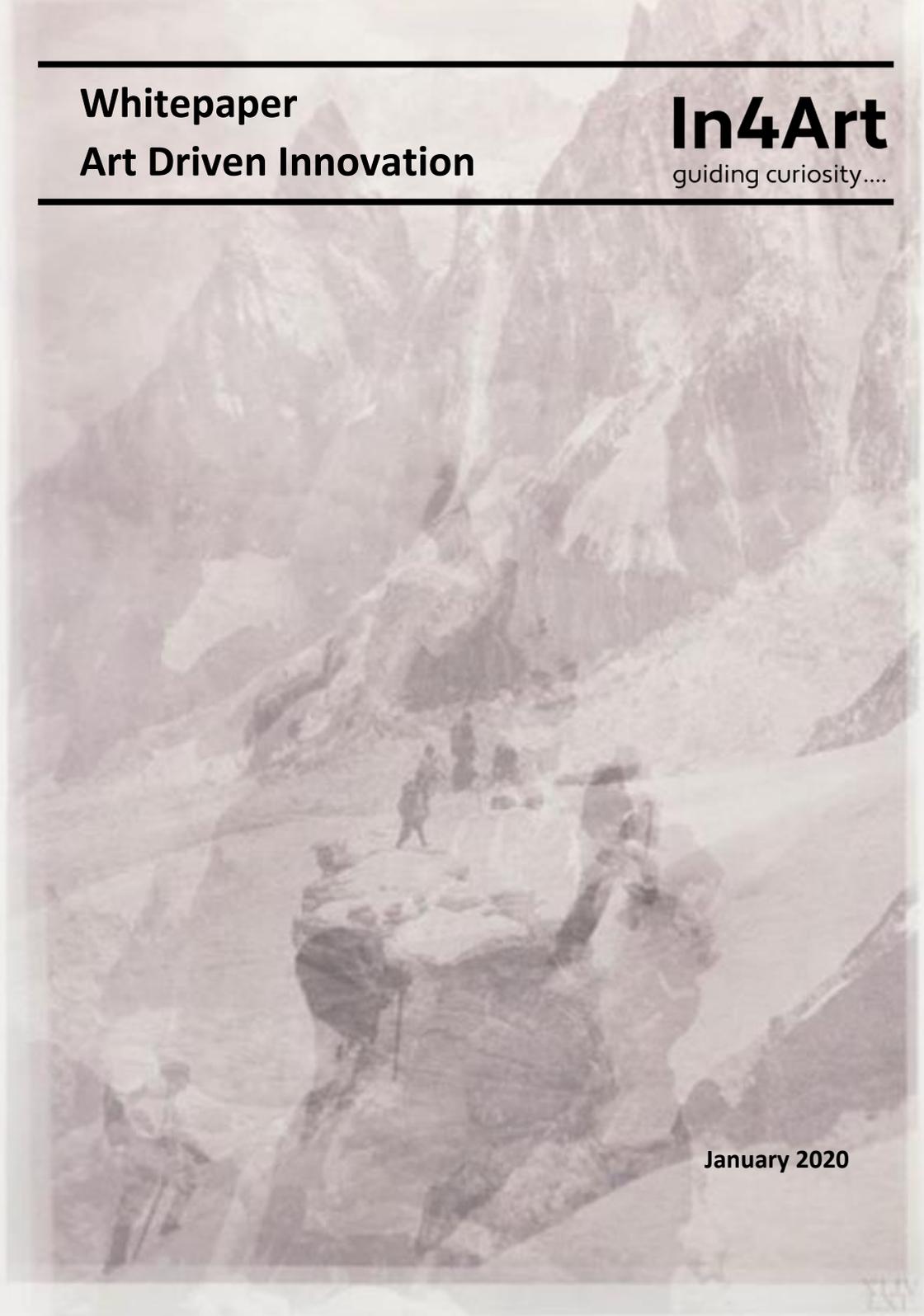


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**Whitepaper**  
**Art Driven Innovation**

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**In4Art**  
guiding curiosity....



