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CROSS FERTILISATION THROUGH ALIGNMENT, SYNCHRONISATION AND EXCHANGES FOR IoT

H2020 – CREATE-IoT Project

Deliverable 03.01

Methodology for integrating ICT and Art

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Summary					
No and name	**D03.01 Methodology for integrating ICT and Art**				
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Editor	L.M. Girao (ARTS), O. Vermesan (SINTEF), and R. Bahr (SINTEF).				
DoW	The document presents the methodology for integrating Information and Communication Technologies (ICT) and the arts for stimulating innovation and acceptance. It furthermore evaluates the criteria and characteristics of innovation in a heterogeneous IoT ecosystem by analysing the innovation, creation and adoption by focusing on new methods for injecting activities involving arts that leads to successful deployment in the Internet of Things (IoT) large-scale pilots (LSPs) to bring results to the market. The activities include promoting artistic practices within the IoT large-scale pilots, exchange between the IoT large-scale pilots on creation and liaison with arts and science. The methodology describes how to use co-creation workshops for consumer-citizens facilitated by artists in a real-life consumer environment with the objective of turning users into active actors by means of artistic practice. The document represents the basis for the Wiki on the methodology for integrating ICT and the arts focusing on IoT creation, innovation and adoption.				
Comments					

Document history

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Figure 1: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 several 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." in the catalogue of NEXT THINGS_NEXT STARTS Exhibition, LABoral, Gijon, Spain.

Table of contents

1. EXECUTIVE SUMMARY

"Technology, like art, is a soaring exercise of the human imagination. Art is the aesthetic ordering of experience to express meanings in symbolic terms, and the reordering of nature--the qualities of space and time--in new perceptual and material form. Art is an end in itself; its values are intrinsic. Technology is the instrumental ordering of human experience within a logic of efficient means, and the direction of nature to use its powers for material gain. But art and technology are not separate realms walled off from each other. Art employs techne, but for its own ends. Techne, too, is a form of art that bridges culture and social structure, and in the process reshapes both."

Daniel Bell

1.1 Publishable summary

This report introduces a *methodology* for integrating ICT and arts in the IoT European large-scale pilots programme [1] based on the belief that innovation is born when art meets science and technology. The methodology and associated *modules of action* are concrete and designed to be employed in the areas of innovation of the IoT LSPs initiative, with a specific focus on real-life contexts. By extension, they can be used in any IoT domain.

The CREATE-IoT methodology extends the STARTS (Science, Technology and the ARTS) European Commission (EC) initiative [30] to the IoT domain. It supports collaborations between artists and the IoT pilots with the goal to stimulate experimentation and innovation in the LSPs. Such STARTS collaborations can furthermore contribute to a radical change in perspectives and practises in the LSP teams regarding user acceptance, public participation and SME engagement. The methodology also aims to concretely and in practice promote the cross fertilization between those IoT LSPs vertical domains as well as to nurture innovative business driven technical applications that might emerge from specific combinations of those domains.

The report describes the purpose and target group, and the landscape of the STARTS initiative. It presents a general, horizontal methodology to design, deliver and evaluate the combination of ICT and arts for innovation and acceptance in any IoT pilot. Specific methods are presented, including a STARTS method for artistic facilitation of co-creation in a real-life laboratory with groups of potential consumers. Throughout, the focus is on replicable and concrete components and stages. These are specified through modules of action available for implementation and adoption of the methodology in the LSPs. Among these are supporting methods to scope challenges and engage stakeholders in the STARTS co-creation process.

The methodology incorporates an evaluation framework to evidence and articulate the benefits to the IoT pilots. Evaluation is an integral part of each phase and feedback is continuously incorporated into the subsequent phases and cycles. Internal and external communication practices are embedded into each phase of the methodologies and responsibility for the various practices of communication is allocated to various project stakeholders with an important emphasis on the dissemination of the results.

The report concludes by detailing conclusions and next steps in regard to adoption of STARTS for innovation and acceptance in the European IoT large-scale pilots.

1.2 Non-publishable information

This document is public.

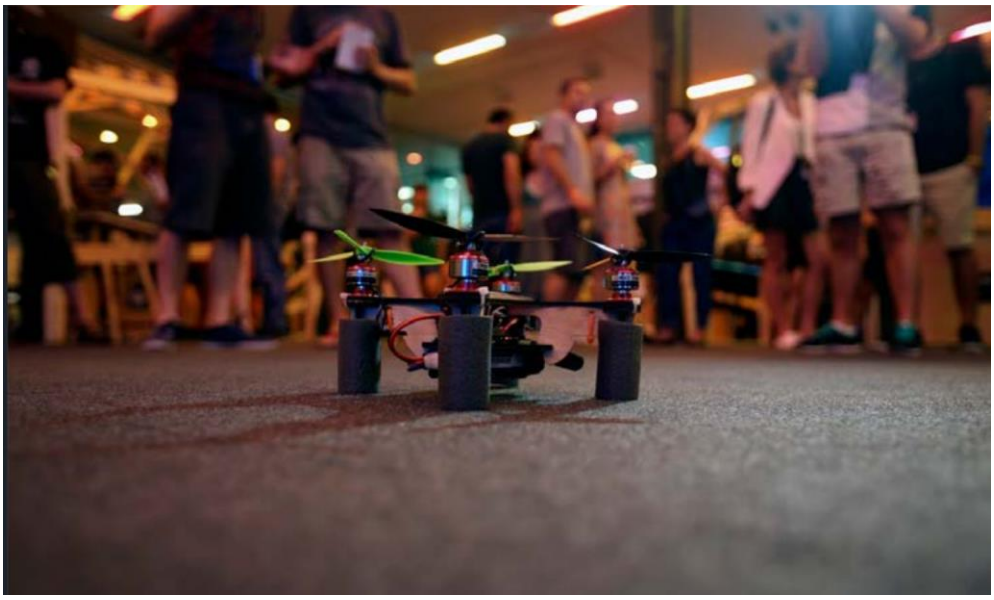

Figure 2: Flone, the flying phone byLot Amorós, Cristina Navarro, Alexandre Oliver

"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."in the catalogue of NEXT THINGS_NEXT STARTS Exhibition, LABoral, Gijon, Spain

2. INTRODUCTION

"The art challenges the technology, and the technology inspires the art."

John Lasseter

2.1 Purpose and target group

The aim of this report is to provide a methodology for integrating ICT and Arts to stimulate innovation and acceptance in the IoT European large-scale pilots programme. The methodology is built on the cooperation with the STARTS initiative as part of the EC Digital Single Market (DSM) strategy. The methodology for integrating ICT and Art provides a systematic analysis of the methods applied to selected use cases of IoT European large-scale pilots projects. It comprises the analysis of the methods and principles associated with IoT and includes the conceptual, phases and quantitative or qualitative techniques applied through modules of action. The methodology offers the background for understanding which set of methods, and best practices can be applied to specific IoT European large-scale pilots use case where the involvement of artists will provide most efficient results. The methodology integrates the ICT and Arts as access points for guiding IoT ecosystems' stakeholders inquiry, dialogue and critical thinking.

The methodology is inspired by the notion of artistic intervention, and aims to facilitate on on-the-ground actions. It engages the full range of stakeholders of the LSPs – ranging from the promoter, the EC, to end beneficiaries, also including partners of the LSPs, small and medium enterprises (SMEs), start-ups and artists. The role of artists is to enable artistic contexts stimulating the creative participation of all stakeholders, including themselves, in the ongoing business cycle of innovation processes thereby creating additional value to the LSPs.

The methodology is a system for the delivery and analysis in the IoT domain of a body of methods arising from the arts. Specifically, it presents a framework to innovate and evaluate the processes of creation of values of the IoT European large-scale pilots' projects. The methodology and its associated modules of action are concrete and to be applied in the specific areas of innovation of the IoT LSPs programme: food and farming, healthy aging, public mass events, self-driven vehicles and smart cities. Furthermore, the methods aim to, concretely and in practice, promote the cross- fertilization between those IoT LSPs domains as well as to nurture innovative business driven technical applications that might emerge from specific combinations of those fields.

