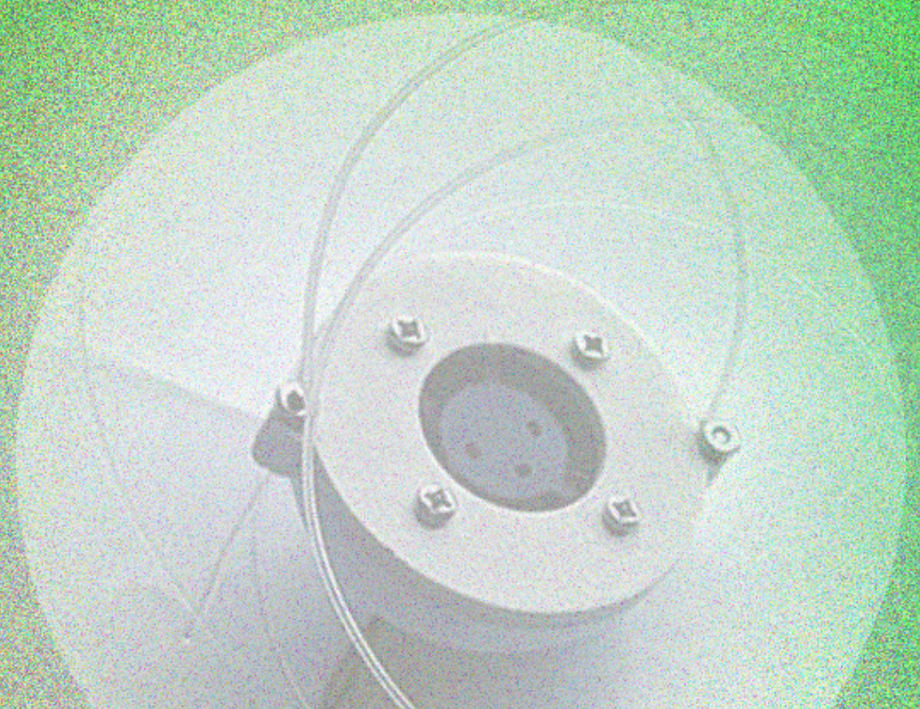




MICROBIAL SMELLSCAPE

Tuning into Blooming Futures through Design



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PREFACE

This thesis began with a simple but often overlooked experience: noticing the smell of water. During walks through Delft, I became increasingly aware that canals, ponds, and other everyday water environments are not silent or passive backgrounds. They are continually changing through weather, microbial activity, infrastructure, plants, animals, and human practices, yet many of these changes remain difficult to perceive.

My interest gradually shifted from asking how environmental change could be communicated more clearly to asking how design might help people notice, experience, and imagine it differently. Smell became central to this exploration because it is unstable, intimate, difficult to control, and closely connected to memory, place, and bodily response. These qualities also made the research challenging. I often had to work with uncertainty rather than against it, accepting that smelling does not provide objective evidence or a straightforward explanation of ecological conditions.

The idea of tuning gradually became central to the project. Here, tuning does not mean achieving perfect sensitivity or arriving at a single, accurate interpretation. Instead, it describes an ongoing process of adjusting attention: learning to notice subtle changes, becoming more receptive to unfamiliar environmental relations, and recognising the limits of what can be sensed and known. The project therefore developed through interconnected phases of attuning, speculating, materialising with cross-phases making and reflecting. Smellwalks helped me explore how everyday water environments are experienced, interpreted, or overlooked. Participatory speculation opened conversations about possible microbial futures. Material speculation translated these imagined futures into tangible forms, allowing ideas about microbial change to be explored through materials, prototypes, and sensory experiences. This process ultimately informed the final wearable probe, which brought fragments of these imagined futures into present-day encounters with Delft's waters.

Working on this thesis changed my own design practice. I began the project with an instinct to make invisible environmental processes more understandable and controllable. Over time, I learned to value ambiguity, situated experience, and partial knowledge. Rather than designing a device that claims to detect or explain microbial change, I developed a design approach that supports curiosity, reflection, and a gradual tuning of attention towards the environments around us.

This thesis documents both the outcomes of the project and the uncertainties that shaped it. It is an invitation to pause near familiar waters, breathe with greater attention, and tune into changes that might otherwise remain unnoticed. In doing so, it asks us to consider how possible environmental futures may already be sensed within everyday life.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisors, Elvin Karana, Stefano Parisi, and Fanzhe Zeng, for their thoughtful guidance, critical feedback, and encouragement throughout this project. At times, I felt frustrated and uncertain because my project differed considerably from many other graduation projects. Yet they continued to encourage me and helped me recognise the value and distinctiveness of the perspective I brought to the work. Their insights supported me in navigating the uncertainties of working with smell, microbial life, and more-than-human relations, while giving the project space to develop in its own direction. I am also deeply grateful for their generous and practical support throughout the prototyping process.

I would also like to thank the TU Delft Biodesign Lab for providing a supportive environment in which I could experiment, reflect, and develop this research. The lab provided materials for collecting and documenting smells during the smellwalks and gave me an important starting point for understanding cyanobacteria and microbial processes. My thanks also go to Kate McLean and Natarsha Bates for generously sharing their knowledge and perspectives on smellwalking, sensory research, and environmental engagement. I am grateful to the Delfland Water Board for regularly sharing local environmental data, and to the researchers at the Netherlands Institute of Ecology (NIOO-KNAW) for contributing their knowledge of local algal blooms and aquatic environments.

I would like to thank everyone who participated in the smellwalks, co-speculation workshops, prototype encounters, and informal conversations. Their observations, stories, questions, and imaginative responses shaped the project in ways I could not have anticipated.

I am especially thankful to the friends who accompanied me on daily walks, challenged my ideas, helped document the process, tested unfinished prototypes, responded openly to unfamiliar smells, shared suggestions about materials and making, and supported the filming of the project video. I am equally grateful for the critiques and reflections I received along the way. Many important and unexpected conversations about the project emerged while we walked together through the very smellscape environments I was studying. These shared walks allowed the project to be continually questioned, reconsidered, and developed in relation to the places around us.

Finally, I would like to thank my family and those close to me for their patience, care, and continuous support throughout my graduation journey. This project has taught me that noticing is rarely an individual act. It develops through sensing, experiencing, imagining, reflecting, and discussing together. Through this process, I have also become more grateful for the fragile ability to smell and experience the world around me.

ABSTRACT

Microbial Smellscapes: Tuning into Blooming Futures through Design investigates how design can support people in noticing and experiencing future microbial smellscapes in the present. Situated within the context of harmful algal blooms and microbial change in everyday water environments, the project approaches smell as an unstable, situated, and more-than-human form of environmental experience. Rather than communicating microbial change only through scientific data, visual warnings, or technological sensing, the research explores how olfactory and speculative design can make ecological transformation more bodily, affective, and open to collective discussion.

Following a Research through Design approach, the project developed through the interconnected phases of attuning, speculating, and materialising, with making, reflection, and synthesis occurring across the research process. Contextual research, expert input, situated smellwalks, participatory speculation, and material speculation informed the development of a speculative olfactory design set consisting of a wearable smell probe, a walking and reflection zine, and a small archive of microbial-inspired smell references.

The wearable probe uses GPS-based triggering to release subtle, bloom-like smells during situated walking encounters. Publicly available water-monitoring information and local ecological knowledge informed the selection and interpretation of the locations, but the probe does not claim to reproduce or diagnose their actual ecological conditions. The zine supports noticing, imagining, and reflection, while the smell archive brings together scent references associated with past, present, and speculative future water conditions.

The project does not aim to detect, explain, or solve harmful algal blooms. Instead, it creates conditions for situated smellscape attunement. By bringing speculative microbial smells close to the body and into encounters with familiar waters, the design invites people to pause, sense, question, and reflect on their relationships with changing aquatic environments. In doing so, the project demonstrates how design can tune attention towards ecological transformations that often remain difficult to perceive.

KEYWORD Microbial smellscapes; algal blooms; olfactory design; situated attunement; speculative design; more-than-human design; Research through Design.

"Our task is to make trouble, to stir up potent response to devastating events, as well as to settle troubled waters and rebuild quiet places.

— Donna Haraway, Staying with the Trouble (2016, p. 1)

This thesis made me understand smell not only as something that tells us about our environment, but also as a personal and situated experience. While working with microbial smellscapes, I became more aware of my own ability to smell, and sometimes my inability to do so. Waking up with a blocked nose made me realise how easily this sense can change, and how much I normally take it for granted.

To notice smell is therefore also a kind of privilege. It depends on a body that is open, available, and able to be affected. At the same time, smell is a way through which place enters the body. It carries traces of atmosphere, water, microbes, weather, decay, care, and change. This project begins from that fragile capacity: to smell, to be affected, and to stay with what is usually overlooked.

- The author

TERMINOLOGY

This project uses several terms from environmental science, smell studies, sensory ethnography, and design research. The definitions below clarify how each term is understood and used in this report.

Microbial Smellscapes and Algal Smellscapes

In this project, microbial smellscapes refers to smell environments shaped by microbial and ecological processes in water bodies. It includes not only smells produced by microbes, but also the broader atmospheric conditions created through interactions between water, algae, cyanobacteria, bacteria, nutrients, weather, animals, infrastructure, and human bodies.

Within this broader concept, the project focuses on algal smellscapes: smell experiences associated with algal bloom conditions in everyday water environments. While the design work centres on blooming water and algae-related odours, algal smellscapes are understood as part of a wider microbial smellscape rather than as a separate phenomenon. This allows microbial smellscapes to serve as the overarching conceptual framework, with algal smellscapes describing the specific sensory focus of the project.

Harmful Algal Bloom (HAB)

Harmful algal blooms refer to the rapid growth of algae or cyanobacteria in water environments. They can affect water quality, aquatic life, and sometimes produce unpleasant smells or toxins (EPA, 2025). In this project, blooms are not treated as something to scientifically detect, but as an ecological condition that may become part of everyday urban water experience.

Smellwalk

A smellwalk is a walking method where participants pay attention to smells in a specific environment. It has been used to explore and map urban smellscapes (Perkins and McLean, 2020; Quercia et al., 2015). In this project, smellwalks helped participants notice Delft's water environments through smelling, pausing, comparing, and reflecting.

Tuning

In this project, tuning refers to the gradual adjustment of attention and bodily sensitivity toward microbial smellscapes. It is used as an active and accessible form of attunement, describing how people may become more responsive to subtle environmental signs through smelling, walking, hesitation, curiosity, discomfort, and reflection. Tuning does not mean detecting microbial risk scientifically. Instead, it describes how design can invite people to sense, imagine, and relate to blooming futures in the present.

Noticing

Noticing refers to paying attention to things that are usually ignored, backgrounded, or taken for granted. Tsing (2015) describes noticing as a way of staying with unstable, damaged, and more-than-human environments. In this project, smell becomes a way to support ecological noticing: slowing down, sensing water environments, and becoming aware of microbial change as part of everyday life

Design Fiction

Design fiction uses fictional but believable formats, such as future headlines, objects, or scenarios, to make possible futures feel more concrete (Bleecker, 2009; Coulton et al., 2017). In this project, future headlines and collage were used to help participants imagine everyday life with water, blooms, and smell.

