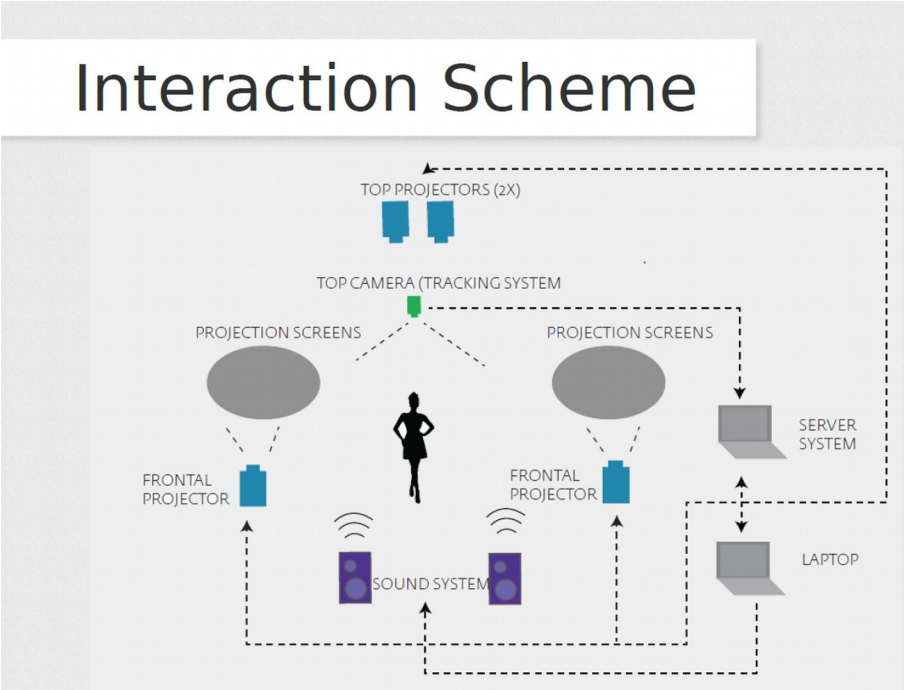

Figure 10 - Interaction Scheme of Collectron.

As pointed out before, from the perspective of cognition as embodied action, the body is understood in this thesis as medium to access consciousness. The concept of *Collectron* was developed based on those ideas and it was during the *Skilled Art* project that the notion of the human body as interface started to mature. In *Collectron*, it is through the body and through its actions that dialogue is established. *Collectron* is also a representation of the notion of bioelectromagnetics, but just in terms of sensing, not of induction. Cameras track humans' positions and movement and the system reacts with audiovisuals.

It is important to bear in mind that cooperation is the only way forward for human development. The key in innovation is human nature itself and not technology. Technology as an end in itself is not an answer for the future. Technology is an enabler of human innovation and only human innovation will lead to socio-economic innovation. Therefore, the author is starting to establish an infrastructural network of the above described research and development platform as a measure for nurturing innovation through Information and Telecommunication Technologies. This development is happening in the context of the CREATE-IoT project further described in this section.

Let our claim be reinforced here that this research should lead to a sustainable model of such a network: any new developments achieved by a partner will be distributed through the network itself. This self-renewing feature should produce an infinite cycle of developments. An example of these are the add-up features for *Collectron* in the field of the transmission of sensation by means of bioelectromagnetism. The bioelectromagnetic stimulations developed in the context of this study is being added to the system *Collectron.*

The *Skilled Art* project was developed based on smaller artistic actions. Artistic sub-projects were developed around a specific technology to be integrated into the system that became *Collectron.*

Figure 11 - Official promotional flyer of Collectron.

Flocking was a digitally mediated collective environment, in the context of a Traditional European Ball, aiming at enhancing self-awareness and making each participant contribute to the success of the group. Group achievements on synchronising in a specific way were made visible by technological applications that induce changes in the music played by the musicians. These musical changes lead dancers to reorganise themselves and look for another stable dynamic sync that will trigger the whole process again ad infinitum. *Flocking* was representation and a reflection about the potential of the inherent collective of bioelectromagnetism as a social dimension. In *Flocking,* the image of electromagnetism as viscous mass, as stated in Chapter 2, was understood. It was

in reality part of the system to interpret people's movement as a collective. Computer vision algorithms of flow analysis were utilized in order to visualize and analyse that viscous mass.

Walking on Earth was another artistic project directed by Rolf Gehlhaar that had its first developmental phase in July 2010, and was used to develop *Collectron.* In reality, Collectron was an extension of Gehlhaar's work. It extended the notion of musical topologies to the notion of informational topologies.

Rolf Gehlhaar, a German composer and digital artist, born in 1943, conceived his pioneering invention in 1984 as a consequence of his philosophical evolution. SOUND=SPACE is an electronic music instrument that shortens the distance between the composer and the musical listener. This is done in such a way that listeners themselves become creative agents in the composition. They are literally inside the composition: indeed, the key feature in SOUND=SPACE is addressing sound events to specific locations in space. This is what has been classified as Musical Topologies in a previous article (Gehlhaar, R. et alia, 2008).

Musical Topologies are a unique conceptual outcome of SOUND=SPACE that attribute all time related decisions to participants. The sequence of sound events results from the movement of participants of this interactive installation. In some Musical Topologies information about movement of participants is also used for the manipulation of the triggered sounds. This concept is clearly an idea of space-time correlation systems as well as an architectural perspective on music.

Technically, the implementation of this concept is possible due to an array of ultra-sonic sensors that allow for a precise location of people in space. Usually,

the surveyed space is about 10 x 10 meters and the ideal group of participants is about 12. The information generated by the sensors is then processed by a computer that produces a sound output. The function of the composer is to create topologies in a computer. SOUND=SPACE can be used as public installation or in the context of workshops. In the latest workshop, the most recent update we conducted allows for participants to create their own topologies and test them in a simulator. This system along with the original SOUND=SPACE is resident at Casa da Música, Porto, Portugal.

The basis of the above can be described as an informational interactive system where interaction is induced by a context specific manipulation of digital data. Stripped down to this level, one can easily extrapolate new applications made possible by the rapid recent developments of information and communication technologies. It is here, at this point of this specific conceptual space, that the idea of Informational Topologies was born. Chronologically, this concept originated in July 2010, in Porto, as a conclusion of the development of *Walking on Earth*.

Walking on Earth is an old idea of Gehlhaar's that was realised in the context of the *Skilled Art* project by Miguel Ferreira, Gehlhaar being the author of this study. This interactive visual installation allows users to walk over projections of real-time satellite imagery and to see randomly chosen real-time video streams of web cameras of the geographical area they are stepping on.

Walking on Earth makes use of the camera based system we have been developing in the *Skilled Art* project. In this system, the idea of topology is also

applied, but in this case the concept is broad in its systematic abstraction: information as a transdisciplinary concept.

Information Topologies are an organised group of spatial locations to which information is specifically addressed. An example, from outside our developmental context, is the specific concept Air Tagging that fits in this broader concept of Informational Topologies. Air Tagging is a shared database of information related to particular GPS locations, usually places to related daily life, such as restaurants, bars or hotels. Information Topologies embrace these and other concepts as resulting from technological developments, but not related to a specific technology.

A shared Information Topology combined with individual specific information forms the technological conceptualization of the system. Accessing, manipulating and exchanging digital information in a particular space location are the actions which the system aims for. Therefore, the project was a systematic approach that created the opportunity for users themselves to bring content into the system. It was a sort of blank page waiting to be filled by the users along the process of interaction. In *Skilled Art*, there were two clear developmental areas regarding digital information. Individual information, on the one hand, and information about the collective on the other.

The aim was to generate a sort of behavioural taxonomy. i.e., classifying individuals by their behaviour in digital environments, distributing them by groups and making this classification available to agents of the digital worlds in order for them to adapt their proposals to the expected reaction of the users.

The focus of investigation in *Skilled Art* was the collective of human participants in such a system. As described above, the collective can be described by the sum of the individuals. Here, the innovative approach of this project is to apply interfaces for groups in opposition to what is common ground nowadays. The proposal was to shift from the concept of a Personal Computer to the one of a Common Computer. Aligning with Nikola Tesla's concept of Common Power Source, the Common Computer is an interface that allows groups of people to interact in specific space-time contexts as well as to interact telematically with other collectives. (This telematic interaction is made through virtual spaces, raising the question of Hybrid Spaces. Hybrid Spaces are the merging of Physical Spaces and Virtual Spaces.

Computer Vision techniques can be divided into two areas: one describing the whole image by parts, and the other by which the image is analysed as a whole. In the digitally mediated environment being developed in *Skilled Art,* both were applied: the first one to address questions related with information about individuals in space and the second to extract information about the collective. The latter, as stated before, is the principal idea at this stage, and it applies techniques concerned with the analysis of the optical flow of the whole image. These were the sort of techniques used in *Flocking*. By means of the analysis of real time video stream of a camera providing a top view of the dance floor, information was transmitted to musicians, video-artists and computers involved in producing audiovisual environment for the ball, in real-time. Human- and algorithm-based interpretations led to the fine and delicate equilibrium between

changes induced by dancers and the needed balanced outcome of the performers, in order to maintain the flow of the dance.

This was actually the most complex part of the project to achieve. Experience has revealed the need to give dancers a minimally organised musical form in order for them to be able to reorganise themselves in a new dance form, then generating a new musical form. Obviously, the difficulty in this feedback loop results from the provoked dialogue between the aesthetics of conserved traditions of dance music practices and contemporary dance music practices, themselves representations, or a prototype of models of social organisation.

Technically, the basis for those developments was the characterisation of the dynamics of a group of dancers. An analogy can be made here: it is as if the group of people interact with a sort of a virtual viscous mass generating patterns that are clearly distinct if created by individual interaction of group interaction. *Flocking* favoured collective actions.