Because of its artistic origin, the methodology goes beyond user engagement as implemented by U4IoT [2]. It is distinctive because of the concrete on-the-ground integration of all relevant stakeholders in the specific LSPs use-cases, and because it puts forward the plural of value in order to highlight the importance of not (or not yet) capitalized immaterial values. The individual methods considered in the report result from the wide experience of the partners of CREATE-IoT committed to develop and implement the methodology. Synergies with the complimentary project U4IoT also contributed to the development of the methods, especially as concerns user engagement.

2.2 Integrating the arts for enhancing innovation in the IoT

IoT is at an early stage in a new era of ICT. In the IoT, consumers are more than simply users. They are key active agents of innovation in the creation of new IoT specific processes, products and services. They can be assemblers and beta-testers of combinations of off-the-shelf solutions made available by the IoT LSPs. Potentially, they transform themselves from consumers into producers - prosumers. They may even become entrepreneurs and create their own businesses as providers of new services built upon the IoT platforms being implemented by the LSPs.

The idea of co-creation of values is based on the notion of value creation. Creation is, in its original sense, an artistic act. Therefore, value co-creation expands both the concepts of value creation and co-creation towards wider, holistic and more inclusive approaches to social and economic development in the European Union (EU), contributing to the creation of jobs and growth. The aim of the STARTS – the Science, Technology and the Arts initiative of the Digital Single Market – is to enable artists to contribute with a holistic innovative view over technologically driven ongoing projects and to consequentially stimulate a radical change of perspectives in their ICT R&I teams. This radical change in perspective is a key anticipated impact of the STARTS co-creation process.

2.3 Specific approach to IoT

To think out-of-the-box is a well-known objective in innovation processes. Artists, however, are more interested in getting rid of the box. It is this disruptive approach that is seen as fundamental to create a critical approach to technological developments. In this context, the integration of artists in technological research processes can be instrumental for the attribution of meaning to new technologies. A solid critical approach is fundamental for competitiveness based in knowledge and creativity. The critical approach is one of the main differential elements between artists and designers. An artist involved in a technological challenge would go deeper in the analysis of the challenge, with a critical eye. On the other hand, a designer would be driven by finding a solution – problem solving.

An example of artistic critical approach in IoT is the work of artist James Bridle who is trying to build his own self-driving car and published all the code developed in pursuit of the DIY self-driving car via this link[1]. Bridle 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.

The concept of integrating Art and Technology is applied in places such as the Los Angeles County Museum of Art (LACMA) [4], which paired artists with technology companies in Southern California, the Art + Technology Lab at LACMA and supports artist experiments with emerging technology.

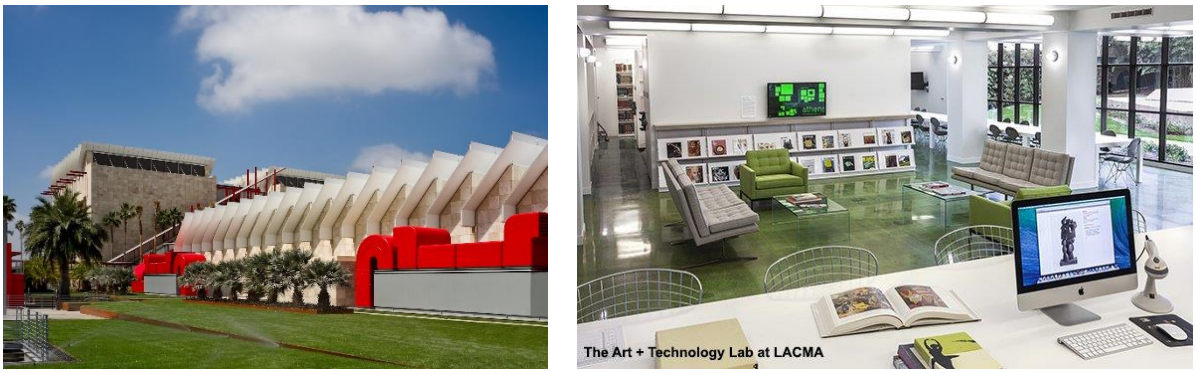

Figure 3: Art + Technology Lab at LACMA [4].

1 https://github.com/stml/austeer

2.4 IoT European large-scale pilots use cases

The IoT European large-scale pilots programme includes the seven innovation consortia that are collaborating to foster the deployment of IoT solutions in Europe through integration of advanced IoT technologies across the value chain, demonstration of multiple IoT applications at scale and in a usage context, and as close as possible to operational conditions. The projects involved are described below.

ACTIVAGE (ACTivating InnoVative IoT smart living environments for AGEing well) brings together 48 partners from 9 European countries with the aim to build the first European IoT ecosystem across 9 Deployment Sites (DS) in seven European countries, reusing and scaling up underlying open and proprietary IoT platforms, technologies and standards, and integrating new interfaces needed to provide interoperability across these heterogeneous platforms, that will enable the deployment and operation at large scale of active and healthy ageing IoT based solutions and services, supporting and extending the independent living of older adults in their living environments, and responding to real needs of caregivers, service providers and public authorities. The objective is to deploy innovative and user-led pilot projects capable of supporting and extending independent living at home for older adults based on IoT technologies. The smart living environments should be based upon an integrated system of a range of IoT-based technologies and services with user-friendly configuration and management of connected technologies for homes and outside.

AUTOPILOT (AUTOmated driving Progressed by Internet Of Things) brings together 43 partners from 14 European countries and 1 from South Korea with the objectives to increase safety, provide more comfort and create many new business opportunities for mobility services. The market size is expected to grow gradually reaching 50% of the market in 2035. AUTOPILOT develops new services on top of IoT to involve autonomous driving vehicles, like autonomous car sharing, automated parking, or enhanced digital dynamic maps to allow fully autonomous driving. AUTOPILOT IoT enabled autonomous driving cars are tested, in real conditions, at four permanent large-scale pilot sites in Finland, France, Netherlands and Italy, whose test results will allow multi-criteria evaluations (Technical, user, business, legal) of the IoT impact on pushing the level of autonomous driving. The aim is to address the added value and the potential of applying IoT for autonomous vehicles in a connected environment. The focus is to test scenarios of deployment of safe and highly and fully autonomous vehicles (up to SAE38 international level 5, full automation) in various representative use case scenarios, exploiting local and distributed information and intelligence. Core technologies include reliable and real-time platforms managing mixed criticality car services, advanced sensors and Internet information sources around which value-added apps may be constructed, efficient navigation and improved decision-making technology, interconnectivity between vehicles, vehicle to infrastructure communication. The selected scenarios provide proofs of concept showing how such technology provides benefits affecting users on a daily basis, for instance on the highways or in urban congested environment, either on dedicated lanes or mixing autonomous connected vehicles and legacy vehicles. The developments are supported by open service platforms, which have access to in vehicle embedded information sources and to vehicle surrounding information, in view of providing value-added apps e.g. intelligent maintenance. Important elements considered are overall user acceptance and economic, ethical, legal and regulatory issues.

IoF2020 (Internet of Food and Farm 2020) brings together 70 partners from 16 European countries with the objectives to accelerate adoption of IoT for securing sufficient, safe and healthy food and to strengthen competitiveness of farming and food chains in Europe. It will consolidate Europe's leading position in the global IoT industry by fostering a symbiotic ecosystem of farmers, food industry, technology providers and research institutes. The heart of the project is formed by 19 use cases grouped in 5 trials with end users from the Arable, Dairy, Fruits, Vegetables and Meat verticals and IoT integrators that demonstrate the business case of innovative IoT solutions for

many application areas. A lean multi-actor approach focusing on user acceptability, stakeholder engagement and sustainable business models boost technology and market readiness levels and bring end user adoption to the next stage. This development is enhanced by an open IoT architecture and infrastructure of reusable components based on existing standards and a security and privacy framework. The aim is to include an adequate combination of different farms to ensure that the deployment of the technology is adapted to the needs of different types and sizes of farms across Europe. Activities allow for a wide geographic coverage within Europe and benefit both conventional and organic agro-food chains. In addition, the activities cover at least three sub-sectors (e.g. arable crops, livestock, vegetable and fruit production) and the fall under the concept of multi-actor approach and allow for adequate involvement of the farming sector in the proposed activities.