**January 2020**

**“Arts aren’t a luxury; they are your competitive advantage”**

– Christian Madsbjerg

**“We see In4Art as a farm with works of art as the seeds of possible futures. Seeds that with effort and care might yet be grown into wiser, more considered, more just and generous ways of living together upon the Earth”**

– Lija & Rodolfo Groenewoud - van Vliet (founders of In4Art)

Front image: Sybren Renema (2016) Wanderer Fantasy No1 - In4Art collection

## Introduction

We believe that innovation has a problem. There is too little of it happening due to ongoing financialization of the economy<sup>1</sup> and what is happening ends up being structurally irresponsible in the sense that its creators have a naïve understanding of what their technology will do to society<sup>2</sup>. In other words, innovation has lost touch with what creates actual value as well as what it means to take responsibility. Today's economy can be described as divisive and degenerative by default<sup>3</sup> where value-extraction is rewarded more highly than value-creation<sup>1</sup>.

Change is needed to achieve the Sustainable Development Goals (SDGs) through innovation. These are the 17 global goals for sustainable development as identified by the United Nations<sup>4</sup>. There is an urgency for a paradigm shift of economic thinking and a human interest in more purpose driven alternatives. This requires new forms of acquiring knowledge, new actors to contribute and new types of entrepreneurship. What is needed are systematic methods which are based on building responsibility in from the start when pursuing innovation.

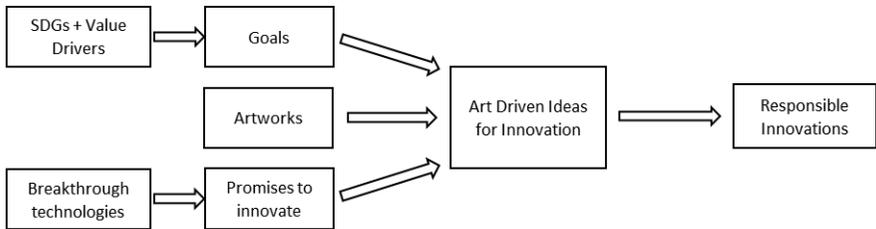
At In4Art, we position artworks as drivers for change. We have seen that collaborations on the intersection of art, technology and economics create the conditions needed to conceive valuable and responsible innovation opportunities.

Today's cutting-edge art is an offspring of science and technology, offering us to see beyond existing structures and presenting visions of possible futures<sup>5</sup>. Art Driven Innovation is designed to translate the visions that are embedded in artistic projects into solutions for a sustainable future.

## Responsible Innovation

*“Responsible innovation compels us to reflect on what sort of future(s) we want science and technology to bring into the world, what futures we care about, what challenges we want these to meet, what values these are anchored in, and whether the negotiations of such technologically- enabled futures are democratic. It asks how the targets for innovation can be identified in an ethical, inclusive, and equitable manner.”<sup>6</sup>*

In this paper, we propose a solution to the problem of irresponsibility of technological innovation and we respond to the challenge put forward to innovate responsibly. We have developed a methodology where ideas emerge on the intersection of art and technology and are further developed in a way which is distributive and regenerative by design. Realising responsible innovation as a condition to launch, not a choice.