Preface & Acknowledgements
Abstract
Table of Contents

Chapter 1. Introduction

1.1 Introduction

1.2 Problem Framing

1.3 Motivation, Research Questions and Gap

1.4 Report Structure

Chapter 2. Context and Design Positioning

2.1 Related Works

2.2 Positionality

2.3 From Controlled Smell Experiments to Situated Attunement

Chapter 3. Methodology

3.1 Methodological Positioning

3.2 Research Design

3.3 Ethics and Limitations of Method

Chapter 4. Attuning to the Present

4.1 Delft Water as a Situated Research Context

4.2 Autoethnographic Smell Journal: Learning to Notice

4.3 Designing and Validating the Smellwalk

4.4 Smellwalk Deployment: Experiencing Delft Water Smellscapes

4.5 Annotated Portfolio Analysis of Smellwalks

4.6 Emerging Insights: Smell as Situated Ecological Noticing

Chapter 5. Speculating Microbial Futures

5.1 Building the Bloom Future

5.2 Co-Speculation Workshop and Future Worldbuilding

5.3 Annotated Portfolio Analysis of Co-Speculation

5.4 Three Possible Microbial Futures

Chapter 6. Designing for Situated Attunement

6.1 From Themes to Design Goal and Criteria

6.2 Exploring Embodied Design Direction

6.3 Materialising the Wearable Probe

6.4 Developing Smell Materials and the Bloom Archive

6.5 Prototype Calibration and Testing

6.6 Enacting the Probe: First-Person Encounters

6.7 Final Probe Set and Tuning Experience

Chapter 7. Discussion

7.1 Critical Reflections on the Design Approach

7.2 Ethical Responsibilities of Speculative Smellscape Design

7.3 Limitations

7.4 Future Work

Chapter 8. Conclusion

8.1 Revisiting the Research Questions

8.2 Conclusion and Discussion

8.3 Personal Reflection

References

Appendices
appendix A - Smellwalk zine
appendix B - Bloom future cards
appendix C - Finished templates
appendix D - Smellwalk refelections
appendix E - Arduino code
appendix F - Observation notes
appendix g - Timeline & pestel analysis
appendix h - Speculative news
appendix I - Project proposal form

25 Summer

Chapter 1
AS A NEW COMER

Navigating new city Delft with my nose

25 Autumn

PERSONAL MOTIVATION

Previously working experiences as an interactive make me question: How much we overlook the power of smell.

25 Winter

LAB EXPLORATION

Initial explorations in lab make me realise that there is huge gap between indoor olfactory experience and environ-mental awareness, which leads to the shift to outdoor olfactory explorations.

26 Spring

MEMORIES OF BLOOM

That fishy smell reminds me of last greenery summer nights walking with my friends near Delftse Hout.

26 Summer

Chapter 2
Outdoor nature spaces

RESEARCH GOAL

To investigate how design can support people in noticing and experiencing possible future microbial smellscapes shaped by changing climate conditions in the present.

Chapter 3
METHDOLOGY

Research through Design

Chapter 4
ATTUNING TO THE PRESENT

Situated Attunement

RQ 1
How are microbial smellscapes currently experienced, ignored, or made sense of in everyday water environments?

Chapter 5
SPECULATING MICROBIAL FUTURES

Participatory speculation

RQ 2
How do people imagine living with intensified microbial smellscapes in possible futures?

Chapter 6
DESIGN FOR SITUATED ATTUNMENT

Material speculation

RQ3
How can design make future microbial smellscapes experientially accessible in the present?

Chapter 7
DISCUSSION

Critical reflection

Chapter 8
CONCLUSION

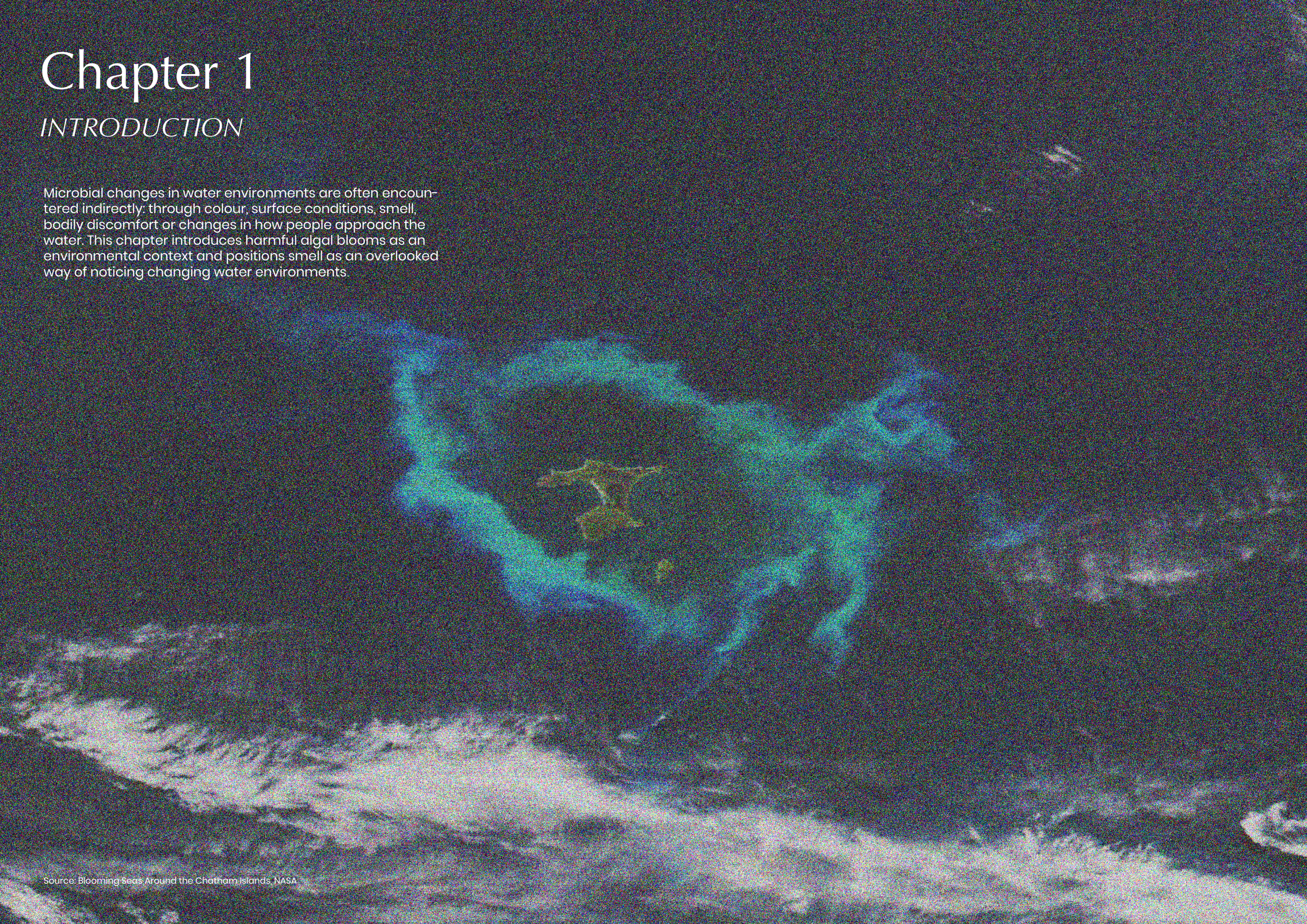
RTD Synthesis

RIPPLE EFFECTS: Spreading out awareness through dialogues

Chapter 1

INTRODUCTION

Microbial changes in water environments are often encountered indirectly: through colour, surface conditions, smell, bodily discomfort or changes in how people approach the water. This chapter introduces harmful algal blooms as an environmental context and positions smell as an overlooked way of noticing changing water environments.



Source: Blooming Seas Around the Chatham Islands, NASA

INTRODUCTION

This project began not from a laboratory, a dataset, or a warning sign, but from walking beside water in Delft. The canals and small water bodies of the city are part of everyday life. People cycle past them, sit near them, row through them, photograph them, and sometimes ignore them completely. At first, these water environments appeared familiar and ordinary to me. They were part of the background of the city. However, through repeated walks and observations, I began to notice that they were not always as stable or neutral as they seemed.

During warmer periods, the waterways began to change subtly. Thin layers of green gathered along canal edges. Earthy odours appeared briefly and then disappeared again into the air. At other moments, the smell became harder to ignore: stagnant, damp, almost decaying. Sitting near Oostpoort beside a still body of swamp-like water, I watched everyday life continue around it. Cyclists passed by without slowing down. Conversations continued across terraces. People rowed through the canal. Children swam nearby. Ducks dipped their heads beneath the surface searching for food. Daily routines unfolded as usual, even while something within the water seemed to have shifted, and with it, the atmosphere of the place.

These moments made me aware of a quiet tension. Environmental change does not always appear as a dramatic event. It may emerge through small sensory shifts: a smell that lingers, a colour that gathers at the surface, a bodily hesitation to move closer, or an uncertain feeling that the place is no longer the same. These changes are easy to overlook because they do not always demand immediate attention. They may be present, but not fully understood. They may be sensed, but not easily discussed.

This experience became the starting point of the thesis. I began to ask how people notice environmental change when it is not only visible or measurable, but atmospheric, bodily, and unstable. More specifically, I became interested in how microbial changes in urban water environments might be encountered through smell. While microbial processes, algal growth, and changing water conditions are increasingly shaped by climate change and urban environmental pressures, they often remain difficult to perceive, interpret, or emotionally engage with in everyday life.

This thesis therefore begins from a situated sensory encounter with Delft's water environments. It asks how design can support people in noticing possible future microbial smellscapes, not by making environmental change fully measurable or controllable, but by making it more experienceable, discussable, and imaginable.



Mid-summer water environment at the city center of Delft

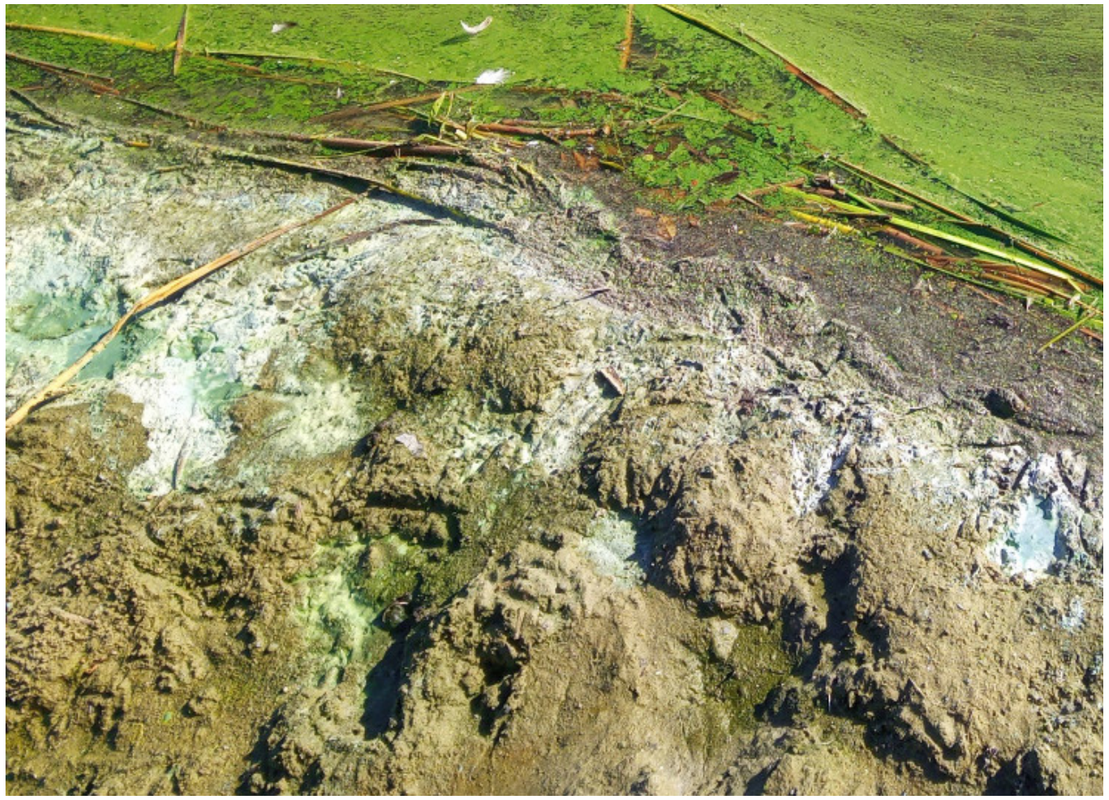
PROBLEM FRAMING *Invisible Microbial Change in Everyday Water Environments*

This project begins from the observation that microbial and algal changes in water environments are not only scientific or ecological events. They also affect how people sense, approach, avoid, and imagine everyday water bodies. Canals, ponds, lakes, and rivers may appear familiar, but their sensory conditions can shift through colour, surface texture, floating matter, animal presence, warning signs, and smell. These changes are often unstable and difficult to interpret. A water body can look visually normal while still containing microbial activity, and a strong odour does not automatically provide reliable evidence of danger. This uncertainty creates a design challenge: how can people relate to ecological change when it is not fully visible, stable, or knowable?