MONICA (Management Of Networked IoT Wearables – Very Large Scale Demonstration of Cultural Societal) that brings together 28 partners from 9 European countries with the objectives to provide a very large-scale demonstration of multiple existing and new Internet of Things technologies for Smarter Living. The solution will be deployed in six major cities in Europe. MONICA demonstrates a large-scale IoT ecosystem that uses innovative wearable and portable IoT sensors and actuators with closed-loop back-end services integrated into an interoperable, cloud-based platform capable of offering a multitude of simultaneous, targeted applications. All ecosystems are demonstrated in the scope of large scale city events, but have general applicability for dynamically deploying smart city applications in many fixed locations such as airports, main traffic arterials, and construction sites. Moreover, it is inherent in the MONICA approach to identify the official standardisation potential areas in all stages of the project. The aim is to demonstrate innovative wearable solutions and services integrated in interoperable IoT ecosystems with focus to actuating functions providing whenever feasible fully automated closed-loop solutions. Prototype developments and demonstrations address healthcare, well-being, safety, security and infotainment applications. Actions are driven by concrete business cases, open design approaches and user requirements, considering data protection and liability concerns and involve the actors of the entire innovation value chain, potentially including creative and artistic actors, and aim at demonstrations in real world settings. The number of users involved is sufficient to ensure statistical significance in impact analysis.

SYNCRONICCITY (SynchroniCity: Delivering an IoT enabled Digital Single Market for Europe and Beyond) that brings together 33 partners from 9 European countries and 1 from South Korea with the objectives to deliver a Single Digital City Market for Europe by piloting its foundations at scale in 11 reference zones - 8 European cities and 3 more worldwide cities. SYNCHRONICITY is working to establish a reference architecture for the envisioned IoT-enabled city market place with identified interoperability points and interfaces and data models for different verticals, that includes tools for co-creation and integration of legacy platforms and IoT devices for urban services and enablers for data discovery, access and licensing lowering the barriers for participation on the market. SYNCHRONICITY pilots these foundations in the reference zones together with a set of citizen-centred services in three high-impact areas, showing the value to cities, businesses and citizens involved, linked directly to the global market. The aim is to cover a series of cities to operate as reference zones for showcasing and experimenting new citizen-centred IoT services. Starting from users' expressed preferences and needs, these cities experiment and test similar new services and solutions, also through involvement of creativity hubs such as fablabs, co-working spaces, and gather experience at scale and evaluate citizens' acceptability and endorsement. This enable SMEs to use open demonstrators to test innovative new services that includes advanced solutions for traditional services' provisioning e.g. water management and solutions that are at the edge of authorised business practices or regulation (ex: sharing of electricity, autonomous vehicles) and thus require dedicated testing zones. The aim is to provide evidence of access to city areas where legal contexts are adapted to the demonstration requirements (i.e. 'reference zones').

The methodology presented in this document is to be combined with the LSP Use Cases and the STARTS co-creation concept. The full range of stakeholders of each specific LSP Use Case is to be defined according to the end-of-chain beneficiaries of each LSP. The following use case end of chain beneficiaries were defined in the context of the user acceptance workshops[2].

ACTIVAGE AUTOPILOT IoF2020 MONICA SYNCHRONICITY

Figure 4: IoT European large-scale pilots programme [1].

ACTIVAGE:

- Elderly end-users;
- Caregivers;
- Health and social professionals;
- Public healthcare service providers.

AUTOPILOT:

- Private vehicle drivers and occupants;
- Shared vehicle (e.g. taxi) passengers;
- Fleet operators;
- Carpark operators;
- Municipal and public service authorities.

IoF2020

- Farmers;
- End consumers;
- Industry partners.

MONICA

- Event organisers and managers;
- Event security personnel;
- Auxiliary services (first-aiders, police, fire services);
- Event attendees;
- Neighbours and citizens;
- Municipal authorities.

SYNCHRONICITY

- Citizens and public transport users;
- Public sector employees;
- Transport providers.

In close coordination with the LSPs, the methodology will engage relevant participants according to the targeted use case context.

[2] As described in *D03.03 User Acceptance* of CREATE-IoT

Figure 5: 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." in the catalogue of NEXT THINGS_NEXT STARTS Exhibition, LABoral, Gijon, SpainFigure 2 – Flone, the flying phone byLot Amorós, Cristina Navarro, Alexandre Oliver

3. SCIENCE TECHNOLOGY AND THE ARTS (STARTS)

"Science has to do with facts, art with phenomena. To science, phenomena are of use only as they lead to facts; and to art, facts are of use only as they lead to phenomena."

John Ruskin

Innovation in industry and society is not about technology as such but about a better life for all of us. To achieve that, business and technology have to think in a more holistic way – uniting different modes of thinking – to conceive radically novel products, services and processes that are putting the human being in the centre.

Artistic creativity and critical thinking are essential for innovation in today's digital world…

Günther H. Oettinger, European Commissioner (2014-2019), Budget & Human Resources.

3.1 (S+T)*ARTS = STARTS

The European Commission has launched the STARTS initiative to promote Innovation at the nexus of Science, Technology, and the Arts By facilitating the inclusion of artists in innovation projects funded in H2020.

In the STARTS perspective, industry has to think more holistically about technologies and services that put people in the centre and create values for all.

At the same time, the digital transformation of industry and society is already naturally uniting science and engineering with design and artistic approaches.

Recognizing these trends, STARTS is bringing artists into innovation. One of the areas in which STARTS is naturally collaborating with is Internet of Things (IoT), the new wave of ubiquitous connectivity and intelligence that represent the next step towards the digitization of our society and economy.

The arts can bring resourceful insights in the process of creating lively, human-centred and trustworthy IoT systems for broader adoption.

"I think that more and more we all understand that innovation in the future will be on the intersection of arts and sciences."

Carlos Moedas, European Commissioner (2014-2019), Research, Science and Innovation.

3.2 STARTS Cooperation Model

The graphic in Figure 14 describes the STARTS challenge focused on the Arts as catalyst of an efficient conversion of Science and Technology research activities into innovative products, services and processes.

The key element of this conversion process is Industry, as it is what spreads Innovation in Society and Economy through the introduction of new products, services and processes in markets.

In detail, the Arts have the fundamental role of understanding the needs (and feelings, to that matter) of Society, because Artists are highly sensitive beings that work as sensors that can integrate and express contextual feelings – what we call in bureaucracy, Societal Challenges.