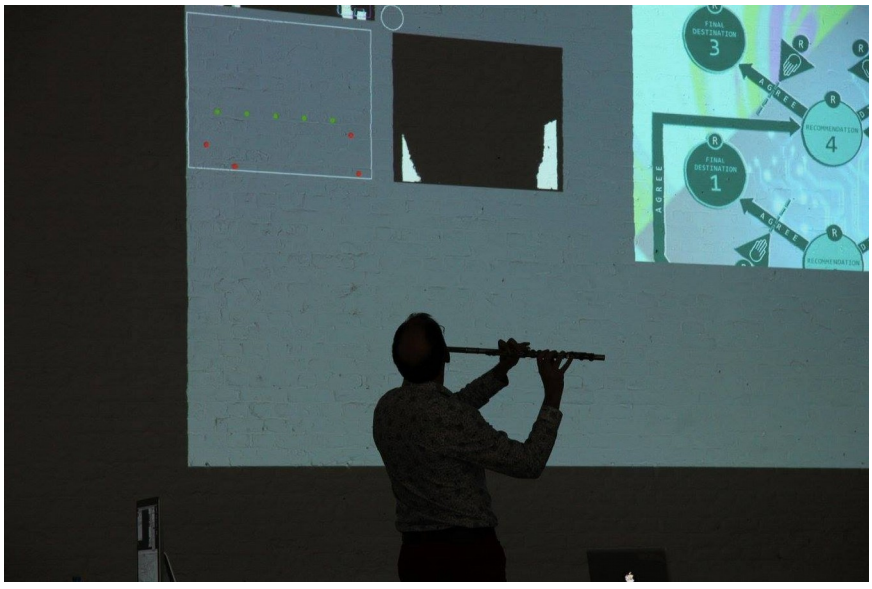

Figure 12 - The author performing with Collectron.

In sum, the different projects and experiments in the context of the *Skilled Art* project were crucial in revealing and maturing the ideas and concepts exposed in this dissertation as fundamental for the thesis. In *Collectron,* mostly the notions of interconnectedness, the inherent collective in electromagnetism and the intrinsic bipolar nature of electromagnetism led to the idea of *urgency* of artistic practice as composed of *realisation* and *manifestation*.

4.4 Bioelectromagnetic art

Nowadays, due to contemporary technological advancements, artists can design interaction embedded in the object of art. This can be done either at the level of input from the subject to the object, or at the level of output from the object to the subject. The technological advancements described in Chapter 2 – in support of this thesis – have been generating from the latter category and created the possibility of bioelectromagnetic induction.

Art works employing electromagnetic technology will be analysed here mostly utilizing the first category, i.e., utilizing bioelectromagnetism for sensing the observer. After thorough research, no other works using bioelectromagnetic induction were possible to identify during this study.

Indeed, recent technologies can allow the artist to induce sensations, alter feelings and transform notions directly in the nervous system of the subject of art. This is the new and paramount knowledge this thesis has been exploring. However, this notion of designing by the maker of the object – the artwork as a kind of interplay between object and subject of art – is nothing new. Instead, the rhizome connecting and substantiating all sorts of art practices, old or new, is the

primordial aspect of art practice in this thesis. This process is one of revelation, with a central notion similar to the prosumer:

The term prosumption was coined by Alvin Toffler in 1980 and refers to a combination of production and consumption. Prosumption is not new but is actually primordial. Many scholars have dealt with the issue, at least implicitly, but only recently have they begun to deal with it explicitly as prosumption. Prosumption has always existed, but various social changes (e.g., the rise of the Internet and of social networking on it) have greatly expanded both the practice of prosumption and scholarly attention to it. Prosumption has its most obvious and direct relevance to the economy. As a result, it has also been framed in terms of contemporary capitalism. (Ritzer et al., 2012)

It is however, not appropriate to use the notion of prosumer in this thesis because art practices here are not considered as production process. Artistic practices here are understood as a process to generate knowledge. This aspect is extremely important because urgency in art is not money-driven and it is exactly why it is so much needed in our current society where knowledge generation systems are mainly driven by economic and financial interests.

Bioelectromagnetism has not been established at all as a means for expression. A growing interest in electromagnetics, though, has established itself in a small specific artistic community. Yet, few are the works that venture to approach electromagnetism and its biological manifestations. The reason for that fact might be found in the context and direction of the generation of scientific

knowledge, and its consequent industrial applications. The techniques and tools needed for the development of such novel ways for artistic expression have not been made available yet. Artists tend to use existing technology in alternative and inventive ways. They tend to develop applications, but not to create new technologies. In the particular case of bioelectromagnetism, completely new tools need to be developed, and that is one of the main purposes of this research project. Research and development in general has been directed towards information technologies and digital systems. Even technologies based on electromagnetic phenomena, such as MRI or fMRI, have been digitally controlled and manipulated. Information systems have been very effective and useful, but they have reached their limits, and nothing genuinely new has emerged from this area of research lately. It's now just a question of scale and application development: nanotechnology allows for the making of smaller components, raising the possible number of components in a single unit and, therefore, making faster processors.

It is appropriate here to reiterate that digital systems are reductionist versions of electromagnetic systems. Digital systems are mechanical: they work based on chain reactions and repetitive tasks. Conceptually, they are pretty much like engines composed of digital pistons and sprockets. Electromagnetic systems, however, are inherently feedback entities, in constant interaction always simultaneously on the macro, micro and nano scales.

Post-digital researchers have been developing electromagnetism building on the revolutionary inventions of such illustrious minds like Nikola Tesla and Lev Theremin. Ideas such as Tesla's Common Sources of Energy are in the process of

being realised. MIT's WiTricity is a near-to-market device to wirelessly transfer power energy (Giler, 2009).

One of the guardians of Tesla's heritage is Nina Czegledy. In her article "Bioelectromagnetism – Discrete Interpretations", (Czegledy, 2003) she contextualises the origins of the concept from ancient references to more recent approaches such as Robert Becker's *The Body Electric* (Becker and Selden, 1985), establishing the perspective of the human body as including electromagnetic phenomena in its nature. Works on electromagnetism by well known artists such as Taki, Wharhol and Jasper Johns are also referred to. Yet, they are obviously not extremely relevant to the field of bioelectromagnetism. The work of three contemporary artists about the electromagnetic environment are presented in that text: Curiosity Cabinet, by Catherine Richard; Aeriology by Joyce Hinterding; and Bodies of Light, by Marie-Jeanne Musiol.

Bodies of Light utilises bioelectrography, also known as Kirlian photography, to reveal low intensity electromagnetic fields in the visible spectrum resulting from the exposure of bodies to high voltage electric currents. Aeriology is about hearing the electromagnetic spectrum: an antenna of about 1 metre in diameter is used to capture variations in the electromagnetic environment, including that originated by the presence of human bodies, and transduce them into the audible spectrum by moving coils – loudspeakers. Opposed to this, Curiosity Cabinet invites participants to be shielded from all electromagnetic interference by getting inside a copper box.

The work of Musiol, Richards and others was presented in the exhibition "Resonance – The Electromagnetic Bodies Project". Along with Louise

Provencher, Nina Czegledy invited a number of artists to produce work in response to Tesla´s inventions. The exhibition gathered the outcome of that invitation, and was presented in Montreal, Karlsruhe, Madrid, Rotterdam and Budapest, during 2005 and 2006. The aim of the works presented in this exhibition was to make the public aware of the invisible parts of the electromagnetic spectrum as well as of its persistence as an environment.

Making the invisible visible. This seems to be the bottom line of all the artistic work being developed in this area as is demonstrated in the title *Spectropia – illuminating investigations in the electromagnetic spectrum*. (Šmite et al., 2008) *Spectropia* was an exhibition, a scientific conference and a publication of the 10th international festival for new media culture *Art+Communication*, in Riga, Latvia, in October 16-25 of 2008. Co-organised by MPLab of Liepaja University and RIXC Media space, it was the continuation of the previous research project *Waves – electromagnetic waves as a medium and material of art* (2006).[25] The homonymous exhibition was organised by Hartware MedienKunstVerein, Dortmund, Germany in cooperation with Ars Electronica, Linz, Autria and RIXC, Riga. Latvia. The idea for both initiatives as well as the third one entitled *Spectral Ecology* originated from Armin Medoch. *Spectral Ecology* was held in 2007 as a cooperative project between RIXC and the Spectral Investigations Collective from France.

The main aim of *Spectropia* was to establish the theoretical background for Electromagnetic Art. *Spectropia* has an excellent approach to electromagnetism,

[25] http://rixc.org/en/acousticspace/all/79/ (last accessed on 31-08-2017)

and that is very clear in its sub-themes: I – Electromagnetic Cosmology and Investigations in Spectral Ecology, II – Cultural Intelligence: from Ideology and Art of Spying (and Security) to Conversion of Military Technologies; III – Free Spectrum: Waves And Electromagnetic Politics; IV – Spectral Investigations: Waves Science, Electromagnetic Myth and Artistic Interpretations. (Šmite et al., 2008)

The inherent social characteristics of electromagnetism have been expressed before and it is relevant to reiterate that they constitute the ultimate developments in this field of research, simply because they cannot be dissociated from electromagnetic phenomena.

Electromagnetism is interaction. This is patent in its applications such as, for instance, networking: wireless and non-wireless digital networks are built over the electromagnetic spectrum. Contemporary society has become dependent on computer and satellite networks, and this is only possible due to electromagnetism. The emergence of Electromagnetic Art is aligned with the understanding of contemporary society in a natural way, and the first is a reflection of the second.

Artworks generated in this context either deal with electromagnetism representing ideas and concepts associated with the phenomena or with making us aware of the existence of that spectrum by transducing electromagnetic variations into the audible spectrum, the realm of mechanical vibrations. Or by transposing them into the visible part of the same spectrum, or even transforming them digitally, establishing virtual correlations so that they can be perceived. Most of the works are using high level applications of electromagnetic

technology to represent conceptual approaches to the context and environment of the electromagnetic spectrum.

This has been clearly reflected in the programme of "Reheat09 – Receiver in the Rye", Kleylehof, Austria, 22nd of August 2009. This small festival highlights the idea that electromagnetism as a medium has grown stronger in the field of art. However, works presented there concerned mainly radio waves as a way of transmitting sound as well as sound material resulting from electromagnetic noise.