Within this project, microbial smellscapes is used as the broader conceptual frame for smell environments shaped by microbial and ecological processes. More specifically, the project investigates algal smellscapes in relation to algal and cyanobacterial bloom conditions. Harmful algal blooms are influenced by multiple environmental pressures, including warmer water temperatures, nutrient enrichment, slow-moving water, and changing weather patterns (EPA, 2026). Excess nitrogen and phosphorus can stimulate algal growth, while warmer and slower-moving waters can favour cyanobacterial harmful algal blooms (NOAA, 2025; EPA,2026). These conditions are increasingly relevant in urban and recreational water environments, where microbial change may reshape how people experience water through smell, atmosphere, bodily distance, comfort, discomfort, and concern.

Current forms of environmental communication often rely on scientific data, monitoring protocols, maps, reports, warning signs, and public-health advice. In the Netherlands, public bathing-water information is made available through platforms such as Zwemwater.nl (Zwemwater.nl, n.d.), while the Dutch Cyanobacteria Protocol guides water managers in inspecting bathing sites and taking measures to protect bathers' health (Rijksinstituut voor Volksgezondheid en Milieu [RIVM], 2023). These forms of communication are necessary for risk management and public safety. However, they do not always help people experience environmental change as something situated, embodied, and close to daily life. A map or warning label may explain that a water condition exists, but it may not help people sense how the atmosphere of a place changes, how smell affects their willingness to approach the water, or how human bodies, aquatic life, infrastructure, and microbial processes become entangled.

This challenge can also be observed in public responses to harmful algal blooms in other countries as well. For example, in South Australia, recurring blooms have led to ecological damage, fish deaths, and public concern, prompting authorities to communicate risks through monitoring updates, advisories, and media reports from Environment Protection Authority South Australia (2025). While such communication is essential for public awareness and safety, it often frames blooms primarily as environmental hazards to be managed. Less attention is given to how people encounter these changing conditions through everyday sensory experiences, including smell, atmosphere, and embodied perceptions of place.



Bloom in Delft 2023. Image shared by the researcher from NIOO

"Tricky...because they can't see if it is toxic and there is no direct link between unpleasant smell and toxicity"

An Expert from NIOO-KNAW

Smell is especially relevant in this context because it sits between environmental condition and bodily response. A smell can attract, disturb, warn, comfort, or trigger memory. It can make people move closer, hesitate, or step away. It can change how a place feels even when the visual appearance remains almost the same. At the same time, smell is unstable, subjective, and difficult to control. It changes with wind, humidity, temperature, distance, movement, time, and individual sensitivity. For this reason, algal smellscapes should not be understood as clear indicators of water quality, but as partial and atmospheric cues through which people may begin to notice microbial water change.

Rather than designing a detector, warning system, or scientific monitoring tool, this project asks: **How could design support people in noticing, and experiencing future microbial smellscapes shaped by climate conditions in the present.** Through speculative and sensory design, the project explores how algal bloom futures might be made experientially accessible: not as fixed predictions, but as embodied encounters that invite noticing, reflection, and imagination.

MOTIVATION

This project emerges from my interest in smell, water, ecological change, and more-than-human relations. Through previous nature-related design projects and daily walks along Delft's canals, I became increasingly aware that environmental change is not only understood through data or visual evidence. It can also be encountered through the body: through breathing, smelling, walking, hesitation, discomfort, memory, and curiosity.

Smell became central to the project because it is both immediate and overlooked. It can strongly influence how people feel about a place, yet it is often treated as subjective, unstable, or secondary compared with visual and data-based forms of environmental communication. During my walks along Delft's waterways, I often wondered: *Do people have the choice not to inhale these smells?* This question led me to consider how environmental degradation may become normalised through everyday exposure, especially when odours gradually fade into the background of daily life.

My motivation was therefore not to design a scientific detector for algal blooms. Instead, I wanted to explore how design could support more situated and bodily ways of noticing microbial smellscapes. Rather than making microbial change fully measurable or controllable, this project asks how smell, speculation, and wearable probes can open up moments of attention, reflection, and imagination around changing water environments.

GAP

Existing research on water quality and harmful algal blooms often focuses on monitoring, toxicity assessment, forecasting, public health risk, and ecological management. These approaches are important because harmful algal blooms can affect aquatic ecosystems, human health, recreation, and drinking-water safety, and they require reliable systems of assessment and early warning (Altenburger et al., 2019; Brooks et al., 2016; Feng et al., 2024). However, this body of work tends to frame microbial water change through data, indicators, toxicity, warnings, and risk categories rather than through everyday sensory experience.

At the same time, olfactory and smellscape research shows that smell is not only an isolated scent or fragrance, but a situated, emotional, bodily, and relational way of experiencing place. Smell can connect environments to memory, atmosphere, social meaning, and bodily response (Bratman et al., 2024; Canniford et al., 2018; Hsu, 2020; Xiao et al., 2020). Yet this perspective has been less explored in relation to microbial or algal futures, especially in everyday water environments. While speculative and olfactory design have begun to imagine environmental futures and smell-centred futures, there remains limited exploration of olfactory probes that allow people to bodily experience, notice, and reflect on future microbial smellscapes in the present (Beşevli et al., 2024; Dunne & Raby, 2013; Zou & Morrison, 2022).

Therefore, this project addresses the gap between water quality as monitored ecological risk and microbial smellscape as situated sensory experience. It asks how design can support people in noticing and experiencing future microbial smellscapes through speculative, olfactory, and place-based probes.

Existing focus	***Research gap***
Water quality as just data, monitoring and risk (Altenburger et al., 2019; Brooks et al., 2016)	Limited attention to sensory and bodily experience
Harmful algal blooms as visual or ecological problems (Brooks et al., 2016; Feng et al., 2024)	Less attention to smell as environmental encounter
Smell as isolated scent or fragrance (Hsu, 2020; Bratman et al., 2024)	Less attention to smellscape as situated, unstable, and relational
Speculative design for environmental futures (Dunne & Raby, 2013; Zou & Morrison, 2022;Besevli et al., 2024)	Less exploration of olfactory probes for microbial futures

RESEARCH GOAL

To investigate how design can support people in noticing and experiencing possible future microbial smellscapes shaped by changing climate conditions in the present.

RESEARCH QUESTIONS

1. How are microbial smellscape currently experienced, ignored, or made sense of in everyday water environments?

2. How do people imagine living with intensified microbial smellscapes in possible futures?

3. How can design make future microbial smellscapes experientially accessible in the present?

Chapter 2

CONTEXT & DESIGN POSITIONING

Having introduced microbial water change as the environmental context, this chapter positions the project within smellscape research, sensory design and more-than-human design. It considers water not as a passive background, but as a dynamic environment shaped through relations between microbes, algae, weather, infrastructures, animals and people.

Source: Cyanobacteria bacteria photoed by the author

RELATED WORK

This section positions the project in relation to design research on environmental sensing, smellscape studies, olfactory design, and speculative more-than-human futures. Across these fields, ecological phenomena are increasingly understood not only as scientific data or environmental problems, but also as lived, sensory, and situated experiences. This is important for this thesis because microbial water change and harmful algal blooms are often difficult to perceive directly. They may be present before they become visually obvious, and they are shaped by water movement, temperature, weather, smell, seasonal change, and everyday human encounters with water. Building on related work, this project explores how smell-based design can support people in noticing, experiencing, and imagining future microbial water conditions in the present.

Understanding Ecological Phenomena in Design

Design and HCI have increasingly engaged with ecological phenomena such as air pollution, soil contamination, urban waste, water pollution, and climate change. These phenomena are often difficult to sense directly because they may be invisible, slow, dispersed, or too large in scale for everyday perception. As a result, design projects often translate environmental conditions into more tangible forms through data visualisation, sensing devices, public installations, participatory mapping, multisensory interfaces, or speculative artefacts.

For example, Calvillo and Garnett's work on air pollution explores how invisible particulate matter can be made bodily and atmospheric through mist, public installation, and embodied encounter rather than only through air quality graphs or numerical indicators (Calvillo & Garnett, 2019). Similarly, work on data polysensualisation proposes that contamination data can be translated into multisensory forms such as light, sound, touch, smell, and material experience through a workshop (Ammar-Khodja & Celerier, 2025)(see Fig. 2.3). Neves and Câmara also show how smell and taste can be used in multisensory HCI to communicate environmental health issues beyond visual media alone (Neves & Câmara, 2020; Neves, 2024). These projects demonstrate that ecological conditions can be made more accessible when they are not only seen, but also felt, smelled, heard, touched, or narrated.

Other work in environmental HCI further shifts attention from individual data collection towards collective and situated forms of environmental sensing. Pritchard and Gabrys (2016) argue that citizen sensing can function as a form of collective monitoring, through which sensing generates affective, political, and social relations around shared environmental conditions. This perspective is illustrated in The Data Story 5 (Figure 2.1). Gabrys (2020) similarly frames environmental sensing as a practice of planetary health, connecting urban air pollution with everyday witnessing, community participation, and environmental justice. Rosén, Normark, and Wiberg's design ethnography of urban farming further demonstrates how design can support the noticing of more-than-human environmental relations rather than simply extracting environmental data. Their project, BeeNoculars (Figure 2.2), enables users to "see with new eyes" aspects of the environment that cannot be experienced through human senses alone (Poikolainen Rosén et al., 2022).



Figure 2.1 an extensive inventory of possible particulate emission sources, Data Story 5: Liberty Township citizen air quality monitoring, Citizen Sense (Pritchard & Gabrys, 2016)

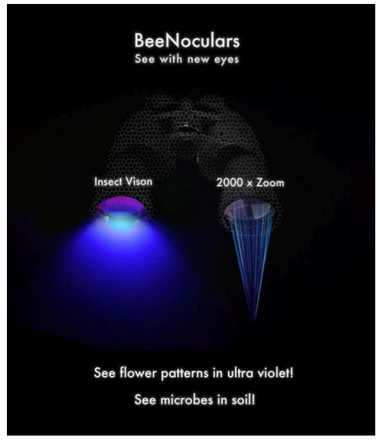


Figure 2. 2 BeeNoculars (Poikolainen Rosén et al., 2022)

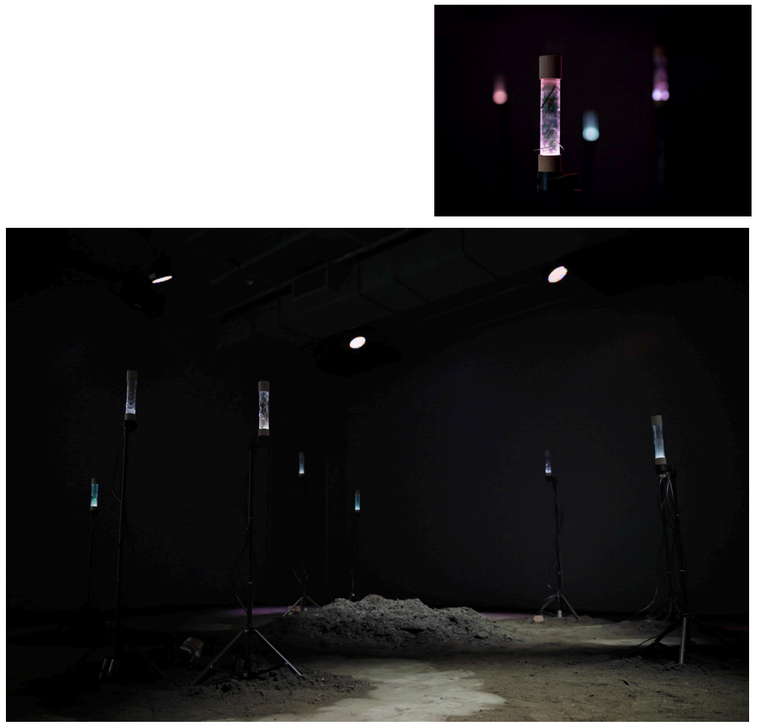


Figure 2.3 Top: An immersive installation used sample collected from the participatory workshops as augmented archives. Bottom left: The second version of Ballets Résiduels, an instrument brought multisensory engagement with invisible traces of contamination. Bottom right: Participants sniff the synthesised fragrance, feel the vibration and hear the unpreditable sound. (Ammar-Khodja & Celerier, 2025)

These works are useful because they show how ecological phenomena can be brought closer to everyday bodily experience. However, they also reveal a tension: environmental design often begins from data, measurement, or detection. This project learns from these approaches, but does not aim to create a precise sensor or monitoring system. Instead, it asks how design can create conditions for situated attention. In this thesis, microbial water change is approached less as a dataset to be represented and more as an uncertain ecological phenomenon to be sensed, questioned, and imaginatively engaged with

Water Environments as More-than-Human Ecologies

Water environments are not passive backgrounds for human activity. They are dynamic ecological settings shaped by interactions between water, weather, sediments, nutrients, microbes, algae, cyanobacteria, plants, animals, infrastructures, and human practices. A canal, pond, lake, or river can therefore be understood not only as a physical site, but as a living and changing relational environment. This perspective resonates with more-than-human and hydrosocial approaches, which understand water environments as produced through relations among ecological processes, infrastructures, materials, and human practices (Linton & Budds, 2014). Hurst et al.'s (2022) discussion of the Colilert® water testing system (see Fig. 2.4) offers a useful example of this relational view: microbial presence becomes knowable through interactions between water samples, testing materials, colour changes, institutional standards, and human interpretation. While such systems make water quality measurable, this thesis turns instead toward how microbial water change might become sensed atmospherically through smell.