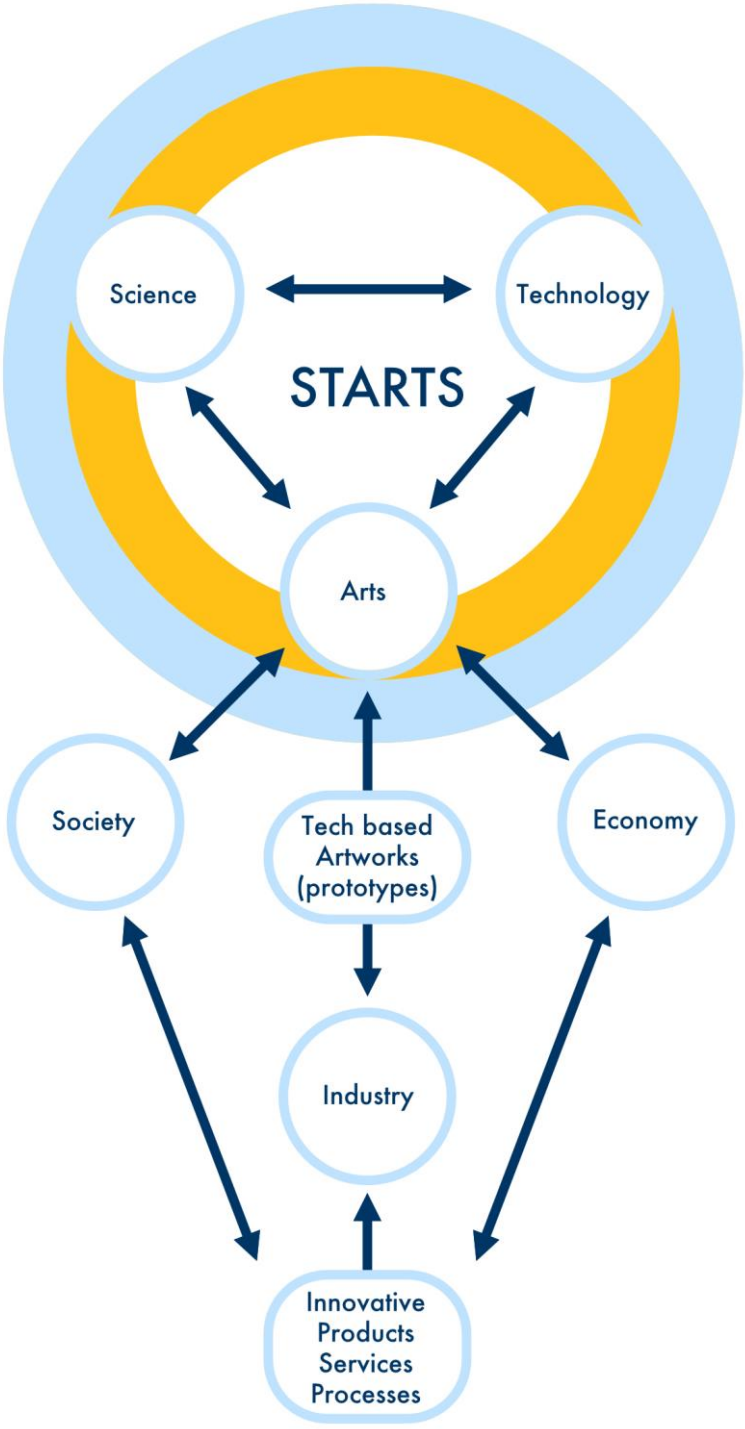

Figure 6: STARTS Cooperation model.

Therefore, Artists are also sensitive to Economy as the survival mechanism of the human species. Artists react, consciously and, most importantly, unconsciously to fluctuations in the stability of economic systems. They can express those fluctuations and survive them by creating alternative paths.

This creation of alternatives is the catalytic process in Innovation. Furthermore, Artists can easily make ideas flow in-between Science, Technology, Industry, Society and Economy because of their capability of establishing dialogues.

3.3 STARTS Innovation Model

The STARTS Innovation Model creates neutral grounds for transdisciplinary collaboration. In the context of Regional Development, STARTS is creating innovation centres made available by cities or regions. These spaces do not belong to a specific institution. They belong to all.

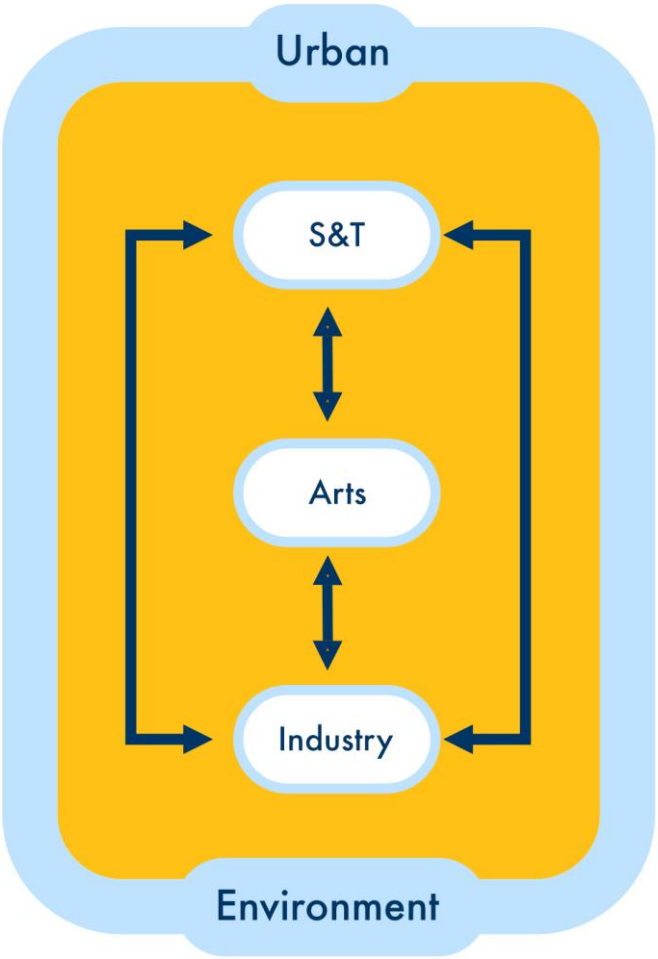

Figure 7: STARTS Innovation model.

Therefore, in this context, all participants of STARTS driven projects are outside the comfort zone of the labs, studios or offices of their universities or companies. Over the duration of the project, participants will contribute to the creation of innovative approaches to be shared widely and openly, in the spirit of open innovation.

The methodology is intended to support these models.

4. METHODOLOGY FOR INTEGRATING ICT AND ART

"The faculty of art is to change events; the faculty of science is to foresee them. The phenomena with which we deal are controlled by art; they are predicted by science."

Henry Thomas Buckle

4.1 Background and landscape of the methodology

The methodology for integrating ICT and Art provides a holistic framework to integrate artistic practices in a model of ICT development. Broadly speaking, the methodology systematizes the delivery and analysis of artistic practices in several typical phases of creation, development and implementation of ICT technologies or applications. Section 5 describes the implementation of the methodology in the context of the LSPs

It is important to clarify at this stage that the main principle of integration is that the world of ICT is opening up to host and welcome a set of practices that are not yet common in its domain. STARTS driven projects have to therefore find the appropriate places in the ICT domain where the contribution of artistic practices can be relevant, significant and can better contribute to innovation in ICT.

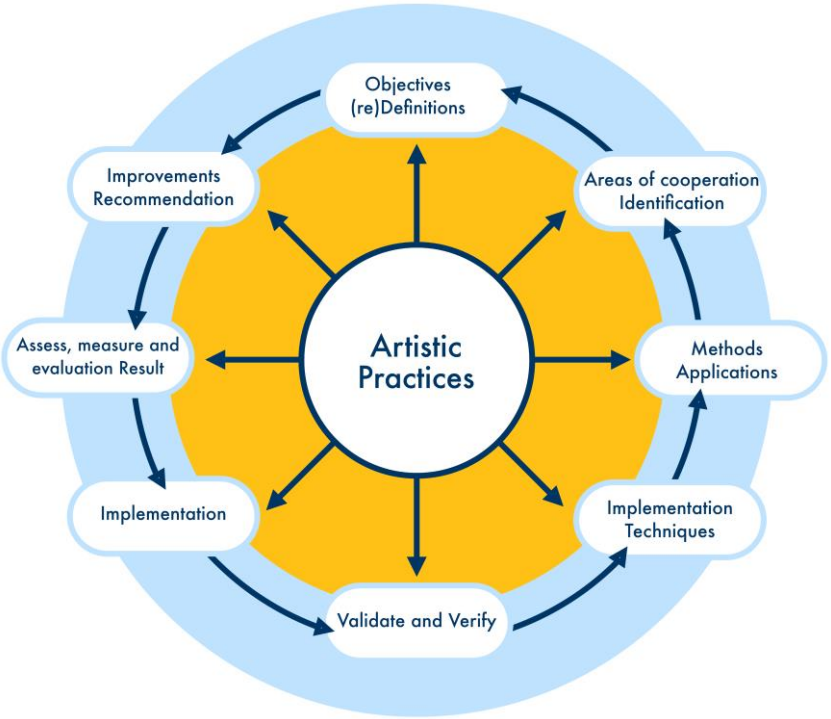

Figure 8: Holistic nature of artistic practices

The methodology departs from the principle of the holistic nature of artistic practices. Those practices are not constrained by context, tools or means of expression. Historically, and particularly in the past century, artistic practices assumed several forms of expression. In the case of conceptual art, for example, the practice is simply the expression of a concept in any available form. In the context of ICT, as the figure above represents, artistic practices could potentially be integrated in any phase of development, from the definition of objectives to validation and verification, including implementation and methods of application.