The Electromagnetic Art community is still very small as is testified by the list of participating artists in the exhibitions referred to. *Resonance* and *Spectropia* especially share a considerable number of authors.

The newness and incipience of this artistic approach to elecromagnetism can also be perceived in some details that in themselves convey some misconceptions. Some of them are surely due to practical reasons. Yet, they are interesting for understanding where electromagnetism as a medium originated from. For instance, the publication of *Spectropia* is part of a collection entitled acoustic space, which in technical terms is a mistake. The underlying reason for this might be of editorial practical order: the collection on acoustics probably already existed before the idea of producing such a publication on electromagnetism. It was surely much easier to use that channel in order to publish it. Nonetheless, the imprecision of integrating electromagnetism in acoustics studies is extremely relevant because it has somehow erroneously merged two different, although not separate, dimensions: mechanical vibrations on the one hand, a certain range of

frequencies of which is audible, and variations on the electromagnetic spectrum that happen to be visible in a certain range of frequencies on the other.

A similar remark in this context can be made about the use of the concept of the wave. Waves are often referred to as if they were the phenomenon itself. In this case, they are normally associated with electromagnetism, but also with sound. And since radio is the common way to transmit sound, a number of artistic works have been utilising correspondences based on frequencies, though not revealing an understanding of the application of the same frequency in the description of different phenomena. A wave is a mathematical function that is useful to describe and characterize certain kinds of phenomena, normally associated with motion.

Electromagnetism is not composed of waves. Wave theory has been used to partially characterise electromagnetic phenomena. Electromagnetism is not the phenomenon itself. Electromagnetism is a conceptualisation of an observed phenomenon.

Notwithstanding those imprecisions, it is interesting to understand a certain demystification of electromagnetism. While in Nina Czegledy's text expressions can be found such as “the magic of our bio-environment” or “indiscernible magnetic energies”, the sub-title of *Spectropia* indicates the need for clarification: “illuminating investigations in the electromagnetic spectrum”.

Electromagnetic Art is an emerging field. Bioelectromagnetism is only part of that emergence as far as biological beings have electromagnetic properties, generally used to interfere with electronic devices. Most of the works in the field of Electromagnetic Art do not integrate bioelectromagnetism yet. *Metal Leather*

(2006), by Csaba Csik and Péter Szabó, presented in the Budapest iteration of Resonance, is one exception to the general context. It somehow has made the idea of interaction between participants and the piece itself relevant by means of the electromagnetic spectrum. The interference of human bodies over the metal surface is transduced into sound so that participants are aware of each other's personal contribution to the system.

Variations V (1965), by John Cage in collaboration with David Tudor, for The Merce Cunningham Dance Company, is of course the classic example for this kind of application of electromagnetism. Although the system was built just to detect movement in space in order to produce interference in the electronic music being generated in real-time, electromagnetism of the human body was utilised. Four human scale antennae determined the interactive space where the dancers would perform. The final aim of such a system was to integrate music and dance, not to make the audience aware of electromagnetic fields.

The aim of *Sensitive Spheres* (2008), the piece resulting from the homonymous research project described before in this text as part of this study, was to integrate participants and electronic devices, to make them understand the relevance of their own presence in the dimension characterised by the electromagnetic spectrum. Sphere-shaped sensitive devices try to simultaneously refer to particles, atoms and planets, merging scales of forces of aggregation. *Sensitive Spheres,* however, was still a representational system. It is about bioelectromagnetism. It is not Bioelectromagnetic Art.

Interaction within the same dimension is understood in this study as the sine qua non condition for art forms to be considered bioelectromagnetic. In other words,

considering electromagnetism as interactive by nature, the electromagnetic spectrum in bioelectromagnetic art is the main, if not the only, channel of expression. Induction is the key concept in this discourse. Most of the art works dealing with electromagnetism use either transduction or translation techniques in order to make electromagnetic variations effectively perceivable. Inducing sensations only by manipulation of the electromagnetic spectrum is what makes bioelectromagnetism a distinct channel of expression. The phenomena described by bioelectromagnetism are obviously not new. They have been always around, and we live in them. Quoting Sheldon Lee Glashow,

Everything we see, hear or touch is electromagnetism. (Punset, 2004).

What is new are the devices to operate within the spectrum. Indeed, the basic principles were already established long ago. Even the uniqueness of these devices can be questioned. In technological developments, there is nothing really new. However, novelty is a derivation or a combination of the old. In fact, some devices for induction of sensations within bioelectromagnetism already exist. The *Microwave Auditory Effect* (Frey, 1962), by means of pulsed modulation of microwaves directed to the area around the cochlea, allows the hearing of sounds without the normal acoustic process involved in hearing. The ultimate example is the already mentioned induction of full Out-of-Body Experiences by means of Transcranial Magnetic Stimulation, as experimented and described by Blanke and Thut (Blanke, 2007). Through the electromagnetic stimulation of the temporoparietal junction of the human brain, autoscopic experiences are induced in the subject of such stimulation.

Bioelectromagnetic art utilising those technologies will produce non-representational experiences. This means that the application of electromagnetic phenomena is different from the already existing applications in the field of art. The difference lies in the active principle of induction. The techniques to operate at this level already exist, and their main field of application is experimental neuroscience. The proposal of this thesis is to extend this practice to artistically driven research.

Induction through the manipulation of the bioelectromagnetic spectrum is what distinguishes bioelectromagnetic artistic expression from other mediums of artistic expression. This manipulation is by nature omnisensory, which means that by interacting only with the electromagnetic spectrum, it is possible to generate very 'concrete' variations in a number of senses simultaneously. The reason why no practical examples of bioelectromagnetic artworks have been presented yet is because of the non-accessibility of the available technology.

In reality, bioelectromagnetic art is an advanced form of integrative art. The artwork about to be described, understood as *ready-made* artwork, is an astonishing example of the potential of bioelectromagnetic art. When Álvaro Pascual-Leone, from the Beth Israel Deaconess Medical Center, Harvard Medical School, presented the footage of one of his patients suffering from Parkinson's Syndrome, before and after undergoing a rTMS treatment, the audience was amazed. The gentleman on the video, who could not walk more than a few steps at a time, due to the effects of a specific neuromodulation technique, was suddenly walking at a fast pace immediately after the treatment. An experience of this sort, even that it does not last more than a few dozen minutes, is surely not

considered by the subject to be a simulation. It is something that really happened. Something truly real. The integration of experiences in daily life that transform consciousness have been pursued by artists for a long time, as described in Chapter 1. Bioelectromagnetic techniques applied to artistic expression allow for the birth of truly integrative art: a sort of artistic practice that is non-representational, non-simulatory and in its extreme form might become non-mediated.

4.5 *Executive art* – practicalities of research and policy making

In 2010, in a lecture in the University of Sao Paulo, Brazil, the author of this thesis declared for the first time that one of his artistic practices was *executive art*. That practice very simply consists of bringing into society and the economy more artistic concepts by navigating the worlds of public and private management. *Executive art* is another form of integrative art and can be easily mistaken for another executive function. It is very similar in form to another executive function but its rather not driven by career progression, power or financial targets. It is driven solely by the urgency of artistic intervention in society and economy. The announcement provoked a very lively discussion with Professor Gilbertto Prado (1954-) a prominent artist and academic in Brazil and recognized worldwide. Since then, the term has only been referred to in private discussions but the practice has intensified. This section summarizes the results of this practice, which has a crucial relevance for the integration of the new form of artistic driven research presented here.

Figure 13 - The author presenting STARTS at Transmediale, Berlin, with Peter Friess from the European Commission and Bruce Sterling, artist.

For a long time, the thinking patterns of the author of the thesis have been rather peculiar, different from the majority of the people surrounding him. His determination of promoting these alternative ways of thinking to a wider group of people as well as implementing processes of transferring knowledge to civil society, preferably in the form of prototypes has always been firm. The principle of differentiation is fundamental here: as a principle of action in research. What is still missing for the European Union to develop as an innovative power in the world's market of knowledge is to have a group of 'free radicals' that promotes 'combustion'. One of the problems of our world economy is that no 'chemical reactions' are happening. The economic system is stagnated.

The latest international economic crisis can well be perceived as a natural phenomenon of the type of complex system[26]. Therefore, the ideas of Self Organised Critically[27] (SOC) in which a number of research organisations have

[26] *A complex system is a system composed of many components which may interact with each other. In many cases it is useful to represent such a system as a network where the nodes represent the components and the links their interactions.* https://en.wikipedia.org/wiki/Complex_systems (last accessed on 31-08-2017)

[27] *In physics, self-organized criticality (SOC) is a property of dynamic systems that have a critical point as an attractor. Their macroscopic behaviour thus displays the spatial and/or temporal scale-invariance characteristic of the critical point of a phase transition, but without the need to tune control parameters to a precise value, because the system, effectively, tunes itself as it*

been investing, could be explained by the fact that the human economic system has a sort of 'pond'. The mechanical principles that humans thought could bring some predictability to the system failed and has proved not to be working at all. SOC can be provoked by a lack of disruption in the system. Causality does not seem to 'compute' in a productive way either. In fact, over the years, the observations of the author as an insider of the market of technology – meaning how real people, who run real companies in the field of technology have been thinking – have been that their way of thinking is just imitating previous models, mainly the American model. They do not seem to recognise that 'Silicon Valley is dead'. Obviously, what is happening now as an apparent boom of technology is a repercussion effect of the crazy free California of the sixties and seventies of the 20th century. There is almost nothing fundamentally new in the computer world. They are just smaller, faster and branded differently.

In short, the mechanical deterministic world-view that was envisaged in a post-industrial era has 'broken down'. It has failed and has led to competition over a scarcity of ideas. Reading the news about technology is quite depressing, such as the fight in Germany between Motorola and Google about the intellectual property of the side slide technique in touch screens. It is ridiculous. As if there was anything intellectually new in all that. As a result, there has been no real innovation going on in the field of close to market technology.