From a design perspective, this connects to more-than-human design, which questions whether human-centred design alone is sufficient for responding to ecological conditions. More-than-human design expands the design space by attending to relations between humans and nonhumans, and by asking how nonhuman beings, materials, systems, and environments participate in shaping design situations (Forlano, 2017; Giaccardi et al., 2016; Wakkary, 2021). For this project, this does not mean treating algae, microbes, water, or animals as design "users" in a simple way. Instead, it means recognising that they are active participants in the conditions through which environmental experience becomes sensed.

This framing is important for water-based ecological change because changes in water are not always encountered as clear or stable events. They may appear gradually through colour, smell, surface texture, temperature, floating matter, animal presence, warning signs, or shifts in how people approach or avoid the water. Smell is particularly relevant here because it is unstable, atmospheric, and difficult to separate from place, memory, movement, and weather (Henshaw, 2013; McLean, 2019; Maggioni et al., 2020).

A relevant design precedent is Lucrezia Alessandroni's Olfactory Echoes shown in Figure 2.5 , which explores the impact of climate change on the olfactory heritage of ecosystems, environments, and cities through biodesign and speculative olfactory methods(University of the Arts London, n.d.). This project shows how smell can become a design medium for engaging with environmental change, memory, disappearance, and future imagination. It also connects to olfactory heritage research, which argues that smells can carry cultural, environmental, and historical significance, even though they are ephemeral and difficult to preserve (Bembibre & Strlič, 2017, 2022).

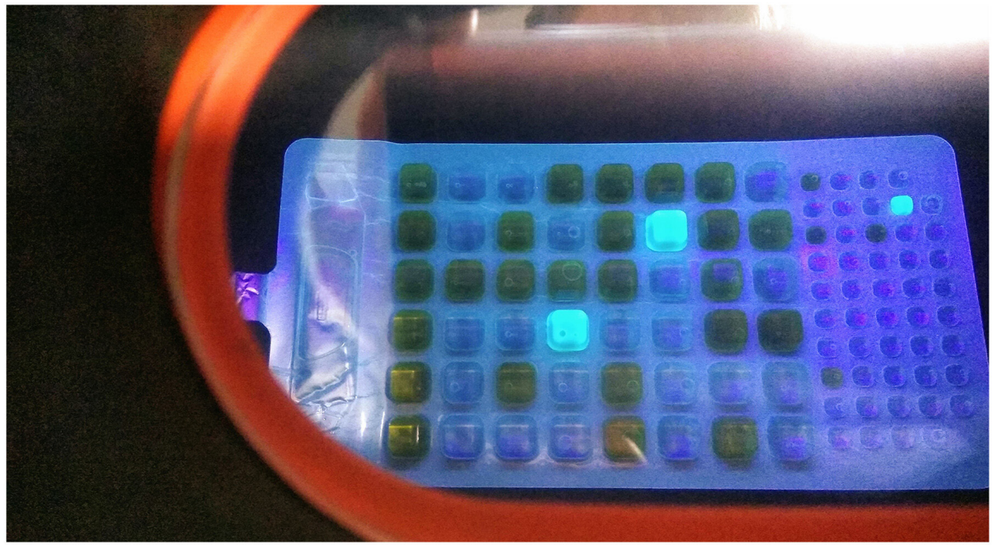


Figure 2. 4 The Colilert® (BASE Milano, 2026)



Figure 2. 5 Olfactory Echoes (BASE Milano, 2026)

By approaching water environments as more-than-human ecologies, this thesis moves away from understanding ecological phenomena only as scientific problems to be detected, measured, or solved. Instead, it asks how design might help people notice and relate to unstable environmental conditions as they unfold in everyday places. This creates a bridge to algal smellscapes as one specific way in which microbial water change becomes sensed atmospherically.

Microbial Smellscapes as Atmospheric Uncertainty

The concept of microbial smellscapes is used in this thesis to describe smell environments shaped by microbial and ecological processes. Within this broader frame, algal smellscapes describe smell experiences associated with algal and cyanobacterial bloom conditions in everyday water environments. Although the term foregrounds algae, bloom conditions are not produced by algae alone. They emerge through relations between microbes, nutrients, water movement, weather, infrastructures, aquatic life, and human activity.

This understanding draws on Henshaw's (2013) concept of smellscapes, which frames smell as an important component of environmental experience, and on more-than-human perspectives that recognise ecological phenomena as relational and multispecies processes rather than isolated events (Giaccardi & Redström, 2020). From this perspective, smells associated with water environments are not simply chemical outputs but part of broader ecological atmospheres that shape how places are sensed and interpreted.

Algal smellscapes are uncertain because they do not function as simple or reliable indicators. A water body may appear visually normal while still undergoing microbial change, and a noticeable odour does not necessarily indicate ecological danger. Research shows that algae and cyanobacteria can produce taste-and-odour compounds such as geosmin and 2-methylisoborneol (MIB), yet the presence, intensity, and perception of these smells vary across environmental conditions and individual experiences (Watson, 2003). Smell is therefore better understood as a partial and situated cue rather than as scientific evidence on its own.

Studies of cyanobacterial blooms show that bloom conditions affect not only ecological health but also recreational use, aesthetic perception, and sensory experience (L'Ecuyer-Sauvageau et al., 2019). People may encounter blooms through visual, olfactory, and situational signs, including green surface accumulations, musty odours, stagnant water, floating matter, warning notices, or changes in the presence of aquatic life. These cues shape how water environments are perceived, used, and interpreted.

From this perspective, algal smellscapes can be understood as forms of atmospheric uncertainty. Drawing on Böhme's (1993) notion of atmosphere as something emerging between environment and perception, algal smellscapes are sensed through unstable relations between environmental conditions and bodily responses. Rather than communicating clear information, they generate hesitation, curiosity, discomfort, avoidance, memory, or speculation. This provides the foundation for the next section, which discusses smellscapes and situated olfactory noticing as ways of engaging with environmental change through embodied experience.

Smellscapes and Situated Olfactory Noticing

Design research has used many sensory strategies to make environmental issues more experiential. Visualisation, sound, vibration, haptic feedback, thermal sensation, mist, taste, walking, and virtual reality have all been used to translate environmental conditions into forms that people can feel or interpret. Among these sensory approaches, smell is especially relevant to this project because it is intimate, bodily, atmospheric, and strongly connected to memory and place.

Smellscape research provides an important foundation here. Rather than treating smell as an isolated odour, smellscape studies understand smell as part of spatial, temporal, social, and emotional experience. Smells move with wind, weather, temperature, distance, and bodily movement. They appear and disappear, mix with other odours, and are interpreted through memory, association, disgust, curiosity, or familiarity. Methods such as smellwalking, smell mapping, smell notes, and olfactory archives have been developed to make these normally neglected smells more noticeable and communicable (Xiao et al., 2020; Parker et al., 2024). Scentscape from Singapore and China town as shown in Figure 2.7 are one of the inspirations for this project. (McLean, 2019)

This understanding also connects back to the atmospheric uncertainty discussed in the previous sector Henshaw's work on urban smellscapes shows that the smell of a city is rarely produced by a single source. Instead, urban smellscapes emerge through the combination of natural processes, built environments, infrastructure, weather conditions, human activities, and temporal rhythms. And it could be catergorized into three different levels shown in Figure 2.8 (Henshaw, 2013). This perspective is useful for thinking about microbial water change because odours associated with algal blooms are encountered alongside many other environmental smells. What people notice at the water's edge is therefore not simply the smell of algae, but a changing composition of water, vegetation, mud, traffic, animals, waste, weather, and microbial activity, which leads to th smellscape composition with different notes.

This supports the method of smellwalking in this thesis. During smellwalks, smell becomes a situated way of sensing place: subjective and unstable, but still meaningful. Xiao, Tait, and Kang show that smell-triggered emotions are connected to place through processes of recognition, association, anticipation, and interpretation (Xiao et al., 2020). Parker, Spennemann, and Bond's review of smellwalk and scentwalk methods also highlights the importance of method, time, and context when studying smell in place (Parker et al., 2024). Spennemann, Parker, and Bond further show that outdoor smells are shaped by attenuation, wind, temperature, and distance, which is important for interpreting smellwalks in open environments (Spennemann et al., 2023).

These studies help frame the smellwalks in this project not as a way to produce objective smell data, but as a way to support situated olfactory noticing. Around water environments, smells are affected by wind direction, humidity, temperature, stagnant water, nearby plants, animals, traffic, food, and urban infrastructures. In this project, these unstable conditions are not treated only as methodological difficulties. They become part of the design learning, showing that smell is not something to fully control, but something to become attuned to.

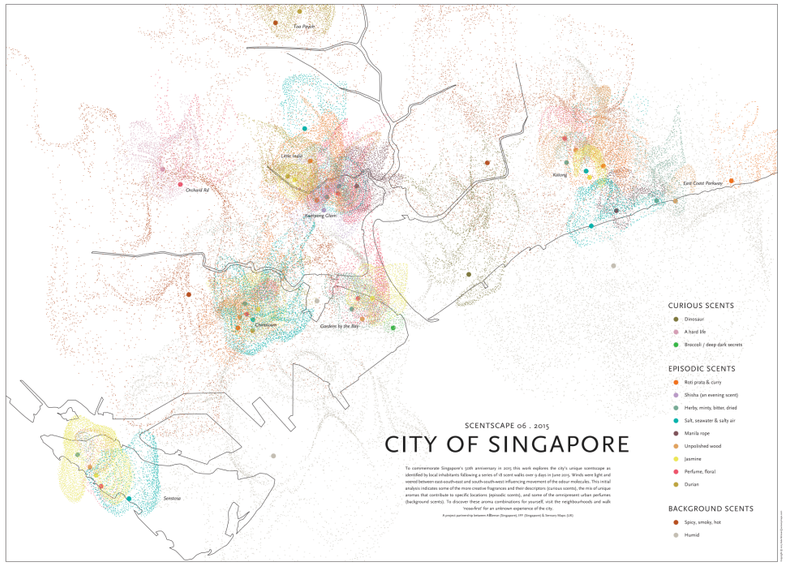






Figure 2. 7 Top: Scentscape of Singapore. Bottom left: Smellnote booklet and Bottom right: smellscape mapping of Chinatown (McLean, 2019)

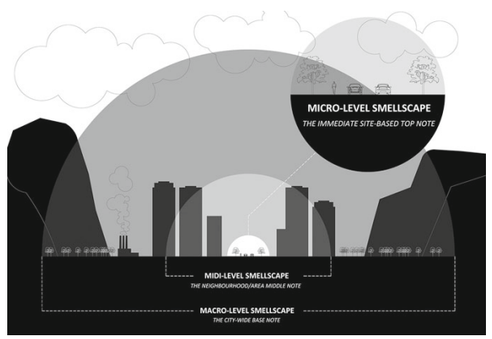


Figure 2. 8 The Smellscape as a composition of different notes (Henshaw, 2013)

From Present Smellscapes to Future Smellscapes

Smell does not only belong to the present. It can also carry traces of the past and suggestions of the future. Research on smell, memory, heritage, and urban experience shows how smell can shape place identity, nostalgia, belonging, discomfort, and social meaning. Abbassy, El-Husseiny, and Shaker use smell-walking as a cognitive mapping tool to understand Syrian food smellscapes in Cairo, showing how smell can support memory, placemaking, and emotional connection (Abbassy et al., 2025). Gao and colleagues discuss smellmarks and smellevents as part of urban perception, suggesting that smell can shape spatial memory and route-making (Gao et al., 2022). Cheng and Bowring's work on industrial heritage further shows that non-pleasant smells such as rust, dust, smoke, and industrial traces can be important for remembering difficult histories rather than being removed from experience (Cheng & Bowring, 2024).