However, the overarching principle of the STARTS Initiative (that led to the current exercise of integration of ICT and Art) helps defining concrete areas of integration by excluding less interesting ones. It is important to reiterate that the main aim of STARTS is to boost innovation in ICT Research and Innovation actions by the broad stimulation of creativity in the associated

processes. The methodology is therefore outcome-focused. Clear definition of the outcomes expected from the STARTS project will help attract participants, including those SMEs who are most able to contribute to and benefit from those outcomes. It will also facilitate the transferability of the methodology to other scenarios that seek the same outcome, be it increasing trust in the use of a solution or the identification of constraints to SME development of solutions within a given domain (farm to fork, smart cities, etc.)

Nonetheless, the methodology is designed to amplify and not constrain the particularity and uniqueness of the artistic practice. STARTS is in itself a process of inclusiveness in the European Union. Therefore, STARTS has developed its main CSA, VERTIGO, as a co-creation process. The STARTS Co-creation methodology aims for the inclusion of all relevant participants as stakeholders. This process of bringing everybody together as stakeholders goes beyond merely allowing participation of the user or the consumer as envisioned in other, more conventional notions of co-creation.

Key findings in VERTIGO from the considered case studies and literature include the importance of managing the initial scepticism and resistance of the artists' presence in the organisation. Key methodologies to overcome this resistance include anchoring practices and the engagement, commitment and involvement of multiple layers of the organisation as early on as possible. Preconceptions and prejudices related to the diverse profile, skills and working practices of artists and other types of professionals need to be addressed early on in the process.

The methodology for integrating ICT and Art extends a tradition of combining art, creativity and technology innovation at organisations such as Ars Electronica, MIT, Eyebeam, Waag Society, etc. Applied tools and resources draw on the knowledge and experience of artists, technologists, curators and entrepreneurs in creative technology and public participation projects.

The methodology is based on existing case studies from emergent experiences of science, technology and arts collaborations. This is particularly important, as there is much to take into consideration when facilitating these transdisciplinary collaborations.

Two other basic principles for integrating artistic practices in ICT to stimulate creation, innovation and acceptance are of relevance and need to be clearly articulated: *transparency* and *trust*.

4.1.1 Transparency

The combination of art and ICT through the methodology can engage all stakeholders, including consumers and the public to explore and interact with the IoT systems. Artists create interfaces and interactions that will apply and therefore test applications and features, presenting new concepts and capabilities through creative prototypes, interaction design and participative experiences. Art installations make transparent the range of data that can be captured and represented, and enable users (specialist or citizen) to explore and interact with the IoT systems, and thereby to grasp and/or influence the IoT capability.

4.1.2 Trust

The methodology exposes and question aspects of technologies in ways that can build awareness, literacy and trust in the solutions. Artists and other stakeholders can collaborate to create experiences around important social impacts and consequences of technology, and thereby enable end users, consumers' citizens to question whether solutions are either, or both, acceptable and desirable.

This can include security and privacy elements such as confidentiality, user data awareness and control, integrity, resilience and authorisation. The art lead co-creation process provides a basis to engage users in trials to explore a wide range of acceptance factors, and thereby build trust in the solutions.

4.2 Areas of Knowledge

The methodology is sustained by a transdisciplinary discussion that juxtaposes five areas of knowledge: technical, humanistic, domain specific, holistic and artistic.

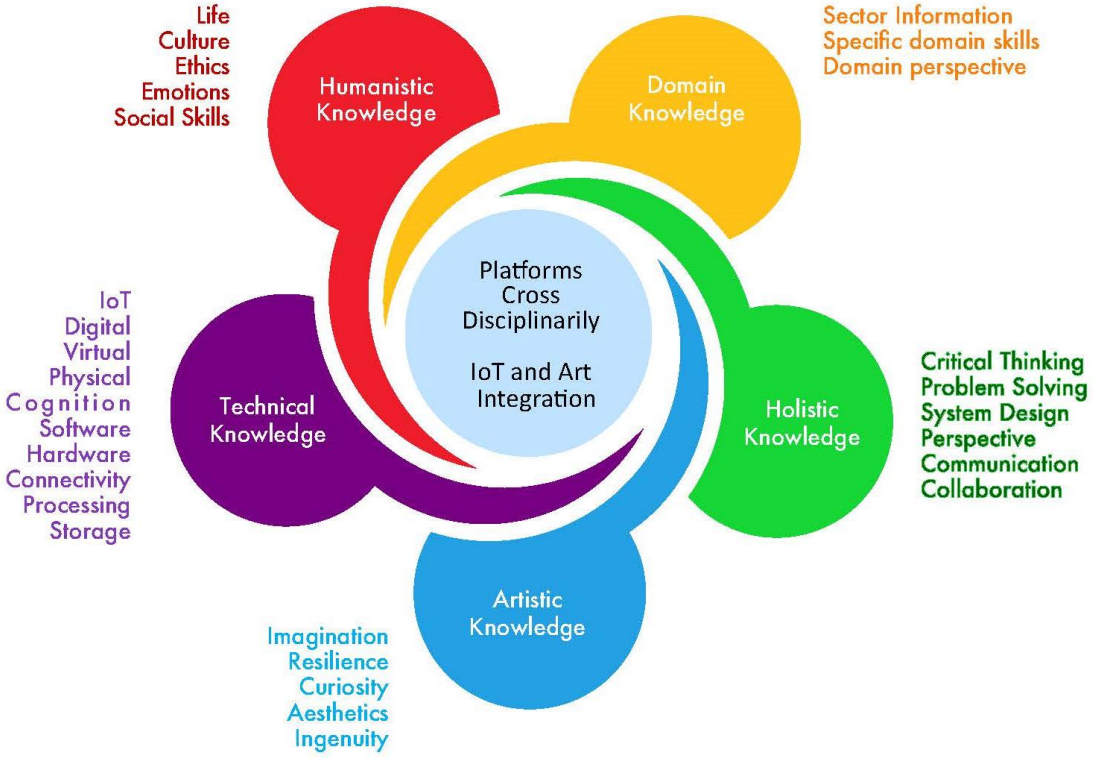

Figure 9:Relevant areas of knowledge

Technical knowledge is here considered to be related with basic digital concepts such as hardware or software. It feeds the discussion with substantial aspects such as digital connectivity and its impact in cognition both human and artificial. Understanding IoT as a merge of the virtual and the physical is relevant, as it is to understand (big) data, its processing and storage as crucial components in the integration of ICT and Art.

Complementarily, humanistic knowledge has a very important role in the discussion. It is one of the aims of STARTS to nurture a human-centred approach to technology. Understanding technology as an enabler of better lives, characterized by culture and ethics is extremely relevant. As it is the integration of social skills and emotion in, for instance, potential hybrid systems.

Domain knowledge – meaning concepts related to a specific application domain: agriculture, automotive, ... – has also an important role in the discussion, especially when it comes to specific domain applications of IoT.

Properly conceiving research and innovation problems, detached from the detailed specificity of potential solutions is nowadays indispensable. Holistic knowledge also allows for better communication of ideas and system design.

Critical thinking makes the connection of holistic with artistic knowledge as it is a strong characteristic of artistic practices. However, aspects such a certain ingenuity as condition *sine qua non* for imagination are indeed a strong contribution to the discussion. Resilience and curiosity are fundamental aspects for experimentation and improvisation leading the constant redefinition of aesthetics.

The transdisciplinary discussion in the methodology juxtaposes the above described knowledge domains through their constitutive concepts. The concepts of each domain become constitutive of other domains of the discussion.

4.3 Types of Actions and Methods

The main exercise that gave origin to the methodology of integrating ICT and Art was the establishment of significant correlations between specific parts of the ICT creation, development and implementation cycle and methods related with artistic practices.

It is important to underline, that similarly to what is the case in the STARTS Co-creation methodology, the production of artworks in this context is not the main objective of the integration of artistic practices in the ICT cycle.

Artistic practices are taken as relevant activities for impacting the direction of creation, development and implementation of a specific technology in order to innovate those processes towards acceptance and up-taking of the technologies.