To define and establish an interface research field between Information and Telecommunication Technologies (ICT) and Art can be instrumental for dealing

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evolves towards criticality. https://en.wikipedia.org/wiki/Self-organized_criticality (last accessed on 31-08-2017)

with post-crisis processes of recovery in the European Union, by enabling creativity and innovation through art and ICT. Investments in this area of research and technological development are expected to be profitable both on a social and economic level. The intrinsic nature of the arts combined with ICT can be levers for the development of creative digital futures of social innovation in a cohesive European Union. In 2013, although visibly emerging all over the world, the field of ICT and Art was not clearly defined as a coherent force of development, neither in Europe nor beyond. Therefore, mapping ongoing activities linking ICT and the Arts and the consequent formulation of a strategy to further developments in the field was necessary. The author of this thesis was the coordinator of such a study for the European Commission. It was titled ICTARTCONNECT.study.[28] Some attempts have been made in order to map those activities, but they tend to collapse, mainly because they're triggered by small organizations and do not have the initial lift-off power that that study brought into place. Another reason for the collapse is the fact that the number of organisations involved in such initiatives is very small, often focusing on either territorial or institutional niches. Specific activities tend to group under specific umbrella concepts. The most popular ones are New Media and Media Lab. The origins of the theoretical basis of such definitions can be found in the work of Marshall McLuhan, the philosopher of communication theory who became famous for his statement: “The medium is the message”. The main practical reference is the MIT Media lab, which is still the most relevant worldwide educational institution in this context.

[28] https://ec.europa.eu/digital-single-market/en/news/innovation-about-starts-when-ict-and-art-connect (last accessed on 31-08-2017)

Artists tend to break up emerging technologies and redistribute them in unexpected ways, with a focus on enaction and embodiment, boosting or swelling the extended mind around the product; they can act as first movers or style leaders for the general public's role in turning new technologies in a particular direction. So as well as fostering the direct instrumental relation, we need to see Art and ICT experts working together without a particular aim. This idea of unpredictable creation with unpredictable benefits is where the European Commission can serve both the resilience and the innovation agendas. It also contributes to creativity generally as art, science and technology all become mutually inspiring. The long-term social gain may be an ICT-enabled evolution of consciousness.

As stated before, artistic processes are methods of integration of subjectivity in the generation of knowledge. Again, the report referred to supports our directions of thought:

The element of the aesthetic in the ICT innovation process may also need more study. Artists do not like environments in which they are an afterthought, getting a pat on the back for making it pretty. This is decoration not true co-innovation on the Apple model; what are the right conditions for true co-innovation? How do we integrate the artistic ethos that art should be not mean (i.e. it is 'a way of happening' without a priori message or purpose) into the generally executive concerns of those involved with ICT? From another point of view, there has also for centuries been a competing set of artistic credos that are expressly executive and set out to send a message. Perhaps the best way to think about this dichotomy in an ICT context is as unplanned and planned innovation. The point

in Luis Girao's presentation below about how to integrate the revelation processes of art into scientific/policy methodologies is highly relevant here. (ICTARTCONNECT.study, 2015)

Other research results reveal the interdependency of emotional and cognitive aspects of human brains. Damasio's Somatic Markers Hypothesis raises the relevance of emotions in decision-making processes. According to his findings, emotions, a speciality of artists, are essential to rational thinking and to social behaviour.

Taking all this into consideration, the practices of art seem to be as relevant as the practices of science as methods to access and generate knowledge. This is another strong reason to put effort into the integration of artistic practices in ICT development. The prevailing question at this stage is: What methods, processes and instruments should be put in place so as to allow such developments? This question was the main focus of the conference "*Skilled Art* -Talks about Art, Consciousness and Transdisciplinary Practices", in Guimaraes, Portugal in 2010. Discussion at that conference led to a model where ICT occupies a central position. Enaction distinguishes artistic from scientific practices in knowledge generation. Learning by doing is a characteristic of art. Making becomes a thinking process. Therefore, by manipulating ICT tools, artistic researchers can produce new knowledge. Because it is technical, and therefore reproducible, this knowledge becomes not just philosophical but scientific. The artistic approach to technology, because it is different but as valid as the scientific approach, might produce a priori unforeseeable results. As artists are sensory beings, artistic

practices always generate conscious and unconscious dialogues with global aspects of humanity and its social environments.

This is the model envisaged to shorten the period of time between artistic visions and their concrete materialisation as innovations, whether they are products, services, solutions or ICT based responses to societal challenges.

The fast materialisation of high-potential artistic concepts is essential to position the EU as the technological leader of global markets, especially in times of crisis recovery.

Golan Levin, one of the most prominent individuals of the emerging field of ICT and Art, very clearly presented how artistic projects presented ICT solutions much before they became known: Myron Krueger's Video Place (1974), and the Sony EyeToy (2003); Michael Naimark & MIT ArchMac's Aspen Movie Map (1978–1980), and Google StreetView (2007–); Jeffrey Shaw's Legible City (1988) and E-fitzone exercise equipment (2008) and Art+Com's Terravision (1996) and Google's Google Earth (2001, 2005–). The artist and technologist states he wrote his article *New Media Artworks: Prequels To Everyday Life*,[29] as consequence of the following:

I struggled to justify the value of new-media arts research to an audience of Silicon Valley business people; while simultaneously, some new-media artist friends of mine discovered that their work had been 'appropriated' by a large corporation. (Levin, 2009)

[29] http://www.flong.com/blog/2009/new-media-artworks-prequels-to-everyday-life/ (last accessed on 31-08-2017)

This example reveals one of the most important gaps in the generation of new businesses models in global markets: the one existing between creativity and business. The US, moreover, is home of crucial players in the field, such as the most relevant academic publisher in the field, *Leonardo*, and SEAD, the network for Sciences, Engineering, Arts & Design. However, the European context nurtures the development of institutions such as Ars Electronica that distinguished Golan Levin with its Prix. The same institution that also distinguished Linus Torvalds, considering the collective process that lead to Linux as an artistic expression. It is this same European context that recognized the emergence of ICT & ART so as to allow for the worldwide establishment of STARTS, the European Commission initiative in Science, Technology and the Arts, as a recognized field of Research and Technological Development.

A considerable amount of organisations, institutions and programmes promoting activities linking ICT and Art proliferate in the European Union. Some of these institutions are worldwide leaders such as Ars Electronica (AT), ZKM(DE) or IRCAM(FR), to name but a few. However, it is from small organisations and individuals that the most innovative projects or actions originate. As an example, the Finnish artistic/researcher Laura Beloff, who has been operating as an individual focused on the development of wearable technologies, has recently been appointed the Head of Section–Interaction Design and Computer Game Development, at IT University, in Copenhagen, Denmark. The Finnish Bioart Society that she founded and directs was one of the participants of a workshop on bioart, promoted by the FBI, in California, USA. Laura is just one of many artists

that are becoming institutionally prominent not in the field of the Arts but in the field of ICT.

Figure 14 - The author inaugurating a STARTS exhibition at the LABoral in Gijon, with the centre's artistic director and the Minister of Culture of Asturias.

Small organisations seem to be in fact the strategic focus of promoters, as funding in the field is mostly directed to groups of people than to individuals. Medialab-Prado (SP), Kitchen Budapest (HU), F.A.C.T. (UK), Pervasive Media (UK), iDAT (UK), iMAL (BE) and CIANT (CZ) seem to be good examples of organizations promoting more relevant activities. More and more ideas of collaboration, co-creation, shared knowledge and participation are present in their initiatives. The concept of lab, from OpenLab, to FabLab and Living Lab, has been instrumental in the diffusion of techniques of digital fabrication and physical prototyping, allowing everybody to go, learn and create. From pieces of 3D printing to lines of code for multimedia installations, activities linking ICT and Art seem to follow a model of establishing an artistic context for creative participation, be it in the form of interactive installations or workshops to learn how to make or to create. It seems that we are moving from models of engaging

the arts to illustrate and communicate science, such as the one implemented at CERN, to the ideas of living labs, such as the iMinds' own iLab.o or Barcelona Laboratori Cultural, promoted by Josep Perelló that was previously responsible for the Science Area on behalf of the University of Barcelona at Arts Santa Mònica centre in Barcelona (SP).

There are already a considerable number of small and medium businesses developing around these activities, such as InMotion (PT) or Libelium(SP). The concept of providing creative learning platforms as a new business model is actually expanding as a strategy. What started as an artistic project is becoming the standard for rapid prototyping in physical computing: Arduino (IT). This development platform created and has been maintaining a large community of developers around itself, based on the establishment of an easy-to-use programming language, a playful set of online tutorials and an active online form. The same model has been applied in Processing or openFrameworks. The community started with a majority of artists and expanded to become of a majority of technologists. Almost every electronics store in big European cities sells Arduino and related products. The expansion of this model is becoming visible in big companies such as Farnell and its community platform Element 14 or the DIGI. Also in this last case, the new Xbee project gallery results from the collaboration of Rob Faludi (US) with the electronics corporation. At the University of Cambridge's Computer Laboratory (UK), what is becoming the next platform for development was created: the Raspberry Pi.

In education, the most interesting model seems to be related to the concepts of ubiquity and the internet of things. i-DAT24 of the University of Plymouth (UK)

has been promoting exemplary initiatives such as the *Confluence* Project: where a group of students of schools located at North Devon's UNESCO Biosphere Reserve, in collaboration with artists and technologists, developed and implemented remote wireless networks from which they created online data visualisations.

In research, the most relevant worldwide network of researchers in the field of Art, Science, Technology and Consciousness Studies is the Planetary Collegium. The network has nodes in Lucerne, Trento, and Shanghai. The main hub is at the University of Plymouth.

A considerable number of conferences on the crossings of ICT and Arts happen all over the world, the most relevant ones being, for example, ISEA, Ars Electronica, Siggraph, HCI International and Transmediale.

At the level of Social Innovation, the growing intersection between the application of ICT and Art in the field of disability is notable. The Artabilitation (DK) group has been joining a relevant number of researchers in this area, including the exemplary case of Rolf Gehlhaar. Gehlhaar developed a number of digital interfaces for musical expression, some of them recently integrated in the British Paraorchestra. The orchestra opened the Queen's Christmas Speech of 2012 and played at the Paralympics closing ceremony in London, in 2012.

