



Participatory Futuring with Citizens as One Way of Designing for Sustainability Transitions of a National Art Museum in Korea

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While participatory futuring is gaining traction in the emerging research and practice of design for sustainability transitions, there is limited understanding on how to operationalize it in real-life design practices and the practical challenges in doing so. This design case study explores the use of participatory futuring with citizens as one way of designing for sustainability transitions of a national art museum in South Korea. Highlighting its democratic and practical potential for public institutions, this paper examines the challenges and opportunities in employing this approach and discusses the capabilities necessary for designers to successfully apply the approach in real-life design practices.

Keywords – Citizen Engagement, Design for Sustainability Transitions, Participatory Futuring, Public Art Museum.

Relevance to Design Practice – The reported participatory futuring case provides useful insights for employing participatory futuring when designing for sustainability transitions. Practitioners and educators can benefit from both the strategic and practical considerations in engaging with citizens across wide-ranging age groups, as well as the necessary design capabilities outlined in this paper.

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Introduction

As we live through the Anthropocene, the world is increasingly witnessing the impact our collective actions have made on the globe and, in turn, on our living conditions (e.g., Crutzen & Stoermer, 2021). As a response, the transition towards a more sustainable future and the necessary methodological frameworks have become important research topics in the field of design. With *defuturing*, Fry (1999) critically examines how the current and past generations have been exploiting the future generation and argues that a sustainable future can only be achieved starting by understanding the dialectic consequences of our present actions. In line with this, some scholars have put forward the integration of design and future studies as an important research agenda (Angheloiu et al., 2020; Candy, 2010; Ilstedt & Wangel, 2014), while others have fostered creative and critical ways to explore the future through the practices of speculative design (Dunne & Raby, 2013) and design fiction (Bleecker, 2009). Following these developments, studies have explored the importance of ensuring social legitimation (Reeves et al., 2016) and explicitly acknowledging and dealing with politics in designing future visions (Mazé, 2019). Together, they call for expanding the contribution of design and growing the capacity of designers to shape more desirable and sustainable futures.

Design for Sustainability Transitions (referred to as DfST hereinafter) is an emerging research and practice rooted in the sustainability transitions research drawing upon “complex adaptive systems theories, sustainability science, system innovations and transitions theories, social practice theory and

environmental ethics” (Gaziulusoy & Erdoğan Öztekin, 2019, p. 12). At its core, DfST requires a multi-level perspective on systems innovation considering both time and scale, aiming at “large-scale disruptive changes in societal systems that emerge over a long period of decades” (Loorbach et al., 2017, p. 600), and thus emphasizes the importance of futuring: actively envisioning and shaping desirable futures by changing the current actions (Ceschin, 2014; Gaziulusoy & Ryan, 2017a; Irwin, 2018). Futuring is a critical and delicate process that involves engaging various stakeholders in a participatory manner, which is seen as essential given the complex and interdependent nature of sustainability problems (e.g., Ceschin, 2014; Huttunen et al., 2022; Mok & Hyysalo, 2018). In other words, futuring for sustainability transitions necessarily requires involving diverse stakeholders to successfully facilitate the emergence of radical shifts to complex sustainability challenges.

However, there seems to be a gap between research and practice when one seeks to operationalize participatory futuring in real-life design practices with and for public institutions. Though it is essential to involve *anyone* affected by a particular issue in

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the design process (Irwin, 2018), public institutions and transition designers seeking to foster necessary transitions in shaping public policies and services suffer from the lack of examples through which they can learn and adapt tried-and-true methods in involving citizens. Supportingly, Huttunen et al. (2022) find citizen engagement relatively rare and spot loose connections between such engagements and transitions approaches in reviewing and taxonomizing citizen engagement in sustainability transitions literature. Further, as the case studies cumulated thus far tend to concentrate largely on Western and European contexts, more examples from other areas of the world are called for to further the discourse (e.g., Scholz & Methner, 2020). In bridging this gap, this paper reports on a real-life project that explored the use of participatory futuring involving citizens and museum staff in a series of workshops for the transition towards carbon neutrality of a large national art museum in South Korea. In doing so, we intend to contribute to the recent development in this field by demonstrating a possible way for designers to operationalize participatory futuring for sustainability transitions, reflecting upon the process and outcome of the project, as well as the unique project context of the Museum as a niche experiment space (e.g., Salgado, 2013).

The first part of this article explores participatory futuring as one way of designing for sustainability transitions and the challenges inherent in this approach against the backdrop of the extant literature. It is followed by the case description of our project, highlighting the context and preparation, how the workshops unfolded, and how the resulting ideas were derived. We then discuss how participatory futuring may alleviate the barrier caused by the technical expertise required for laypeople when joining discussions about the institutional transition and that extreme future scenarios may help participants engage with questions that challenge the status quo. Our reflections also imply that designers' translation may contribute to the interplay between niche experiments and regime change. Finally, we reflect upon the design capabilities we identified for this new line of design practice in futuring and sustainability transitions.

Hyori Lee led the project reported in this article during her master's studies in the Department of Design at Ulsan National Institute of Science and Technology (UNIST). Now, as a doctoral student at UNIST, her research interests lie in the use of design and futures to empower people and collectively create a more sustainable society. She worked for several years as a graphic and brand identity designer before redirecting her focus towards design research.

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Literature Review: Designing for Participatory Futuring with Citizens towards Sustainability Transitions

The definitions, tools, and techniques of futuring are dispersed without unified terminologies (e.g., Bibri, 2018; Candy, 2010; Kozubaev et al., 2020; Tuominen et al., 2014). Described as *the gentle art of re-perceiving*, immersive performances and artifacts from futuring are employed in business planning to mitigate risks and find alternative opportunities (Wack, 1985 in Candy, 2010, p. 44). In futures studies, backcasting is seen as a strategic planning approach that begins with envisioning and then working backward to identify the steps needed toward the preferred future (Bibri, 2018). With its *normative, goal-oriented, and problem-solving characteristics* (Bibri, 2018, p. 24), backcasting allows the possibility for the radical socio-technical changes necessary for sustainability (Tuominen et al., 2014). In design, Kozubaev et al. (2020) consider exploring futures as a practical design approach to influence or change the present, while Fry (2008) stipulates ethical, political, social, and ecological concerns as essential considerations for a new design practice he terms as *design futuring*. As this paper seeks to offer an example of operationalizing participatory futuring as a way of designing for sustainability transitions for design practitioners, we hereupon treat *futuring* as an umbrella term that encompasses various activities, such as envisioning, speculating, backcasting, and scenario building. In other words, for the purpose of this paper, we see futuring as a verb that represents an action rather than a certain time and period.

Futuring has been adopted and become a staple in different contemporary design practices through varying techniques and tools, though not always under its original terminology. In specific, the form-giving capability of designers in making prototypes, building scenarios, and generating visions is highly appreciated for their futuring aspects. For instance, design fiction creates a diegetic prototype that can deliver a future narrative that blends science facts and science fiction (Bleecker, 2009). Making a reference to Walton's make-believe framework (1993), Dunne and Raby (2013) stressed the importance of props in design speculation to facilitate imagination and to explore alternative possibilities to challenge the status quo. Armstrong et al. (2014) used a speculative and participatory approach to set out a vision and a strategy to develop future scenarios for their social design research agenda. More recently, practitioners of service design prescribed vision generation as an essential step for successful projects subscribing to the view that design-driven innovation can emerge from a compelling vision (e.g., Heapy et al., 2018).

The recent approaches for futuring in DfST can generally be seen as participatory. Developing a product-service system design framework, Ceschin (2014) employs a logic that is similar to participatory backcasting in that it formalizes PSS concept visions and develops strategic pathways together with the participation of academics, local companies, city officials, and citizens. Gaziulusoy and Ryan (2017a) examined the participatory design process in developing visions, scenarios, and pathways

to transform Australian cities towards low-carbon and resilient futures. Concretizing transition design as a new design practice, Irwin (2018) prescribed backcasting as a collective activity for stakeholders to develop visions and influence present actions. Designing a path creation toolkit for transition management, Hyysalo et al. (2019b) explored a collaborative design approach for planning and accelerating socio-technical changes. Connecting studies in experience design and futures for sustainability transitions, García and Gaziulusoy (2021) refer to futuring as a participatory process of experiencing the future with and for citizens. In all these examples, futuring seems righteously to be employed as a participatory practice with multiple stakeholders, as sustainability transitions are a *multi-actor process* (Köhler et al., 2019, p. 2).

Participatory approaches involving multi-stakeholders lend benefits for sustainability transitions research ranging from framing to implementation in the process. Introducing diverse perspectives from varying participants may help reframe the problems and generate creative solutions by broadening the scope of wicked problems (Dorst, 2015). Codesigning with diverse stakeholders helps build trust and reduce negative feelings while allowing participants to associate with one another, which can be the key as stakeholder feelings are often related to the root cause of wicked problems (Irwin, 2018). Further, participatory design processes often lead to more sustainable solutions in the long run, gaining legitimacy and shared awareness among stakeholders (Huttunen et al., 2022). To this end, citizen participation is now considered as the key to successful service provision and policymaking in the public sector with the shift from top-down governmental decision-making to complex multi-agent governance (Nijkamp et al., 2023).

Participatory characteristics have been regarded as a prominent nature of some of the recent studies on backcasting (e.g., Robinson et al., 2011) capturing a wide range of views for sustainability transitions in the context of the public sector (Tuominen et al., 2014). Neuhoff et al. (2023), in their review of the forms of participatory futuring for urban sustainability, defined the approach as a way to deliberate and find alternatives engaging disenfranchised people who were typically excluded in the strategy planning and decision-making process. Some of the futuring practices focus on engaging laypeople and identifying the opportunities and challenges as a research agenda (e.g., Heidingsfelder et al., 2015; Tseklevs et al., 2022; Tyszcuk, 2021). Therefore, there is a clear need to explore the participatory futuring engaging citizens in shaping public services and policy as well as for democratic governance.

Despite its potential for shaping future public services and policy for sustainability transition, designing for participatory futuring can involve multiple challenges across a few dimensions. First, discrepancies can be observed between the ideal of citizen engagement and the practicality of realizing it in a real-life context. For instance, in assessing the association between democratic participation and energy transition, Clulow and Reiner (2022) questioned the efficacy of uncared citizen participation. Similarly, advocating for what she terms *policy futures studios*,

Kimbell (2019) asserts that participatory workshops can rarely replace the need for government bodies and political entities. These pragmatic considerations call for concrete cases of participatory futuring to develop tools and techniques and to identify (Loorbach et al., 2017) real-life contexts to which these developed methods can successfully be applied.

Second, ineffective debate may arise between multiple actors due to differences in perspectives and values (e.g., Tschersich & Kok, 2022). As transitions are a highly political process for its ambition of disruptive systemic change, research of different agency and governance is emphasized to identify more effective ways to reach the desired state (Loorbach et al., 2017). In their report on understanding deep democracy for just transitions in agri-food systems, Tschersich and Kok (2022) pose the possible tensions caused by differing perceptions of justice between participants and require balancing them. As these tensions are a common phenomenon in the process of transitions, careful facilitation to ease them is needed (Scholz & Methner, 2020).

Third, scholars observe a gap between the imagined future and reality (Candy, 2010). Visions play a key role in DfST (e.g., Ceschin, 2014; Gaziulusoy & Ryan, 2017a; Irwin et al., 2015) functioning as *normative reference points* that give directions to pathways and stimulate debates in the complex and dynamic process of transition. (Hölscher et al., 2022, p. 3) However, the gap between an imagined future and reality hinders reflexive experiences of the future, which Candy (2010) deems as an *experiential gulf*. Also, Tseklevs et al. (2022), in their case study of the participatory speculative design project in Malaysia, found it difficult for participants to imagine diverse and extreme futures beyond the status quo. Therefore, many futuring approaches have been developed to overcome this gap, especially by utilizing design capabilities of form-giving and problem-solving (e.g., Bleecker, 2009; Candy, 2010; Dunne & Raby, 2013; Mazé, 2019).

