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Codesign as an operative framework for Responsible Research and Innovation: the case of Krakow Technology Park

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Abstract
The governance of emerging science and innovation has been conceptualised as a major challenge for contemporary democracies. Responsible Research and Innovation (RRI) emerged to tackle this issue by placing an emphasis on broad public engagement in the field of policy design based on the early involvement of multiple actors - citizens, civil society, researchers, industry, public sector and policy makers. Nevertheless, such early engagement is facing many challenges and it rarely goes beyond the stage of consultation (Grimpe, Patel, Wilford, Niemelä & Ikonen, 2013; Delgado, Lein Kjølber & Wickson, 2010; Chilvers, 2008). The SISCODE project, funded under H2020, identifies the application of co-design approach to overcome this challenge. This paper documents the experimentation conducted in one of the SISCODE living pilot in Krakow to support a public engagement action between policy makers, citizens and stakeholders. Addressing the acute issue of air pollution in Krakow led to a strategy of ecosystem activation applying co-design involving a variety of actors with a twofold objective: co-designing a policy as a prototype and experimenting with it through a process of development of tangible solutions.

KEYWORDS | CO-CREATION, CO-DESIGN, POLICY DESIGN, RESPONSIBLE RESEARCH AND INNOVATION, PILOTING, BOTTOM-UP INITIAVES

1. Introduction

The influence of science and technology on people's lives has been increasing continuously, certainly providing unprecedented benefits to humanity. Science is focusing its research effort on a wide set of Key Enabling Technologies (World Conference of Science, 1998), which are not only very important for innovation processes and therefore for industry and the technological players, but also for society and individuals as well, enabling solutions for specific and global challenges and changing societies, economies and working conditions. Significant impacts have already been generated in fields like health, quality of life, operations in the domestic, urban and wider environment, in transport, services and industry as well, which has a wider impact on consumers and markets. However, hand in hand with these developments, a considerable degree of public mistrust of science and fear of technology has been building up among different population segments. It is related to the fear of some individuals and communities that they will be the ones to suffer some direct and indirect negative consequences of technical innovations, which are being introduced to benefit only a privileged minority. In certain circles, citizens face scientific assessments and statements with suspicion (Wynne, 2006; Palliser & Dodson, 2019), since they fear the bias of possibly partial evaluations and impacts. European institutions have since long recognised the importance of developing and intensifying the relationship of science and technology with citizens and stakeholders, involving them in the knowledge sharing, priority setting and in the co-creation process. This started in 2001, when the European Commission published a Communication setting out the Science and Society Action Plan, the EU interventions to shorten the distance between Science, Technology, Innovation (STI) and citizens it continued with the Science in Society strategy and finally developed into the Science with and for Society (SwafS) programme and Responsible Research and Innovation (RRI) themes in Horizon 2020. This strategic setting has deepened the discourse on Public Engagement (PE) and Responsible Research and Innovation (RRI), demanding the deep involvement of multiple actors throughout the entire process - citizens, civil society, researchers, industry, public sector and policy makers - in science and innovation (Jasanoff, 2003; Owen et al., 2012; Meijer et al., 2016).

Narrowing the focus citizens are one of the key sources to establish the priorities and to guide the development of solutions and therefore it is necessary to establish a structured and regular dialogue with them and with stakeholders, facing the challenge of going beyond a mere communication effort and putting in place mechanisms to engage citizens in a science-society co-creation action of priorities, expectations and concerns shifting the role of the public from consultation towards real co-creation.

A useful approach to be applied to operationalise these twofold objectives is co-design (Bason, 2014; Brown, 2009; Sanders and Stappers, 2011; Deserti & Rizzo, 2012).

