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## CREATE *Your* IoT

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Luis Miguel Girao<sup>1</sup>, So Kanno<sup>2</sup>, Maria Castellanos<sup>3</sup> and  
Patricia Villanueva<sup>4</sup>

<sup>1</sup>Artshare – Investigacao, Tecnologia e Arte, Portugal

<sup>2</sup>Artist, Japan

<sup>3</sup>uh513, Spain

<sup>4</sup>LaBoral Centrode Arte y Creación Industrial, Spain

### Abstract

This chapter describes the background and origin of the artistic series CREATE Your IoT. The series is a very special one as it is being created and hosted at the heart of the Large-Scale Pilots Programme of the European Union (LSPs). The series puts artworks at the core and makes them the motive for dialogue between all actual and potential stakeholders in use-cases of the LSPs aiming at pointing out ways of how other innovative actions can be implemented on top of the developments made available by LSPs. The text looks at how art and technology are intrinsically related, how art practices historically expanded their field of action to make the world and life a canvas and how more recently the influence of artistic ideas in the creation of new products, services and processes is irrevocable. More specific examples of this connection between technology and the arts in the field of ICT and IoT are presented. Finally, an updated report on ongoing artistic actions in the context of the CREATE IoT coordination and support action are presented.

### 8.1 Introduction

Technologies and the arts have always been closely related. Indeed, this relationship is invoked with every mention of the word technology, which has its origins in the Ancient Greek *tékhnē*, meaning art. In this project, we will explore the contemporary relationship between technology and the arts,

reflecting on how they can influence each other and the conditions under which their synergies can flourish. New technologies have shaped artistic practices since the dawn of history. Demand for tools to accomplish specific tasks has compelled technology to develop in new directions.

Potentially, the first tool one can conceive *Homo erectus* to have created, after winning the fight between the weight of their brain and gravity, was the invention of the stick – to more easily pick fruit from trees. The stick as an extension of the arm. The paint brush as an extension of the stick – an artistically driven technological innovation – is naturally conceivable as well. More recently, Andy Clark and David Chalmers conceived the iPhone as an extension of the mind [1]. Understanding Steve Jobs as the most contemporary artist of the past century then becomes key to pursuing the transformations of the timeless intertwining between technologies and the arts.

*“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 [2]*

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 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 [3].

“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.

The attribution of meaning to technologies is a relevant aspect for understanding the intertwining of technologies and the arts. For example, the invention of photography in the 19th century is possibly the event that had the

most impact in the course of the history of art. On the one hand, it liberated painters from the duty of portraying personalities and started a movement of abstraction in painting that gave origin to great diversity of styles in the 20th century. On the other hand, it created a new tool for expression that is nowadays one of the most established forms of artistic expression. In sum, new meanings were attributed to the technique of painting and to a new technology – photography – which lead to new forms of images with its associated novel techniques. For instance, Pointillism can be interpreted as the first step towards a digital format of images, similar to what we nowadays call pixels.

## 8.2 CREATE Your IoT

Artistic practices are thinking processes as well as they generate reproducible knowledge. The peculiarity of the knowledge generated by the arts using technology is that by reverse engineering the final products of those creations, one can fully understand its functionality. One of the characteristics of the practice of art is that artists act first and rationalize later. The actual context of the relationship between ICT and art allows for an unprecedented integration of subjectivity in the context of technological research.

### 8.2.1 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 [4]. 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” [5].

According to Landgraf, Moritz sees *urgency* as being about the productivity of nature that serves as media. It links the artist and the artwork as well as driving 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*.

*Artistic* is that which 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 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* [6], 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* [7] and Derrida’s free play of sense.

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

*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.<sup>1</sup>

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*.

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*

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

*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" [8].*

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 contributions for knowledge-generation systems<sup>2</sup>. It is relevant to understand and recognise the opposed concepts of *noumena* 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* [9], has resumed the discussion on *noumena* and *phenomena* by proposing the concept of *phenomenon*. The notion of *phenomenon* 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 *phenomenon*” [10].