*Art Driven Innovation Framework*

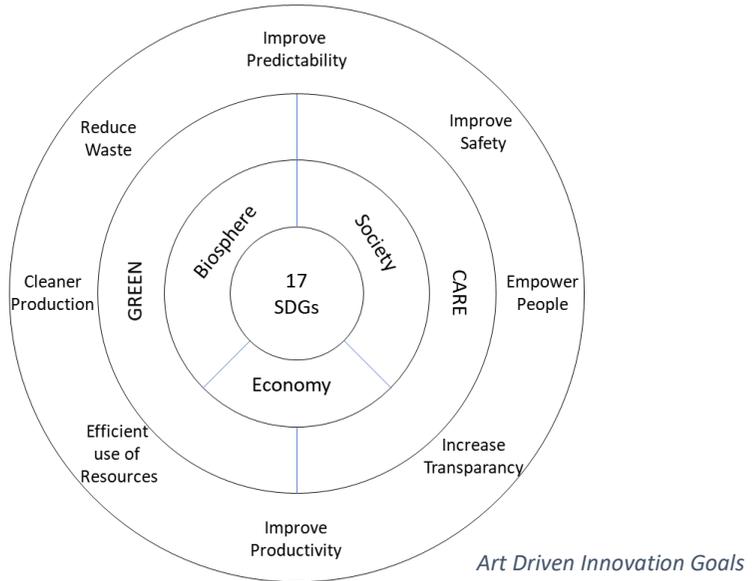
## Goals and Value Drivers

*“For hundreds of years philosophy has taught us there are four causes that jointly hold responsibility for the creation and effect of something. They are: 1. Causa materialis, the material something is made of; 2. Causa formalis, the shape and form something takes on; 3. Causa finalis, the goal which determines the shape and material something must be made of; and 4. Causa efficiens, the creator of the effect, who made it.”<sup>7</sup>*

The methodology we propose begins with preparing for the *causa finalis* or the goal of the development, since the goal determines the shape and material the responsible innovation must be made of. By combining SDGs with specified value drivers, goals that contribute to one or both of two main paths to sustainable innovation (Green or Care<sup>1</sup>) can be formulated:

The green path proposes to remake the way we have made things in either one of two categories: products for consumption (biological cycle) or products as a service (technical cycle).<sup>8</sup>

The care path proposes to include important activities into the realm of the productive economy which are currently left out: this includes education, healthcare and biodiversity amongst others.



From the two paths, we have identified 8 drivers for societal and economic value that contribute to the development of Art Driven Ideas for Innovation.

### Promises to Innovate

The second source of variables that enters the process is a list of innovation promises embedded in breakthrough technologies and social domains. We have identified 45 technologies and 11 social domains that both appear in the list of breakthroughs for innovation as drawn up by the European Commission in 2019<sup>9</sup> and which are often applied in technology a/o science influenced art works.

These technologies are drivers for the future. Most of them are still in the early stages of development with expected maturity within a 10-30-year horizon. This gives us a unique opportunity to work on the forefront of development and design valuable and responsible use cases to apply these technologies.

The technologies can be placed within nine thematic groups of radical innovation breakthroughs for the future: Artificial Intelligence and Robots (AI), Human-Machine Interaction & Biomimetics (HM), Electronics & Computing (EC) , Biohybrids (BH), Biomedicine (BM) , Printing & Materials (PM), Breaking Resource Boundaries (BR), Energy (EN), Social Innovations (SI).

<b>Group</b>	<b>Art Driven Innovation Promising Technologies and Social Domains</b>			
<b>AI</b>	Deep Learning	Blockchain	Chatbots	Mixed Reality
	Soft Robots	Drones	Swarm Intelligence	Holograms
	Emotional Recognition	Gesture Recognition	Driverless	Speech Recognition
	Indoor Farming	Neuroscience	Computational Creativity	Humanoids
<b>HM</b>	Bionics	Brain Machine Interface	Brain Mapping	
<b>EC</b>	Flexible Electronics	Quantum Computing	Computing Memory	Graphene Transistors
	Carbon Nanotubes			
<b>BH</b>	Bioelectronics	Bioinformatics	Plant Communication	
<b>BM</b>	Bioprinting	Gene Editing	Genomic Vaccines	Drug Delivery
	Microbiome			
<b>PM</b>	3D Printing	4D Printing	Self-Healing Materials	Hydrogels
<b>BR</b>	Bioplastic	Disaster Preparedness	Underwater living	Wastewater Nutrient Rec
	Asteroid Mining	Plastic-Eating Bugs		
<b>EN</b>	Energy Harvesting	Microbial Fuel Cell	Water Splitting	
<b>SI</b>	Alternative Currencies	Car-Free City	Gamification	Commons Based Economy
	Quantified Self	Life Caching	Read/Write Culture	Collaborative Innova Spaces
	Local Food Circles	Reinventing Education	Owning and Sharing Data	

## Artworks

To develop ideas for innovation from the promises and the goals, we propose to turn to works of art as a source of idea generation.