Over the last 10 years, co-creation has emerged as a significant novelty especially with the diffusion of Social Innovation (SI), a bottom-up process - social in its means and in its ends - in which social innovators, creative communities, citizens, vulnerable groups and civil servants co-produce the solutions they need at the interplay of state, private sector and civil society (Terstriep et al., 2015), tackling complex societal challenges (social inclusion, employment, migration, climate change, etc.). As the results of the SIMPACT, SIC, SI-DRIVE, Transit and Transition EU projects among others have pointed out, co-creation is an inherent part of SI. SI develops in co-creation ecosystems (Terstriep et al., 2015), as described by the

quadruple helix model (Committee of the regions, 2016; Carayannis et al., 2012) and often adopts design approaches, methodologies and tools to start from situated problems and develop solutions through a process of co-design and co-production engaging all the affected actors. In these contexts, co-creation starts from the needs, competencies and experiences of each actor, and strives to set up new modes of interaction that will flow in new assembly and network configurations. If well conducted, the process may lead not only to the generation of new solutions, but also to the reconfiguration of the same socio-technical system where it takes place. In other words, change occurs not just at the level of the outputs or single organisations, but across the entire ecosystem within which co-creation occurs. This overall system - which could be described as the complex combination of ideas, institutions, regulations and policies - constitutes at the same time the environment where more responsible approaches to science and innovation can unfold, and the result of their diffusion.
In this paper the authors present results of the SISCODE H2020 project. In particular, the paper describes and discusses results from the long terms experimentation conducted in Krakow where the Krakow Technology Park, as a project partner, led a project of the co-design of new solutions and policies to face the issue of air pollution in the Małopolska Region where the city is located. The results obtained from the experimentation show potentialities for co-design to become one of the most suitable approaches to shorten the distance between STI development and the society's needs and challenges.

2. The Project SISCODE

The SISCODE project (www.siscodeproject.eu), funded under H2020 and coordinated by the Department of Design of the Politecnico di Milano, aims to further push the frontier of the vision of RRI based on the principle of inclusiveness, involving all actors at an early stage, allowing innovation and STI policies to be conceived in a co-building mode in order to ensure shared responsibility. SISCODE aims at establishing, testing and validating 10 pilots across Europe as co-creation ecosystems (European Commission, 2016), which actually shape the scientific and innovation process and demonstrate the effectiveness of real involvement of societal stakeholders in the acceptance and use of STI in everyday people life.

2.1 Co-design as a framework to operationalise co-creation in Public Engagement and RRI

To reach the project objectives SISCODE have adopted the co-design approach, methodologies and tools that already have shown to be one of the most suitable knowledge domains to practice co-creation starting from situated problems and developing solutions through a process of co-design and co-production engaging all the affected actors. In these contexts, co-creation starts from the needs, competencies and experiences of each actor, and strives to set up new modes of interaction that will flow in new assembly and relationship configurations. The role of the co-creation pilots is to experiment with design methodologies and tools as an approach to shorten the distance between ideation and real implementation of solutions and policies (implementable co-creation). The

experimentations verify the hypothesis (and will produce knowledge) to make RRI implementable by introducing design methodologies and competences in the organisational, institutional and policy domains where it develops. The introduction of new knowledge and competences is expected to trigger transformations in the co-creation ecosystems to overcome the barriers and constraints to the real implementation of RRI. As the experimentations in the pilots proceed, the project aims to further verify the hypothesis of the application of the design process as a learning framework for policy makers to reconnect small-scale experimentation in real contexts with high level policy design.
The SISCODE system of pilots will represent a space where policy makers experiment with a design-based learning framework. SISCODE is based on the hypothesis that the introduction of effective co-creation in RRI and PE should be primarily based on its practice, or else on a learning-by-doing framework that can be complemented with reflection to achieve a sustainable transformation. This is not only in line with generic organisational learning principles (Cohen & Levinthal, 1990; Senge, 1990, Wenger, 1998, Bouwman & Grimmelikhuijsen, 2016; Beckman & Barry, 2007) but also with the way in which design knowledge and culture is built, which is historically bound to practice. In such a setting, the role of prototypes and context-based experimentations, core ingredients of the co-design approach, can be regarded as key for developing co-creation knowledge and for its appropriation in the field of policy making. The scheme in Figure 1 represents the SISCODE learning framework (Rizzo et al., 2017).