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 *phenomenon*. In other words, art is simultaneously embodying inwards and outwards. 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.

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<sup>2</sup>Knowledge-generation systems refer 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](http://www.starts.eu) (last accessed on 14/08/2017).

### 8.2.2 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. The ideas and practices of John Cage influenced Fluxus, especially his understanding of the work as a site of interaction between artist and audience [11].

For Vostell, a human’s physical *action*, the handling of things, was already considered art. What happens, the *happening*, is already art only if 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. 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 artistic interventions in the European Commission *STARTS Initiative* and the *Internet of Things Large-Scale Pilots*.

Those interventions are 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 [12].*

Integrative art is the integration of artistic practice into daily life. The way it is envisaged in this chapter is through the technology described above. Nowadays, integrative art is not a common practice amongst artists in the sense that is envisaged here. However, some relevant examples are emerging.

An example of artistic critical approach in IoT is the work of artist James Brindle who is trying to build his own self-driving car and published all the code developed in pursuit of the DIY self-driving car<sup>3</sup>. Brindle says:

*“Self-driving cars bring together a bunch of really interesting technologies – such as machine vision and intelligence – with crucial social issues such as the atomization and changing nature of labour, the shift of power to corporate elites and Silicon Valley, and the quasi-religious faith in computation as the only framework for the production of truth-and hence, ethics and social justice.(. . .) The attempt to build my own car is a process of understanding how the dominant narratives of these technologies are produced, and could be changed.”*

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<sup>3</sup><https://github.com/stml/austeer>



### 8.2.3 ICT and Art

Golan Levin, one of the most prominent individuals of the emerging field of ICT and art, very clearly demonstrated how artistic projects presented ICT solutions well before they became known:



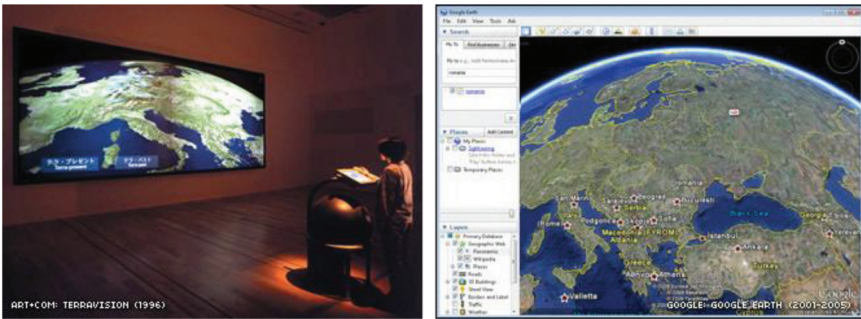
**Figure 8.1** Myron Krueger's Video Place (1974), and the Sony EyeToy (2003).



**Figure 8.2** Michael Naimark & MIT ArchMac's Aspen Movie Map (1978–1980), and Google Street View (2007–).



**Figure 8.3** Jeffrey Shaw’s Legible City (1988) and E-fitzone exercise equipment (2008).



**Figure 8.4** Art+Com’s Terravision (1996) and Google’s Google Earth (2001, 2005–).

The artist and technologist states that he wrote his article *New Media Artworks: Prequels to Everyday Life*,<sup>4</sup> 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.”*

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 and Design. However, the European context nurtures the development of institutions such as *Ars Electronica* that distinguished Golan Levin with its Prix; the same institution also distinguished Linus Torvalds, considering the collective process that

<sup>4</sup><http://www.flong.com/blog/2009/new-media-artworks-prequels-to-everyday-life/>

led 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 number 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 one of many artists that are becoming institutionally prominent not in the field of the arts but in the field of ICT.