This matters because microbial smells should not only be understood as bad smells to remove or avoid. A microbial or bloom-like smell may be interpreted as disgusting, natural, dangerous, seasonal, familiar, nostalgic, or strange depending on the person and context. Smell can therefore hold ambiguity. It can make people uncomfortable, but it can also invite curiosity and speculation.

Olfactory design and speculative smell projects extend this further by using smell to imagine possible futures. Beşevli and colleagues' Smell Above All explores smell-centred future worlds, showing how smell can become a medium for imagining alternative social and environmental arrangements and create three speculative smell world see Figure 2.9 (Beşevli et al., 2024). Zou and Morrison similarly propose "scentory" futures as a way to sharpen anticipatory design senses for sustainability (Zou & Morrison, 2022). Lindborg and Liew's work on real and imagined smellscapes also suggests that smell can be evoked through imagination and cross-modal association, not only through direct odour exposure (Lindborg & Liew, 2021).

In this thesis, this shift from present smellscape to future smellscape is central. The project asks not only: what does Delft water smell like today? It also asks: what might future microbial water smellscapes feel like to live with? Through simulated bloom smells, future collages, a smell archive, and a wearable smell probe, smell becomes a bridge between present noticing and future imagination.



Figure 2. 9 Three Smell Worlds (Beşevli et al., 2024)

From Problem Solving to Speculative Attunement

Many environmental design projects are solution-oriented. They aim to monitor, detect, warn, visualise risk, change behaviour, or support environmental management. These approaches are important, especially when environmental risks affect public health. However, they can also make environmental issues appear as problems that can be solved through clearer data, better sensors, or more efficient communication.

This project takes a different position. It does not aim to solve harmful algal blooms, clean the water, or provide accurate microbial detection. Instead, it creates space for noticing, discussion, discomfort, imagination, and reflection. This position is informed by work on attuned sensing, cultural probes, speculative design, and more-than-human HCI, where design is used not only to produce solutions, but to open new relations with uncertain environmental conditions. Calvillo's concept of attuned sensing shifts air pollution sensing from the question of "how much" pollution exists toward the atmospheric, political, and bodily conditions through which pollution is lived. 'Being alongside the mist' installation (see Fig. 2.10) is part of Yellow Dust, the sensing infrastructure (Calvillo &Garnett , 2019). Lau and Cheng's work on cultural probes for environmental research similarly frames probes as speculative and creative methods that cultivate attentiveness and uncertainty rather than producing direct solutions (Lau & Cheng, 2024).

This is why the wearable smell probe is framed as a speculative attunement tool rather than a functional warning device. It does not tell the wearer whether the water is safe or unsafe. Instead, it makes a possible microbial future bodily present for a moment. It asks the wearer to notice the water, the air, the weather, their own breathing, and their emotional response. In this way, the project shifts from environmental problem-solving toward speculative attunement.



Figure 2. 10 'Being alongside the mist', Yellow Dust. The installation create data intimacies with the public. (Calvillo &Garnett , 2019)

Speculative and More-than-Human Design for Microbial Futures

More-than-human design provides a further lens for this project by challenging the idea that design should only focus on human users. Microbial water environments are not shaped by humans alone. They involve algae, bacteria, water, sediments, aquatic plants, fish, birds, canal walls, nutrients, temperature, rainfall, wind, smell molecules, and human activities. These relations are not always visible, but they shape how water environments change and how people experience them.

More-than-human design helps make these relations more visible as design concerns. Coulton and Lindley argue for moving beyond human-centred design by considering "other things" as part of design situations (Coulton & Lindley, 2019). Hupkes and Hedman similarly discuss speculative design as a way to shift toward non-anthropocentric futures (Hupkes & Hedman, 2022). Wilkie and Michael's speculative energy briefs also show how more-than-human design can work through propositions, feelings, and alternative relations rather than optimisation alone (Wilkie & Michael, 2025).

Speculative wearable and embodied environmental design projects are especially important for this thesis. High Water Pants shown below Figure 2.12 uses wearable speculative technology to make climate change and sea-level rise tangible at the scale of everyday cycling (Biggs & Desjardins, 2020). Toxic Speculations uses Ray-Flats shown below (see Fig. 2.11), a pair of shoes that glow near toxic sites, and an accompanying navigational guide to make diffuse environmental pollution affectively perceptible through the body (Janicki et al., 2026). These projects are useful because they do not treat speculative artefacts as finished products, but as ways to rehearse alternative relations with environmental conditions.

This project builds on this direction, but shifts the material and ecological focus from water level or toxic sites toward microbial smellscape. The smell probe does not represent microbes directly. Rather, it creates an encounter in which microbes, blooms, water, smell, weather, and human bodies can be considered together. This positions microbial smellscape as a more-than-human relation rather than a single sensory output.



Figure 2. 11 Ray-Flats (Janicki et al., 2026)



Figure 2. 12 High Water Pants (Biggs & Desjardins, 2020)

POSITIONALITY

Together, these bodies of work demonstrate how ecological phenomena can be engaged through embodied data, multisensory experiences, smellwalking, speculative methods, and more-than-human design. Yet important gaps remain across these areas. Environmental sensing research often prioritises data collection and measurement, while smellscape studies tend to focus on existing urban odours and everyday sensory experiences. Olfactory HCI frequently explores controlled scent delivery or mediated sensory environments. Although speculative and more-than-human design approaches encourage alternative ways of relating to ecological futures, microbial aquatic smell remains largely underexplored as a design material and mode of engagement.

This thesis addresses this gap by framing microbial smellscape as an embodied, atmospheric, and more-than-human sensory encounter. Building on the understanding of algal blooms as relational ecological phenomena, it combines smellwalks, participatory speculation, simulated bloom smells, and a wearable olfactory probe to explore how future microbial water conditions might become experientially accessible in the present. Rather than developing a scientific detection tool or proposing a solution to harmful algal blooms, the thesis contributes a design approach for situated attunement—supporting people in noticing, sensing, and imagining microbial water futures through smell.

FROM CONTROLLED SMELL EXPERIMENTS TO SITUATED ATTUNEMENT

At the beginning of the project, I explored whether the smell of lab-grown cyanobacteria could communicate climate change and microbial changes in water (see Fig. 2.13) . These early experiments focused on observing and describing cyanobacteria odours and testing whether they could evoke ideas of warming water, algal growth, and ecological change.

However, the experiments revealed a limitation: when isolated from its environmental context, the smell was difficult to connect directly to climate change. While people could notice and describe the odour, its meaning was not self-evident. Without the presence of water, weather, public space, or lived experience near urban canals, the smell risked becoming an abstract material sample rather than an environmental encounter.

This insight marked a turning point. Rather than treating cyanobacteria smell as a direct message, I began to understand smell as something that gains meaning through place and context. The project therefore shifted from communicating climate change through an isolated biological smell toward designing conditions for situated attunement. Smell became part of a wider aquatic smellscape shaped by environmental, bodily, and social relations. This shift also informed the methodology, leading to a combination of Research through Design, smellwalks, autoethnographic smell journaling, co-speculation, materialising, thematic analysis, and annotated portfolios.

Figure 2.13 Initial smell profiling cyanobacteria in the lab



Chapter 3

METHODOLOGY

The theoretical positioning established in Chapter 2 is translated here into a RTD approach. The project moves iteratively through three interconnected phases: attuning, speculating, materialising with reflecting and making across all phases to investigate present smell experiences, possible futures and experiential design interventions.

Source: Oil drop under the microscropy, photoed by the author

METHODOLOGICAL POSITIONING:

RESEARCH THROUGH DESIGN AS THE GUIDING FRAMEWORK

This project adopts Research through Design as the guiding methodological framework. Research through Design is suitable because the project does not only aim to study microbial smellscapes from a distance, but also uses design practice as a way to explore how such smellscapes might be noticed, imagined, and materially experienced. In Research through Design, artefacts, prototypes, and design processes are not only final outcomes; they can become vehicles for inquiry and knowledge production. Zimmerman, Forlizzi, and Evenson (2007) describe Research through Design as an approach in which designers produce knowledge through the creation, evaluation, and reflection of designed artefacts. This is especially relevant for this project because the central research concern — how invisible microbial change might become sensorially and emotionally noticeable — cannot be fully answered through interviews or observation alone. It requires situated engagement, speculative imagination, and material experimentation.

Within this Research through Design framework, several complementary methods were combined: smellwalks, autoethnographic reflection, participatory speculative design, material speculation, thematic analysis, and annotated portfolios. These methods were not used as separate or isolated procedures. Instead, they formed an iterative process of sensing, imagining, making, and reflecting. The project also included elements of research for design. Frayling (1993) distinguishes research conducted through design practice from research undertaken to inform and support design.

Smellwalks were used as a situated sensory method to investigate how people currently notice, experience or overlook smellscapes around Delft water environments. Smellwalking has been developed within smellscape research as a way of attending to the olfactory qualities of places through embodied movement and sensory observation (Henshaw, 2013; McLean, 2019). The method is particularly relevant because smell is spatial, temporal, subjective, and often difficult to articulate without being physically present in an environment. Smellwalks have been used to reveal how people perceive, interpret, and negotiate environmental conditions through smell, making them suitable for exploring microbial smellscapes that are often overlooked or invisible (Parker et al., 2024; Porteous, 1985). In this project, smellwalks were used to ground the research in present water environments. Participants were invited to walk, smell, pause, compare, describe, and reflect on how smellscapes were experienced across different sites. This helped reveal the smellscape as a situated experience shaped by wind, water proximity, weather, bodily movement, memory, and uncertainty.

Autoethnography supported the researcher's own self-sensing, smell journaling, and reflective documentation during field visits and prototype testing. Autoethnography is valuable for examining lived, embodied, and sensory experiences because it positions the researcher's personal experience as a legitimate source of knowledge and reflection (Adams et al., 2015). This was important because olfactory experience is embodied and subjective. The researcher's own sensory responses, uncertainties, and bodily reactions became part of the design inquiry, rather than being removed from it. In this project, autoethnographic reflection was used to document how smell was encountered through changing weather, wind, location, distance from water, and repeated exposure. It also helped trace the shift from treating smell as a controllable output toward understanding it as part of a situated and unstable smellscape.

Participatory speculative design was used to move from present conditions to possible microbial futures. Speculative design uses design to ask "what if" questions and open discussion around possible futures, rather than only solving present problems (Dunne & Raby, 2013). Participatory design further supports the involvement of participants as contributors of experience, values, and imagination, rather than treating them only as research subjects (Sanders & Stappers, 2008). In this project, speculation was made participatory so that future microbial smellscapes were not only generated by the designer, but also shaped through participants' memories, concerns, values, and imaginative responses. Through the co-speculation session including the future worldbuilding, speculative news headlines, future timelines, bloom future cards, and zine templates, participants imagined future relationships between humans, water, smell, aquatic life, urban infrastructures, and everyday objects. This helped reveal how people might emotionally, socially, and bodily make sense of intensified microbial smellscapes.