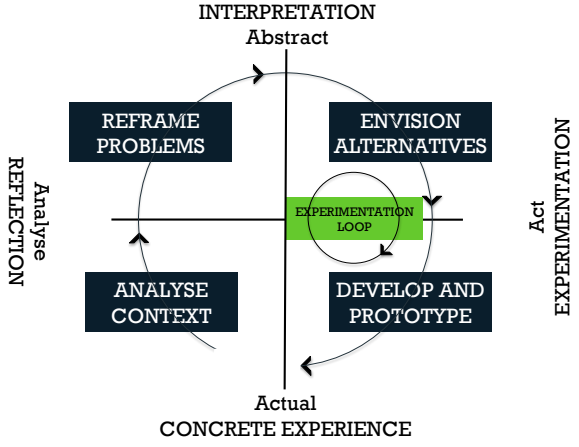

Figure 1. SISCODE design-based learning framework

2.2 SISCODE methodology for pilots' implementation

To implement this learning framework SISCODE proposed a design-based methodology to be applied in each of the single pilot projects run within the project. The use of design tools and methodologies have been defined in a modular toolbox composed of different tools for each of the phases in the design cycle to put co-creation in practice in all the pilots notwithstanding the differences among their specific challenges.

The methodology is put in practice by 10 co-creation pilots across Europe as real-life experiments. Each pilot follows a co-creation journey previously defined within the project and depicted as a scheme in Figure 2.

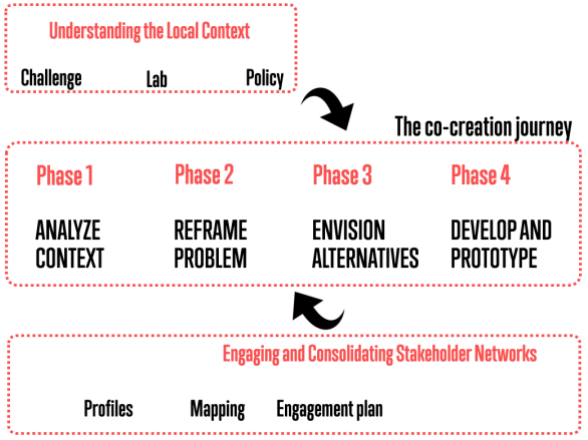

Figure 2. SISCODE's co-creation process proposed for the pilots

Starting from an analysis of the local situation, citizens and the policy environment, an initial challenge has been defined for each pilot based on the local context and the already existing relations with local authorities and policy makers influencing mainly the first three phases up to the ideation phase in which alternatives are envisioned. Throughout the entire process, stakeholders were to be identified, mapped and involved from the analysis until the prototyping phase. Each of the four phases contains activities defined by the pilots when drafting their co-creation journey. Those activities are again interrelated with specific design tools varying for the different pilots depending on their challenge, context and environment. In the following, one of the ten cases is represented in detail describing the co-creation journey, the ideated solution and individual reflections on opportunities and obstacles identified throughout the process.

4. KTP – Krakow Living Pilot

Situated in the Polish city of Krakow, the Krakow Technology Park (KTP) is a joint venture of State Treasury, the Municipality of Krakow, the region, various universities and the largest steel producer in Poland. Its main focus lies on the local development of the surrounding Malopolska region with an emphasis on technological development and innovation providing direct support to businesses. Their living lab has already experimented with co-creation, mainly from a business point of view and involving users and stakeholders mostly in the final phase testing already developed products. When required by the client, also wide

ranges of stakeholders have been involved in various stages throughout the development process of past projects. In the context of SISCODE, KTP has been involved with 2 specific aims: working on relevant societal challenges and involving a consistent group of stakeholders to identify together a potential solution to experiment with.
KTP has decided to work in partnership with the Malopolska region and the city of Krakow to tackle air pollution as one of the biggest issues for the region and its citizens.