The European Commission has been supporting a number of projects engaging the arts as described in the call for tender. However, the most relevant recent activities come from DG CONNECT, specifically resulting from the actions of Ralph Dum. He has been at the origin of the ICT ART CONNECT workshops

and related events which have been dedicated to better understanding how to integrate the arts with ICT. The COST Arts and Technologies Event, took place in Zagreb, from the 25th to the 28th of November 2013.

The COST Arts & Technologies (CAT) workshop assumes that there are large potential gains in integrating arts on the one hand with technologies on the other, to a larger extent than what has been done so far. Combining artistic creativity with technological expertise should in itself have a great potential to lead to new products, services and social innovations. The workshop aims at enabling innovative integration of arts and multi-, inter-, and transmedia technologies and their actual and potential integration with industries and society as a way of enhancing competitiveness and creativeness of European innovation in arts and technologies. The workshop will deliver initiatives and applications enhancing innovation, welfare and greening of Europe.[30]

The CAT workshop gave rise to a relevant collective white paper entitled *Organisms for Change and Transformation.*[31]

DG Connect of the European Commission has been promoting key initiatives in the context of the Digital Single Market (DSM), under the umbrella of the STARTS Initiative.

However, bearing in mind long term targets such as 2050, it will be in the context of the now developing Framework Programme 9 (FP9) of the European Commission that further development of STARTS will have to develop. In order

[30] http://www.cost.eu/events/cat (last accessed on 31-08-2017)

[31] http://www.cost.eu/download/47808 (last accessed on 31-08-2017)

to find conditions for the nurture of these future activities, areas of opportunity need to be found within this context. The present understanding seems that regional development will be instrumental. The reason behind this assumption is that the Regions of Europe strategically dedicated to this area of innovative development will be determined to a large extent by this program. The context of the Cultural and Creative Industries (CCIs) seems to be the ideal host of the ideas forthcoming from the potential research results from the future of STARTS. Nonetheless, it seems that the focus of this emerging field should probably not lie in the utilization of ICT for digital content, cultural industries and creativity. The utilization of the Arts as ways to communicate aspects of Science on its own also does not seem to be innovative enough for the purposes of the emerging field in question: this practice has emerged and spread worldwide, as these activities have been happening worldwide since the last century and are already quite established as described.

The engagement of the arts with ICT can be instrumental in allowing active participation of a large number of European citizens to create and live their own lives in a better way. Protocols such as Open Data and Open Source allow for digitally mediated forms of social innovation both at the level of opinion-making participation as well as at the level of self-employment. In this perspective, the creation and establishment of new business models and entrepreneurship becomes an active form of social innovation. This implies nurturing not only the visionary and exploratory characteristics of artistic practices, but also furthering their wider capability of research and development.

These ideas are clearly aligned with actual objectives such as Inclusive Societies by which “The European cities have to be at the heart of policies aiming to create growth, jobs and a sustainable future.” and “the increasing socio-economic importance of digital inclusion, research and large-scale innovation actions will promote inclusive ICT solutions and the effective acquisition of digital skills leading to the empowerment of citizens and a competitive workforce.” In her report on H2020, MEP Maria da Graça Carvalho proposes “education and science, arts and humanities as fundamental drivers of social and economic progress and well-being”.

Social innovation generates new goods, services, processes and models that meet societal needs and create new social relationships. It is important to understand how social innovation and creativity may lead to change in existing structures and policies and how they can be encouraged and scaled-up. Grass-roots on-line and distributed platforms networking citizens and allowing them to collaborate and co-create solutions based on an extended awareness of the social, cultural, political and environmental context can be a powerful tool to support the objectives of Europe 2020.

Moreover, aspects of participation are also in the core of the programme: “...address social-network dynamics and crowd-sourcing and smart-sourcing for co-production of solutions addressing social problems, based on open data sets. They will help to manage complex decision-making, in particular the handling and analysis of huge quantities of data for collaborative policy modelling, simulation of decision-making, visualisation techniques, process modelling and participatory systems (…) as well as to analyse changing relationships between

citizens and the public sector. Increased levels of complexity, the implications of questions posed by technology, advanced computation, life sciences and bio-engineering impinge upon areas of knowledge traditionally related with human studies, such as philosophy, theology, and legal, political and economic thought should be addressed. It is important to combine art, science and entrepreneurship; new forms of urban expression; knowledge, art and entrepreneurialism related to the integration of multiculturalism and integration of migratory flows; multilingualism."

The same applies for creativity and innovation: "Exploring processes which provide a favourable background to creativity and innovation. Providing a better understanding of the social, cultural, economic and political context for innovation shall be a priority. In particular, the role of youth perception of the opportunities for innovation in the current economic environment of high unemployment in many EU regions shall be carefully understood in relation to education and to the risk of brain-drain."

Finally, Cultural Heritage and European Identity are also important: "The aim is to contribute to an understanding of Europe's intellectual basis [...] European collections, including digital ones, [...] should be made accessible through new and innovative technologies and integrated information services to researchers and citizens to enable a look to the future through the archive of the past and to contribute to the European participative intelligence."

In sum, an understanding of the crossroads of science, technology and the arts on all these levels is crucial to fostering post-crisis processes of recovery in the European Union.

At the heart of the Fourth Industrial Revolution lies the outstanding feature of the automation of mechanisation. Artificially intelligent computerised machines liberate humans from mechanistic tasks in chain with machines. The actual concept of a hybrid system integrates humans in industrial chains where subjectiveness is a need. In this general context, disciplinary specialisation in research is giving way to transversal and holistic approaches, with the assurance that intelligent machines are in place to perform highly precise and effective tasks. Humans are no longer needed to perform complex operations but instead, they become indispensable to trigger and correlate highly complex operations, where knowledge convened by subjective processes is crucial for the achievement of results.

Research and development practices are no longer methodological processes of confirming expectations or hypothesis, but now become flexible processes of discovery due to the availability of easier means of experimentation and repetition.

Sciences of cognition set a very good example of that expressed above. They often cross knowledge from different disciplines, they depend on high-tech imaging and measuring equipment and their results are mostly dependent on subjective reports. Therefore, they demand an articulation of many different disciplines and their experiments are led by enquiry on subjective aspects of perception. Already in this field of research, the integration of artistic practices is an emerging factor.

Art practices are transdisciplinary by nature, independently of the channels of expression used. Throughout history artists have specialised in developing

technologies and implementing techniques in the design of artistic experiences. Therefore, in the present context of experimental integration of subjectivity, artists are emerging as relevant contributors in research and development of technology. Technologies being a consequence of scientific developments, artistic practices become interesting experimental methods for the generation of new knowledge. Strategies are needed for the integration of these new ways of thinking amongst different scientific communities, leading to true social and economic innovation.

Historically narrowing our perspective over more recent events, one can say that the existing collaborations among artists and scientists are a consequence of the work of Frank Malina. He was at the origin of NASA's Jet Propulsion Laboratories, of which he was the first director. In 1968, in Paris, as a way of pursuing his interest in kinetic art, he founded the Leonardo Journal, which is still the leading publication on the crossings of arts, sciences and technologies. His son, Roger Malina, continuing his father's work, is one of the most prominent agents in the field, by running the Leonardo project as well as triggering other actions such as SEAD. At the moment of the writing of this proposal, SEAD is looking into congregating best practices of collaborations in science, engineering, arts and design. However, all actions in the field tend to make the old fashion model prevail ,where every single actor of the collaborative system conserves and develops his or her own speciality, which of course enhances political aspects of real and productive collaboration. Their results are mostly limited to theoretical papers, and in cases that could result in practical applications, issues of generating economic value such as Intellectual Property generation and

protection are generally dismissed. Not to mention how far these practices stay from aspects of creation of new products, services, and of the business aspects of generating new jobs and self-employment. Nurturing the expansion of fields of action of each discipline and solving conflicts resulting from their overlapping of functions are the instruments to achieve transdisciplinarity. However, the main question still remains: How to integrate arts and sciences in truly productive ways, both in the direction of the generation of new philosophical knowledge, as well as in the direction of the creation of new technology-based businesses, in order to make of European Union the world leader of emerging markets and creating future ones?

The adoption of artistic practices such as research methodologies is instrumental for the integration of subjectiveness in the production of scientific, reproducible knowledge, allowing for a holistic approach, not only to the emergence of future sciences, but also of future technologies, leading to close-to-market results, especially concerning the intersection of the Arts and Information and Communication Technologies.

Therefore, the main benefits of STARTS are in its features of nurturing socio-economic innovation by mediation of digital information and communication technologies. By promoting the intersection of scientific and artistic practices, inevitably leading to new methodologies and processes of generating new knowledge, STARTS aims at transforming the way research and development communities face their own research targets. At one stage, to make them more open to novelty, exploration mechanisms, creativity and imagination. At another,

to make them focus on concrete research outputs, in the form of close-to-market prototyping.

The main targets of STARTS should be to disperse the idea that blue-sky thinking-based research can generate added value, not just because of its inherent novelty, but because this novelty, by being tracked at intermediate states of development, will lead to new scientific and technological developments.

Innovation at the social level where scientists and artists interact will lead to both new knowledge and new technologies, in accordance with actual demands of society and markets. In other words, STARTS aims at benefiting European Research Communities by merging Scientific and Artistic research and innovation (R&I) practices into producing new philosophical knowledge and new technologies, as well as making R&I practitioners aware that having both of the above combined might allow for the creation of new markets, based on new business models, new products and new services.

At the time of this writings STARTS has 3 dedicated projects running and a relevant intervention in the Large Scale Pilots Initiative. *Vertigo* is promoting the integration of artists in knowledge generation systems by attributing 900,000.00 EUR in artistic residencies in research projects. *Wearsustain* is promoting the creation of new artistic driven prototypes by distributing 2,100,000.00 EUR in innovative projects.

Figure 15 - The author part of the Ars Electronica STARTS Prize Jury, in Linz.