Lastly, the lack of interplay between niche experiments and regime change may pose challenges for sustainability transitions. Radical innovations in niches are crucial in transitions because they yield *seeds for change* (Geels, 2002, p. 1261). Although not all niches succeed in interacting with regimes and landscapes, they gradually *follow trajectories of niche cumulation* and start to be applied to the institutional level (Geels, 2002, p. 1271). However, while there are innovative green experiments and practices in niches, there also is a strong force to maintain the status quo with the entrenched system (Köhler et al., 2019). Referred to as *the capture of transitions*, this pattern of transitions initiatives that are apparently accepted but become silently neutralized by incumbent players has been recognized by scholars as an important pitfall to overcome for a long-term policy outcome (Voß et al., 2009, p. 296). To this end, the translating role of intermediaries is stressed to bridge between niches and regimes (Ehnert, 2023; Kivimaa et al., 2019).

In response, this paper reports on the participatory futuring with citizens in an experimental policymaking project. Through this design case study, we explore the designerly approaches taken for participatory futuring with citizens for sustainability transitions within the context of a public art museum in South

Korea and these taken for possibly alleviating the challenges that arose in the experimental project. In doing so, we answer the call for state-of-the-art cases by DfST scholars to further sustainability transitions discourse (Irwin, 2018) to close the gap between research and practice (Gaziulusoy & Erdoğan Öztekin, 2019).

Case: *Futuring with Citizens as a Way to Enable Sustainability Transitions of a Public Art Museum*

Observing and reporting on real-life design practices in-situ poses a multitude of practical challenges. Consequently, design scholars from early on have employed conducting protocol studies in laboratory settings as a valid alternative to probe into designerly approaches (e.g., Dorst & Cross, 2001; Goldschmidt, 1997). Over time, the design research community has come to recognize the sanitized nature of such studies (e.g., Crilly, 2015, pp. 60-61) and the value of investigating the ambiguity and uncertainty inherent in real-life design practices (Daalhuizen, 2014, pp. 18-20; Leifer & Steinert, 2011). To this end, McDonnell (1997) argues that “the form and nature of design decision-making cannot be gained otherwise than by studying the designing in the context of professional practice” (p. 473). In response to this call for methodological exploration, studies have employed various research methods, including interviews (Paton & Dorst, 2011; Tzortzopoulos et al., 2006), ethnographic observations (e.g., Lloyd, 2000; Nicholas & Oak, 2020; Stompff et al., 2016), and case studies (e.g., Badke-Schaub & Frankenberger, 1999; van Kuijk et al., 2019), to investigate the daily practices of professional designers. More recently, scholars and practitioners have been offering design case studies providing lessons and reflections from the unique experiences from the field (e.g., Hussain et al., 2012; Hyysalo et al., 2019a; Lin et al., 2011; Wang et al., 2022).

Building upon this development, this paper reports on a real-life design project that aimed to assist a public modern and contemporary art museum in South Korea in kickstarting its sustainability transition. Accounting for the citizen engagements designed for and used in the project, we explore the potential of futuring with citizens as a way to provide an impetus to sustainability transitions. The ambition is to play the role of a *generator of new design knowledge* by contributing to the ongoing exploration of, and reflections upon, new processes, frameworks, and tools (Wilson & Zamberlan, 2015, pp. 12-13) in design practice for sustainability transitions (e.g., Gaziulusoy & Ryan, 2017a; Irwin, 2018). In doing so, we aim to provide helpful examples to build a flexible process while growing understanding that can be transferred to other real-life contexts (Slevin & Sines, 1999).

The following section describes the case: how the project unfolded in chronological order, the design decisions made along the way, the props produced to enable and facilitate the intended participatory futuring, and how the resulting policy ideas were organized and delivered to the art museum. Reflecting upon the lived experiences of participating in the project as designers, the authors hope to share a *nuanced view of reality* and produce context-dependent knowledge (Flyvbjerg, 2006, p. 223).

Preparation (March–July 2022)

The exploratory and experimental policy design project (referred to as the Project hereinafter) was commissioned by the National Museum of Modern and Contemporary Art (referred to as MMCA hereinafter) in order to create policy ideas and directions towards carbon neutrality through citizen participation. The Project was initiated as a part of a broader performing art program comprised of several multidisciplinary projects in the forms of analysis reports, panel discussions, and participatory workshops aimed at exploring and reflecting upon how art museums and the art scene in Korea could achieve carbon neutrality in the Anthropocene. As one of the largest and most prominent public modern and contemporary art museums in South Korea with multiple locations, MMCA has the widest reach and thus bears the responsibility of spearheading efforts to address this global threat. Fifteen projects constituted the art program, each of which was carried out by individual experts, groups, and/or companies in various fields, including art, architecture, carbon emission analysis and trade, chemistry, curation, economics, ESG, geoscience, industrial design, law, material science, and natural history. The specific themes of the projects included estimating the museum’s current carbon emission, exploring alternative materials for more sustainable art making, applying passive building technology, and designing staff uniforms with reduced environmental impact. The fifteen projects did not have explicit links or communication among them except for the chief curator’s intermittent updates to different teams to avoid duplicate efforts and/or unwitting omissions in the information disseminated in the participatory workshops.

As a design practice and research laboratory that explores the potential of design for service and policy (referred to as the Lab hereinafter) under the department of design at a research-driven public university in Korea, the Lab was invited to participate in the above-mentioned art program. Ultimately, the team of six¹ was commissioned to create and carry out a process that would engage visitors to generate new policy ideas that would help MMCA achieve carbon neutrality and, at the same time, foster changes in people’s behaviors and mindsets. Given the stature of the museum and our recently established affiliation with an institute for carbon neutrality of the university, the members of the Lab saw a unique opportunity to experiment with participatory futuring (e.g., Gaziulusoy & Ryan, 2017b; Hyysalo et al., 2014) to enable the museum’s sustainability transitions (e.g., Gaziulusoy & Erdoğan Öztekin, 2019; Irwin et al., 2015).

From March 2022, the Lab, together with the curator and coordinator in charge at MMCA, started looking into extant cases of (art) museums seeking to innovate to reduce their environmental impact. For instance, the International Committee for Museums and Collections of Modern Art has developed an online toolkit that guides contemporary art museum professionals on implementing the necessary changes to attain environmental sustainability (CiMAM, 2021). The toolkit was designed to provide a comprehensive list of relevant cases, platforms, resources, and companies that art museums can reference and utilize immediately to facilitate their transition. Similarly, the German Federal Cultural Foundation (2021) conducted a pilot

project aimed at reducing carbon footprints in 19 local art institutions by measuring carbon emission rates and fostering knowledge-sharing between them. In South Korea, an exhibition entitled *Sustainable Museum: Art and Environment* aimed to raise awareness about environmental issues surrounding art museums and explore practical and applicable alternatives (Museum of Contemporary Art Busan, 2022). The exhibition sought to explore the environmental impact and social implications of art museums.

While the efforts made in the cases above are commendable to realize more environmentally sustainable museums, a majority tend to focus on technical solutions such as energy conservation, waste reduction, LED lighting, and modular exhibition walls. As the carbon emission analysis on MMCA's operations was being conducted as a part of the above-mentioned art program, the curator in charge of the Project and the Lab hoped to explore beyond the technical aspects of achieving carbon neutrality. Indeed, scholars in DfST argue that, in addition to such technical solutions, one should also consider the broader and longer-term perspectives of societal transitions (Irwin et al., 2015) as “[s]ustainability transitions necessitate [...] systemic changes at societal level” (Gaziulusoy & Erdoğan Öztekin, 2019, p. 2). Following these lines of reasoning, we decided to devise an experimental process that focuses on the hopes and wishes of future museumgoers and unearth what they would demand the museum to change and what they are willing to sacrifice from their museum experiences in exploring potential carbon neutrality policy for systemic change.

As part of the aforementioned art program, the Project was tasked with developing a process that would not only gather insights and ideas from citizen engagements to inform MMCA's carbon neutrality policy but also create a valuable experience for all participants as museumgoers. To achieve this goal, the Lab generated multiple concepts for the structure and specific events of citizen engagements through numerous ideation sessions and held regular meetings with the museum curators to gain insights from their experience in implementing participatory programs during the initial months of the Project. Some of the early concepts included employing design games (e.g., Vaajakallio & Mattelmäki, 2014) to envision specific carbon neutrality policies or asking the participants to imagine a new department responsible for achieving the museum's carbon neutrality. We rejected these concepts for the following reasons: the former due to its complexity and the limited time available for each session (maximum 2 hours); the latter due to the potential confusion and friction that could arise from the existence of an established department already responsible for facilities and energy management. The concept chosen involved engaging citizens from diverse backgrounds in fourteen rounds of participatory futuring workshops, allowing them to collectively envision the future for the museum's sustainability transition.

In the process of furthering the concept and ideating detailed activities and necessary props, the Lab engaged with a large number of internal and external stakeholders of MMCA to prepare for the upcoming series of workshops: having a discussion with a curator and a researcher at the children's education department; observing the Children Advisory Group giving feedback to a developing educational program² to learn about its role and the

mechanism (thirteen elementary school children were present); visiting a meeting of the Customer Advisory Group³ to learn about its role and share our progress (forty adults of diverse background were present); and running a discussion session with seven staff of the museum and its foundation⁴ to share our progress and hear their thoughts on the Project.

These observations helped us understand that our participants for the resulting workshops, regardless of their age, could have widely varying levels of interest and understanding about climate change and its consequences, as well as carbon-reducing solutions available today and their socio-technical challenges. For instance, most did not display a clear distinction between the terms *carbon neutrality* and *environmental sustainability* despite their differing focuses on reducing carbon emissions and encompassing broader ecological principles. They did not see how they, as citizens, could contribute to the transition. Further, many of the staff of MMCA and the foundation did not see how the museum could play a role in reducing carbon emissions and/or help create a constructive discourse about the climate challenge discussions and solutions for the broader society. This may reflect a broader pattern: although the awareness about climate change has gradually risen, there is still a lack of widespread readiness for necessary actions in South Korea. A survey conducted in 2019 shows that the public considers air pollution (56.2%) and waste management (36.3%) more critical than climate change (25.6%) when asked about the most important environmental challenges in Korea (Choi et al., 2020). Also, though people welcome new regulations to enable a green lifestyle, most are not ready to accept economic punishments for non-compliance (Ha et al., 2023).

This meant in practice that it was critical to ensure that all participants gained a basic understanding of key concepts, such as climate change and carbon neutrality, within the limited time allocated for the workshops without losing interest. Also, the Lab needed to devise tools and activities to help workshop participants be fully immersed in constructive and solution-focused discussions, and not be too cautious about their use of language when reflecting upon the potential role MMCA can play. Among the props we devised to assist participants were a storybook and scraps of newspapers. For elementary school children, we created a storybook about a day of a fictitious future child of 2081 based on climate change projections by the Intergovernmental Panel on Climate Change (2023). Also based upon the projections by IPCC were future newspapers of 2061 for older participants, in which they could see how climate change may have an impact on all facets of their lives, including energy, dwelling, food, and culture. In order to spark critical discussions among the participants and keep them interested, we devised extreme future scenarios of the museum with flexible tasks to perform. The following section describes how a series of participatory futuring workshops unfolded and how these props and activities were utilized along the way.

A Series of Workshops (August–November 2022)

As a participatory workshop and policy design experiment in exploring the carbon-neutral future of MMCA, the Project engaged with a total of 164 citizens and six staff of the museum

between August and November 2022. As our experiment was part of a broader performing art program, all participants joined our workshops by using the museum’s online booking system or by signing up at the museum if there were seats left. In other words, we had little control over the representativeness of the participants except for their age group. We employed envisioning the carbon-neutral futures as a means of engaging, empowering, and delegating citizens, many of whom were unfamiliar with the museum’s policies or carbon neutrality goals. In so doing, we adopted an inclusive approach: we began by involving elementary school children and gradually expanded our engagement to include older participants and, finally, the museum staff. The series of workshops the Lab administered followed the steps of a reversed *futures cone* (Candy, 2010; Dunne & Raby, 2013; Taylor, 1990; Voros, 2003). In addition to its original purpose for strategic and systemic exploration of futures, our intention was also to ensure that the voices of the future citizens were first heard, as they will suffer from the long-term impacts of climate change but currently have little agency to change the world to prevent such consequences. Based on the results from the workshops

with the young participants, older participants contributed their ideas to mitigate climate change as they demanded changes to the museum. Finally, the MMCA staff, including the director, were to play a role in examining these ideas to realize them into actionable measures for implementation. The youngest group of participants were invited to 2081, while the older group of participants were invited to 2061. Referring to the IPCC SSP3-7.0 scenario (Intergovernmental Panel on Climate Change, 2023), our intention was to allow the participants to imagine the futures where net-zero goal set in Paris Agreement 2015 was not met (see Figure 1).