4.1 Challenge analysis

Starting from the challenge of the air pollution the first activity that KTP has conducted with the regional authorities has been to analyse and reframe it into a problem where citizens could have an active role as co-designers.
Pursuing concrete goals in terms of lowering emission consist of a few different dimensions such as industrial pollution monitoring, development of the system of public transport, providing alternatives for traditional heating systems. One of the most important factors are the citizens of the region and their behaviour regarding everyday activities like heating and mobility. This reduction of emissions shall be dealt with by mobilizing residents.
Based on this premise KTP aims to create a space for stakeholders, policy makers and citizens to co-design a policy that includes citizens and motivate them to change attitude and habits in order to reduce air pollution. With a strong focus on air pollution and mobility, the challenge is a part of the new Air Protection Programme of the region for 2021-2030.

4.2 Co-creation journey

To tackle the previously described challenge, a co-creation journey based on the SISCODE approach has been developed by KTP splitting the single phases in activities and assigning specific tools of the SISCODE toolkit to be applied during these activities as well as addressing expected outcomes as a guideline for the experimentation (Fig. 3).
The results from the execution of this journey are described successively with a strong attention to the outputs of the single phases and the step-by-step development of the prototype.

	Activity	Tools	Expected Outcomes
1. Analyse Context	1.1 Desk Research	Desk research, Key facts, Interviews, Research participant map	Outline of the local challenge Varied stakeholders list
	1.2. Interviews with relevant stakeholders	Interest Groups Discussion Research Planning Survey Activity Network	Participants on board Data/ information collected, pilot for further analysis Outline of the perspectives of key stakeholders regarding the challenge
	1.3 Synthesize & analyse data	Initial opportunity map Trends matrix Convergence map Buzz reports	Situational analysis Map stakeholders Identification of trends and initiatives Repository of ideas and solutions Initial Report of this phase

	2.1 Understand the data collected	Mind mapping Insight clustering matrix Persona definition	Outline of the clear vision of the local challenge Data summary and visualisation
2. Reframe Problems	2.2 Aligning the pilot concept with knowledge gathered	Comparative analysis Concept sorting Concept scenarios	Realistic / feasible defined problem/ challenge Report on the chosen local challenge
	2.3 Frame opportunities	Brainstorming exercise Best practice identification	List of possible opportunities
3. Envision Alternatives	3.1 Idea generation	Brainstorming exercise Convergence map Soft „hackathon" / Design challenge	Summary of tenable ideas
	3.2 Idea selection	SWOT analysis Concept sorting Solution evaluation Concept grouping matrix	Summary of the selection of the appropriate idea
	3.3.Generate a concept	Concept scenarios Persona definition Solution roadmap	Report of solutions and policies (D3.2)
4. Develop & Prototype	4.1 Concept development	Solution storyboard Description of prototype Competences plan Strategy roadmap	Fully elaborated and detailed concept with outlined operational plan
	4.2 Prototyping	Solution prototype Solution Enactment Pilot development and testing Implementation plan	Report on the tested prototype

Figure 3: KTP's definition of their co-creation journey

Context analysis

The context analysis has been carried out starting with a desk research on the current status analysing reports and official documents as well as already active policies. The challenge has been discussed and refined iteratively in various meetings with stakeholders and policy makers on the basis of the data coming from the analysis of the context. Furthermore, an opening meeting with more than 220 stakeholders attending brought together keynote presentations, moderated discussions and Q&A's. The challenge has been refined and narrowed down in the end of this stage leading to the following objective:
How to improve the quality of the air in Krakow by motivating citizens and supporting decision makers with relevant co-creation tools and instruments?