The *STARTS Prize* attributes yearly two 20,000.00 EUR distinctions for technological innovation through the arts. *Create-IoT* is the coordination project of the Large Scale Pilot projects (LSPs) of the EU that add up to an investment of 300 million EUR. STARTS has a crucial role in *Create-IoT* by promoting the notion of co-creation based on artistic practices within the LSPs and by introduction of the Experience Readiness Level indicator.

The author of this study is involved in all the projects and is the community coordinator of STARTS. This is his main activity as *executive artist*.

4.6. Homo Conscientis

In conclusion, *Homo Conscientis,* an audiovisual integrative experience applying bioelectromagnetics, is presented as the first manifestation of the new artistic practice of bioelectromagnetic art proposed. Its technical aspects are described below.

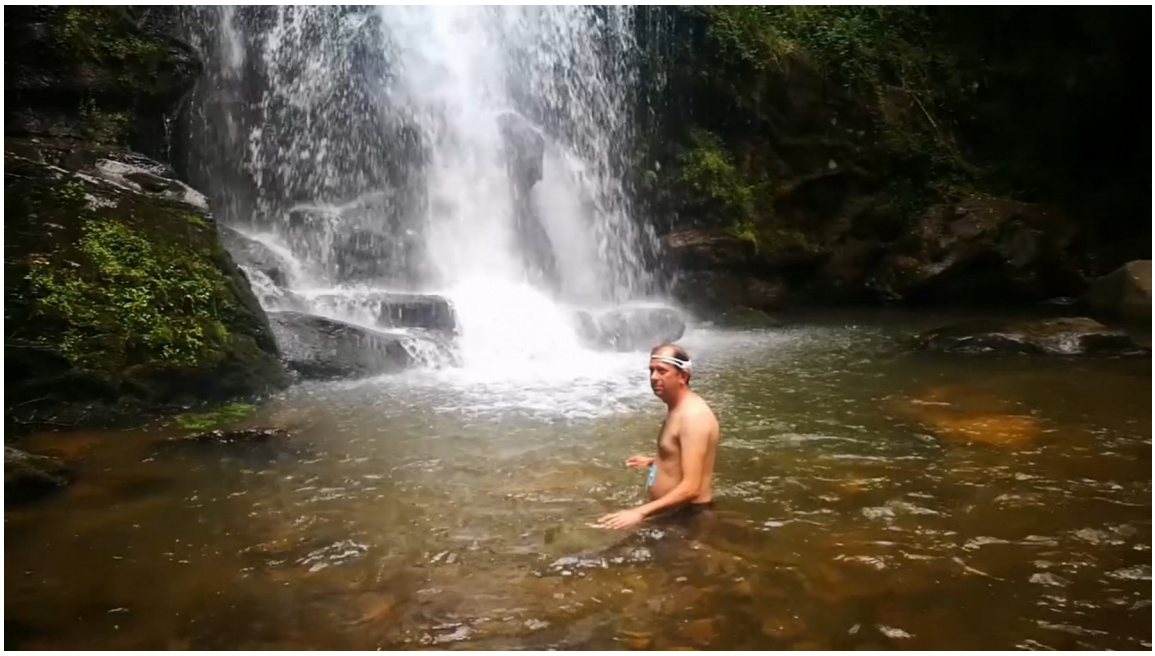

Figure 16 - Homo Conscientis Performance.

Homo Conscientis is an ongoing project that started in early 2017. It is an extension of *Collectron* as it builds upon its audiovisual interactive system and adds two new layers. The first layer is the integration of two wireless brain sensors. The second layer is the integration of direct current stimulators targeted at the enteric nervous system, or the second brain.

It is important to reiterate here that *Collectron*, and consequently, *Homo Conscientis*, are not content-driven artworks. This means that the artwork is a technical system that can be easily adapted to any content. This is fundamental in understanding *Homo Conscientis* as a cooperative tool. It is a system to allow

dialogues in which content, meaning video, sound and images can be added almost instantly. *Homo Conscientis* is a tool for artistic improvisation. Therefore, it is also an instrument for research: an instrument for the new type of research proposed by the thesis, grounded in technology to allow for the integration of subjectiveness in which experimentation and improvisation have a fundamental role.

However, the system in itself, the way the different devices are connected, is the artistic message. In a way, it can be seen as a literal realization of McLuhan's *The medium is the message*.

More precisely, *Homo Conscientis* is an infinite loop between two human organisms. The signals captured by the brain sensor in participant one are used to manipulate the stimulation of the second brain of participant two. Reversely, the same happens with the signals captured by the brain sensor of participant two which are used to stimulate the second brain of participant one.

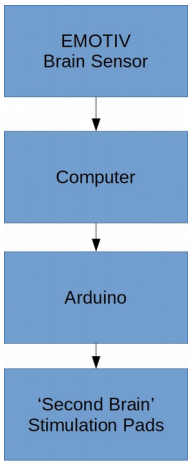

Figure 17 - Homo Conscientis System.

The correspondences between signals, i.e. which brain signal is used and how it is used in order to stimulate the second brain is an open process. The learning

curve is long because there is no literature in terms of bioelectromagnetic stimulation of the second brain for purposes of emotional modulation. As exemplified by the artistic work described in Chapter 2 of this dissertation, *Second Brain*, most of the studies focus on the notion of *gut feeling.*

Figure 18 - Homo Conscientis Stimulation of the 'Second Brain'.

The activity of the second brain or enteric nervous system is at the level of microbes and therefore they are mostly biochemical. However, there are some references to neurostimulation of the second brain in terms potential treatment of anxiety.

Non-invasive and/or natural orifice procedures, apparatus and methods for modulating the enteric nervous system using one or more energy modalities. A system may include a probe for insertion into a natural orifice (e.g., nasogastrically, orogastrically, nasojejunally) with or without a tube to therapeutically apply energy to modulate one or more portions of the enteric nervous system. The methods described herein may provide energy to stimulate

the enteric nervous system to treat disorders such as irritable bowel syndrome, constipation, depression, anxiety and/or to enhance gastric motility, intestinal motility or other neurological responses. (patent WO 2013082587 A1, 2013)[32]

Furthermore, later in the patent description other references are made to anxiety but based on general principles. This patent seems to be one to protect any potential future applications in this field that are not yet available. It seems to be an industrial property legal protection mechanism.

[000108] An alternative modulation pathway could involve using the technology to neuromodulate the ENS in order to regulate the production and distribution of a neurotransmitter, such as serotonin. Serotonin is an important neurotransmitter for the regulation of neural activity in the management and treatment of various mood disorders, as evidenced by the significant use of SSRI's (Selective Serotonin Reuptake Inhibitors) used as antidepressants in the treatment of depression, anxiety disorders, and some personality disorders. By regulating the production of such a neurotransmitter, one could use the technology to treat any one of several neurological and/or mood disorders where such a neurotransmitter is involved. (ibidem)

Another article, by Simone Vigneri, a medical doctor at the Department of Experimental Biomedicine and Clinical Neuroscience (BioNeC) of the University of Palermo, Italy, refers to a hypothesis on the different effects of tDCS on non-erosive (NERD) vs. erosive (ERD) disease, but no concrete practical application is described. Therefore, *Homo Conscientis* as a research

[32] https://www.google.com/patents/WO2013082587A1?cl=en (last accessed on 31-08-2017)

apparatus is potentially in the forefront of research in the field of bioelectromagnetic stimulation of the enteric nervous system.

Both the brain-sensors and second brain bioelectromagnetic stimulators are operated using the Open Sound Control (OSC) Protocol, which allows for easy patching of signals.

Figure 19 - Homo Conscientis Wireless Brain Sensing.

Open Sound Control (OSC) is a protocol for networking sound synthesizers, computers, and other multimedia devices for purposes such as musical performance or show control. OSC's advantages include interoperability, accuracy, flexibility and enhanced organization and documentation.[33]

Although designed for musical purposes OSC is widely used for other ones, mainly in multimedia applications. The protocol allows almost instantaneous patching of signals.

[33] http://opensoundcontrol.org/introduction-osc (last accessed on 31-08-2017)

The two brain sensors are of the brand *Emotiv* and model *Insight*. The *Emotiv Insight* is a 5-channel, wireless EEG headset that records brainwaves and translates them into meaningful data. The 5 channels measure activity at AF3, AF4, T7, T8 and Pz at 128 samples per second per channel with a frequency response between1 and 43 Hz. The advantage of this system is that, besides raw data of the sensors and the four major frequencies Delta, Theta, Alpha and Beta, it delivers already computed signals that directly characterize some states of the person being monitored. Those are called *Performance Metrics* measuring 6 different emotional and sub-conscious dimensions in real time – Excitement (Arousal), Interest (Valence), Stress (Frustration), Engagement/Boredom, Attention (Focus) and Meditation (Relaxation). These are the signals that can be mapped from the brain sensors to the bioelectromagnetic stimulators. For example, using the relaxation performance metrics of participant one to manipulate anxiety levels of participant two by bioelectromagnetic stimulation.

The bioelectromagnetic stimulators are composed of a pair of stimulation pads controlled by an *Arduino* board. With one pad being the cathode and the other anode with interchangeable possibility (reversed current), they induce a flow of current in the second brain. Different frequencies, wave forms and pulses can be applied to that current flow and it is here that more experimentation is needed.

All the devices are connected to a computer that runs the central control of *Collectron* which allows for combining the brain sensing and stimulation in a multimodal manner by generating audiovisuals with the brain signals and synchronizing the project of sound and light to enhance the effect of the bioelectromagnetic stimulation.

At the time of these writings, a series of experimentations are planned to start shortly in collaboration with PETER M FRIESS.[34] The experiments will focus on the different possible mappings of brain signals to second brain stimulations.

This chapter exposed the basis of the artistic practice of the author that sustains the ideas put forward by the thesis. Artistic practice is crucial for the philosophical development of the author. This chapter demonstrated how and at which stage of the creative process the theories described in this study originated from artistic practice as a thinking process.