The first phase of the Project began in August of 2022 with 54 elementary school children as the participants across four workshop sessions. The children *traveled* to 2081 with audio-visual aids we devised and were asked to describe a day in the future in detail to express their wishes for future selves. Then they listened to a storybook about a fictitious future child that hardly affords the daily joy that is taken for granted today, such as outdoor activities at noon and frequently consuming meat, which was based on the projections by the IPCC (for excerpts, see Appendix A).

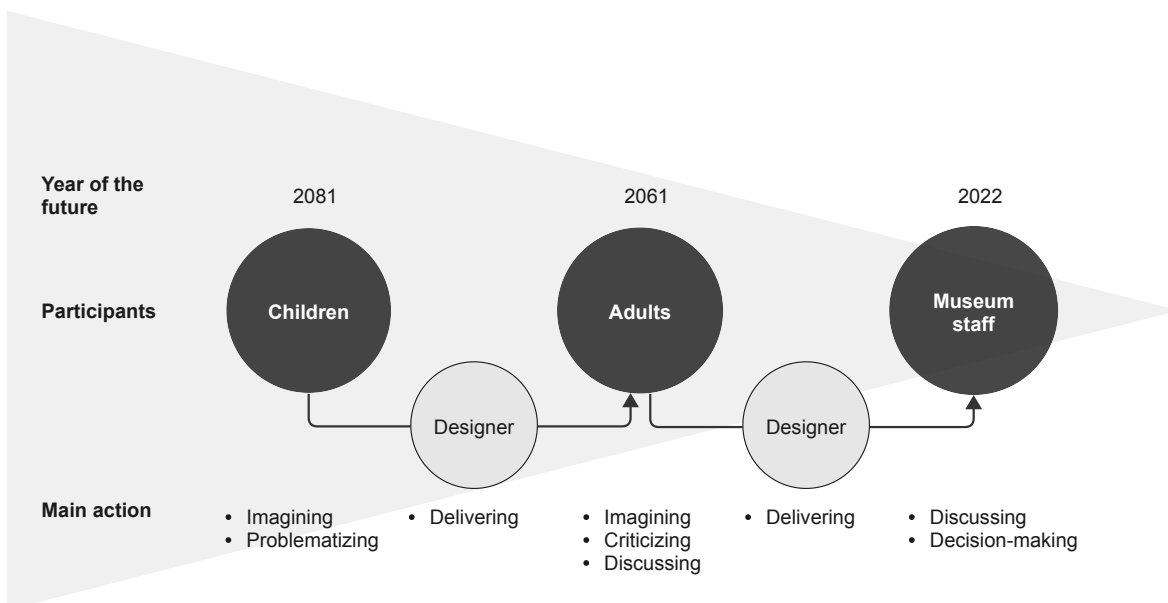


Figure 1. The series of workshops structured with a reversed futures cone.



Figure 2. Children participants listening to the storybook and exploring the museum.


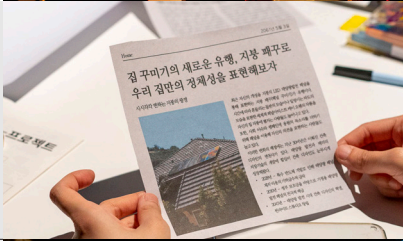


The young participants were then asked to revise their descriptions of the day in 2081, as the intention was to convey an empathic understanding about a possible climate scenario backed by the scientific community but not in a way that feels like a one-way communication. The children also toured around MMCA, and the facilitators took pictures of what they deemed to be wasteful (unsustainable) practices in the museum. During the tours, the facilitators suggested a few environmental issues as discussion points, including the number of brochures produced by the museum annually, the energy used to keep artworks intact, and the materials used during installation and waste generated in deconstructing exhibitions. By the end of the two-hour workshop, the children were encouraged to write a letter to the adults of the past from 2081, hence 2022, demanding the changes they want for a more sustainable museum.

The next phase of the project consisted of 8 workshops, starting with teenagers (12 participants in total), then people in their 20s (34 in total), later people between 30 and 45 (42 in total), and those beyond 46 (22 in total) each with two workshop sessions from September to November 2022. Similarly to the children’s workshops, we invited the older participants to imagine a day in life in 2061 and later rethink how the day may actually unfold, reflecting upon more

age-appropriate props—newspapers written and also designed based on the projections by IPCC. These newspapers included stories that helped participants imagine possible futures, such as the opening of a climate trauma therapy center and the tightening regulations on carbon credits (for examples of the newspaper contents, see Appendix B). They also contained advertisements for artificial lung implants due to the poor air quality and restaurants that specialize in meat substitutes that hire older people as meat sommeliers as they had had the chance to taste real meat when they were young.

During the workshops, participants were encouraged to share their thoughts about these stories with others around their table and later with all the workshop participants. Each table was then given one of the four speculative future scenarios of MMCA that were designed based on the letters written by the elementary school children during the first phase. These scenarios were intentionally made extreme and intended to spark discussions about the value of art under the climate crisis. The scenarios were: (1) a fully digitalized museum, (2) a 100% zero-waste art museum, (3) a museum that involuntarily takes breaks when the carbon emission hits a set limit, and (4) a museum that only opens exhibitions chosen by citizens (for fuller descriptions and accompanying discussion points, see Appendix C).

Table 1. Summary of artifacts devised and used.

Utilized in	Artifacts	Format	Synthesized from	Photographs from engagements
Phase 1	Storybook from future	Presentation slides with illustrations narrated in real-time	<ul style="list-style-type: none"> • IPCC AR6 Report 	
Phase 2	Newspaper from future	11 pieces of the articles printed on the newsprint paper and roughly cut	<ul style="list-style-type: none"> • IPCC AR6 Report 	
	Four extreme scenarios	Provocative scenarios for future museum operation with three "What-if" questions and related abstract images	<ul style="list-style-type: none"> • The letters from the participants in Phase 1 • Workshop records in Phase 1 	
Phase 3	Policy ideas	Three matrices in the temporal order on which the policy ideas are mapped (Current–near future–far future)	<ul style="list-style-type: none"> • GaaS toolkit by the Policy Lab • The letters and the workshop records in Phase 1 and 2 	

For example, one group was tasked to discuss the third scenario: “What if all public organizations, including MMCA, were assigned a carbon-emission limit and had to close their doors when emissions went over the threshold?” They were prompted to consider sub-questions such as “Who should set the annual carbon emission limit and how?” “Should we include or not include the carbon emissions from the visitors coming to the museum?” and “What should museum staff, cafes, and other vendors do if and

when the museum is closed?” These scenarios and questions aimed to encourage participants to immerse themselves in futuring and speculating, pushing their imaginations to the limit. The teenagers and adults who participated in these workshops were unaware that the scenarios and questions they discussed were the products of the children’s workshop, allowing for unbiased discussion and exploration of possible futures for the museum’s carbon-neutral future.



Figure 3. Teenagers and older reading fictitious newspaper articles.



Figure 4. Teenagers and older discussing and sharing about extreme museum scenarios.

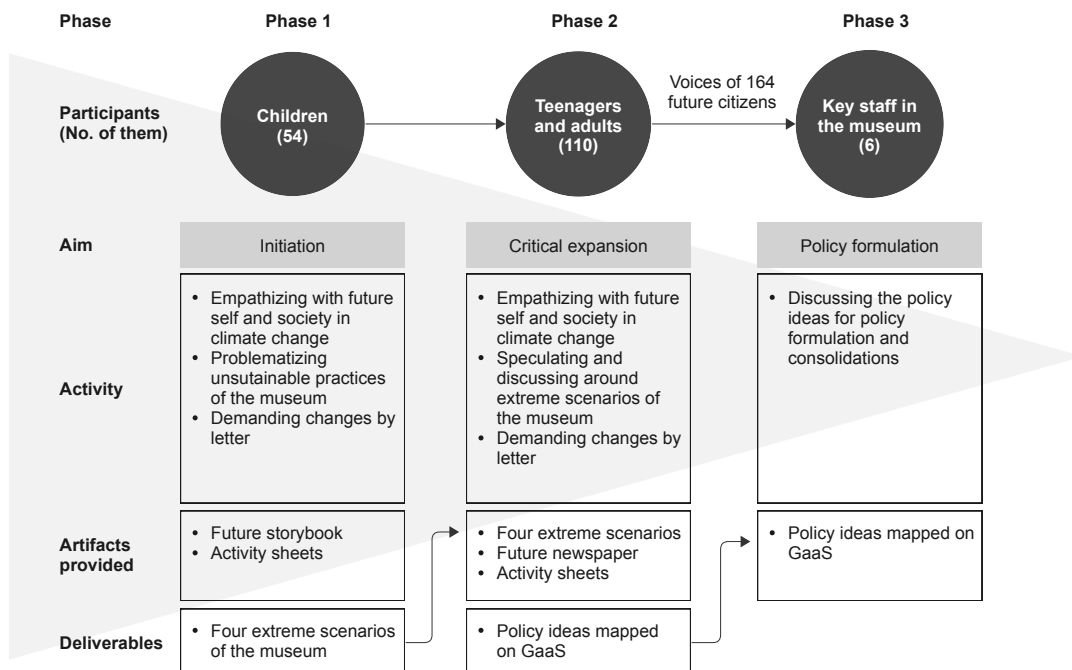


Figure 5. The series of workshops with their aims, activities, artifacts, and deliverables.

The third and last phase of the project entailed a workshop with six museum staff members, including the director, to operationalize policy ideas for sustainable future practices of MMCA. We synthesized a total of 624 insights from the participatory workshops—301 from the written letters by the citizens and 323 from the detailed records of the discussions recorded by the Lab—into 104 policy ideas. To indicate the nature of each policy idea, we situated them on the *Government as a System toolkit*, a framework devised by the UK Policy Lab (Siodmok, 2020) that shows 56 proactive government actions by two axes: the horizontal axis outlining from beginning to mature phases of policy ecosystem; and the vertical axis charting various approaches government can exert power from soft power including informing citizens and setting consensus to hard power such as legislating.

To deliver many policy ideas with the framework effectively, we sorted them into three temporal orders based on their level of complexity and need for further investigation: (a) those already

being realized to a more or lesser extent, (b) those that MMCA should pursue immediately, and (c) those we suggest MMCA to consider for a long-term strategy towards sustainability transition.

For example, using solar and geothermal energy or operating a customer advisory group belongs to category (a), as these are already in place. Ideas that should be pursued as soon as possible belong to category (b), for example, reducing carbon emissions by replacing and improving aging facilities or MMCA acting as an active collaborator with other science institutes and art schools to further the efforts and prepare future artists and curators. More ground-breaking ideas that involve large budgetary commitment and, thus, national politics are included in category (c), such as dismantling the large museums of today and creating numerous smaller exhibition halls across the country. Participants stated that this would allow the exhibitions to come close to where people reside rather than people driving far distance to the landmark museums, thereby promoting the use of public transport and reducing carbon emissions.

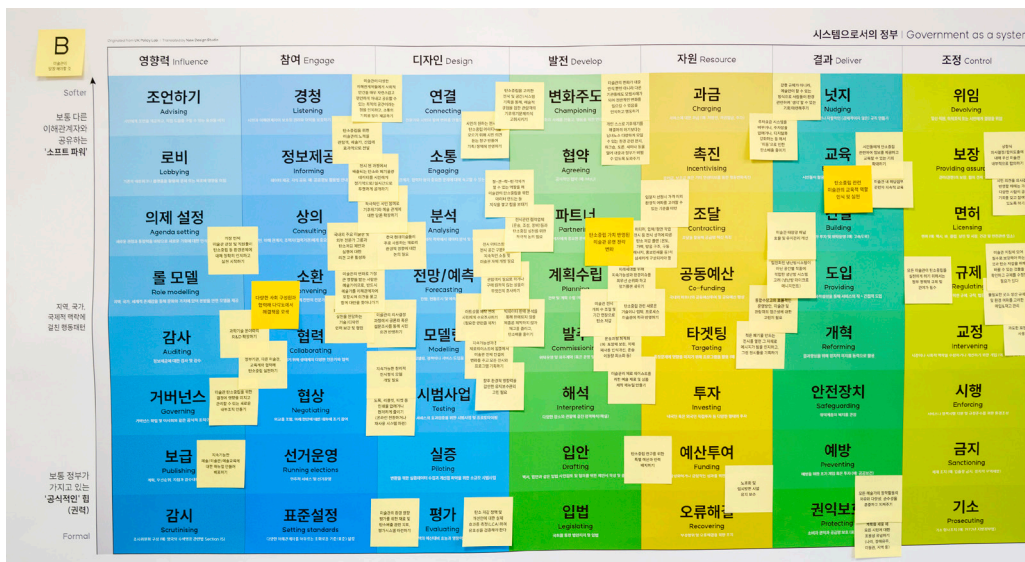


Figure 6. Policy ideas mapped onto the matrices of Government as a System toolkit (Category B in Korean).