Material speculation was used in this project to translate sensory and speculative insights into tangible design exploration. Rather than treating artefacts as functional solutions, they are framed as counterfactual propositions that enable embodied reflection on possible futures (Wakkary et al., 2015). The smell chamber and wearable smell probe are not scientific instruments or finished products, but speculative probes that introduce elements of a potential future microbial smellscape into present experience. The wearable probe, in particular, asks: if intensified microbial smells became part of everyday water environments, how might people perceive and respond to them? Making and testing these artefacts explored how smell can be released, carried, perceived, and connected to body and environment. This process revealed tensions such as outdoor instability, olfactory fatigue, airflow constraints, body positioning, scent design, and control of intensity. Rather than limitations, these factors are treated as design knowledge, showing that microbial smell encounters are relational, contingent, and shaped by environmental and bodily conditions rather than stable or controllable.

Thematic analysis was used to interpret the qualitative materials generated through fieldwork, smellwalks, participant responses, workshop discussions, and speculative outputs. Braun and Clarke (2006) describe thematic analysis as a flexible method for identifying, analysing, and reporting patterns of meaning within qualitative data. In this project, thematic analysis was used to identify recurring concerns, sensory experiences, emotional responses, and speculative directions. The analysis focused not only on what participants said, but also on how they related smell to place, memory, warning, bodily protection, aquatic life, and everyday urban futures. The themes helped connect present sensory experience with future design opportunities and informed the later development of the speculative probe set.

Finally, **annotated portfolios** were used as both an analytic and communication method. Gaver and Bowers (2012) describe annotated portfolios as a way of communicating design knowledge through collections of artefacts and brief annotations. This method was suitable because the project generated many different kinds of design materials, including smellwalk tools, photographs, workshop templates, speculative cards, participant outputs, prototype iterations, and the final wearable probe. In this project, annotated portfolios helped interpret smellwalk photographs, workshop materials, prototype iterations, and design decisions. Rather than treating images and artefacts only as documentation, annotations were used to identify bodily gestures, emotional reactions, interaction qualities, uncertainties, and emerging design insights. The annotated portfolio therefore shows how design knowledge emerged across multiple artefacts and activities, rather than only through the final outcome.

In this project, thematic analysis and annotated portfolio analysis worked together. Thematic analysis was used to identify repeated patterns across smellwalk observations, participant reflections, co-speculation materials, and prototype testing notes. Annotated portfolio analysis then became the main format for presenting and synthesising these patterns through selected photographs, workshop outputs, speculative future things, and design fragments. In this way, themes were not only described in text, but also traced through situated moments and material artefacts.

Together, these methods supported the project's movement from present smell experience to speculative future-making and material design exploration. Research through Design provided the overall framework, while smellwalks and autoethnography grounded the work in situated sensory experience. Participatory speculative design opened possible microbial futures, material speculation translated these futures into embodied artefacts, and thematic analysis and annotated portfolios helped interpret and communicate the design knowledge generated through the process.

RESEARCH FOR DESIGN

Literature review
Expert interview
Context research
Site observations

From Past& Present

RESEARCH THROUGH DESIGN

Reflecting & Synthesising

Phase 1
ATTUNING
Autoethnography
Smellwalks

RQ1

Insights

Phase 2
SPECULATING
Co-speculation

RQ2

Insights

Phase 3
MATERIALISING
Material speculation

RQ3

To Future

Reflecting & Synthesising

**RQ = Research Question*

REFLECTING	Thematic analysis		Annotated porfolio
MAKING	Sensitising tool	Speculative 'things' &Future-making prompts	The wearable probe, smell archives, the zine

DESIGN KNOWLEDGE

Key themes & Reflections
Design knowledge for situated smellscape attunement

Figure 3.1 Research through design process

RESEARCH DESIGN

This research was guided by the question:

How can design support people in noticing and experiencing future microbial smellscapes in the present?

The project followed a Research through Design (RtD) approach with four interconnected phases: Attuning, Speculating, Materialising, and Reflecting (Figure 3.1).

Attuning focused on noticing present microbial smellscapes in Delft water environments. Through an autoethnographic approach including smell journaling, context research, site observations, smellwalks that also helped others attune to these environments, and the making of sensitising tools. This phase explored how aquatic smells are influenced by weather, movement, distance, uncertainty, memory, and bodily response.

Speculating extended these present experiences into possible microbial futures through co-speculation. Participants used future-making prompts: a future timeline, speculative news headlines, a collage, Bloom Future cards with the template, and making future 'thing' to imagine changing relationships between humans, water, smell, aquatic life, microbes, and urban infrastructure.

Materialising translated emerging insights into tangible design explorations through material speculation. Prototypes such as the smell chamber, scent cartridge, and the final Blooming Breath probe functioned as speculative artefacts. They were not designed to measure microbial smell scientifically, but to make future microbial smellscapes experientially present, bodily felt, and open to reflection.

Reflecting brought together the insights generated through the project. Thematic analysis and annotated portfolios were used to identify patterns across field notes, participant responses, workshop outputs, photographs, speculative future things, and prototype reflections. This phase examined how design knowledge emerged through the movement between attuning, speculating, and materialising, and clarified the project's contributions. Reflection also fed back into the first phase of attuning, informing new observations, reframing interpretations, and supporting further iterations of the design process.

Making occurred across all phases rather than only in Materialising. In Attuning, sensitising tools were designed and refined to support noticing and articulating environmental smells. In Speculating, future prompts and workshop materials were created, while participants made speculative future things and scenarios. In Materialising, these insights informed the final speculative probe set through scent, electronic, wearable, and interaction prototyping.

Figure 3.1 presents this process as an iterative RtD framework. The phases informed one another: attuning shaped speculation, speculation opened possible design directions, materialising made these directions experienceable, and reflection helped clarify what the project contributes. At the same time, **synthesis, reflection, and iteration** operated throughout the whole process, continuously reframing and refining tools, prompts, materials, interpretations, prototypes, and design decisions.

Outside the cycle, the diagram highlights two supporting elements: **research for design** inputs, including literature review, expert interviews, and context research; and an ongoing synthesis, reflection, and iteration loop, through which the project was repeatedly interpreted, adjusted, and refined. The **outputs** of this process is the design knowledge in each step included sensitising tools, co-speculation workshop materials, participant-generated future scenarios and things, design prototypes such as Blooming Breath, an olfactory wearable probe, and the articulated **design knowledge** presented through thematic analysis and annotated portfolios.

ETHICS AND LIMITATIONS OF METHOD

Several ethical and methodological considerations shaped the design and implementation of this project. Because the research involved participants, sensory experience, field documentation, and speculative representations of environmental change, careful attention was given to consent, safety, interpretation, and the limits of the design methods.

First, photo and audio consent was required for documenting the smellwalk, workshop activities, and participant interactions with the tools. Participants were informed that photographs, quotes, and workshop materials might be used in the report for research and design communication purposes. When photographs included identifiable faces, bodies, or gestures, consent was especially important. Images were treated not only as documentation, but also as visual research material for annotated portfolio analysis.

Second, the project considered smell sensitivity. Smell is a subjective and embodied sense that can trigger discomfort, irritation, memory, disgust, or emotional response. Participants were not forced to smell anything closely and could decide their own level of engagement. This was especially important during the smellwalk and prototype testing, where smell intensity, proximity to water, and repeated exposure could affect participants differently.

Third, the project recognises the subjectivity of smell as a methodological limitation. Unlike visual data or numerical environmental measurements, smell is unstable, personal, and difficult to describe consistently. Different participants may perceive the same smell differently depending on their memory, cultural background, physical sensitivity, expectations, and bodily position. Weather, wind, humidity, rain, and location also influenced whether smells were noticeable. For this reason, the project does not treat smell descriptions as objective environmental data, but as situated sensory accounts.

Fourth, the project did not use harmful biological material. Although the project refers to microbial smellscapes, harmful algal blooms, and future microbial change, the smell materials used in the prototype were symbolic and experiential rather than biologically active. The project did not attempt to reproduce toxic algae, cultivate microbial substances, or expose participants to hazardous material. This distinction was important for both safety and ethical clarity.

Fifth, safety near water was considered during field activities. Participants were not asked to enter the water, touch unsafe surfaces, or take physical risks near canals or water edges. The smell capture tools were designed to support careful engagement from a safe distance. The fieldwork therefore focused on sensory noticing and reflection rather than direct environmental sampling.

Sixth, the project does not claim scientific detection. The smell capture tools and wearable smell probe are design probes, not scientific sensors or water quality detection devices. They do not measure microbial concentration, identify harmful algal blooms, or provide accurate environmental warnings. Their purpose is to support noticing, speculation, and discussion around microbial smellscapes, rather than to produce scientific environmental data.

Finally, the project is limited by a small participant sample and a specific local context. The smellwalk and co-speculation workshop were conducted with a limited number of participants and were situated in Delft water environments. The findings should therefore not be understood as generalisable conclusions about all urban water bodies or all microbial smell experiences. Instead, the project offers situated design insights into how microbial smellscapes might be sensed, discussed, imagined, and materialised through design.

Chapter 4

ATTUNING TO THE PRESENT

Chapter 3 established the methodological framework for investigating microbial smellscapes through situated and sensory research. Chapter 4 begins this inquiry in present-day Delft, using observation, smell journaling and smellwalks to explore how water smells are noticed, ignored, interpreted and shared.

Source: https://nioo.knaw.nl/en/news/ancient-blue-green-algae-bloom-more-and-more

DELFT WATER AS A SITUATED RESEARCH CONTEXT

Delft water environments were selected as the situated context for this project because water is deeply embedded in the everyday urban fabric of the city. Canals, ponds, water edges, bridges, plants, birds, boats, benches, and walking routes form part of daily life. People pass by these water bodies, sit near them, cycle along them, walk beside them, and sometimes swim or interact with them more directly. However, these ordinary water environments are often visually familiar but sensorially overlooked. Their microbial conditions, seasonal changes, and subtle smell differences are rarely part of everyday public attention.

This made Delft water an appropriate context for exploring the design question of this project: how can design support people in noticing, experiencing, and reflecting on microbial smellscapes? Rather than treating water as a neutral background, the project approaches Delft water as a living, changing, and relational environment. The canals and water edges are understood as places where ecological, infrastructural, climatic, social, and sensory relations meet.

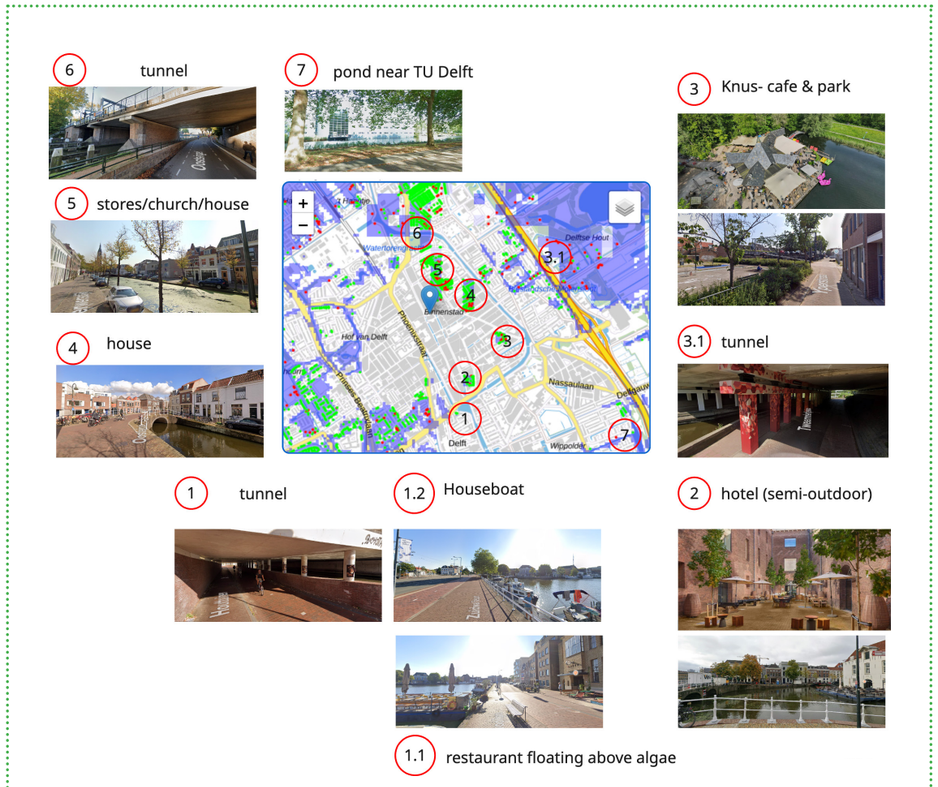


Figure 4.1 Selected locations for site observation based on the risk of flood level shown on zwemwater.nl, a public website in the Netherlands monitoring the water quality and risk

SITE SELECTION: FLOOD RISK, ORDINARY WATER, AND MICROBIAL TRACES

The selection of location was shaped by three considerations:

First, Delft is situated within the wider Dutch delta context, where water management, flood risk, rainfall, canals, and everyday urban life are closely connected. As a low-lying country, the Netherlands continually negotiates relationships between water, infrastructure, climate adaptation, and public space. Water is therefore not only an environmental backdrop but a condition that can become increasingly present through rainfall, runoff, changing water levels, and extreme weather events.