Homo Conscientis, a unique form of bioelectromagnetic art was described as the apparatus for novel artistically driven research practice. The notion of *executive art* was put forward as the artistic practice of the author to integrate the arts into research contexts in the European Union. *Executive art* deploys the bureaucratic mechanism to allow the integration of *bioelectromagnetic art* in research contexts.

[34] http://www.petermfriess.com/ (last accessed on 31-08-2017)

5. The new perspective - visions of the future of artistic practices in technological research

This fifth and final chapter identifies the potential invention of a new form of perspective made possible by the recent developments in bioelectromagnetic stimulation previously exposed in the text. It also demonstrates in particular how society and economy could be shaped and endowed with visions expressed and embodied by artistic practices coupled with innovative technological research. The recent findings of Olaf Blanke regarding the induction of out-of-body experiences by bioelectromagnetic stimulation are reassessed as technological foundations for the new artistic realisations proposed in the confluence of philosophy, art and science.

The chapter builds upon the notion of *seeing* and how it was transformed with the works of Brunelleschi, Pessoa and Blanke. The *Brunelleschi Experiment* is presented in the dichotomy between reality and perceived reality, and how the invention of linear perspective changed the notion of *seeing*.

Pessoa joins Brunelleschi in demonstrating how art plays a fundamental role in creating alternative forms of communication as well as in congregating and mediating consciousnesses at a collective level. Similar to the insights of Bohm, their work demonstrates the role of artistic practices in creating cultures of interactions between biological beings and their spiritual dimension. The description of their work also reiterates the idea of the practice of art as a methodology to access knowledge, a thinking process. Both Brunelleschi's and Pessoa's experiments re-establish the assumption that one of the fundamental

characteristics of art is to impact the consciousness of those interacting with its forms.

Aspects of disembodiment present in the work of Brunelleschi, Pessoa and Blanke form the proto-foundational grounds for the new research practice proposed.

5.1 The Brunelleschi Experiment

The Brunelleschi Experiment is examined here in order to establish and corroborate the assumption that one of the fundamental characteristics of art is to impact the consciousness of those interacting with its forms. Filippo Brunelleschi (1377–1446) was an Italian artist and architect, and is considered one of the founding fathers of the Renaissance. He is generally well known for having developed a technique for linear perspective as well as for building the dome of the Florence Cathedral. His formulation of linear perspective governed pictorial depiction of space until the late 19th century. (Vesely, 2014)

> *The first scientific design he made in perspective was of the Baptistery of Florence. To draw it he stood within the portal of the Duomo. It was so finely done, showing all the inlaid work of black and white marble, that no miniature could have been more finished; the view included all the part of the piazza from the Misericordia to the Canto di Paglia and the column of S. Zenobio. He put in the skies with burnished silver, which reflected the real clouds being carried by the wind, and, as the chronicler says, "gave great reality to the scene."*
>
> *Not only did Brunelleschi invent (or rediscover) the rules of perspective, but he invented a wholly original method of looking at such drawings. Fearful lest beholders should mistake the point of vision, he made a hole in his picture, which was painted on a thick panel of wood. The hole, which was just at the point of vision, was funnel-shaped, the wider orifice being at the back of the picture. The beholder had to put his eye at the back of this hole, and hold a mirror the size of the design at arm's length, facing the picture. Thus he saw it reflected in the mirror with a stereoscopic effect of depth and reality. As the writer says: "You seem to see it in very truth, and I have had it in my own hand, and have seen it several times in my days, so I can bear witness to it." (Scott, 1901)*

Brunelleschi wanted his new perspective ‘realism’ to be tested not by comparing the painted image to actual Baptistery, but to its reflection in a mirror according

to the Euclidean laws of geometric optics. That 'realism' was achieved by changing the point of view of the original painting through a mirror. Consciously or unconsciously, Brunelleschi created a method of disembodiment.

The great potential of monocular vision was recently demonstrated by the Flemish artist Eric Joris (1955-). His work *Collateral Rooms*, an immersive live-art installation developed for the Frankfurter Buchmesse 2016, allows people to experience 3D vision through a single eye and the moving of the participant's body. The 3D effect is not conveyed by stereoscopic glasses or 3D projections, but only by a single naked eye, in movement. In Joris' words: "That is sufficient to recreate the world as we know it."[35] Joris, similar to Brunelleschi, invites the participant of his installation to wear a position-tracking device, close one eye, and in this manner to make sense of two planar video projections in the corner of a wall. While Brunelleschi used a very simple system, Joris employs more sophisticated technology developed by himself and his team specially for the installation.

Brunelleschi re-accessed the medieval notion of medieval *perspectiva*. "[…] *perspectiva* postulated the binocular vision whereas linear perspective would adopt the conditions of monocular vision." (Raynaud, 2016) Many centuries after Brunelleschi, and in a time where digital technologies of immersion are in fashion, such as Virtual Reality, Joris makes the medieval notion of perspective current again, pointing out the uselessness of apparently sophisticated emerging technologies.

[35] http://www.crewonline.org/art/project/715 (last accessed on 29/08/2017)

It is relevant to understand that the Brunelleschi Experiment is presented by many authors, including Scott, as a “scientific design”. Nowadays, it is an artist that requestions the notion of perspective and the apparent evolution of technology.

However, the most relevant contribution to this thesis is that Brunelleschi created a piece of apparatus that modulates the consciousness of the observer. He created an experience that taught many designers how to interpret and represent the reality they perceived from a single and different point of view.

> *[…] medieval perspectiva was a tripartite science embracing optica, catoptrica and dioptrica, whereas perspective would focus exclusively on direct vision; (Raynaud, 2016)*

Damasio’s definition of somatic markers in decision-making processes (Damasio et al., 1996), which as previously explained in this dissertation reveal that emotion is the first step of a rational decision, is instrumental at this point of the discussion. It makes a deterministic view that perspective focusing exclusively on direct vision is less interesting than medieval *perspactiva*. The notion of a practice that embraces many different aspects is exactly what is proposed by this thesis. It is a practice of reflections, of knowing thyself.

5.2 Sculpting the selves – Fernando Pessoa

The Socratic notion of *know thyself* was previously referred to to describe the core process of establishing dialogue between the conscious and the unconscious as a process of modulation of consciousness. It was also demonstrated how electromagnetism is a manifestation of an intrinsic bipolarity between immaterial (magnetism) and material (electricity). Furthermore, improvisation was referred to as a process of accessing consciousness in the dialogue between the conscious and unconscious, material and immaterial, and physical and non-physical. Improvisation, in the context of music, was described as an individual and as a collective process.

The famous Portuguese poet and philosopher Fernando Pessoa (1888-1935) merges both the individual and collective aspects in artistic practice. In Pessoa, the individual is always a collective of multiple identities. He invented the literary concept of heteronym and actually exercised it in his daily life. Pessoa was simultaneously a number of different writers, all of them with specific and well-defined psychological behaviours, personal histories and writing styles. (Pessoa and Quadros, 1986) Four of those heteronyms have been well studied and have been quite representative in Portuguese literature. Álvaro de Campos, Ricardo Reis and Alberto Caeiro are in reality the ones studied most. Yet Bernardo Soares wrote a book that is extremely relevant for the thesis. This is *The Book of Disquiet* (Pessoa and Zenith, 2003), which expresses a *restlessness* leading to the poet's urge for artistic expression that in this thesis is described as

the bipolar concept of *urgency*: the conjunction of the needs of *Realisation* and *Manifestation.*[36]

Recent discoveries by Pessoa's most considered biographer Teresa Rita Lopes show that he created about 70 different heteronyms. (Lopes and Pessoa, 1990) Pessoa was a prolific writer and a number of recently discovered writings are still to be studied and classified. His work has become so important that the Portuguese state is in the process of insuring it. Most relevant on the heteronymia of Fernando Pessoa is the fact that some of his heteronyms exchanged letters among themselves, translated each other's articles, and publicly argued opposite ideas by publishing against each other in newspapers.

As stated before, some of this has only been recently discovered. This means that all of it was not in the public domain at the time. Pessoa manipulated concrete aspects of Portuguese society in his interplay of journal publications. In this sense, as an artist, Pessoa's 'canvas' was the Portuguese society of the time. This aspect of having the world as a canvas is common ground with the ideas of this

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[36] The notion of bipolarity is also widely understood in contemporary health systems as a psychiatric perturbation. Similarly, some authors refer to Pessoa's heteronymia as another psychiatric perturbation, schizophrenia. (Saraiva, 1998) The discussion about the mental health of Pessoa or the comparison of the concepts proposed in the thesis with the psychiatric perturbation are not relevant for the argumentation. This thesis builds upon the assumption that integration is unarguable, it is a given, including people with special needs or mental health problems. All humans are included in this thesis without exception.

thesis in which technology is seen as a body into which artistic ideas can be embedded and better spread into society and economy.

The consistency between the practice and philosophy of Pessoa and the Brunelleschi Experiment is that both take the body as a medium in a retroactive manner. In Brunelleschi, the body was root for disembodiment. The experiment shifts the point of the observer by revealing the notion of linear perspective. The one going through such an experience would literally see the world in a different way afterwards. The invention in the Renaissance of linear perspective changed "our vision of the universe". (Edgerton and Edgerton, 2009) The physical body of Fernando Pessoa took residence in different figures of his contemporary literature scene that interacted with each other. His physical body allowed as many as 70 different characters to manifest in the world. Pessoa's body was their medium.

> *This tendency [to create a fictitious world around me] which exists since I realized that I was a self, has always been with me, modifying slightly the kind of music it uses to bewitch me but never altering its manner of bewitching.*

in Fernando Pessoa, Letter to Casais Monteiro, 01-13-1935.

Fernando Pessoa gained the ability to cross the worlds he was creating and existing in. In other words, he was living a world of multiple selves—a sort of 'multiverse' where those various characters were not in parallel states but entangled in such a way that they could not be dissociated. (Girao, 2007)

However, more relevant is that this process of being many simultaneously was a way of sculpting his *self*. Interestingly, Pessoa, like Cage and Schafer, refers to listening to certain music. This music satisfied his tendency to create fictitious

worlds, which fascinated him. Pessoa's *tendency* can also be understood as a synonym of the notion of *urgency* assumed by the thesis; the bipolar, almost uncontrollable need of *Realisation* and *Manifestation*.