Small organisations seem in fact to be the strategic focus of promoters, as funding in the field is mostly directed more to groups of people than to individuals. Medialab-Prado (ES), Kitchen Budapest (HU), F.A.C.T. (GB), 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, who 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 Libelium (ES). 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 is a result of the collaboration of Rob Faludi (US) with the electronics corporation. At the University of Cambridge's Computer Laboratory (GB), 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: 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 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 into 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 which promoted 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 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 aimed 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.<sup>5</sup>

The CAT workshop gave rise to a relevant collective white paper entitled *Organisms for Change and Transformation*.<sup>6</sup>

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 Horizon Europe of the European Commission that further development of STARTS will have to develop. In order 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 programme. The context of the Cultural and Creative Industries (CCIs) seems to be the ideal host for 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 a means 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

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<sup>5</sup><http://www.cost.eu/events/cat>

<sup>6</sup><http://www.cost.eu/download/47808>

happening worldwide since the last century and are already quite established as described.

The engagement of the arts with ICT are also instrumental in allowing the 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. From 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 online 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 at 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 into industrial chains where subjectivity 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. 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-fashioned 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 transdisciplinary. 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 the 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 subjectivity 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 to transform 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 to benefit 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 writing, STARTS has three 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 grants for artistic residencies in research projects. *Wearsustain* is promoting the creation of new artistic driven prototypes. The *STARTS Prize* attributes yearly two distinctions for technological innovation through the arts. CREATE-IoT, the coordination project of the Large-Scale Pilot

projects (LSPs) of the EU, also integrates the arts. CREATE-IoT has a crucial role in STARTS by promoting the notion of co-creation based on artistic practices within the LSPs and by introduction of the Experience Readiness Level indicator.

#### **8.2.4 Next Things Next Starts**

Between December 2017 and April 2018, in Gijon, Spain, the exhibition Next Things Next Starts showed for the first time the results of the research and production residency programme called Next Things organised by LABoral Centro de Arte y Creación Industrial in conjunction with Telefónica R+D over a five-year period with the mission to forge new connections and collaborations between art, science, technology and society. Following an open call issued to artists and other creatives, the most innovative ideas and projects related with the Internet of Things were chosen. The award consisted of organizing and funding a six-month residency – two months at LABoral, in Gijon and four at Telefónica I+D, in Barcelona – to materialise their ideas and projects.

The exhibition was centred on the critical role played by creativity and social involvement in processes of innovation. Along with scientific and technical know-how and learning, art is a catalyst that helps transform knowledge into objects or processes. The showcased projects presented the paths which are opened up when combining creative thinking with the possibilities of open technology.

The five critical and innovative projects chosen for the programme rethink and open a debate on contemporary situations stemming from technological advances. Through the creative use of new technologies, these projects propose prototypes for new solutions and working spaces.

The exhibition was a first for STARTS in learning from previous experiences on artistic residencies in research contexts. The artists awarded with the prize were: Laura Malinverni and Lilia Villafuerte; Lot Amorós, Cristina Navarro and Alexandre Oliver; Sam Kronick; María Castellanos and Alberto Valverde; Román Torre and Ángeles Angulo. Here we present only three of those works as they represent a useful spectrum as examples for the integration of artists in the context of the IoT European Large-Scale Pilots.

*Environmental Dress* represents the tendency of artists to engage with global matters such as climate change. Furthermore, the project demonstrates the capability of artists to technically implement elaborate systems as well as reiterating the importance of open source code and hardware.



**Figure 8.5** *Environmental Dress*, by María Castellanos and Alberto Valverde.

*“We are surrounded by polluting agents and other factors that have a direct impact on our everyday lives, our mood and, ultimately, on our behaviour. Variations in noise, temperature, atmospheric pressure, ultraviolet radiation or amounts of carbon monoxide are some of the challenges we have to face on a daily basis. At the end of the day, they are agents that influence our temper and our behaviour with others.*

*Environment Dress is a piece of smart clothing that uses a number of sensors to measure the aggressiveness of our surrounding environs, detecting environmental variables and alerting us to them. Our body’s natural sensors are unable to measure and anticipate factors such as an increase in ultraviolet radiation, dust or noise, and others.*