Second, the selected Delft sites were intentionally ordinary and familiar.The aim was not to identify a scientifically confirmed harmful algal bloom location. Instead, the project explored how microbial smellscapes might be noticed within everyday urban water environments. This was important because the project speculates on possible futures in which microbial smells, bloom-like conditions, or changing water ecologies may become part of familiar routes, canal edges, walls, benches, and public spaces.

Third, the selected sites contained visible water-edge traces that invited sensory and speculative attention. During field observations, I photographed green surface traces on walls and materials located near water edges. These traces appeared as green stains, algae-like textures, moisture-related growth, or paint-like markings at the boundary between water, wall, and air. However, these traces were not scientifically tested but compared with existing researches(See figure 4.2). Therefore, this project does not identify them as cyanobacteria, harmful algal bloom, or confirmed microbial bloom material. Instead, they are treated as visual prompts for microbial noticing: small signs that make the water-land boundary feel alive, changing, and uncertain.

This distinction is important. Scientific identification would require laboratory testing, which was outside the scope of this project. The role of these observations is therefore not to prove microbial bloom, but to support the research question and think abut how might people begin to notice microbial or algae-like traces like smell when they appear beyond the expected surface of water into our dailylife? In this sense, the green surface traces helped extend the project's attention from water itself to the surrounding water-edge environment, where moisture, surfaces, plants, infrastructure, animals, and possible microbial life interact.

Initial observations were conducted across several Delft water sites, including canal edges, bridges, planted water margins, open water surfaces, house boat edges and areas where people regularly walk, sit, cycle, or pass by. The observation process paid attention not only to the appearance of the water, but also to weather, wind direction, smell, human behaviour, animals, plants, water infrastructure, and signs of care or neglect. (Figure 4.3 Ecological relationship map)

Across the observation period, the water appeared in different ways depending on weather and location. On sunny days, the water surface often looked calm, reflective, and visually pleasant. On rainy or windy days, the smell became harder to locate, and the water edge felt more unstable and atmospheric. In some locations, floating materials, plants, algae-like textures, or greenish surfaces made the water appear more alive or more suspicious. In other places, the water looked visually clean, but still carried subtle earthy, damp, fishy, or rotten smells.

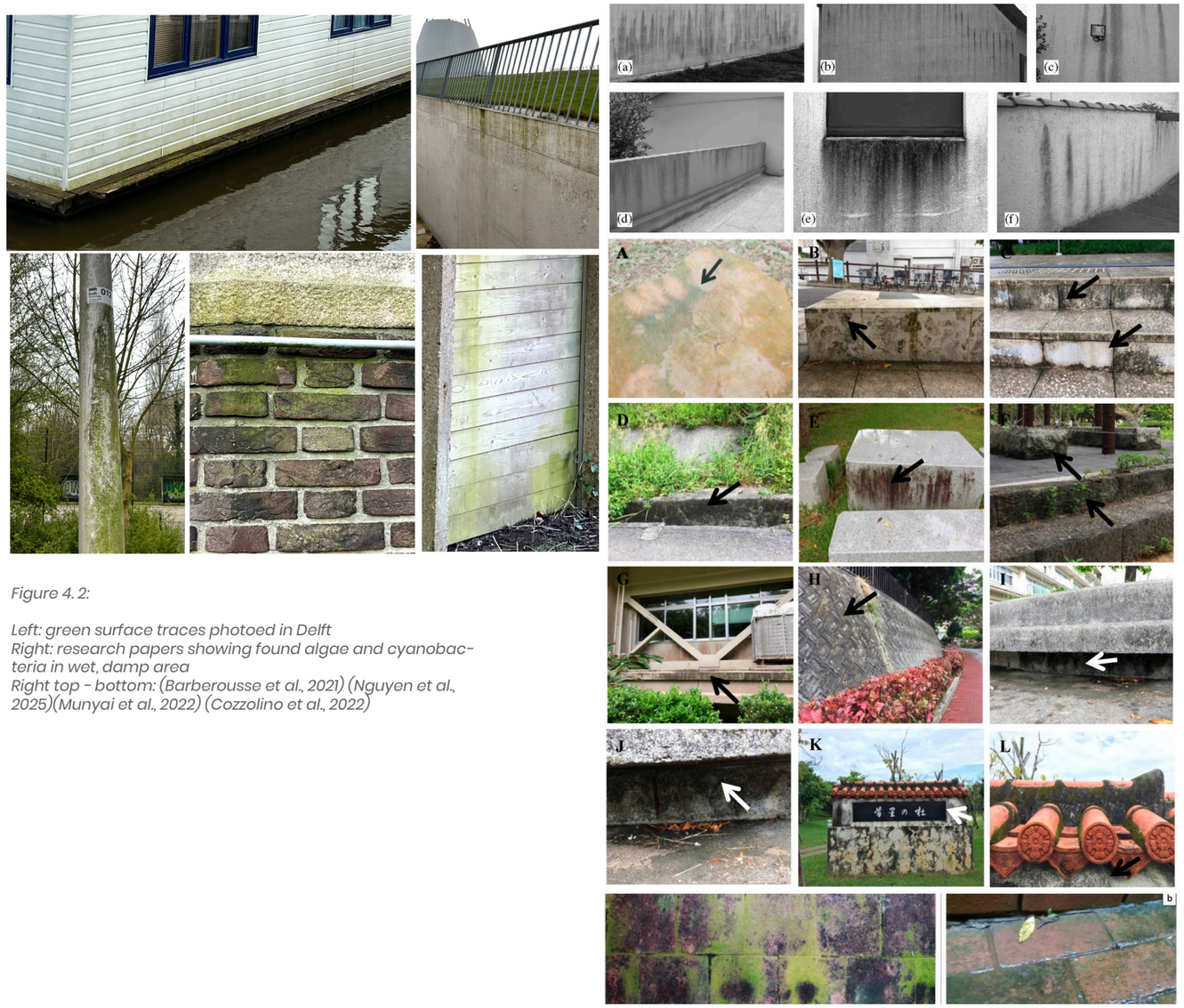


Figure 4. 2:

Left: green surface traces photoed in Delft
Right: research papers showing found algae and cyanobacteria in wet, damp area
Right top - bottom: (Barberousse et al., 2021) (Nguyen et al., 2025)(Munyai et al., 2022) (Cozzolino et al., 2022)

EXPERT CONSULTATIONS

The expert consultations informed two main areas of the research: the methodological development of the smellwalk and the broader positioning and scope of the project. These exchanges were not treated as formal interviews or analysed as research data. Instead, they provided guidance for refining the research activities, defining the type of inquiry being undertaken, and avoiding unsupported scientific claims.

Consultations with people knowledgeable about water quality, ecology, and microbial bloom risk highlighted that microbial changes in water are rarely perceived or understood directly by the public. Water quality is generally assessed through scientific monitoring, while everyday users rely on partial sensory and contextual cues, such as colour, smell, warning signs, or personal intuition. The consultations also emphasised that microbial water conditions emerge through complex ecological and climatic relations and therefore cannot be fully represented through a single smell, sensory cue, or design intervention. This reinforced the need to clearly distinguish the project from scientific detection, predictive modelling, or the communication of verified water conditions.

"WE DO RECEIVE COMPLAINTS, BUT THERE IS NOTHING MUCH WE COULD DO...

IT'S A VERY COMPLICATED ISSUE AND INVOLVES ECONOMY, AGRICULTURE AND SO ON"

— Expert 1

"PEOPLE DO FEEL FRUSTRATED ABOUT BEING BANNED FROM SWIMMING. WE'RE JUST RESPONSIBLE FOR MONITORING THE WATER QUALITY IN THE LAB. OTHERS

— Expert 2

Methodological guidance from a smellscape researcher informed the design and facilitation of the smellwalk. Participants may lack confidence in their own olfactory sensitivity and therefore need explicit encouragement to pause, sniff, and articulate what they perceive. The smellwalk was consequently designed to support participants in trusting their sensory impressions rather than identifying smells correctly. Attention was directed toward how smells emerged, disappeared, or changed in relation to place, weather, bodily movement, and surrounding activities.

Expert 5 also helped clarify the project's methodological scope by encouraging reflection on the timeframe, available techniques, and type of research that could realistically be undertaken. This contributed to positioning the project as an experiential and speculative design inquiry rather than a technical or predictive one.

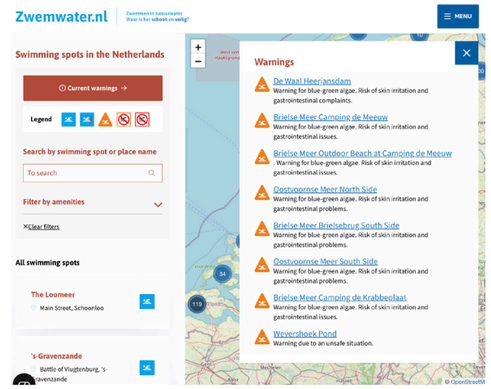
" YOU COULD ENCOURAGE PEOPLE TO SMELL. PEOPLE ARE JUST NOT CONFIDENT ENOUGH IN THEIR SMELL SENSIBILITY."

— Expert 4

"MAYBE THINK ABOUT THE TIMEFRAME AND TECHNIQUES THAT ARE ACCESSIBLE TO YOU, THEN DEFINE WHAT TYPE OF PROJECT YOU ARE GOING TO DO."

— Expert 5

Experts	*Profession*	*Expertise*	*Organisation*	*Channel*
E1	Senior policy advisor	Water management	Hoogheemraadschap van Delfland	Interview
E2	Researcher	Algal Bloom	Netherlands Institute of Ecology	Interview
E3	Advisor Water Quality	Water quality impact advising	Hoogheemraadschap van Delfland	Biweekly emails
E4	Researcher, Artist	Smellwalk method	University of Kent	Online meeting
E5	Artist, Researcher	Microbial smell	Umeå Institute of Design	Online meeting



Public water risk website

Locatienaam	≤1 Categorie drijflaag	≤1 Categorie bentische mat	≤12: geen maatr. >12 en ≤75:waarsch. >75: neg.zwemadv. "Fluoroprobe waarde" (zwemwaterregister) µg/l
Plas Prinsenbos	0	0	11.1
Plassen Madestein, Loosduinen	0	0	<2.0
Plassen Madestein, Noordzijde	1	0	38.8
Plassen Madestein, Zuidzijde	1	0	45.3
Krabbeplas Oostzijde	0	0	3.8
Delftse Hout	0	0	<2.0
Dobbeplas	0	0	<2.0
Naturistencamping Delft	0	0	<2.0
Wollebrand	0	0	5.0
Plas Wilhelminapark	0	0	<2.0
Waterspeelplaats Tubasingel	0	0	2.7
Natuurbad Te Werve / Zwembad de Put	0	0	<2.0

Email with Expert 2 screenshot

TAKEAWYAS

The consultations clarified that microbial water change is difficult to perceive through everyday experience and cannot be fully represented by a single sensory cue. They also showed that participants may need encouragement to trust and articulate their smell perceptions. Together, these insights informed the smellwalk methodology and positioned the project as a situated, sensory, and speculative inquiry focused on noticing and imagining possible microbial futures rather than detecting or verifying actual water conditions.