In Pessoa, autoscopy, i.e. seeing one self from an external position to one's own body, is a process of *artistic modulation of consciousness,* similar to what was referred to before in relation to the notion of improvisation. It is a fundamental form of *argumental coupling* transposed from the one described by Tennenbaum in chapters 1 and 2. (Doubochinski and Tennenbaum, 2007) Or, from Bohm's perspective, a constant creative process based on constant dialogue with consciousness.

> *Yes, that's right. I live myself aesthetically in someone else. I've sculpted my life like a statue made of matter that's foreign to my being. Having employed my consciousness in such purely artistic way, and having become so completely external to myself, I sometimes no longer recognise myself.[...] I want to be a work of art, at least of the soul, since I can not be one of the body.*

in "Aesthetics of Artificialitty", *The Book of Disquiet,* by Bernardo Soares (Pessoa and Zenith, 2003)

The employment of consciousness in a purely artistic way by Pessoa is here interpreted as a dialogue between his unconscious and conscious. The creative act understood in this manner is unique to artistic practices and is indispensable to a holistic approach in knowledge-generation systems. It is pure integrative art: an integration in the Portuguese society of the early 20th century; a confluence of philosophy and art through the medium of printed media. Therefore, the practices of Pessoa are proto-foundational in the new research practice proposed. To

complete it, the scientific component of such practice needs to be aggregated to the artistic and philosophical one.

5.3 Ancient traditions – future possibilities: medieval angels and the new perspective

Autoscopy can be interpreted, as it is in this thesis, as a very important aspect in the generation of knowledge through artistic processes. It can also be interpreted as an illness. As stated by James Grotstein (1925-2015), referring to the literature review of Lhermitte on the subject matter, “one may call it the idosyncratic quintessence of self-consciousness” or a product of “mental illnesses secondary to epilepsy or syphilis”. (Grotstein, 1982) However, this being a transdisciplinary study, other references from a different field of research than Grotstein psychiatry open new possible interpretations of autoscopy and strong support for the first approach.

Ancient traditions of thinking, including medieval, interpret representations of angels in paintings as symbols of astral projections. (Proclus and Dodds, 1992) Astral projections are, in spiritual terms, another designation of what today from a scientific perspective are referred to as out-of-body experiences. In 2002, in *Nature* magazine, Olaf Blanke and his colleagues declared: “The part of the brain that can induce out-of-body experiences has been located.” (Blanke et al., 2002)

Regardless of whether they are considered the product of illness or a higher from of spirituality, the fact is that out-of-body experiences can be provoked technologically with a specific type of bioelectromagnetic stimulation. They are no longer just part of discussions in philosophy, theosophy and spirituality, but are also part of scientific and technological discussions and research.

Olaf Blanke and Gregor Thut, in their article entitled “Inducing Out-of-Body Experiences” (OBEs), consider that OBEs happen when “agency (or the feeling of being the agent of one’s actions and thoughts) is localised at the position of the elevated, disembodied self.” (ibidem) Both authors describe OBEs as follows:

> *In an out-of-body experience (OBE), people seem to awake and feel their ‘self’, or centre of awareness, is located outside of the physical body. It is from an elevated extracorporal location and perspective that the subjects who undergo an OBE experience seeing their body and the world. […] An OBE is minimally defined by the presence of three phenomenological characteristics: disembodied (location of the self outside one’s bodily borders), the impression of seeing the world form an elevated visuospatial perspective (extracorporal, but egocentric visuospatial perspective) and the impression of seeing one’s own body (autoscopy) from this elevated perspective.” (Blanke, Thut, Della Sala, 2007)*

In other words, people when experiencing this phenomenon 'see' themselves from outside of their own body. But an OBE is in fact a multi-sensory experience: people actually feel ‘being an entity’ somewhere outside their body with all their senses.

> *Our findings reveal that multisensory integration at the TPJ [temporo-parietal junction] reflects one of the most fundamental subjective feelings of humans: the feeling of being an entity localized at a position in space and perceiving the world from this position and perspective. (Ionta et al., 2011)*

The induction of OBEs is technically possible and the techniques used in this process constitute a paradigmatic example of what is considered to be the realm of bioelectromagnetism. Furthermore, OBEs can also be controlled. Variations of different types of stimulations produce different results as demonstrated by Lenggenhager et al. (2007) in the article “Video ergo sum: manipulating bodily self-consciousness”:

> *Our results indicate that spatial unity and bodily self-consciousness can be studied experimentally and are based on multisensory and cognitive processing of bodily information. (Lenggenhager et al., 2007)*

This dissertation describes the starting point of the development of new interfaces for multisensory artistic expression that apply bioelectromagnetic stimulation. The techniques applied are the same type as the ones that allow the induction of OBEs. However, due to the restricted access to artists of such techniques, they could not be employed during the study. Nonetheless, as part of the study, two new policies were established that open the way for artists to be considered as researchers in knowledge-generation systems. The first is in the realm of civil research, the STARTS – Science, Technology and the Arts initiative of the European Union. The other, the NATO Arts Framework (ANNEX II), is within the security and military realm – where significant research is being undertaken in the field of bioelectromagnetic stimulation. (Airapetian et al, 2006)

It is within these new contexts that a new research practice is emerging; an artistic practice that has technology in general as a medium to spread artistic concepts in society and economy, in an extension of the Fluxus movement.

The thesis proposes the *Artistic Modulation of Consciousness by Bioelectromagnetic Stimulation* in order to push forward this new research practice into a more integrative method where the approaches of Brunelleschi, Pessoa and Blanke merge. The technological induction of OBEs is as revolutionary as the invention of the linear perspective. The invention of Out-of-Body Experiences is the invention of a new form of perspective. Induced and precisely controlled disembodiments, such as OBEs, allow one to literally see the

world from a different point of view. However, only the artistic urgency of Brunelleschi and Pessoa – the same urgency that gave origin to STARTS and the NATO Arts Framework – can make this new perspective accessible to all, a condition *sine qua non* to trigger the realisation of its full potential.

7. Conclusion

Artistic practices were the main research activity in this transdisciplinary study. Those practices were mostly of technological order – which implied some engineering activities – and they conducted the investigation of related philosophical and scientific insights. Artistic motivation was always at the forefront and drove the research. The thesis is in itself the result of its main claim: a new practice of research in the field of science and technology that has artistic practices at its core.

Artistic practices emerge from the urgency of artistic expression which in its turn results from two major needs: realisation – or the need to make things happen

and manifestation – or the need to create beings. Realisation is at the core of the practice of art, while manifestation sustains the notion of the practice of art as a thinking process.

Artistic urgency is as a process of modulating consciousness both at an individual and a collective level. The notion of modulation of consciousness in human beings is key for the thesis. Consciousness, as such, does not exist. It is immaterial and undefinable. It is constantly being generated in the process of being accessed. The constant generation of consciousness through the practice of art is the most important aspect for the integration of subjectivity in research in science and technology: a variation of panpsychism in which consciousness is constantly being created.

Electromagnetism is as a primordial manifestation of consciousness. Electromagnetism is bipolar in its dimensions. In electromagnetism, electricity and magnetism always relate perpendicularly. They never reach each other but they are indissociable. In electromagnetism, electricity is material and magnetism is immaterial. Conceptually, electromagnetism is very close to the notion of conscious-unconscious dialogue. However, consciousness is not electromagnetic neither a product of electromagnetism.

Bioelectromagnetism is as medium for accessing consciousness and generating knowledge by the process of artistic modulation of consciousness because it is an interface for the interaction between biological entities and the electromagnetic spectrum. The underlying artistic premise in this thesis is that of bioelectromagnetism being the primary stage of the extra-physical existence of

the human being. This means that in the dichotomy electro and magnetic, electro is linked to the body whilst magnetic is linked to the mind.

In the dissertation, a concise update on bioelectromagnetism was presented in order to re-illustrate the electromagnetic nature of the human body-brain as an interface to access consciousness. Bioelectromagnetic interfaces were described as a technical tool for the modulation of consciousness.

The aim of the update on bioelectromagnetism was to prove that the technical ideas of the thesis are not utopian, but have resulted from contemporary technological circumstances, to be found in a number of emerging applications of bioelectromagnetics, including the military ones (ANNEX I). These sort of applications of bioelectromagnetic stimulation were omitted and the ones in the area of health were prioritised.

This thesis' main contribution to new knowledge is the application of bioelectromagnetic stimulation as a medium of artistic expression in the production of new and unprecedented realisations of integrative art.

Homo Conscientis, a unique form of bioelectromagnetic art, is the apparatus for a novel artistically driven research practice. The notion of executive art is one of the artistic practices of the author in order to integrate the arts in research contexts in the European Union. Executive art deploys the bureaucratic mechanisms to allow the future integration of bioelectromagnetic art in research contexts. As part of the study, two new policies were established that open the way for artists to be widely considered as researchers in knowledge-generation systems. The first is in the realm of civil research, the STARTS – Science,

Technology and the Arts initiative of the European Union. The other, the NATO Arts Framework (ANNEX II), is within the security and military realm – where significant research is being undertaken in the field of bioelectromagnetic stimulation.

It is within these new contexts that a new research practice is emerging; an artistic practice that has technology in general as a medium to spread artistic concepts in society and economy, in an extension of the Fluxus movement.

The thesis proposes the Artistic Modulation of Consciousness by Bioelectromagnetic Stimulation in order to push forward the new research practice into a more integrative method where the approaches of Brunelleschi, Pessoa and Blanke merge. The technological induction of Out-of-Body Experiences is as revolutionary as the invention of the linear perspective. The invention of Out-of-Body Experiences (OBEs) is the invention of a new form of perspective. Induced and precisely controlled disembodiments, such as OBEs, allow one to literally see the world from a different point of view. However, only the artistic urgency of Brunelleschi and Pessoa – the same urgency that gave origin to STARTS and the NATO Arts Framework – can make this new perspective accessible to all, a condition sine qua non to trigger the realisation of the full potential of the thesis.

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