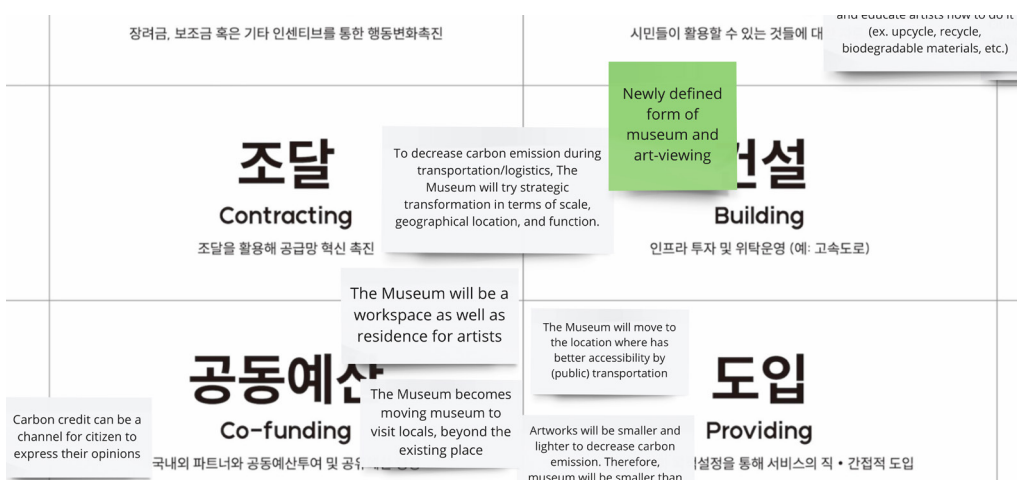


Figure 7. Policy ideas mapped onto the matrices of Government as a System toolkit (a partial view of Category C translated into English for this article).

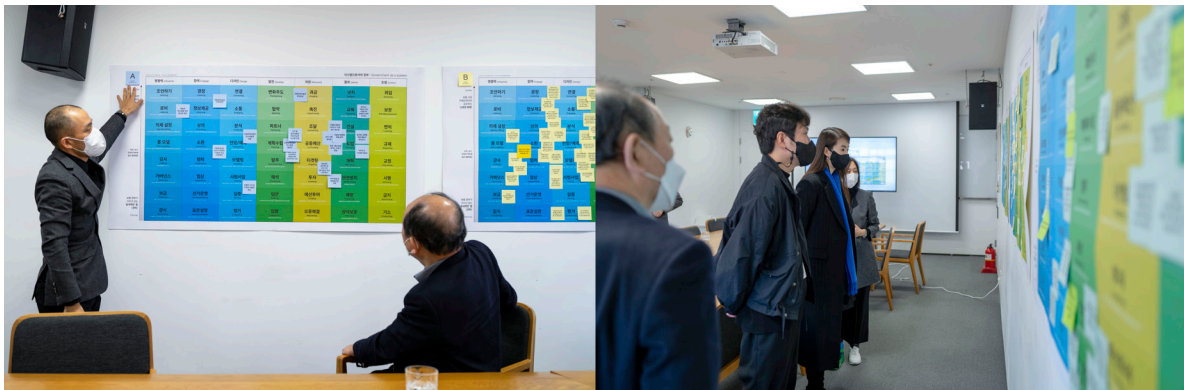


Figure 8. Project director presenting the outcomes to the head of MMCA and decision-makers.

Reflections: *Futuring with Citizens as One Way of Designing for Sustainability Transitions*

As the impact of climate change increasingly influence daily lives of everyone, there is an urgent need for transparent and pluralistic visioning processes to capture a wide range of views (Tuominen et al., 2014). Since successful sustainability transitions are only possible through the participation of various stakeholders, it is considered ideal to involve diverse actors during the process (Köhler et al., 2019). As the process of selecting participants is a democratic and political act (Gaziulusoy & Ryan, 2017a), it is essential to involve citizens with varying backgrounds for just transition and to overcome unsustainable dynamics (Tschersich & Kok, 2022). However, transitions research has largely been engaging those stakeholders, experts, and policymakers that have clear lines of interests or expertise, leaving citizen participation at the periphery (Huttunen et al., 2022) perhaps due to the challenges across few

dimensions (e.g., Candy, 2010; Clulow & Reiner, 2022; Kivimaa et al., 2019; Tschersich & Kok, 2022, for an extended discussion, see Literature Review). In what follows, we share our observations on how a series of workshops employing participatory futuring as the key approach, complemented with props and extreme scenarios, may have helped alleviate some of the challenges discussed earlier in facilitating sustainability transitions of MMCA. These observations are based upon the discussion between coauthors, as well as the text we have collected from citizen participants and our documentation during the project (Table 2).

Reflection 1: *Futures as a Democratic Space*

We observe that employing futures in our workshops may bear democratic potential that may lower the barriers to joining the discussion for socio-technical changes for sustainability transitions and offer an inclusive environment. Having invited museum visitors of different age groups and backgrounds, one of the big challenges we faced was the possible lack of knowledge

Table 2. Text collected from citizen participants during project⁵.

Phase	Participants	No. of participants & workshops	Type of data	No. of words	Language
Phase 1	Elementary school children	54 participants across 4 workshops	Letters written by workshop participants	2,070	English
	Teenagers	12 participants across two workshops	Letters written by workshop participants	603	English
Phase 2	Participants in their 20s	34 participants across two workshops	Documentation of the workshop discussion by designers	4,025	English
			Letters written by workshop participants	3,017	English
	Participants between 30-45	42 participants across two workshops	Documentation of the workshop discussion by designers	2,103	English
			Letters written by workshop participants	2,376	English
	Participants over 46	22 participants across two workshops	Documentation of the workshop discussion by designers	2,947	English
Letters written by workshop participants	1,437	English			
Phase 3	Museum director and six museum staff members	6 participants in 1 workshop	Documentation of the workshop discussion by designers	1,894	Korean

and expertise of the participants, and thus, their being potentially passive during the workshops. As discussed earlier, the Customer Advisory Group and the staff of MMCA and its foundation displayed varied levels of knowledge about climate change and the necessary actions (see *Preparation* under *Case*). To engage participants in developing policy ideas for sustainability transition, we created a setting in which our participants take on the role of future citizens that demand the museum of today to take actions. We observed that what-if features of futures helped the participants quickly immerse themselves in the stories provided and start discussing necessary changes for the museum to make.

A participant wrote in the letter at the end of the workshop, “The time, space, and atmosphere where I and other people could freely share thoughts without burden or prejudice [...] I think it was the only place such things are possible” (participant in the morning session for over 46, 15 Oct). Another participant recognized the usefulness of the futuring approach of the workshop in stating, “Only by today, I have come to think about ‘carbon’ and ‘museum’ together. I also want to talk about this topic with more people” (participant in the morning session for the 20s, 17 Sep). These statements show how participatory futuring employed in our workshops may have lowered the expected level of expertise often deemed necessary in discussing sustainability transitions and thereby create an inclusive environment (see more excerpts from the letters, see Appendix D).

In discussing her craft in science fiction writing, Le Guin describes the potential of future imagination as “a safe, sterile laboratory for trying out ideas [...] a means of thinking about reality, a method” (Gunn, 2014). Similarly, Irwin (2018) emphasized the potential of design speculation to act as a catalyst for collectively redefining our relationship to reality, by inspiring and encouraging people’s imagination and creating spaces for debate. Mazé (2019) described how ideas about the future function as rhetorical, artistic, or literary instruments to keep a *critical distance* from the present and to explore diverse possibilities (p. 33). Our experience during the Project confirms these views. The use of *what-if* features of futures helped the participants move away from the present and navigate these complex socio-technical issues that are typically seen as requiring a high level of expertise and thus only being manageable by engineers, scientists, and politicians. Accommodating participants with diverse backgrounds in different age groups in the bottom-up policy design process, we hereby deem *futures* to be a democratic space where citizens of different walks of life can freely express their thoughts and ideas with reduced concerns about age, experience, and expertise.

Reflection 2: Extreme Scenarios for Engaging and Constructive Discussions

When inviting citizens with diverse backgrounds to imagine sustainability transitions together, the participants may experience difficulties in having constructive discussions due to differences in perspectives and values (e.g., Tschersich & Kok, 2022). Also, there is an *experiential gulf* in-between reality and the imagined future (Candy, 2010, p. 320) that may hinder reflexive experiences that surpass the status quo (Tseklevs et al., 2022).

During the Project, we witnessed the usefulness of extreme scenarios and the degree of absurdity used in them when imagining sustainability transitions of MMCA with citizen participants. As discussed earlier, we provided the teen and adult participants with four extreme scenarios synthesized from the demands of the elementary school children while ensuring enough freedom to decide whether the scenario make sense. Again, the scenarios were: (1) a fully digitalized museum, (2) a 100% zero-waste art museum, (3) a museum that involuntarily takes breaks when the carbon emission hits a set limit, and (4) a museum that only opens exhibitions chosen by citizens (see Appendix C). Our goal in devising such provocative scenarios was to let participants immerse, rethink, and question, and in doing so, engage with the complex and dynamic nature of the socio-technical challenges surrounding the carbon neutrality of the museum. The scenarios sparked heated debates. Many participants criticized the scenarios for their extremity and/or absurdity, shared their own experiences and values, and proposed alternative approaches for sustainability transitions. For example, one group discussing about the zero-waste museum scenario drastically expanded the scope of their discussion from a narrowly defined one about waste reduction to a complex and holistic one dealing with various facets of the goal. The participants were first interested in the use of materials in creating artworks but soon became interested in challenges and opportunities for creativity under the climate crisis; the sizes of artworks and museums would become smaller due to strict regulations upon carbon emission; the mobility of artworks and museumgoers would also be restricted, revitalizing the ethnic and regional qualities of artworks; and the widespread access to enjoying art of today might be dramatically reduced. Conversing about a museum that only opens exhibitions chosen by citizens, another group rejected the scenario entirely, stating that such a scheme may turn important public art museums into populist platforms, making the roles highly educated and valued curators play obsolete. Thus, we observe that extremity integrated with familiar and mundane objects helps in posing fundamental questions about existing systems.

Dunne and Raby (2013) argue for the importance of extreme concepts in absurd or ridiculous forms for thought experiments drawn on *reductio ad absurdum* (pp. 80-82). They postulate that error, fallacy, complexity, or difficulty can be revealed by the opposite of our everyday lives. Exploring the politics of integrating design and futures, Candy (2010) shares a similar view, albeit more from the audience’s experience. Using the expression *the art of double take*, Candy states that the audience is invited twice when encountering an extreme concept: first, the absurd but compelling looks catch the audience’s eyes, and then they are made to rethink and question. During this process, the audience gradually discerns the underlying logic. He argues that if a challenging concept is in an ordinary and familiar form, the audience would have a closer look at it, and the underlying meaning would begin to unfold (Candy, 2010). As such, extreme concepts aspire for intellectual impact by stirring thought and challenging the status quo (Tharp & Tharp, 2022), which may lead to changes in behaviors and thoughts, facilitating transitions (García & Gaziulusoy, 2021).

Our experience in employing extreme scenarios during the Project supports these insights. We observe that the atmosphere created by the extreme scenarios engendered a lively and healthy environment for engaging discussions and novel alternatives, which further enhanced the democratic potential of participatory futuring for sustainability transitions. In addition, since the scenarios were based upon the children's imaginations and synthesized by the designers who intended to empower the young participants, such an approach shed light on a novel way of developing democratic agency and governance in participatory workshops for sustainability transitions.