Reframe problems

Based on the analysis and the narrowed challenge, workshops have been conducted aimed at refining the problem to be addressed. The direct output of the workshops were personas and empathy maps representing the target to be addressed with the upcoming solution. Apart from the methodology and exercises of the workshops, a particular focus has been set on advertising and reaching out to potential participants in order to gather representatives of all relevant stakeholders. The work initiated with the officials of the region in charge of

developing the new Air Protection Programme has been brought forward mainly carrying out open consultation meetings with KTP functioning as a facilitator and mediator. Citizens have been engaged in workshops in order to better analyse their needs and potential opportunities in reaching out directly to single citizens.

Envision alternatives

Collaborating closely with the region, the legal document in development defining the Air Protection programme (needed to officialise the rules, restrictions and actions to be taken by the industry for the following years) has been decided quite early to be a fundamental element of the prototype of KTP. The policy has been then developed with experts and citizens by activating a campaign to inform the policy itself by hearing from the citizens. Here co-design workshops have been implemented involving sufficient numbers of citizens directly inviting and involving specific local communities in order to get a better understanding of the perspective of citizens and their daily challenges.
Targeting the citizens on the other hand it has been decided to develop a more tangible solution to make the policy more visible and understandable with and for the inhabitants of the affected region. Co-design workshops have been conducted specifically oriented at envisioning concrete solutions based on SISCODE canvases leading to new insights.
From the numerous gathered ideas, eight of them have been selected and given into the hands of policy makers for further refinement and implementation. All of them have been taken into consideration by the experts preparing the first draft of the Air Protection Programme and have been used as a base for a Smogathon.

Develop and prototype

The drafting and finalisation of the document for the air protection programme mainly requested various consultation meetings uniting stakeholders and mediating between actors defining the legal boundaries and procedures needed to launch the official document. The draft has been published and presented to all interested stakeholders collecting feedback to then prepare a second version. In parallel, a Smogathon organised by the Municipality of Krakow and KTP developed a prototype of an app for end users to deal with the issue of air pollution. The winning project – a platform supported by an application and a monitoring system for industrial pollution - is to be developed and tested first in one county and subsequently with a broader public.

Effective Stakeholder Group	Level of engagement			
	Co-Producing	Co-Designing	Consulted	Informed
Marshall Office of Malopolska Region	×	×	×	×
City of Krakow, Air Quality Management				×
The Metropolitan Association, Krakow			×	×
University of Science and Technology		×	×	×
Krakow University of Technology		×	×	×
Krakow Smog Alarm Activists		×	×	×
ICT companies, SMI's, Start-ups		×	×	×
Media/wider public		×	×	×

Figure 4 Stakeholder engagement

Throughout all phases, various stakeholders have been involved at different levels of co-creation, ranging from being solely informed to co-producing solutions (see Fig. 4).

4.3 Final solution and outcomes

The final solution consists in two components, the first one is a legal document defining the rules and restrictions of the new Air protection programme of the Malopolska region and can be defined as the legislative frame more addressed to the industry and politics while the second element is a web platform connected to a mobile app and specific monitoring instruments that has the main goal of informing citizens and making them aware of the single contribution each of them can make. Both components of the solution have the common goal to reduce air pollution in the Malopolska region.

1. Air Protection Programme for the Malopolska region
The document for the Air Protection Programme officially applies rules, restrictions and indications for the industry on how the reduction of the air pollution in the region in the following years is to be achieved. Its development included 6 open consultation meetings with over 250 participants representing the various groups of interest.

2. Multichannel solution to provide transparent information on industrial pollution and raise awareness among citizens
The prototype consists of a web platform, a mobile app and monitoring instruments whose functions have been co-designed during the various workshops. The implementation of the solution itself is being carried out in a co-production process that involves the pilot, different stakeholders from the county and region, policy makers and the winners of the Smogathon to make certain that all involved parties have the possibility to express doubts and contribute to the final service.