All works of art that use technologies or domains from the list on the previous page are suitable to analyse and use as a source of inspiration, insight and ideation. Our database currently holds over 500 entries of such works. All of these are analysed in four ways, corresponding to the four causes of responsibility for a creation or effect as mentioned earlier.

### ◇ Artistic Interest

*“Although the artist’s goal is not to solve problems, they surely do solve problems in their journey towards the result.”<sup>10</sup>*

We have identified four grounds of interest from which artists proceed that result in outcomes with a strong correlation to the promises to innovate around.

<b>Questioning technology</b>  An interest in exposing what goes on inside technology, who has access to it, and which intentions it serves	<b>Humanizing technology</b>  An interest in contributing to the reinvention of technology or the use thereof under an ethical paradigm of fairness
<b>Taking science out of the lab</b>  An interest in transmitting scientific information to inform the populace or to advance science by bringing research to the scale of human senses or experiences	<b>Explore new paths to progress</b>  An interest in investigating speculative or hypothetical future scenarios for progress to explore new paths to battle societal and technological grand challenges

*Artistic Interests with potential for Innovation*

◇ Material

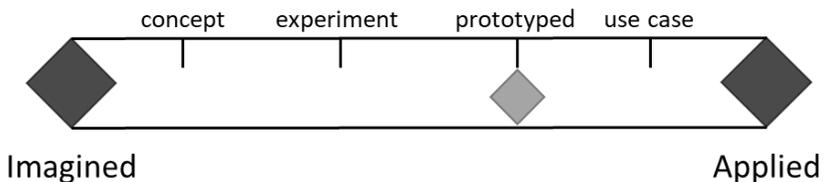
What technology or technologies are applied or combined in the work? What materials are used? Many artists apply what is known as *combinational creativity*<sup>11</sup> in their work. This means they use technologies or materials for something other than it was intended for, often taking it out of one domain and using it in another. The way the material is used and combined is a valuable source of art driven idea generation.

◇ Artist

The maker of the work. Who is it? Was it an individual project or part of a collaboration? And if do, with whom? When was the project realised?

◇ State of development

The shape and form the artwork takes on can be analysed in terms of stage of development. On a scale from imagined to applied, the work of art can be categorized as 1. close to an imagined world (exists in the form of a concept), 2. part of a controlled world (experiment), 3. Part of the real world (prototype) or 4. Applied in the real world (use case).



*Stage of development of Artworks for ADI*

## Report

The outcomes of the analysis are combined in the Art Driven Innovation Report which provides an overview at a glance of the artwork and the SDG's, value drivers and breakthrough that are associated to it.

The report is the point of entry for idea generation and is directly sourced from the database. Reports overlapping in any of the fields can be jointly sourced.

For example: should there be interest in collecting all the reports that share a certain SDG, technology or development stage, then all entries from the database that match the search criteria are presented in the form of reports.