Reflection 3: Translation by Designers as Intermediaries Contributing to the Interplay Between Niche and Regime

Societal transformations undergo co-evolution of technologies, users, policies, institutions, routines, and so on over a long period of time (Geels, 2002). Although not all radical innovations lead to regime change, the cumulation of niche experiments interacts with regimes and landscapes before becoming applied in institutions (Geels, 2002). The role of intermediaries as translators thus becomes a key in bridging niches and regimes (Ehnert, 2023; Kivimaa et al., 2019) overcoming the strong force to maintain the status quo with the entrenched system (Köhler et al., 2019; Pel, 2016).

We notice that the role of designers as an intermediary contributes to the interplay between niche and regime translating participants' voices and language across the series of workshops. As described earlier, *futures* employed for the series of workshops lowered barriers for participants, and the use of extreme scenarios sparked lively and constructive discussions. In so doing, the designers of the Lab took an active role in bridging different groups of participants—we synthesized the results of children's workshops into extreme scenarios of the carbon-neutral future of MMCA and analyzed the discussed of adult participants, mapping them as policy ideas onto the Government as System matrices (see *A Series of Workshops* under *Case*). Immersing into critical discussions enabled by synthesis of previous phases, the participants gradually became advocates for MMCA's efforts pursuing the change process, not only sharing their opinions in team discussions but also expressing their willingness to sacrifice their convenience or to be involved in the following phases of the change process. For example, one participant during a workshop devised a list of inconveniences she could embrace as a visitor for the museum's transition towards sustainability, such as more expensive ticket prices, colder tap water, and so on. Another participant wrote in the letter, "I would like you to publish and promote [the museum's systematic plan to reduce carbon emission] to the public and continue to provide opportunities for such civic participation like today" (participant in the morning session for 20s, 17 Sep, bracket added by authors). Through this process, the museum could learn more about the diverse perspectives on the issues around climate change and carbon neutrality, including citizens' values and preferences and the acceptability for the necessary changes to be made.

Though *niches* create disruptive experiments while *regimes* tend to maintain the status quo, they still interact and co-evolve, leading to changes in routines, policies, and institutions (Pel, 2016). In exploring citizen engagement for rapid energy transitions, Nijkamp et al. (2023) find collecting citizens' voices helpful in developing and distributing public policy and services in the long term. In the transition design approach, the root cause of socio-technical problems is often found to be related to stakeholders' emotions (Irwin, 2018). The process of acquiring advocates, therefore, can enhance social legitimation as a *social license to operate* (Reeves et al., 2016, p. 16). We hereby postulate that the active role we took as intermediaries *translating* in-between different groups of citizens in participatory futuring may answer the call for creative methods to deepen citizen engagement for transitions (Huttunen et al., 2022).

Reflection 4: Design Capabilities Required to Enable Participatory Futuring for Sustainability Transitions

As participatory futuring for sustainability transitions is still an emerging phenomenon (e.g., Gaziulusoy & Erdoğan Öztekin, 2019; Hyysalo et al., 2014; Irwin, 2018) and thus relatively fresh research topic in design, the capabilities required for designers to successfully contribute to the process remain relatively vague. Whereas new ways of designing are called for transitions (Irwin, 2015), there is a theoretical effort to connect transitions research with existing studies of design action (Lähteenoja et al., 2023). Exploring necessary design capabilities for transitions is an important agenda for the evolution of the practice, as design disciplines differ from one another in terms of their artifacts, tools, skills, knowledge, process, involvements, and social aspects (Carvalho et al., 2009; Visser, 2009). Our experience during the MMCA project reported in this paper can provide some evidence of what design capabilities are required and demonstrate how design(ers) can contribute to enabling participatory futuring for sustainability transitions. We derive visual storytelling, facilitation, and synthesis.

First, to help the citizen participants to immerse themselves in futuring, critically examine relevant issues, and reflect upon them as future selves, the designers of the Lab created various artifacts with design fiction that combines scientific projections for robust settings and fictional stories for empathy. During this process, visual storytelling has played a key role in synthesizing these two sets of information and creating a storybook for younger citizens and future newspapers for older ones. In exploring the roles of design in sustainability transitions, Gaziulusoy and Ryan (2017a) discuss the usefulness of *visual snapshots* in envisioning and iteratively developing "emerging disruptive technological and social innovations that could assist with low-carbon transitions" (p. 1300). In doing so, the project is reported to develop visions, scenarios, and pathways towards a more sustainable future. In the museum project reported in this paper, visual storytelling was used slightly more as an informing and sensitizing tool that helped the participants quickly and empathetically comprehend the

consequences of climate change, i.e., to effectively narrow the gap between unexperienced climate futures and lived reality (Candy, 2010, p. 320). This was important because the Lab invited people from all walks of life who showed varied levels of knowledge about the challenge. Many of the participants expressed how the visceral experience from the visual storytelling helped them seriously and constructively discuss the carbon-neutral futures of the museum and ideate for concrete actions. Therefore, we see visual storytelling as a critical design capability in order to encourage experiential reflection about a future and drive the chain processes with different age groups. That said, one should also be cautious because form-giving is a highly political action as the selection and exclusion, by implication, represent designers' preferences and prioritization about the future (Mazé, 2019).

In addition to the visual storytelling, we, as designers of the Lab, have actively facilitated the workshops with the citizen participants for positive and lively interactions, as well as a constructive atmosphere for fruitful discussions. In transition processes that involve multiple types of actors, tensions that arise between them need to be carefully facilitated (Scholz & Methner, 2020). Explicitly analyzing design facilitation practices in two real-life cases, Aguirre et al. (2017) discuss what they deem as *contextually designed facilitation tools*. This is somewhat similar to our approach above in that both projects involved designing expressive tools to allow co-creation. That said, the project with MMCA reported in this paper extends the notion towards carefully tailored and situated practices to allow more critical discussions. As noted earlier (see *A Series of Workshops under Case*), we prepared a list of provocative questions to stir thoughts and enable critical discussions as discussion guidelines for each of the four extreme scenarios derived from the outcomes of children's workshops. In addition to this, we prepared a facilitator guideline listing examples from around the world that share similarities with the scenario in the discussion. The examples were not readily available to the participants, and the designers only mentioned these examples when the discussion stalled or if the participants did not have much to talk about due to the lack of prior exposure to the issues around the scenario. To this end, despite the central role of visual storytelling, we consider facilitation as an important design capability that seamlessly connects the visual storytelling with the rest of the activities and enables discussions across participants with different backgrounds when pursuing participatory futuring for sustainability transition.

Finally, engaging with citizens across many generations, our ambition was to ensure the result of the workshops with children influence the following ones with older citizens and museum staff. In doing so, we analyzed the qualitative data, and transformed and visualized them into persuasive concepts. In other words, we translated and synthesized the outcome of workshops into the four extreme future scenarios of MMCA to spark constructive discussions towards the carbon-neutral futures of the museum. Further, after concluding all the workshops with the citizens, we derived 104 practical policy ideas from the participants' discussions and mapped them onto the UK Policy Lab's Government as a System toolkit (Siodmok, 2020)

and delivered the resulting matrix to the museum staff. Both above-mentioned activities show strong cases of synthesis where designers play an important role in transforming data into tools for discussion and collaboration. Refining design-oriented approaches in public administration, Hermus et al. (2020) see design as a method for creatively and collaboratively *translating* knowledge to enable broader participation for co-creation and to tackle wicked problems (pp. 15-16). Lockton and Candy (2019) also highlighted the translating and mediating roles of design in future imaginations for transitions. Our approach in this project is strongly in line with this conceptualization and thus legitimizes designers' ability to synthesize as an important capability to allow participation, discussion, and co-creation.

Discussion

Offering a concrete example of participatory futuring for sustainability transition, we report on an experimental policymaking process in a public art museum in Korea that involved citizens from elementary school students to elders in the relay. Our reflections show that participatory futuring may: (1) bear democratic potential (e.g., Gaziulusoy & Ryan, 2017a) by reducing the burden of expertise required for creating technical solutions for citizen participants; (2) enable engaging and constructive discussions due to the extreme concepts (e.g., Candy, 2010; Dunne & Raby, 2013); (3) accompanied by translation of designers as intermediaries, contribute to the interplay between niches and regimes (e.g., Pei, 2016). They also show that the required design capabilities for participatory futuring for sustainability transition include visual storytelling (e.g., Gaziulusoy & Ryan, 2017a), facilitation (e.g., Scholz & Methner, 2020), and synthesis (e.g., Hermus et al., 2020). Sharing the reflections above, we aim to narrow the gap in DfST research by contributing to the concretization and operationalization of its ideal (Gaziulusoy & Erdoğan Öztekin, 2019; Irwin, 2018).

The museum here can be seen as a space for niche experiments as niches are *incubation rooms* in transitions that protect experiments from the dominant regime (Geels, 2002) with the potential to function as real-life test beds like Living Labs (Salgado, 2013). The Project was part of a broader interdisciplinary art program of MMCA that not only holds exhibitions but also desires to change its behaviors or systems by making synergy with external specialists of diverse backgrounds. That said, art museums as public institutions have complex relationships between niches and regimes in transition processes: there is public dissatisfaction with the distance from the public voices to institutions, while museum experts fear losing control if/when visitors are empowered (Simon, 2010). As such, the museum can be seen not only as a unique space for niche experiments but also as a window that provides insights into the interaction of niches and regimes.

In what follows, we discuss the challenges we experienced as the designers deeply involved in the policy design experiment and the opportunities to pursue overcoming them in terms of bridging the gap between creating policy ideas, planning for actions, and experimenting with the segmentation of participants groups for a more including policymaking process.

First, to design policy utilizing the imagination from multi-stakeholders, it is necessary to bridge the gap between creating viable policy ideas and planning implementable actions. With the intention to embrace various groups' hopes and wishes, we devised a stepwise process that engages participants according to their age groups and designed the activities and materials accordingly. First, children, perhaps without clear intention, expanded the discourse by expressing unbounded and vigorous imagination. Secondly, older participants critically examined the outcome of the workshops by younger participants and provided alternative paths through discussion. Then, the Lab synthesized the outcomes of all citizen workshops into viable policy ideas. As the final step, the MMCA staff were informed about the results of the series of workshops and tasked to plan implementable actions using their own expertise working in the museum. However, we identify a significant gap between the futures envisioned by citizens and the actionable changes discussed by the museum staff. While synthesizing data from the workshops, we left some of the value-laden opinions without a clear link to carbon neutrality behind to ensure the eventual policy ideas delivered to the museum were actionable and at a similar granular level. For instance, some of the participants demanded that the museum should pursue diversity or balance artists' creativity and the protection of the environment. The museum staff, despite our wishes, allocated only an hour to explore the resulting policy ideas, which severely limited the possibility to focus on planning implementable actions. What is more, only staff from the exhibition department participated in the final workshop, and those dealing with the museum's strategy were not invited due to internal politics.

We were told that this was due to the fact that the Project was an experiment within an art program under the exhibition team and not commissioned as a stand-alone policy and strategy project. Further, as the first-time practitioner of a policy design experiment, the Lab did not succeed in communicating with the key incumbent stakeholders of MMCA from early on. Perhaps this is not surprising, as public institutions have their culture, mechanisms of the policymaking process, and ways of communication (Bailey & Lloyd, 2017) and there is a deficiency of codesign workshops in legitimacy or accountabilities that the established systems of the institutions have (Kimbell, 2019). As this challenge is considered a common phenomenon in the bottom-up policy design process for transitions, sophisticated translation, and strategy are required for its dialectic development (Pel, 2016).

If practically possible, future practitioners could make an effort to build relationships with key stakeholders from an early stage and formalize their participation throughout the process to narrow the gap between creating policy ideas and planning actions. In particular, one could investigate the policymaking process and related factors of a partnering institution from the initial phase of a policy design process. Further, open and inclusive discussion sessions could be pursued to put forward a constructive environment for an exploratory policy design process despite the internal interest or/and power structures of the institution.

Second, we suggest a way to design inclusive participatory workshops by adapting variations of our approach and experimenting with the segmentation of participant groups. As

discussed earlier, our intention in inviting elementary school children was to empower them in facilitating the necessary policy change toward an environmentally sustainable future (see *A Series of Workshops* under *Case*). We created the four extreme scenarios from the results of the workshops with the young participants by analyzing the workshop results considering the following two aspects: (1) the direction of power and legitimacy flowing in the policymaking process (bottom-up or top-down) and (2) the two pillars of climate change responses (mitigation or adaptation). The resulting scenarios had the effect of pulling the discussions among the older participants to an extreme and giving rise to lively engagements and rich conversations. To prevent preconceptions, we concealed how we derived the extreme scenarios from the participants until their discussions concluded. Nevertheless, the stories and scenarios from the previous workshops with the young participants played a key role in our policy design experiment.