*The interface geo-locates environmental analyses and allows users to register their mood through a smartphone app. In consequence, we can establish the relationship between both variables and determine whether an increase in ultraviolet radiation can make the person who wears the dress feel better or whether an increase in noise level can make him or her feel more uncomfortable in a certain place. Finally, all these data are shown on an emotional map, pinpointing the most pleasant and unpleasant areas in a city.” (Source: catalogue of NEXT THINGS\_NEXT STARTS Exhibition, LABoral, Gijon, Spain).*

*Flone* is representative of the need of artists to make technology accessible. In a subject matter such as drones, with profound implications on security and privacy, the exposure and dissemination of how drones' function is crucial, from an artistic point of view.



**Figure 8.6** *Flone, the flying phone by Lot Amorós, Cristina Navarro, Alexandre Oliver.*

*“Flone, The Flying Phone, is a platform to make smartphones fly, involving an innovative drone which combines digital manufacturing, personal empowerment and the use of a smartphone to remotely control the device.*

*Flone is a self-built, low-cost biodegradable drone, conceived as an open source digital design. Some of its design elements (shape, size, material, lack of screws) make it accessible and adaptable for many people to conquer air space.*

*The use of open software and documentation and the simplicity of making it democratise the knowledge needed to manufacture a drone and claim air space as a common domain. Flone aims at opening up the range of applications of air social robotics. This multimedia drone, a mobile multipurpose machine, moves through the public air space thanks to various smartphone sensors (camera, microphone, GPS, accelerometers, gyroscopes) and actuators (LED flash and speaker) together with wireless connections (Bluetooth, Wi-Fi and 4G).*

*The members of this project have imparted workshops in countless schools, art centres and universities in several countries. Dozens of individuals have replicated this project worldwide and made a flone for themselves.” (Source: catalogue of NEXT THINGS\_NEXT STARTS Exhibition, LABoral, Gijon, Spain).*

*Thero reiterates the urgency of giving control to end users of the decision of being connected. Having the option to consciously connect or disconnect to the internet is nowadays extremely important mainly because a great number of people are not aware that they are constantly connected through their devices.*



**Figure 8.7** *THERO* by Román Torre and Ángeles Angulo.

*“As a concept, THERO wishes to raise our digital privacy to the status of a precious and sacred object. Accordingly, the object has been given a highly aesthetic treatment, with the geometry and clean lines of an idol or talisman endowed with a value beyond its material qualities: the value of freedom and the right to digital anonymity.*

*THERO is presented as a heavy sculpture which contains a device that blocks and encrypts our digital communications by allowing the user to directly manipulate the object. By manually rotating its structure, THERO is capable of managing our digital contact with the outside space.*

*The piece basically consists of a router to which we can wirelessly connect all our digital devices. It can be handled physically to offer various levels of privacy: blocking pages we do not want to visualise or which demand excessive attention from us, encrypting our communication by using the TOR network, completely blocking access to the network, cutting all communication with the outside in order to only browse locally.*

*The piece opens up a space for reflection on our actions and their subsequent traces and significance in the net. THERO tries to lower the abstract barrier of the digital tool by means of a number of physical actions that make us more aware of our use of the Internet.*

*The presence of THERO in our homes would give corporeity to the need for privacy in our digital interactions. In essence, THERO gives us the power to decide when we want and when we do not want to be visible.” (Source: catalogue of NEXT THINGS\_NEXT STARTS Exhibition, LABoral, Gijón, Spain).*

The most important conclusion from the Next Things programme is the management of intellectual property in this type of context of collaboration of tech companies and artists: keep it all open source.

### **8.2.5 Artists and the IoT European Large-Scale Projects**

In the CREATE-IoT project a methodology for integrating ICT and the arts – or better put: to include artistic practices in the ICT development cycle – was designed to be fully adaptable. Its implementation in the LSPs will result from specific combinations of its methods according to the specificities, not only of each one of the LSPs they will be tailored for, but of each of the particular LSPs’ use cases.