The resulting artworks are consequence of those activities, similarly to what are scientific papers and reports in scientific and engineering practices. It is therefore a basic assumption that bringing all stakeholders – ranging from the promoter, to end beneficiaries, also including Small and Medium Businesses (SMEs), start-ups and artists – in creative environments in different phases of the ICT cycle is a good practice to achieve acceptance, adoption and up-taking of the technologies in question, creating trust based on transparency.

Figure 10:Integration of artistic related method in the ICT development process.

The ICT cycle is here described in 4 sub-cycles:

1. Identification – including brainstorming, specifications and requirement analysis;
2. Exposure – including activities such as design, prototyping, development, validation, verification and testing;
3. Improvement – including interaction, demos, feedback and testing;
4. Co-creation – the last sub-cycle, in which participation of end beneficiaries is crucial, that includes product technical specifications, development and maintenance.

Activities that are intrinsically related with artistic practices are:

- (Co-creation) Hackathons – it is nowadays very common to have artistic driven hackathons that bring together many different stakeholders [34];
- Artistic Residencies – artists in residence in research and innovation projects, as the STARTS Residencies;
- (Artistic) Exhibitions – displays of artworks, sometimes in the form of (interactive) installations/experiences, that can trigger discussions and create alternative perspective over specific subjects;
- Discussions – typically round-table discussions (often in policy making contexts such as the STARTS Talks at the European Parliament) bring to the table different areas of knowledge, normally a scientist, a company (engineer) and an artist. The discussion is normally mediated by a policy maker (a Member of Parliament or an officer of the European Commission.

According to the exposed above and represented in figure 8, all the activities associated with artistic practices could potentially be applied to any of the phases of the ICT cycle. However, the relevance of correlation was defined based mostly on the possibility of practically experiment or not, with or around the technologies in question.

The notion of correlation has here to do with reciprocity rather than causality. An ICT and an artistic activity correlate when the connection is mutually beneficial.

1. The identification cycle seems to better correlate with discussions, exhibitions and hackathons because the concepts involved can be explores in forms and technologies that area adjacent to the technology in question. For example, concept visualizations or hacking similar technologies.
2. The exposure cycle being more related with the first step of experimentation of the technology in question, seems to correlate better with exhibitions and hackathons. The short-term of the artistic activities is ideal to give short feedback to the technology itself.
3. Improvement seems to better correlate with artistic residencies and hackathons because on the one hand artistic residencies can provide deep insights on the technology due the nature of the activity. On the other hand, hackathons can proportionate short cycle reiterations for feedback for improvement.
4. Co-creation seems to correlate better with artistic residencies, hackathons and discussions because of the visibility that those activities allow for. Exhibitions tend to have a more passive nature, as they wait for visitors to come. While, the other activities can target and engage directly the user/consumer.

4.4 Potential roles for artists in ICT

Artists can play different roles when integrated in ICT research and innovation teams. The role of artists is here defined in the intersection of the four pillars of the ICT cycle.

In the intersection of the Identification and Improvement phases, an artist or a collective of artists can support or extend the activities undertaken in order to help the team to better interpret, or even invert, the base concepts of the technology.

When in the intersection between Improvement and Exposure, artists can promote and influence the development of the technology in order to help the team making it better after reviewing, and evaluating its application.

As a catalyst and an explorer in the intersection of Exposure and Co-creation, an artist can nurture collaboration of the team with other stakeholders, including final beneficiaries, by help better defining collaboration tasks.

Both in Co-creation and Identification, artists can help engage other stakeholders, including end beneficiaries, by helping the team design better experiences. They then become experimenters and moderators.

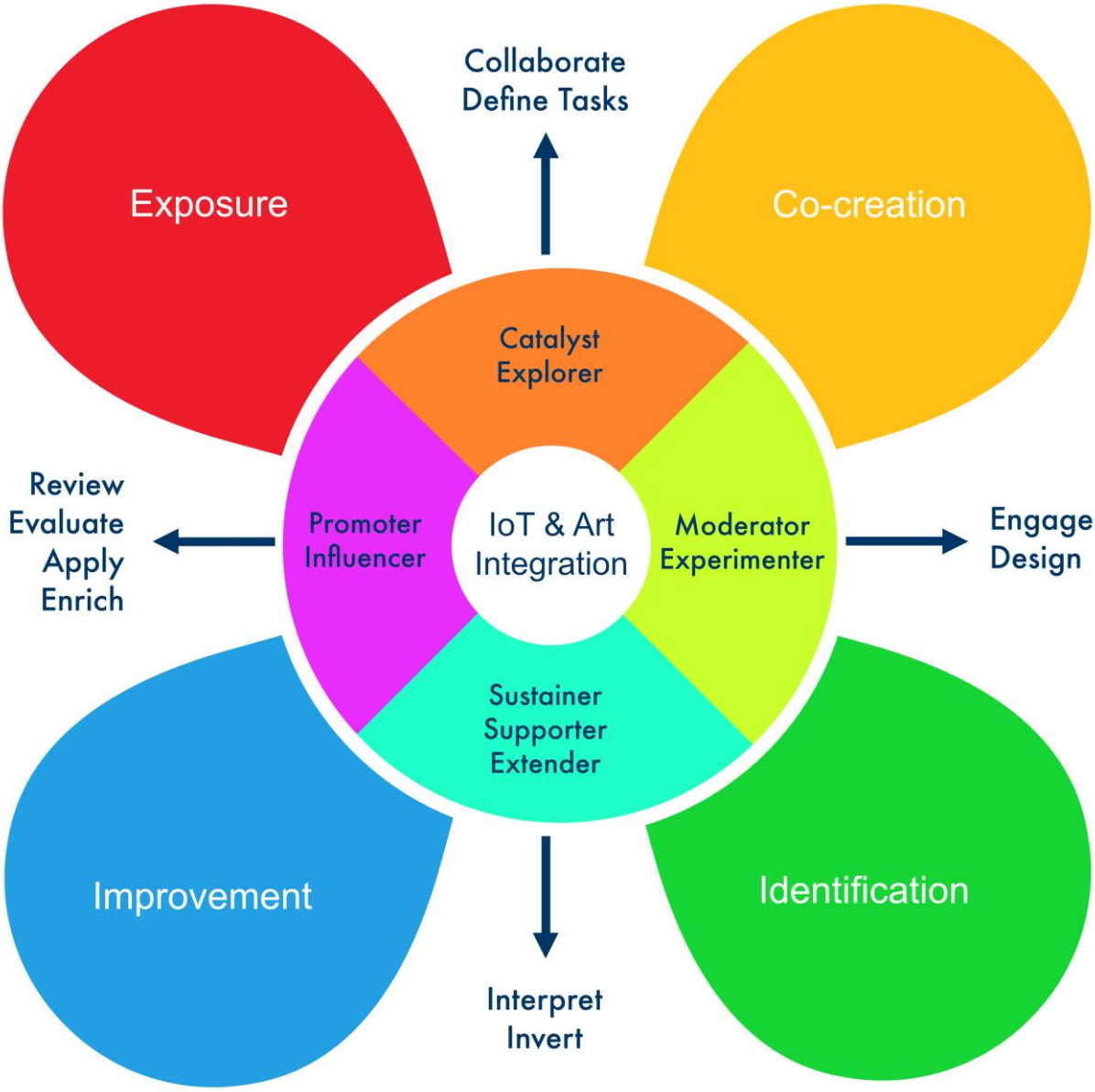

Figure 11:Potential roles for artists in ICT

It is relevant to state that the above assumptions are based on the notion that in the modern days of ICT, and due to the easy generation of feedback data, end-users no longer exist. 'Everybody' using technology is participating in its improvement, even if in a more passive and unconscious way.

Figure 12: Mappoci by Laura Malinverni and Lilia Villafuerte

"Mapocci is an interactive toy, designed to promote emotional communication and education among children aged 3 to 7. Thanks to a system of sensors and emotional intelligence software Mapocci recognises the care it receives from its user and reacts accordingly. Each Mapocci has its own personality and preferences and its reactions to caresses and movements are unique and expressed through an individual language.

Meanwhile, a 3G Internet system allows two Mapoccis to connect with each other, facilitating the remote exchange of emotional messages and making it possible for the physical interactions with one of the toys to have an effect on the behaviour of the other, and vice versa.