Similarly, future practitioners in DfST could invite and empower marginalized citizen groups in policy design endeavors. For instance, they could empower certain groups of citizens by differentiating the segmentation; for example, wheelchair users could be invited as the first participant group of the workshop series to set the norms that affect later participant groups. Practitioners could try experimenting with the segmentation for inclusive policymaking processes, such as physical ability, societal status, and cultural backgrounds. In this way, one can try out new agencies for both designers and participants in transition processes (Lähteenoja et al., 2023). In discussing the politics of design artifacts and the relationships with participation, Opazo et al. (2017) argue that the narratives given to participants could lead to political imagination involving *instituting and dismantling dimensions* (p. 82). During the Project, the scenarios and design fictions varied in terms of the age of participants (young to old), years (2081 or 2061), and fictitious future policy situations (four of them) to express the future full of uncertainties. We believe such designed variations leave ample room for imagination to be applied to policy design projects with other types of public institutions, as well as communities with different contexts.

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Endnotes

1. The team included an assistant professor (the corresponding author) as the project director, three master's students (one of them being the first author), and two bachelor's students in the design department. The university, like a few other research-driven public universities, fosters a hybrid learning environment where students participate in real-life projects from their early years and gain professional experiences.
2. MMCA's education department maintains a Children Advisory Group (referred to as '어린이자문단' in Korean) to test and evaluate new ideas for creating innovative educational programs. Typically consisting of ten to twenty children within the target age group, these sessions allow curators and researchers to observe children's engagements and reactions. At the conclusion of each session, the children provide written feedback, which, combined with the recorded observations, assists the department in further developing their program.
3. The Ministry that funds MMCA maintains a non-paying Customer Advisory Group (referred to as '고객자문단' in Korean) to explore emerging trends in the cultural scene and gather insights from its core visitors. The group consists of members of diverse ages and professional backgrounds. They convene regularly, usually once a month, throughout their one-year tenure and deliver brief presentations on various topics. In 2022, the themes covered included the carbon neutrality of art museums, online marketing strategies, and enhancing the museum's membership program.
4. As a publicly funded museum, it is not allowed to make a profit outside ticket sales. Therefore, MMCA has a foundation that deals with all the profitable activities—renting out spaces to museum shop, bookstore, cafes, and restaurants.
5. Having worked with an international team member who was not a native Korean speaker, the Lab has conducted the project in English—often translating the letters written in Korean to English and documenting the workshops directly in English. However, Phase 3 was conducted in Korean as the international team member's graduation coincided with the second last workshop before the one with the museum staff.
4. Badke-Schaub, P., & Frankenberger, E. (1999). Analysis of design projects. *Design Studies*, 20(5), 465-480. [https://doi.org/10.1016/S0142-694X\(99\)00017-4](https://doi.org/10.1016/S0142-694X(99)00017-4)
5. Bailey, J., & Lloyd, P. (2017). The introduction of design to policymaking: Policy lab and the UK government. In *Proceedings of the DRS international conference on future focused thinking* (pp. 3621-36331). Design Research Society. <https://doi.org/10.21606/drs.2016.314>
6. Bibri, S. E. (2018). Backcasting in futures studies: A synthesized scholarly and planning approach to strategic smart sustainable city development. *European Journal of Futures Research*, 6, Article No. 13. <https://doi.org/10.1186/s40309-018-0142-z>
7. Bleecker, J. (2009). *Design fiction: A short essay on design, science, fact and fiction*. Near Future Laboratory.
8. Candy, S. (2010). *The futures of everyday life: Politics and the design of experiential scenarios* (Doctoral dissertation). University of Hawaii. <https://doi.org/10.13140/RG.2.1.1840.0248>
9. Carvalho, L., Dong, A., & Maton, K. (2009). Legitimizing design: A sociology of knowledge account of the field. *Design Studies*, 30(5), 483-502. <https://doi.org/10.1016/j.destud.2008.11.005>
10. Ceschin, F. (2014). How the design of socio-technical experiments can enable radical changes for sustainability. *International Journal of Design*, 8(3), 1-21.
11. Choi, H., Kim, J. J., & Kang, C. (2020). South Korean perception on climate change. *Issue Brief*. The Asan Institute for Policy Studies. <https://en.asaninst.org/contents/south-korean-perception-on-climate-change/>
12. CiMAM. (2021, July 6). *Toolkit on environmental sustainability in the museum practice*. <https://cimam.org/news-archive/toolkit-on-environmental-sustainability-in-the-museum-practice/>
13. Clulow, Z., & Reiner, D. M. (2022). Democracy, economic development and low-carbon energy: When and why does democratization promote energy transition? *Sustainability*, 14(20), Article No. 13213. <https://doi.org/10.3390/su142013213>
14. Crilly, N. (2015). Fixation and creativity in concept development: The attitudes and practices of expert designers. *Design Studies*, 38, 54-91. <https://doi.org/10.1016/j.destud.2015.01.002>
15. Crutzen, P. J., & Stoermer, E. F. (2021). The 'Anthropocene' (2000). In S. Benner, G. Lax, P. J. Crutzen, U. Pöschl, J. Lelieveld, & H. G. Brauch (Eds.), *Paul J. Crutzen and the anthropocene: A new epoch in earth's history* (pp. 19-21). Springer International Publishing. https://doi.org/10.1007/978-3-030-82202-6_2
16. Daalhuizen, J. J. (2014). *Method usage in design: How methods function as mental tools for designers* (Doctoral dissertation). Delft University of Technology. <https://doi.org/10.4233/uuid:4ac01165-c6b5-4057-a2fe-3418907f251e>
17. Dorst, K. (2015). *Frame innovation: Create new thinking by design*. The MIT Press.

References

1. Aguirre, M., Agudelo, N., & Romm, J. (2017). Design facilitation as emerging practice: Analyzing how designers support multi-stakeholder co-creation. *She Ji: The Journal of Design, Economics, and Innovation*, 3(3), 198-209. <https://doi.org/10.1016/j.sheji.2017.11.003>
2. Angheloiu, C., Sheldrick, L., & Tennant, M. (2020). Future tense: Exploring dissonance in young people's images of the future through design futures methods. *Futures*, 117, Article No. 102527. <https://doi.org/10.1016/j.futures.2020.102527>
3. Armstrong, L., Bailey, J., Julier, G., & Kimbell, L. (2014). *Social design futures: HEI research and the AHRC*. University of Brighton.

18. Dorst, K., & Cross, N. (2001). Creativity in the design process: Co-evolution of problem–solution. *Design Studies*, 22(5), 325-437. [https://doi.org/10.1016/S0142-694X\(01\)00009-6](https://doi.org/10.1016/S0142-694X(01)00009-6)
19. Dunne, A., & Raby, F. (2013). *Speculative everything*. The MIT Press.
20. Ehnert, F. (2023). Bridging the old and the new in sustainability transitions: The role of transition intermediaries in facilitating urban experimentation. *Journal of Cleaner Production*, 417, Article No. 138084. <https://doi.org/10.1016/j.jclepro.2023.138084>
21. Flyvbjerg, B. (2006). Five misunderstandings about case-study research. *Qualitative Inquiry*, 12(2), 219-245. <https://doi.org/10.1177/1077800405284363>
22. Fry, T. (1999). *A new design philosophy: An introduction to defuturing*. UNSW Press.
23. Fry, T. (2008). *Design futuring: Sustainability, ethics and new practice*. Bloomsbury Publishing.
24. García, C. G., & Gaziulusoy, İ. (2021). Designing future experiences of the everyday: Pointers for methodical expansion of sustainability transitions research. *Futures*, 127, Article No. 102702. <https://doi.org/10.1016/j.futures.2021.102702>
25. Gaziulusoy, A. İ., & Ryan, C. (2017a). Roles of design in sustainability transitions projects: A case study of visions and pathways 2040 project from Australia. *Journal of Cleaner Production*, 162, 1297-1307. <https://doi.org/10.1016/j.jclepro.2017.06.122>
26. Gaziulusoy, A. İ., & Ryan, C. (2017b). Shifting conversations for sustainability transitions using participatory design visioning. *The Design Journal*, 20(sup1), S1916-S1926. <https://doi.org/10.1080/14606925.2017.1352709>
27. Gaziulusoy, İ., & Erdoğan Öztekin, E. (2019). Design for sustainability transitions: Origins, attitudes and future directions. *Sustainability*, 11(13), Article No. 3601. <https://doi.org/10.3390/su11133601>
28. Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy*, 31(8-9), 1257-1274. [https://doi.org/10.1016/S0048-7333\(02\)00062-8](https://doi.org/10.1016/S0048-7333(02)00062-8)
29. German Federal Cultural Foundation. (2021). *Carbon footprinting in cultural institutions: Documentation of the pilot project and work materials*. https://www.kulturstiftung-des-bundes.de/fileadmin/user_upload/Klimabilanzen/Carbon-Footprinting-in-Cultural-Institutions.pdf
30. Goldschmidt, G. (1997). Capturing indeterminism: Representation in the design problem space. *Design Studies*, 18(4), 441-455. [https://doi.org/10.1016/S0142-694X\(97\)00011-2](https://doi.org/10.1016/S0142-694X(97)00011-2)
31. Gunn, E. (2014, May). How America's leading science fiction authors are shaping your future. *Smithsonian Magazine*. <https://www.smithsonianmag.com/arts-culture/how-americas-leading-science-fiction-authors-are-shaping-your-future-180951169/>
32. Ha, J. W., Jeon, E.-C., & Park, S. K. (2023). Status of environmental awareness and participation in Seoul, Korea and factors that motivate a green lifestyle to mitigate climate change. *Current Research in Environmental Sustainability*, 5, Article No. 100211. <https://doi.org/10.1016/j.crsust.2023.100211>
33. Heapy, J., King, O., & Samperi, J. (2018). *Customer-driven transformation: How being design-led helps*. Kogan Page.
34. Heidingsfelder, M., Kimpel, K., Best, K., & Schraudner, M. (2015). Shaping future—Adapting design know-how to reorient innovation towards public preferences. *Technological Forecasting and Social Change*, 101, 291-298. <https://doi.org/10.1016/j.techfore.2015.03.009>
35. Hermus, M., van Buuren, A., & Bekkers, V. (2020). Applying design in public administration: A literature review to explore the state of the art. *Policy & Politics*, 48(1), 21-48. <https://doi.org/10.1332/030557319X15579230420126>
36. Hölscher, K., Frantzeskaki, N., Jäger, J., Holman, I., & Pedde, S. (2022). Co-producing transformative visions for Europe in 2100: A multi-scale approach to orientate transformations under climate change. *Futures*, 143, Article No. 103025. <https://doi.org/10.1016/j.futures.2022.103025>
37. Hussain, S., Sanders, E. B. N., & Steinert, M. (2012). Participatory design with marginalized people in developing countries: Challenges and opportunities experienced in a field study in Cambodia. *International Journal of Design*, 6(2), 91-109.
38. Huttunen, S., Ojanen, M., Ott, A., & Saarikoski, H. (2022). What about citizens? A literature review of citizen engagement in sustainability transitions research. *Energy Research and Social Science*, 91, Article No.102714. <https://doi.org/10.1016/j.erss.2022.102714>
39. Hyysalo, S., Hyysalo, V., & Hakkarainen, L. (2019a). The work of democratized design in setting-up a hosted citizen-designer community. *International Journal of Design*, 13(1), 69-81.
40. Hyysalo, S., Kohtala, C., Helminen, P., Mäkinen, S., Miettinen, V., & Muurinen, L. (2014). Collaborative futuring with and by makers. *CoDesign*, 10(3-4), 209-228. <https://doi.org/10.1080/15710882.2014.983937>
41. Hyysalo, S., Marttila, T., Perikangas, S., & Auvinen, K. (2019b). Codesign for transitions governance: A mid-range pathway creation toolset for accelerating sociotechnical change. *Design Studies*, 63, 181-203. <https://doi.org/10.1016/j.destud.2019.05.002>
42. Ilstedt, S., & Wangel, J. (2014). Altering expectations: How design fictions and backcasting can leverage sustainable lifestyles. In *Proceedings of the DRS conference on design's big debates*. Design Research Society. <https://doi.org/10.13140/2.1.4127.1688>
43. Intergovernmental Panel on Climate Change. (2023). *Climate change 2022: Impacts, adaptation and vulnerability*. Cambridge University Press. <https://doi.org/10.1017/9781009325844>
44. Irwin, T. (2015). Transition design: A proposal for a new area of design practice, study, and research. *Design and Culture*, 7(2), 229-246. <https://doi.org/10.1080/17547075.2015.1051829>
45. Irwin, T. (2018). The emerging transition design approach. In *Proceedings of the DRS conference on design as a catalyst for change* (pp. 968-989). Design Research Society. <https://doi.org/10.21606/drs.2018.210>