## Art Driven Innovation Report

<b>artwork</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Title</td><td>Phyigital Plant</td></tr> <tr><td>Artist</td><td>Bastiaan de Nennie</td></tr> <tr><td>Period</td><td>2016</td></tr> <tr><td>Domain</td><td>Bio Tech</td></tr> </table>	Title	Phyigital Plant	Artist	Bastiaan de Nennie	Period	2016	Domain	Bio Tech	
Title	Phyigital Plant									
Artist	Bastiaan de Nennie									
Period	2016									
Domain	Bio Tech									
<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;"> <p>Artistic Interest</p>  Explore new Paths to progress         </div> <div style="width: 45%;"> <p>Material</p> <p>Digitally altering or adjusting scanned objects and printing the results as new objects</p> </div> </div>										
<p>Stage of Development</p>										
<b>SDGs</b>	<div style="border: 1px solid black; padding: 5px; display: flex; align-items: center; justify-content: center;"> <div style="text-align: right; padding-right: 10px;">12</div> <div style="font-size: 8px; text-align: left; padding-right: 10px;">RESPONSIBLE CONSUMPTION AND PRODUCTION</div> </div>									
<b>value drivers</b>	<div style="display: flex; justify-content: space-around; gap: 20px;"> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; font-size: 8px;">Improve Productivity</div> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; font-size: 8px;">Efficient use of Resources</div> </div>									
<b>break through</b>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>Group</td><td>Printing and Materials</td></tr> <tr><td>Field</td><td>3D printing of large objects</td></tr> <tr><td>Likelihood</td><td style="text-align: center;"> <div style="display: flex; align-items: center; gap: 20px;"> <span>low</span> <span>—————→</span> <span>high</span> </div> </td></tr> <tr><td>Promise</td><td>The digital fabrication of everything we encounter in the world</td></tr> </table>		Group	Printing and Materials	Field	3D printing of large objects	Likelihood	<div style="display: flex; align-items: center; gap: 20px;"> <span>low</span> <span>—————→</span> <span>high</span> </div>	Promise	The digital fabrication of everything we encounter in the world
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Promise	The digital fabrication of everything we encounter in the world									

**In4Art**  
guiding curiosity...

### Art Driven Ideas for Innovation

The report provides insight in the building blocks for idea generation but does not guide in the process to translate the information into testable propositions. To do this, three things need to be done. The first two are achieved by completing simple sentences.

- ◇ Describe the goal for Responsible Innovation by combining the SDGs with the identified value drivers and completing the following sentence:

We aim to [*value driver*] and contribute to [*SDG*] because [*breakthrough promise*]

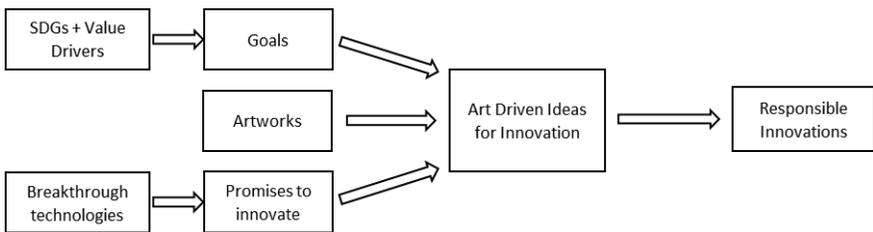
- ◇ Develop value hypotheses that can be tested. In this exercise the purpose is to identify as many hypotheses as possible and then select the most promising one(s) to continue with:

The [*artwork*] envisions [*effect*] which contributes to [*goal*], because [*rationale*]

- ◇ Identify the required collaborators to test the selected hypothesis.

## Conclusion

We have proposed a methodology to identify and develop innovations within a framework of value creation and responsibility. We started with identifying major problems with innovation in the current practice, which is structurally irresponsible because it is often divisive and degenerative by design. To solve this, we proposed a new framework for idea generation where social value, economic value and breakthroughs for innovation form the boundaries within which we work. We introduced the idea to analyse works of art which have been created within these boundaries as a source of inspiration, insight and idea generation for responsible innovations. On their intersection lies great potential to create value and contribute to progress based on distributive and regenerative models for economic growth. Through guiding curiosity we stimulate art driven innovation.



*Art Driven Innovation Framework*

**“It is by logic that we prove, but by intuition that we discover”**

– Henri Poincaré

## References

- [1] Mazzucato, Mariana; The Value of Everything, 2018
- [2] Harari, Yuval Noah; Homo Deus, 2017
- [3] Raworth, Kate; Doughnut Economics, 2017
- [4] [www.un.org/sustainabledevelopment/sustainable-development-goals/](http://www.un.org/sustainabledevelopment/sustainable-development-goals/)
- [5] Miller, Arthur I; Colliding Worlds, 2014
- [6] Owen et al; Developing a framework for responsible innovation, 2013
- [7] Heidegger, Martin; Die Frage nach der Technik, 1953
- [8] McDonough, William and Michael, Braungart; Cradle to Cradle: remaking the way we make things, 2002
- [9] European Commission; 100 Radical Innovation Breakthroughs for the Future, 2019
- [10] Colton, Simon; Refactorable Numbers: A Machine Invention, 1999
- [11] Sautoy, Marcus du; The Creativity Code, 2019

## Case Example of Art Driven Innovation: POND

The artistic experiment Microbial Light by Ermi van Oers, was translated using the Art Driven Innovation methodology into a concept for a responsible innovation: Power of New Discoveries (POND) in 2018.