The methodology is designed to be applied in the specific areas of innovation of the IoT LSPs initiative: food and farming, healthy aging, public mass events, self-driven vehicles and smart cities. The basic principles are implemented in the ICT framework through a sequence of actions that will be selected from the range of artistic related activities and their correlation with the ICT cycle.

The actions of integration of artistic practices in the LSPs are being done mostly around their use cases. The reason for this option is to demonstrate that artistic practices are useful in connecting humans and technology, towards a human-centred approach to technology as an enabler of better lives in general.

The methodology is developed around the development of artworks to trigger dialogue with the LSPs and raise some questions that might help

improve their final solutions. The underlying idea is that the services provided by the LSPs can trigger socio-economic innovation if made available to SMEs and individuals.

The first step was the integration of an artist in residency in the CREATE-IoT project. So Kanno, a Japanese artist proposed creating the *The ideal showroom of IoT*.

*The ideal showroom of IoT* is a two-part composition, a participatory installation. It shows the possibility of sensing, recognising and determining the world through the perspective of objects. A living room full of IoT devices is set out to let visitors experience this shift: sensors and cameras are interweaved into a well-known environment. The second part is providing a new point of view to perceive a post-IoT age perspective onto things and technology.



**Figure 8.8** *The ideal showroom of IoT.*

The installation is set up in two parts:

1. The first is a living room with many small computers, cameras and sensors installed. Most of them are not obvious and are hidden. These systems try to capture information of the visitors. A robot in the room will welcome the visitors. It will introduce and explain the context of the work as well as trying to have a conversation with visitors.

2. In second room, there's a laboratory set up, with a desk and VR headset. Visitors will experience the living room now from different perspectives. When putting on the VR headset, the visitor will have the view from the hidden cameras or robot.

Experiencing the same situation again through an object-related perspective should give the visitors a new perspective on IoT and personal robots.

In this residency between CREATE-IoT and So Kanno, a new artistic work is being developed, challenging the fundamental issues of interest in the Internet of Things. CREATE-IoT provides access to the artist for key people, companies, concepts and technologies associated with Trust in the Internet of Things. Key elements will be made available to the artist regarding the development of a trusted environment for the development of IoT and comprehensive technical and non-technical solutions regarding privacy, security and trust issues.

The development of the new artwork involves various levels of research and development. Existing IoT products are explored and researched and selected regarding the functions they include for the installation. Technology used for the project are IoT devices with hidden cameras, smart speaker systems, personal robots and VR technology. In the development of the art work, the consumer products will be manipulated and adjusted for the artistic purpose.

The developed system will integrate the video stream of hidden IoT security cameras. The IoT devices and robot will be accessed and controlled through a VR headset experience.

The second step is the development of model of artistically mediated co-creation process around an artwork.

Towards the creation of exemplary case studies, the LSPs IoF2020, *ACTIVAGE*, *SYNCHRONICITY* are being developed in order to realise artistic-led co-creation hackathons as a support to some of the use cases of these pilots. The aim of these hackathons is to artistically enhance the context of those use cases and stimulate creativity of all participants.

The concrete target is to better understand the role of artists in pushing for innovative approaches either in the technology in question or its applications. Impact on uptake, adoption and acceptance will also be observed, as well as the potential of new businesses built on top of the technologies made available by the LSPs under study.

At the moment, the use cases that are being considered for action are part of IoF2020:





**Figure 8.9** *Added-value weeding data.*

This use-case collects location-specific camera data to provide insights on the number of vegetables growing on the field, the plants' growth status and best harvesting moment, weed prevalence, nutrient shortages and drought stress. From an artistic point of view, it is interesting to understand how agriculture is becoming less anthropocentric.



**Figure 8.10** *City farming for leafy vegetables.*

IoT technology in city farming enables the production of high-quality vegetables in a predictable and reliable manner, unaffected by plant diseases, free from pesticides and independent of seasonal influences. From an artistic point of view, it is interesting to imagine better lives that could allow free-time to have contact with the vegetables we eat.