46. Irwin, T., Kossoff, G., & Tonkinwise, C. (2015). Transition design provocation. *Design Philosophy Papers*, 13(1), 3-11. <https://doi.org/10.1080/14487136.2015.1085688>
47. Kimbell, L. (2019). What if there were more policy futures studios? *Journal of Futures Studies*, 23(4), 129-136. [https://doi.org/10.6531/JFS.201906_23\(4\).0014](https://doi.org/10.6531/JFS.201906_23(4).0014)
48. Kivimaa, P., Boon, W., Hyysalo, S., & Klerkx, L. (2019). Towards a typology of intermediaries in sustainability transitions: A systematic review and a research agenda. *Research Policy*, 48(4), 1062-1075. <https://doi.org/10.1016/j.respol.2018.10.006>
49. Köhler, J., Geels, F. W., Kern, F., Markard, J., Onsongo, E., Wiczorek, A., Alkemade, F., Avelino, F., Bergek, A., Boons, F., Fünfschilling, L., Hess, D., Holtz, G., Hyysalo, S., Jenkins, K., Kivimaa, P., Martiskainen, M., McMeekin, A., Mühlemeier, M. S., ... Wells, P. (2019). An agenda for sustainability transitions research: State of the art and future directions. *Environmental Innovation and Societal Transitions*, 31, 1-32. <https://doi.org/10.1016/j.eist.2019.01.004>
50. Kozubaev, S., Elsdén, C., Howell, N., Søndergaard, M. L. J., Merrill, N., Schulte, B., & Wong, R. Y. (2020). Expanding modes of reflection in design futuring. In *Proceedings of the conference on human factors in computing systems* (pp. 1-15). ACM. <https://doi.org/10.1145/3313831.3376526>
51. Lähteenoja, S., Marttila, T., Gaziulusoy, İ., & Hyysalo, S. (2023). Transition co-design dynamics in high level policy processes. *Design Studies*, 88, Article No. 101207. <https://doi.org/10.1016/j.destud.2023.101207>
52. Leifer, L. J., & Steinert, M. (2011). Dancing with ambiguity: Causality behavior, design thinking, and triple-loop-learning. *Information Knowledge Systems Management*, 10(1-4), 151-173. <https://doi.org/10.3233/IKS-2012-0191>
53. Lin, M. C., Hughes, B., Katica, M., Zuber, C., & Plsek, P. (2011). Service design and change of systems: Human-centered approaches to implementing and spreading service design. *International Journal of Design*, 5(2), 73-86.
54. Lloyd, P. (2000). Storytelling and the development of discourse in the engineering design process. *Design Studies*, 21(4), 357-373. [https://doi.org/10.1016/S0142-694X\(00\)00007-7](https://doi.org/10.1016/S0142-694X(00)00007-7)
55. Lockton, D., & Candy, S. (2019). A vocabulary for visions in designing for transitions. In *Proceedings of the DRS conference on design as a catalyst for change* (pp. 908-926). Design Research Society. <https://doi.org/10.21606/drs.2018.558>
56. Loorbach, D., Frantzeskaki, N., & Avelino, F. (2017). Sustainability transitions research: Transforming science and practice for societal change. *Annual Review of Environment and Resources*, 42(1), 599-626. <https://doi.org/10.1146/annurev-environ-102014-021340>
57. Mazé, R. (2019). Politics of designing visions of the future. *Journal of Futures Studies*, 23(3), 23-38. [https://doi.org/10.6531/JFS.201903_23\(3\).0003](https://doi.org/10.6531/JFS.201903_23(3).0003)
58. McDonnell, J. (1997). Descriptive models for interpreting design. *Design Studies*, 18(4), 457-473. [https://doi.org/10.1016/S0142-694X\(97\)00012-4](https://doi.org/10.1016/S0142-694X(97)00012-4)
59. Mok, L., & Hyysalo, S. (2018). Designing for energy transition through value sensitive design. *Design Studies*, 54, 162-183. <https://doi.org/10.1016/j.destud.2017.09.006>
60. Museum of Contemporary Art Busan. (2022). *Sustainable museum: Art and environment*. https://www.busan.go.kr/moca_en/exhibition01/1488230
61. Neuhoff, R., Simeone, L., & Laursen, L. H. (2023). Forms of participatory futuring for urban sustainability: A systematic review. *Futures*, 154, Article No. 103268. <https://doi.org/10.1016/j.futures.2023.103268>
62. Nicholas, C., & Oak, A. (2020). Make and break details: The architecture of design-build education. *Design Studies*, 66, 35-53. <https://doi.org/10.1016/j.destud.2019.12.003>
63. Nijkamp, P., Kourtit, K., Scholten, H., & Willemsen, E. (2023). Citizen participation and knowledge support in urban public energy transition—A quadruple helix perspective. *Land*, 12(2), Article No. 395. <https://doi.org/10.3390/land12020395>
64. Opazo, D., Wolff, M., & Araya, M. J. (2017). Imagination and the political in design participation. *Design Issues*, 33(4), 73-82. https://doi.org/10.1162/DESI_a_00462
65. Paton, B., & Dorst, K. (2011). Briefing and reframing: A situated practice. *Design Studies*, 32(6), 573-587. <https://doi.org/10.1016/j.destud.2011.07.002>
66. Pel, B. (2016). Trojan horses in transitions: A dialectical perspective on innovation ‘capture.’ *Journal of Environmental Policy & Planning*, 18(5), 673-691. <https://doi.org/10.1080/1523908X.2015.1090903>
67. Reeves, S., Goulden, M., & Dingwall, R. (2016). The future as a design problem. *Design Issues*, 32(3), 6-17. https://doi.org/10.1162/DESI_a_00395
68. Robinson, J., Burch, S., Talwar, S., O’Shea, M., & Walsh, M. (2011). Envisioning sustainability: Recent progress in the use of participatory backcasting approaches for sustainability research. *Technological Forecasting and Social Change*, 78(5), 756-768. <https://doi.org/10.1016/j.techfore.2010.12.006>
69. Salgado, M. (2013). Museums as living labs challenge, fad or opportunity? *The Journal of Community Informatics*, 9(3), 1-8. <https://doi.org/10.15353/joci.v9i3.3161>
70. Scholz, G., & Methner, N. (2020). A social learning and transition perspective on a climate change project in South Africa. *Environmental Innovation and Societal Transitions*, 34, 322-335. <https://doi.org/10.1016/j.eist.2019.10.011>
71. Simon, N. (2010). *The participatory museum*. Museum 2.0.
72. Siodmok, A. (2020, March 6). *Introducing a “government as a system” toolkit*. Policy Lab. <https://openpolicy.blog.gov.uk/2020/03/06/introducing-a-government-as-a-system-toolkit>
73. Slevin, E., & Sines, D. (1999). Enhancing the truthfulness, consistency and transferability of a qualitative study: Utilising a manifold of approaches. *Nurse Researcher*, 7(2), 79-98. <https://doi.org/10.7748/nr2000.01.7.2.79.c6113>
74. Stomppf, G., Smulders, F., & Henze, L. (2016). Surprises are the benefits: Reframing in multidisciplinary design teams. *Design Studies*, 47, 187-214. <https://doi.org/10.1016/j.destud.2016.09.004>

75. Taylor, C. W. (1990). *Creating strategic visions*. US Army War College.
76. Tharp, B. M., & Tharp, S. M. (2022). *Discursive design: Critical, speculative, and alternative things*. The MIT Press.
77. Tschersich, J., & Kok, K. P. W. (2022). Deepening democracy for the governance toward just transitions in agri-food systems. *Environmental Innovation and Societal Transitions*, 43, 358-374. <https://doi.org/10.1016/j.eist.2022.04.012>
78. Tsekleves, E., Ling Lee, C. A., Yong, M. H., & Lau, S. L. (2022). Exploring the use of speculative design as a participatory approach to more inclusive policy-identification and development in Malaysia. *Design Studies*, 81, Article No. 101118. <https://doi.org/10.1016/j.destud.2022.101118>
79. Tuominen, A., Tapio, P., Varho, V., Järvi, T., & Banister, D. (2014). Pluralistic backcasting: Integrating multiple visions with policy packages for transport climate policy. *Futures*, 60, 41-58. <https://doi.org/10.1016/j.futures.2014.04.014>
80. Tyszczyk, R. (2021). Collective scenarios: Speculative improvisations for the Anthropocene. *Futures*, 134, Article No. 102854. <https://doi.org/10.1016/j.futures.2021.102854>
81. Tzortzopoulos, P., Cooper, R., Chan, P., & Kagioglou, M. (2006). Clients' activities at the design front-end. *Design Studies*, 27(6), 657-683. <https://doi.org/10.1016/j.destud.2006.04.002>
82. Vaajakallio, K., & Mattelmäki, T. (2014). Design games in codesign: As a tool, a mindset and a structure. *CoDesign*, 10(1), 63-77. <https://doi.org/10.1080/15710882.2014.881886>
83. van Kuijk, J., Daalhuizen, J., & Christiaans, H. (2019). Drivers of usability in product design practice: Induction of a framework through a case study of three product development projects. *Design Studies*, 60, 139-179. <https://doi.org/10.1016/j.destud.2018.06.002>
84. Visser, W. (2009). Design: One, but in different forms. *Design Studies*, 30(3), 187-223. <https://doi.org/10.1016/j.destud.2008.11.004>
85. Voros, J. (2003). A generic foresight process framework. *Foresight*, 5(3), 10-21. <https://doi.org/10.1108/14636680310698379>
86. Voß, J.-P., Smith, A., & Grin, J. (2009). Designing long-term policy: Rethinking transition management. *Policy Sciences*, 42(4), 275-302. <https://doi.org/10.1007/s11077-009-9103-5>
87. Wack, P. (1985). Scenarios: shooting the rapids. *Harvard Business Review*, 63(6), 139-150. <https://hbr.org/1985/11/scenarios-shooting-the-rapids>
88. Walton, K. L. (1993). *Mimesis as make-believe: On the foundations of the representational arts*. Harvard University Press.
89. Wang, D., Hsieh, W.-A., Chen, S.-Y., & Tang, H.-H. (2022). The complexities of transport service design for visually impaired people: Lessons from a bus commuting service. *International Journal of Design*, 16(1), 55-73.
90. Wilson, S., & Zamberlan, L. (2015). Design for an unknown future: Amplified roles for collaboration, new design knowledge, and creativity. *Design Issues*, 31(2), 3-15. https://doi.org/10.1162/DESI_a_00318

Appendix





Appendix A. Excerpts from the storybook.