The value hypotheses to start the idea generation was:

*Microbial Light envisions continuous green energy on water through efficient use of resources because it produces energy from bacteria in water.*

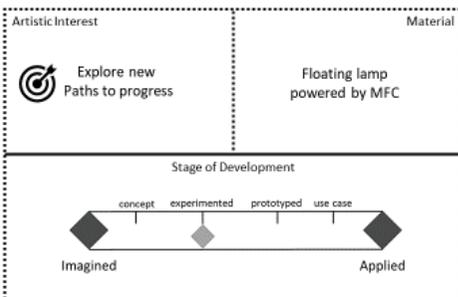
This points to a solution that enables an autonomous sensor hub for water monitoring, off grid. The power generated by using Microbial Fuel Cell Technology is enough to lit up an LED and to power small sensors. The use case identified was monitoring of water quality, temperature and speed in brooks and streams in a smart and green way. This would be of interest to waterboards, provinces and cities to monitor their waterways. The concept was successfully pitched for a waterboard, that showed interest in becoming a launching customer.

The next step is to materialize POND – since the artistic prototype Microbial Light only gave an indication of the possibilities, but POND in itself is a completely new product, which has to be engineered, designed and market on its own value.

POND is currently being developed by the creative start-up Nova Innova.

## Art Driven Innovation Report

artwork	Title	Microbial Light
	Artist	Ermi van Oers
	Period	2016
	Domain	Bio Tech



SDGs	<b>7 AFFORDABLE AND CLEAN ENERGY</b> 	<b>6 CLEAN WATER AND SANITATION</b> 
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value drivers		
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break through	Group	Energy
	Field	Microbial Fuel Cell Technology (MFC)
	Likelihood	
	Promise	The ability to simultaneously treat waste and produce clean energy

## Case Example of Art Driven Innovation: Reboot&Reuse

The artistic concept *Phygital Plant* (2018) by Bastiaan de Nennie resulted in a joint concept with In4Art as part of the artistic exploration for the 'Immaterial' event at V2\_. *Reboot & Reuse* (RnR) is the small scale example of a local 3D printing as a service factory, where customers buy a certain weight in kilo, which can be transformed in shape over time: rebooting the function and reusing the same material in a closed loop.

The first step was to distil the value hypothesis. Based on the value drivers and SDG, the following emerged:

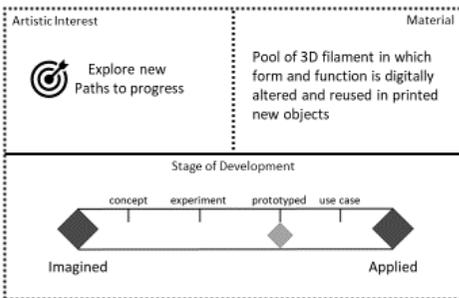
*Reboot&Reuse envisions a blended physical and digital production process through the efficient use of resources, because forms can be digitalised and regenerated by re-using the material, while altering the purpose.*

This points to a solution to transfer value from the object to the materiality; meaning that instead of how the object is used, the materials of the object are the key driver. The value becomes the resource: the kilos of material. This asks for a model where people own material with multiple life cycle of a specific form or function, enabling a circular model for furniture ownership: the form and function of materiality can be endlessly adjusted through digital fabrication.

Hence, it contributes to an access-based economy and is regenerative in nature; enabling efficient, responsible and sustainable production and consumption.