The focus of this use case is mainly on the growth of poultry with respect to animal welfare. This starts with an adequate environment in which the birds



**Figure 8.11** *Poultry chain management.*

feel comfortable, as well as good-quality feed and water. These are extremely important aspects from an artistic point of view. Some years ago, the artistic community started to be concerned with this type of challenges, especially after the film *Baraka*.

An example of the possible impact of these actions in the IoF2020 would be to see in its open calls a focus on more human-centred technology based on the technologies made available by the project. That is one of the underlying principles of the choices use cases to work with.

### **8.2.6 CREATE *Your IoT***

The present result of the work undertaken is a series of works entitled *CREATE Your IoT*. Drawing inspirations from the title of the coordination and support action to the LSPs, *CREATE-IoT*, the series aims at expanding it by pointing out ways of how other innovative actions can be implemented on top of the developments made available by LSPs. It emphasizes the co-creative aspect of the all LSPs but in an alternative sense than that of citizen participation as promoted by the U4IoT CSA. In the series, artworks are the core and are motive for dialogue between all actual and potential stakeholders in use-cases.

The *CREATE Your IoT* Series is at the moment composed of two artworks under development. *The Connected Hennery* and *The Migrant Home*. The artworks are being designed to allow the integration of multiple technologies made available by the LSPs. For example, *The Migrant Home* could host technologies from all LSPs MONICA, AUTOPILOT, IoF2020, ACTIVAGE, SYNCHRONICITY.

*The Connected Hennery* is a reflection about the use case of the Poultry chain management of IoF2020. Inspired by the motto of that use case to respect animal welfare, the artwork starts by giving the chicken the control of the location of their home. It follows recent tendencies of permaculture, within which mobile henneries are substitutes for tractors in the cleaning of agricultural land. In permaculture, chicken inhabiting a defined piece of land clean it and fertilize it. Farmers, by simply moving the hennery around their land, make it ready for cultivation. The digital system of *The Connected Hennery* analyses the position and movement of chicken inside the hennery and predicts in which direction they would like to progress next, freeing the farmer from that work task. Furthermore, other sensors implemented in the hennery allow easier monitoring for the farmer in order to simplify and more effectively manage her/his intervention in the maintenance of the hennery.

The CREATE *Your* IoT Series is looking at decentralized models of production of chicken and at its potential as added value for the associated use cases of the LSPs. Food suppliers are looking at how consumers are more and more interested in biological and organic products and how can they adapt to keep their leadership of the supply markets. This leads these suppliers to create their own production experiments in order to better understand how to create new products the fit customers' demands. It is for this sort of context that works such *The Connected Hennery* are being developed in order to promote the LSPs towards end users.

*The Migrant Home* is still in the early phases of concept development. At this stage it is looking at how an IoT mobile house can be transformed into a home for migrants for short-term jobs/enterprises connected with urban and rural niche developments, for instance recovery of rural and urban cultural heritage.

Preliminary experience of the development of the CREATE *Your* IoT Series reveals that Open Standards and Architectures in the LSPs are crucial to make the technologies developed accessible and allow for the development of new business models.

### 8.3 Conclusion

The actual context of the relationship between ICT and art allows for an unprecedented integration of subjectivity in the context of technological research. The integration of subjective approaches is fundamental in making human-centred technological innovation. Human-centred technological applications fill in the gap between what is possible from a pure technological

point of view and what people can encounter as useful in their daily lives to make those lives better.

The LSPs represent a unique opportunity for the spread of creative approaches to technological solutions and those approaches can help to potentiate the results of the LSPs in terms of new applications and associated business models. It is this reciprocal relationship that will allow on one side for an expansion of the field of action of the LSPs and on the other for the LSPs of potential fields for innovation to be informed.

The instruments of those actions are the co-creation hackathons. They will develop around the artworks of the *CREATE Your IoT* Series to trigger new solutions based on the technologies made available by the LSPs.

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