Mapocci can transmit emotional contents between people in different locations through touch and gestures. The intention is for this social robot to act as an intermediary that facilitates a higher level of physicality and empathy in remote connections.

This proposal by the multimedia artists Laura Malinverni and Lilia Villafuerte wishes to offer new forms of communication able to set in motion networks of empathy among children from different places." in the catalogue of NEXT THINGS_NEXT STARTS Exhibition, LABoral, Gijon, Spain

5. IMPLEMENTATION IN THE LSPS

"The worst scientist is he who is not an artist; the worst artist is he who is no scientist."

Armand Trousseau

The methodology for integrating ICT and the Arts – or better put: to include artistic practices in the ICT development cycle – is 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 individual actions are developed from the experience of the partners of IoT European large-scale pilots (LSPs) programme engaged in implementing the methodology.

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.

5.1 Considerations on the implementation of the methodology in the IoT LSPs

The actions of integration of artistic practices in the LSPs will be 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 technology as an enabler of better lives in general.

At the date of the writing of this report, the LSPs that seem to be readier to host artistic activities as a support to their use-case activities are: IoF2020, ACTIVAGE and SYNCHRONICITY, for obvious reasons of interaction with humans in their system chain. AUTOPILOT and MONICA due to the scale of their use cases, their focus on 'command and control' and less in interaction, would potentially be prune to a more negative critically from artists that could result as non-beneficial for both the pilots and artists involved.

5.2 STARTS Residency in CREATE-IoT

The ideal showroom of IoT is a two-part composition, a participatory installation. It shows the possibility to sense, recognise and determine 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.

The installation is set up in two phases:

1. The first is a living room with many small computers, cameras and sensors installed. Most of them are not obvious and 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.

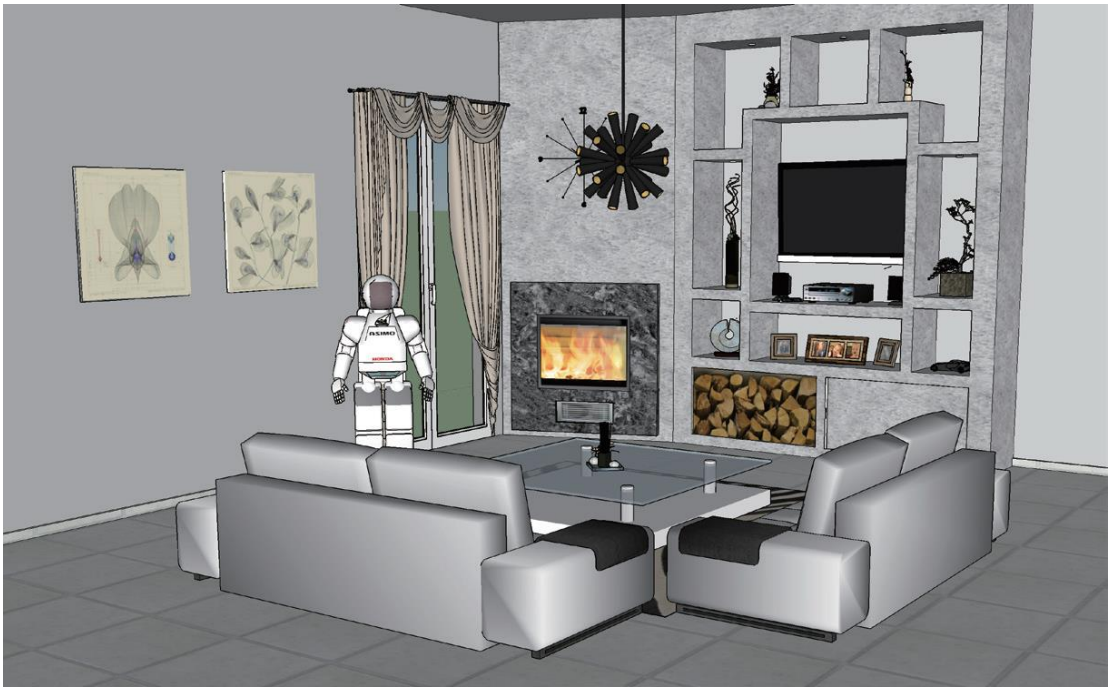

Figure 13:The ideal showroom of IoT.

In this residency between CREATE IoT and So Kanno a new artistic work will be developed challenging the fundamental issues of interest in the Internet of Things. CREATE IoT provides access to the artist to 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 art work 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. CREATE IoT supports the artist in acquiring the technological components of the project. All acquired technology will be tested and networked in order to be aligned for one comprehensive installation, which shall be exhibited in June in Bilbao, Guggenheim during the IoT week.

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.

5.3 Co-creation hackathons mediated by artists

Towards the creation of exemplary case studies, the LSPs IoF2020, ACTIVAGE and SYNCHRONICITY will be approached in order to realise artistic lead co-creation hackathons as a support to some of the use cases of those 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 up-take, adoption and acceptance will also be observed, as well the potential of new businesses built on top of the technologies made available by the LSPs in study.

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

- **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 anthropocenic.

- **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.

- **Poultry Chain Management**

The focus of this use-case lies mainly on the growth of poultry with respect to animal welfare. This starts with an adequate environment in which the birds feel comfortable, as well as good-quality feed and water. This 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 *Baracka* film.

An example of possible impact of this 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.

5.4 Open Prototyping Workshops

Along the CREATE-IoT project Open Prototyping Workshops will take place. They will engage different stakeholders of some LSPs and will assist them in applying the Open Prototyping methodology.

The Open Prototyping Process Model V2.0 (Figure 14a) is a graphical representation of the Open Prototyping process. It supplies a scaffold and a tool for intermediary organisations, to design, deliver and evaluate ICT and Art collaborations.

Two distinct dimensions in a ICT and Art collaboration are represented by two concentric lines. These are research, analysis and dissemination in the Scope and Interpret stages, and interdisciplinary collaboration, creative experimentation, and the production and display of the work in the Connect, Play, Produce and Display stages.

The stages in the Open Prototyping process can also be grouped into two distinctive sets of activities that work towards different types of value for the IoT pilot (Figure 14b).

The first is the capacity for Scoping and Experimentation (green box) that is achieved in the first three stages. The second is the value in public presentation of an artwork, and the interpretation of outcomes that open prototyping delivers for a technology/city partner (orange box).

Each stage has associated deliverables (Figure 14c).

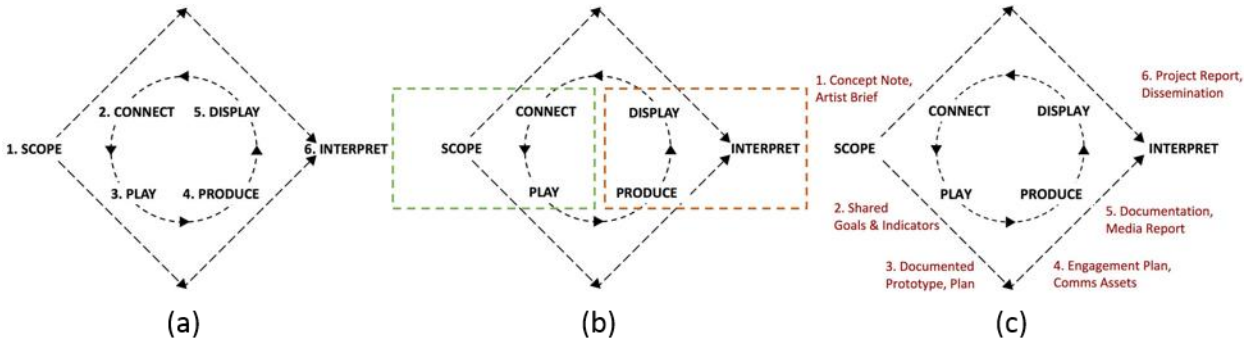

Figure 14: Process model visualization: (a) Open prototyping process model V2.0, (b) Two OP products, and (c) OP deliverables.

Table 1 gives an outline description of each of the stages, including information relating to the activities undertaken and the deliverables that are produced at each stage.

Table 1: Description of the Open Prototyping methodology stages.