## Art Driven Innovation Report

artwork	Title	Reboot & Reuse
	Artist	Phygital Studio x In4Art
	Period	2019
	Domain	Materials for a Sustainable Future



SDGs	<p>12 RESPONSIBLE CONSUMPTION AND PRODUCTION</p>
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value drivers	<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;">Improve Productivity</div> <div style="border: 1px solid black; border-radius: 10px; padding: 5px; text-align: center;">Efficient use of Resources</div> </div>
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break through	Group	Social Breakthrough
	Field	Access / Commons-Based Economy
	Likelihood	<div style="display: flex; align-items: center;"> <div style="margin-right: 10px;">low</div> <div style="flex-grow: 1; border-bottom: 1px solid black; position: relative;"> <div style="position: absolute; right: -10px; top: -5px;">high</div> <div style="position: absolute; right: -10px; top: -10px;">◆</div> </div> </div>
	Promise	new forms of organising access to goods and services, extending the range of sharing and ownership possibilities

## Case Example of Art Driven Innovation: Urban Peels

The master graduation project ‘a new design habit’ by Cecilia Polonara included several proposals to rethink the packaging and use of ingredients in the kitchen and on the table. The proposal ‘spices pencils’ resulted in 2019 in an Art Driven Innovation Pilot: a line of pencils made entirely out of what is currently a waste stream – the peels of oranges, lemons and limes.

The underlying value hypothesis was:

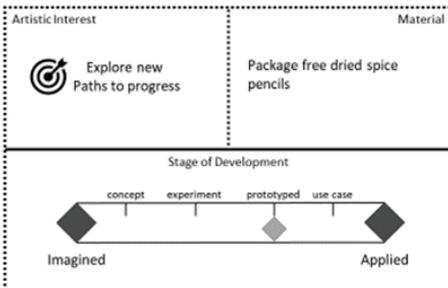
*Spicy Case envision a waste free future of spices which contributes to resource efficiency in production and consumption, because peels from fruits can be turned into a product for human consumption and nutrition.*

This turns to a solution which contributes to a circular economy by adding value to what is currently seen as waste. The use case identified is to source the raw materials, the peels, locally, turn them into set of dried spice pencils, which are brought back into the local food system to spice and flavour any dish or drink.

Started with a pilot production batch end of 2019, the next step is to set up a continuous local production line to create a local food circle under the name Urban Peels

## Art Driven Innovation Report

artwork	Title	Spices Pencils
	Artist	Cecilia Polonara
	Period	2019
	Domain	Materials for a Sustainable Future



SDGs	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	3 GOOD HEALTH AND WELL-BEING
		

value drivers	Reduce Waste	Efficient use of Resources
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break through	Group	Social Innovations
	Field	Local Food Circles
	Likelihood	low  high 
	Promise	A dense net of small sizes local production and recycling food farms



Companies and institutions In4Art worked with on Art Driven Innovation:



Stages In4Art gave (keynote) talks on Art Driven Innovation:



Media In4Art has been featured in:



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Based in Rotterdam, the Netherlands

# In4Art

guiding curiosity....

**In4Art is a European focused innovation platform that supports the creation of new business models driven by art.**

**We do this in the domains of:**



next generation  
internet



materials for  
a sustainable future

**Our approach of Art Driven Innovation allows for inspiration, strategic implications and the development of innovations.**

**We work with companies, institutions and partners to push boundaries with Art Driven Innovations.**

**To support our multidisciplinary approach, we invest in a relevant 21st century art collection, which we share within our network club, and organize various exhibitions and events to unleash imagination.**

## ARTISTIC PROTOTYPING

Business Development Trajectory that brings technologies closer to market & identifies application scenario's. A mix of consultancy, project management and prototyping.

## RADICAL OBSERVATIONS

Inspirational key notes/ lectures or workshop modules giving insight in enabling technologies, frontier innovations and future scenarios tailored to your needs.

## NETWORK CLUB

Our members are brought face-to-face with contemporary art - innovations of tomorrow - through our open collection and special events.

## INCUBATION TRACK

Career development masterclasses, investment and individual coaching to support artist/designers in their professionalisation and business development.