4.4 Transformations, outcomes and reflections

Malopolska is the first region in Poland having started to update the regional Programme for Air Quality Improvement laying a foundation for the other regions with a strategy of activities and specific tasks, actions and obligations representing and considering all affected actors. The co-creation process itself sets new standards for the public administration and policy makers and for the citizens.
With respect to the public administration and policy makers one need identified throughout the entire process of co-designing solutions has been the necessity to provide clear and easy support instruments and tools, that are not too abstract for them completely new to design practices. Tackling such a complex problem as air pollution in a co-design mind set has been found challenging to not only involve all interested parties, but also to consider their interests and needs in all moments throughout the process. Also, the restrictions arising from operating in the field of legislation and law have been limiting the freedom of action

adding a further layer of complexity. Despite the immense challenge it laid out, the co-design approach did succeed in supporting the alignment of the various stakeholders leading to a realistic and implementable solution and the failure of past experimentations exclusively applying top-down approaches to avoid this complexity have not produced satisfying outcomes (Pressman & Wildavsky, 1973; Van Meter & Van Horn, 1975).
However, as an outcome of the numerous workshops with stakeholders and citizens, KTP managed to elaborate a list of policy gaps identified in these working sessions analysing them and elaborating suggestions and recommendations on how each of the issues could be tackled. Furthermore, as a result of the positive feedback on the workshops and the methodology applied there, the region decided to conduct more co-design activities in a different project rolled out at national level. The positive feedback from the regional authorities and their proactivity to apply co-design can be perceived as an enormous success and an important step towards the implementation of consultation processes.
With respect to citizens it emerged how much they are willing to introduce changes in their behaviours and more than this willing to collaborate with public actors even though they are often already discouraged by previous experiences and administrative barriers which can hinder involvement and lead to initially scarce participation. The results from the pilot seem to suggest a positive effect of the co-design approach experimented in SISCODE as the outcome of a process of involvement (from problem definition to solution co-production and experimentation) on the actors' engagement. This type of engagement has received very positive feedback and seemed to have also positive effects on the acceptance of the final solution when the citizens participated in its development and currently in its experimentation.
A first general reflection that the authors can draw from these results is that co-designed solutions might be more likely to be accepted both by citizens and policy makers if those have been actively included in their development and were given the opportunity to discuss problems and needs. The different workshops run during the pilot development (from analysing the problem to co-designing the solution) functioned as a space for discussions appreciated by all participants.
Furthermore, the process of engagement of different stakeholders along the entire process of development of the solution suggests two additional reflections.
First, co-designing a policy implies the engagement of different levels of governance from the local to the regional one and asks for overcoming silos that are still in place in traditional policy design processes. On the basis of the indications coming from the pilot the co-design approach to the policy development allowed the Malopolska region governance system to experiment with a more holistic approach to local and regional sustainable development. Specifically, co-design in workshops enabled policy makers from the different governance levels to gain an in-depth understanding of the barriers, drivers and issues that affect a policy implementation at each level. This understanding supported the policy makers from to develop a more coherent solution to the requirements that governance posed.
Secondly, the involvement of the citizens in the process of policy design rarely can move from public hearing if it is not supported by some level of tangibility and materialisation of

the policy itself. With this respect the pilot results show the benefit that the implementation of a prototype as a service for the involvement of the citizens in the monitoring of the air pollution shortened the distance between the policy and the acceptance of its expected impact/s.

5. Conclusions

The design-based methodology and tools for co-creation applied in the SISCODE project succeeded with respect to the general project aim to introduce in RRI a practical based approach to operationalise it. By putting together science, innovation and technology potentialities with the needs coming from the society in a process of co-design of solutions seems to be promising with respect to the advancement of the more traditional mechanisms of public hearing and consultation that are still prevailing in policy design field.
The importance of the co-design tools and their appropriateness and adaptation for the specific KTP case has been stressed as a fundamental point for successful co-creation in the context. At the same time the application of a co-design process to policy design has pointed out the complexity of a collaboration that must proceed from bottom up (citizens and stakeholder) to top down (governance levels) and vice versa encountering barriers that depend on cultural, economic, legal, societal and regulatory factors that are in place and can prevent real co-creation to occur.