Stage	Description	Deliverable
1 SCOPE	Artistic research and imagination introduces a novel framing of a problem, concept, challenge or capability.	Concept Note / Artist Brief
2 CONNECT	OP builds connections, ownership and trust between partners, teams and among citizens and service users.	Shared goals and indicators (KPIs)/ Stakeholder map
3 PLAY	The unique skills of artists can explore the limits of technologies, ideas, materials and applications.	Documented prototype and/or Production plan
4 PRODUCE	The combination of art and ICT through OP can add novel, imaginative dimensions to the Smart City.	Engagement plan; Promotional materials
5 DISPLAY	Art works can create visibility and attention for the IoT capabilities and consequences.	Artist documentation; Press/media report.
6 INTERPRET	OP can elicit insights and stimulate literacy and industry demand.	Report; Video and other dissemination

5.4.1 Evaluation Framework of the methodology for integrating ICT and Art for LSPs

The Open Prototyping methodology provides a framework to analyse how combining art and ICT can stimulate innovation and demand for IoT and Smart City data and services, and highlight potential roadblocks to acceptance before they are encountered [25] .

Research has assessed the implementation of the Open Prototyping framework in IoT pilots in the UK, Netherlands and Singapore. Findings suggest two key contributions of combining Art and ICT through Open Prototyping are to:

1. Stimulate innovation and demand for IoT data and services in ICT companies, and
2. Enable consumers and industry users to question what is trusted, acceptable and desirable (Ibid.).

The Open Prototyping methodology highlights actionable evaluation to iterate and improve the methodology. Additionally, evaluation material aimed at advocacy should be collected to communicate the results of ART-ICT co-creation and to ensure the continuity of projects in this domain.

The research further identified benefits to the IoT pilots and the artists themselves corresponding to different stages and dimensions of the activity, as detailed in Table 2:

Table 2: Findings of the case studies and perceived benefits to artists and stakeholders through Open Prototyping.

Stage	Benefits to artists	Benefits to IoT pilot / use case
1 SCOPE	Provocation, jumping off point	Domain and problem characterisation
2 CONNECT	Build an interdisciplinary team and network	Build ownership and trust
3 PLAY	Concept and technical development	Creative experiment and artistic user testing
4 PRODUCE	Production of work, engagement strategies.	New expressions, interfaces and experiences
5 DISPLAY	Presentation of the work, audience engagement.	Visibility, attention, participation (in public audiences and industry)
6 INTERPRET	Build legacy and impact	Stimulate literacy and industry demand.

5.5 Round-tables

Round-tables in non-usual places for the context of IoT will be organized. They will take the STARTS Talks model in which the participation of the partners of the LSPs, end-users, scientists and artists are gathered to discuss and present to the audience the innovations undertaken in the pilots. They will take place, for example, in Ars Electronica and European Parliament.

The round-tables will serve as a starting point and as a networking hub for its participants to raise awareness across the LSPs and the artistic community for the importance of creative synergies between the arts, science and technology to foster innovation in European industry.

On the other hand, the European Union strongly relies on innovation to compete globally and to make our society more sustainable and inclusive. It is becoming increasingly clear that in order to succeed Europe has to avoid silos and think more holistically about innovation and technology that is of value to society. In this spirit, high tech companies and funding agencies are currently promoting creative synergies between art and technology.

Participants will reflect on alternative innovation processes that recognise the Arts as a disruptive catalyst for innovation in economy and in society.

5.6 IoT Community of Artists

An IoT Community of Artists around the LSPs will naturally be created as consequence of the activities of the implementation of the methodology for integrating ICT and Art in the LSPs. Already the artists referred in this report are part of this Community.

The initial group of artists of the IoT Community of Artists are the ones exhibited at the exhibition Next Things_Next STARTS, in Gijon, Spain, between December 2017 and March 2018. Their wide experience in working in the context of IoT makes of them a privileged group to address relevant questions in the The IoT European Large-Scale Pilots Programme. Next Things_Next STARTS is showing 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 in a six-month residency (two at LABoral and four at Telefónica R+D) to materialise their ideas and projects, as well as substantial funding.

The artists are:

- Laura Malinverni & Lilia Villafuerte
- Lot Amorós, Cristina Navarro & Alexandre Oliver
- Sam Kronick
- María Castellanos & Alberto Valverde
- Román Torre & Ángeles Angulo.

5.7 Experience Readiness Level policy implementation

The Experience Readiness Level indicator is to be developed and implemented during the CREATE-IoT project. It aims at directly complementing and to be in direct connection with TRL from the point the of view of the user or potential up-taker.

Kevin Ashton in 1999 coined the term IoT, and understood it as an evolution of the Internet whereby "we empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves, in all its random glory".

Nowadays, we understand the power of the hyper-connected society – a society where billions of devices are connected to the global Internet – is about empowering humans, not computers. At the same time, the ubiquity of connectivity is considered an outdated concept because it is here. It is now Nowadays, it is not only needed, it is indispensable. Of course, specialists have understood the notion of ubiquity, mainly because they developed our digital systems to be indispensable. Ubiquitous computing has been hastened through the consumption of networked digital devices, whose adoption, i.e. smartphones, is an irreversible trend in society.

However, the technology-agnostic population, meaning the majority of population that merely wants to live a happy life, has been facing technology as an enabler for better lives. And they are completely correct. Technology is no more than an enabler.

So, where is the challenge then? The challenge is that ubiquity radically changes established innovation paradigms. In an Internet of Things conceived as an enabler for an Internet of Humans, prosumers are empowered, not just users. In reality, in many application domains, such as mobile apps domain, users became beta users. The 21st century consumption supports a growing culture of information sharing, creation, participation and collaboration via digital tools and the World Wide Web, from which projects such as Wikipedia, YouTube, Arduino, and Linux have emerged.

In the hyper-connected society, everyone has a say and is part of the system: human beings, machines, artificial intelligences, companies, governments, associations, armies, etc. We are much more than hyper-connected systems: we are entangled organisms and living realities that are simultaneously real and unreal, and have at the same time truth and post-truth. As soon as we understand this, we also understand that we always stick to our primordial condition: survival, to be alive and to live well.

In this context, artists are privileged candidates that can guide us in such an entangled system of organisms rationally, emotionally, and also spiritually. Feelings about a specific technology, such as the feeling of trust are crucial for us to accept new technologies in our lives. Similarly, to the feeling of trust, the feelings and sensations that are trigger during experience from the perspective of the utilization of IoT applications by the participating user, or prosumer is extremely relevant.

The main idea is that a technology in low level TRL can be ready to create interesting experiences that could contribute to the improvement of the technology in question, guide future applications, create awareness at early stage to a potential product, enhance acceptance, trust and adoption. ERL will be ideal for artistic experimentation of technology.

The European Union by adopting and implementing the ERLs will fulfil its goals of making a Digital Single Market that puts humans, or in other words European citizens at the centre.

6. CONCLUSIONS AND NEXT STEPS

"Art is the beautiful way of doing things. Science is the effective way of doing things. Business is the economic way of doing things."

Elbert Hubbard

6.1 Contribution to overall picture

The methodology for the integration of ICT and Art addresses the potential of Science, Technology and Arts (STARTS) collaborations to boost IoT innovation, adoption and market penetration in the specific application areas of the five LSPs.

The activities of the proposed methodology assume that IoT creation, innovation and adoption require an effective combination of different skills, knowledge, resources and business models in a collaborative context between sciences, technologies, arts, businesses and users. The methodology is adaptable to the specificities of each one of the LSPs for the implementation of values co-creation actions stimulating innovation and acceptance. The methodologies will be tested on the IoT LSPs to identify specific features and mechanisms leading to successful innovation, creation and the adoption processes.

6.2 Next steps

Next steps for the implementation of the methodology for integrating ICT and Art in the LSPs are:

- Have a clear notion of what are the use-cases to be run by LSPs;
- Work with the LSPs the realization of the activities proposed as a support to the use-cases;
- Support the smooth implementation of artistic residency in CREATE-IoT and maximize its impact both with the LSPs context as well as in the outside world;
- Make happen the co-creation hackathons with the selected LSPs;
- Organize the round-tables in Ars Electronica and the European Parliament;
- Develop and implement the LSPs;
- Make happen the Open Prototyping workshops.

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