Page no.	Original slide of the storybook (in Korean)	Contents
4		<p>“... today I have banana and pineapple. My mum says that when she was younger, she used to eat strawberries, but now they only grow in Northern Europe, which is the coldest part of the world, and it’s hard to get strawberries because so many people in the world want to eat them.”</p> <p>“오늘은 바나나와 파인애플을 먹어요. 엄마가 어렸을 때엔 딸기를 자주 먹었다고 해요. 하지만 지금은 지구에서 가장 추운 지방인 북유럽에서만 딸기가 자라는데, 세상 많은 사람들이 딸기를 먹고 싶어해서 딸기를 구하기 어려워요.”</p>
6		<p>“... I’m grabbing my football, putting on my football boots, and my home assistant robot reads me a notification: it’s too hot to go outside today, and it could be dangerous to my health, so I’m going to the library with my mum.”</p> <p>“축구를 챙기고, 축구화를 신고 있는데, 우리집 비서 로봇가 알람을 읽어줬어요. 오늘은 기온이 너무 뜨거우니 나가면 건강이 위험할 수 있대요. 하는 수 없이, 오늘은 엄마와 함께 도서관을 가기로 했어요.”</p>
8		<p>“We went into the library and my mum read me an interesting book called Save the Hot Planet. It said that the reason the Earth is so hot is because it has lots of ‘greenhouse gases’ like carbon dioxide and methane, but if we don’t have enough greenhouse gases, there could be an ice age, so we need to have just the right amount of greenhouse gases so we can live in a comfortable world.”</p> <p>“도서관에 들어가서 엄마가 재밌는 책을 읽어줬어요. <뜨거워진 지구를 구해줘>라는 책이에요. 지구가 이렇게 뜨거워진 것은 이산화탄소나 메탄가스 같은 ‘온실가스’가 많기 때문이에요. 하지만 온실가스가 너무 없으면 지구에 빙하기가 찾아올 수도 있대요. 그래서 우리는 적당한만큼의 온실가스가 있어야 쾌적한 세상에서 살 수 있어요.”</p>
12		<p>“If I’m going to live on Earth in the future, I need your help to change the past so I can live in a cooler world!”</p> <p>“앞으로도 지구에서 살기 위해선, 여러분들의 도움이 필요해요. 제가 좀 더 시원한 세상에서 살 수 있도록 과거를 바꿔주세요!”</p>

Appendix B. Examples of the newspaper contents.

Future newspaper image	Summary
	<p>Type: News report</p> <p>Headline and subhead: Only Track and Field Sprinters May Be the Only Ones to Run In The Real Sun This Summer: Is the Campi Flegrei volcano eruption a blessing for the 2062 Naples Olympics?</p> <p>Summary: The Olympics were moved entirely indoors due to the unbearably hot weather, but ash from the volcano's eruption blanketed the atmosphere, lowering temperatures in the host region. The only exception is the track and field sprints, which will be held outdoors to protect athletes' respiratory systems.</p> <p>Date published: March 19, 2061</p>
	<p>Type: News report</p> <p>Headline and subhead: Rocket Economy Ticket Prices to Mars Have Been Revealed: One-way is \$5.72M, cheaper than a flat in Taebaek city</p> <p>Summary: An article criticizing the high price of one-way tickets to Mars and the polarization between the migratable population and Earth's inhabitants. It includes a history of how a typical wealthy neighborhood in South Korea (Gangnam, Seoul) has seen its real estate values plummet due to frequent flooding from low-lying land.</p> <p>Date published: December 3, 2061</p>
	<p>Type: News report</p> <p>Headline and subhead: Climate Trauma Therapy Centre in Jongno opening draws 1,500 people: Emergency opening after last week's wildfires in the Bukhak mountains.</p> <p>Summary: As a multinational team of researchers continues to analyze evidence to trace the causes of the wildfires, the government has opened a climate trauma healing center as an official health center to help residents recover from the psychological effects.</p> <p>Date published: June 22, 2061</p>
	<p>Type: Column</p> <p>Headline and subhead: The Link Between Arctic Glaciers and Art (2): The current state of art museums in the polarisation of access to the arts</p> <p>Summary: A contemporary art critic (her image is generated by A.I. program) wrote a series of columns for the newspaper to criticize elitist art museums that failed to respond to the climate crisis and neglect the polarisation of access to the arts.</p> <p>Date published: Not specified</p>
	<p>Type: Advertisement (right-hand side of the image)</p> <p>Description: An advertisement of a restaurant specializing in plant-based meat substitute, which is recommended by an old meat sommelier who had had the chance to taste real meat when they were young (implying that the majority of the people in 2061 don't have the experience).</p> <p>Date published: February 3, 2061</p>

Appendix C. Extreme scenarios and their discussion points.

Title and visual aid	Scenario	Discussion points
	<p>What if the Museum were to completely transform into a 100% digital art museum in the midst of climate crisis to allow freedom of movement for visitors?</p>	<ul style="list-style-type: none"> • What would happen to the artworks currently kept by the museum? • How would the life of artists change? • How would art education be affected?
	<p>What if museums were required by strict government regulations to achieve zero waste throughout the entire process, including pre-production, production, transportation, and exhibition</p>	<ul style="list-style-type: none"> • How would the museum's exhibitions change? • What is the biggest challenge the museum would face? • How would the life of artists change?
	<p>What if there were annual carbon emission limits and museums have to take breaks when these limits were exceeded</p>	<ul style="list-style-type: none"> • What should museum staff or businesses such as cafes do during the museum's closure? • Should carbon emissions from visitors traveling to the museum be included or excluded? • Who should determine and how should annual carbon emission limits be set?
	<p>What if citizens make decisions on which exhibitions shall be open to reduce waste and carbon emissions from unnecessary exhibitions?</p>	<ul style="list-style-type: none"> • How would such a museum be perceived by the public? • What issues or drawbacks might arise? • What constitutes an unnecessary exhibition? • What information should be provided for citizens about each exhibition plans to make right decisions? • Who should be given decision-making power among the citizens at large?

Appendix D. A sample of excerpts from the letters written by the workshop participants.

Date	Workshop session	Original quotation in Korean	Quotation in English
Sep. 3, 2022	10s	예산의 일부를 친환경 에너지 발전기에 투자해서 지속가능한 에너지를 만들어주세요. 그리고 오늘처럼 환경에 관한 프로젝트를 자주 해 주시는 것도 학교에서 배우는 내용보다 더 좋았던 것 같아요. 감사합니다.	Please invest a part of your budget in eco-friendly energy generators for sustainable energy. And doing more projects related to the environment today was better than what I learnt at school. Thank you.
Sep. 17, 2022	20s (Morning)	오늘에서야 '탄소'와 '미술관'을 동시에 생각해보게 되었어. 더 많은 사람들과 함께 이 주제에 대해 나눠보고 싶다는 생각도 해.	Only today have I come to think about <i>carbon</i> and <i>museum</i> together. I also want to talk about this topic with more people.
Sep. 17, 2022	20s (Morning)	친환경 제품이 참 비쌉니다. 종이도 자재도 많이 비싸지만 예산을 아끼지 않고 지원해주셨으면 좋겠습니다. 그렇다고 전기세를 아낀다고 여기저기 불을 끄진 말아주세요. 기획팀에서도 고심해서 에너지 효율을 높일 수 있도록 충분히 고민해주시고 있으실 거예요. 저는 아래와 같은 희생을 감수할 수 있습니다: (1) 전시도록 온라인으로 열람하기; (2) 까끌까끌한 재생휴지; (3) 불편한 전시동선; (4) 비싼 관람료 (만원까지 가능); (5) 겨울에도 차가운 수도물	Eco-friendly products are pretty expensive. Paper and materials are expensive, but I hope you don't hesitate to purchase them. But don't turn off the lights here and there to save on electricity bills. I'm sure the planning team is thinking hard enough to increase energy efficiency. I can make the following sacrifices: (1) View online brochures (2) Rough toilet tissue made of recycled material; (3) Inconvenient exhibition routes; (4) Expensive admission; (5) Cold tap water even in the winter
Sep. 17, 2022	20s (Morning)	탄소배출량 측정 후 저감 방안이 수립되면 대국민적으로 공개 및 홍보해 주시면 좋겠고, 앞으로도 지속적으로 이런 시민참여가 가능한 기회를 제공해주시길 바랍니다.	I would like you to publish and promote [the plan for reducing carbon emission] to the public and continue to provide opportunities for such civic participation like today.
Oct. 1, 2022	30 to 45 (Afternoon)	예술은 우리의 삶이 풍요로운 상황에 가치를 더해주는 가치로운 일이라고 생각합니다. 그런데 나의 예술소비가 완전히 나의 풍족에만 해당되고 그 뒤에서 다른 면으로 '불편함', '환경파괴'가 진행되고 있다면 전 이 가치로운 일에 시간을 더 쓸 거예요.	I believe that (making) art is valuable work, making our lives prosperous. However, if my consumption of art is completely limited to my enjoyment (abundance), and <i>inconvenience</i> and <i>environmental destruction</i> are going on behind the scenes, I will spend more time on (more) valuable stuff.
Oct. 1, 2022	30 to 45 (Afternoon)	우선 미술관에서도 탄소중립을 위해 해결방안과 앞으로도 미술과 지속가능해지기 위한 노력을 하고 있다는 점에서 놀랐다. 예전과 지금 형태의 미술관은 사라질 수 있지만 새로운 지속가능한 미술관이 생길 수 있도록 다양한 시도가 필요해보인다. 교육, 문화, 예술 등 이를 위해서라도 미술관은 사라지면 안된다. 미래를 위해서라도 미술관이 계속 열릴 수 있도록 힘써주세요.	First of all, I was surprised by the fact that the museum is also making efforts to become more sustainable with art in the future, as well as to create a solution for carbon neutrality. The conventional and present forms of art museums may disappear. Still, various attempts are needed to create a newer, sustainable art museum. Art museums must not disappear for the sake of education, culture, and art. Please make an effort to keep the museum open for the future.
Oct. 1, 2022	30 to 45 (Morning)	제가 생각하는 미술관은 미술, 예술 작품을 "구경(관람)"하러 오는 곳이 아닌, 생각을 시작할 수 있는 "경험, 체험"을 할 수 있는 곳입니다. 제로 웨이스트를 지향하거나 친환경적인 작품을 만들고 그것이 좋은 것이다 계몽하는 것보다, 더 나은 세상을 만들기 위한 "생각"을 할 수 있는 "경험, 체험"을 많이 기획해주세요. 저는 시대의 필요에 맞게 적극적으로 변화, 유지하겠습니다. 걸어다니고, 소비도 줄이고, 오래오래 '지구'를 공유할 수 있도록.	In my opinion, the art museum is not just a place to see art but a place to <i>experience</i> where you can start reflecting. Rather than aiming for a zero-waste or eco-friendly art museum and enlightening people, please plan many <i>experiences</i> to make people <i>reflect</i> about creating a better world. I will actively change my behavior and maintain it according to the needs of the times by walking more and reducing consumption in order to <i>share the Earth</i> for a longer time.
Oct. 15, 2022	46 and up (Morning)	미술관에서 오늘날 가장 당면할 문제를 현실적으로, 또는 공감할 수 있는 시간이 된 것 같아요. 다른 분들의 생각을 부담없이, 편견없이 나눌 수 있는 시간과 공간, 분위기 ... 이런 것이 유일하게 가능한 공간이지 않을까 싶어요.	It was time to empathize realistically with the most pressing problem that the museum faces today. The time, space, and atmosphere where I and others could freely share thoughts without burden or prejudice ... I think it was the only place such things are possible.
Oct. 15, 2022	46 and up (Morning)	미술관 - 탄소 프로젝트 워크샵에 참여하게 되어 기대 이상의 좋은 시간을 보냈습니다. 평소 깊게 인지하지 못했던 문제점들을 다시 돌아볼 수 있는 좋은 기회였어요. 저 또한 앞으로 개인적으로 노력해야 할 부분이 무엇인지 노력해야겠다는 생각이 드네요. 앞으로도 이런 기회가 자주 있으면 합니다. 감사합니다.	I had a better time than expected to participate in this Carbon Project Workshop. It was an excellent opportunity to reflect on the problems I didn't usually recognize deeply. I also think I should try to do what I must do personally from now on. I hope there will be more opportunities like this in the future. Thank you.
Oct. 15, 2022	46 and up (Morning)	지금껏 미래에 내 자신이 하고 싶은 예술작품이나 전시에 대해서만 고민해 왔는데, 오늘 워크숍을 통해 우리가 탄소 중립에 관련돼 막중한 책임을 가져야 한다고 느꼈다. 지구와 인간이 공존해나가기 위해서 디지털 전시를 늘린다는 것, 친환경 재료를 적극 활용한다는 것 등의 연구가 계속되어야 할 것 같다. 환경에 관한 인식 변화를 유도하는 전시나, 이런 아이디어를 공유할 공간이 늘어나면 좋겠다	I have been thinking only about artworks or exhibitions that I want to do in the future so far. But through today's workshop, I felt we should be responsible for carbon neutrality. Research such as increasing digital exhibitions or actively utilizing eco-friendly materials should be continued for the Earth and humans to coexist. I hope there will be more space to share exhibitions or ideas that induce changes in environmental awareness.