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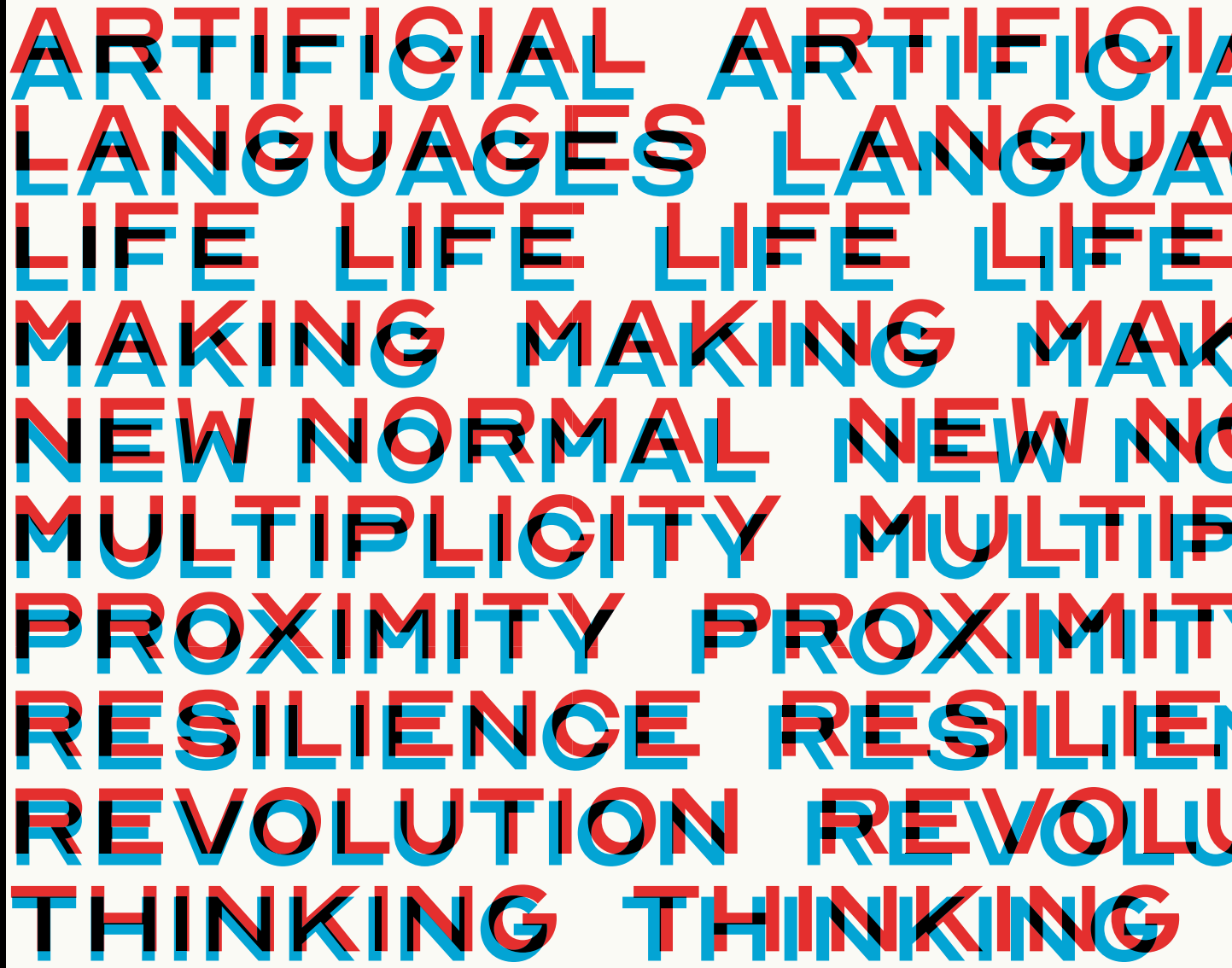
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