ECOLOGICAL RELATIONSHIP MAP

To better understand these relations, an ecological relationship map was developed. The map did not attempt to provide a scientific model of microbial processes. Instead, it visualised the relations that may influence how microbial water conditions become noticeable or remain hidden. These included rainfall, runoff, temperature, wind, nutrients, plants, algae-like traces, animals, water edges, public behaviour, and monitoring systems. It was made by the materials collected during the site observation and auto-ethnographic smell journals. See Figure 4.2



Nonhuman lives and materials
They are not passive background elements; they participate in, respond to, and make microbial change perceptible.

Figure 4.3 Ecological relationship map

Current mitgation
Warning signals are put when the bloom season comes, which are usually in a visual way.

** Detailed photos see appendix*

AUTOETHNOGRAPHIC SMELL JOURNAL: LEARNING TO NOTICE

Before inviting others into the smellwalk, I used an autoethnographic smell journal to train my own attention and to inform the development of the smellwalk route and prompts. My body became part of the research instrument. Through repeated visits, smelling, writing, photographing, and reflecting, I began to understand that aquatic smell is not a stable object waiting to be captured. It appears and disappears. It depends on wind, distance, body position, weather, expectation, and the condition of the water edge. These early observations helped identify locations, sensory cues, and moments of uncertainty that later shaped the smellwalk experience for participants.

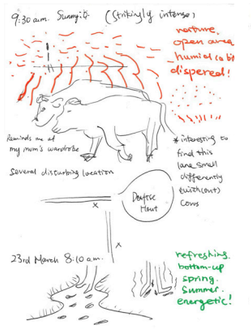
Autoethnography was useful because the project involved subjective, bodily, and sensory experience. Smell is difficult to separate from memory, disgust, curiosity, uncertainty, and personal association. Instead of removing subjectivity, the journal treated first-person experience as a starting point for design inquiry. This follows sensory and autoethnographic approaches that value embodied experience as a way of understanding situated phenomena (Ellis, Adams, & Bochner, 2011; Pink, 2015). The journal therefore functioned not only as a method of personal reflection, but also as a preparatory stage for designing the smellwalk and understanding how participants might encounter and interpret aquatic smellscapes.

During repeated observations, my own way of smelling gradually changed. At the beginning, I often looked for a strong and obvious smell. I expected microbial smell to be something clear, unpleasant, and easy to identify. However, after several visits, I became more attentive to weaker and more unstable smells: damp soil near the water edge, fishy traces after rain, green plant smells, muddy air, rotten leaves, and moments when the smell suddenly disappeared.

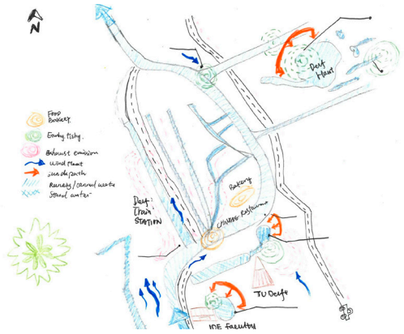
This process also revealed the limits of smelling. Sometimes I was unsure whether I smelled the water, the plants, the soil, the city, or my own expectation. On windy days, the smell moved quickly and became difficult to locate. After smelling for a long period, my nose became tired, and I could no longer clearly distinguish differences. At some moments, I felt attracted by the complexity of the smell; at other moments, I felt disgust, hesitation, or uncertainty about moving closer to the water.

These bodily reactions became important design material. They showed that noticing smell requires slowing down, changing distance, paying attention to wind, and accepting uncertainty. The smell journal therefore informed the later smellwalk prompts. Instead of asking participants to identify smell correctly, the prompts encouraged them to describe what they noticed, where the smell seemed to come from, how confident they felt, and what bodily reaction the smell produced.

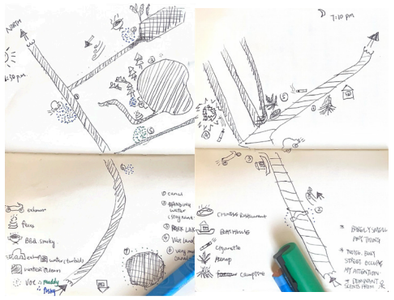
 # Smellwalk 1: Farm - Sunny day - Solo

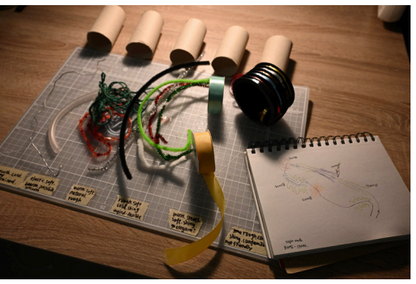


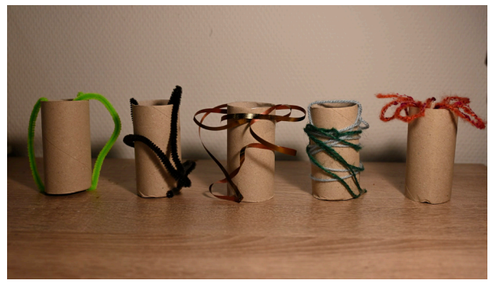
 # Smellwalk 2: City cannal - Windy Night - Solo

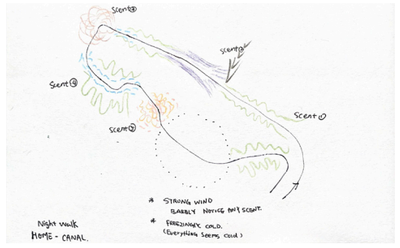


 # Smellwalk 4: Canal - Quite Night - Solo



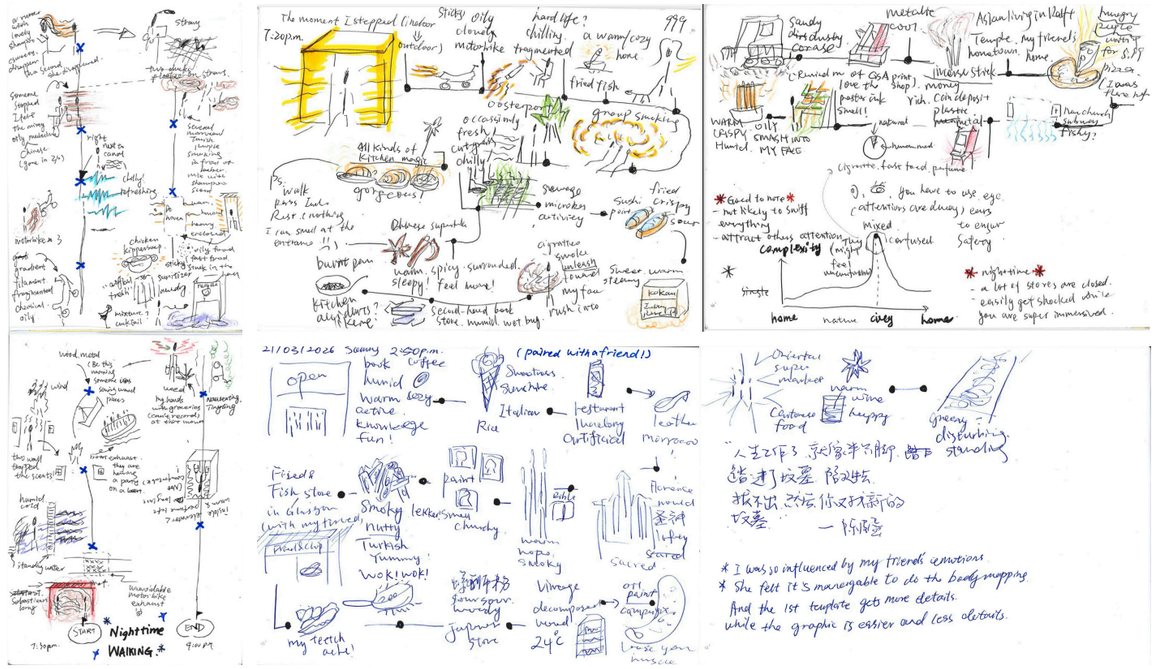






 # Smellwalk 3:
City cannal - Strong Windy Night after rain - Solo

 # Smellwalk 5: Indoor to Outdoors - Cloudy Night - Solo



 # Smellwalk 6:
Tunnel to canal - Windy Night - Solo

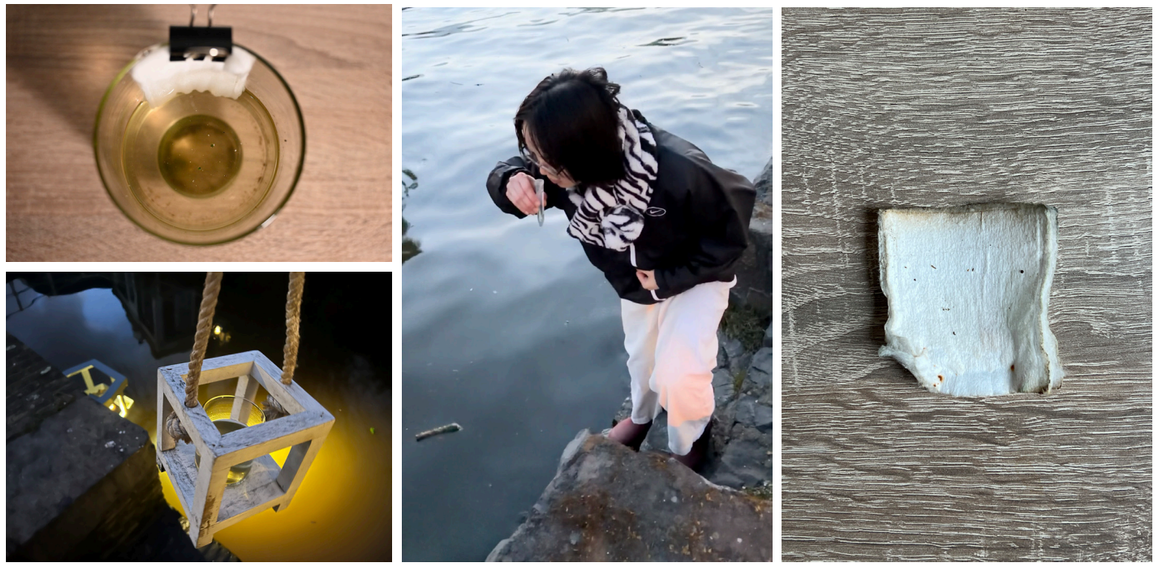
 # Smellwalk 7: Canal to Market Center - Sunny day - Paired

The journal also informed the design of the smellwalk tools. Through my own smellwalk experiences, I realised that smelling water in public was not straightforward. It often felt awkward to stop and deliberately smell, especially when other people were nearby. At times I was distracted by conversations, passing cyclists, surrounding sounds, or visual elements in the environment, making it difficult to focus on smell alone. I also noticed that I frequently looked for social confirmation, wondering whether others could smell the same thing or whether I was imagining it. This highlighted how smell perception is often influenced by peer discussion and collective interpretation rather than being an entirely individual experience.

At the same time, the smellwalks brought moments of excitement and curiosity. Being close to water, plants, birds, and changing weather conditions made the experience feel like an exploration of nature within the city. When I detected an unfamiliar smell, I became interested in tracing its possible source, moving closer to the water edge, observing plants, looking at surfaces, and comparing different locations. This desire to search for and interpret the source of smell became an important insight for the design.

These experiences suggested that participants might need small prompts or tools to make smelling feel intentional and socially acceptable. Without tools, smelling water in public can feel strange, awkward, or too casual to take seriously. With tools, the action of smelling can become more focused and ritual-like. The findings also indicated the importance of creating opportunities for discussion, comparison, and collective reflection, allowing participants to validate, question, or expand each other's observations. These insights later influenced the use of smell vocabulary sheets, reflection cards, smell-noticing tools, and group discussion moments throughout the smellwalk.

The smell journal became a way of learning how to notice. It helped shift the project from looking for clear evidence of microbial change toward designing conditions for attentiveness. The awkwardness of smelling in public, the difficulty of capturing and describing smells, the influence of distraction and social confirmation, the excitement of engaging with nature, and the curiosity to locate smell sources all informed later design decisions. This became a key movement in the research: from detecting water to attuning to water.



Getting samples from canal and record the changes from the current stage till it dries out



DESIGNING AND VALIDATING THE SMELLWALK

SMELLWALK

After several various tests the smellwalk was adopted and redesigned as a situated method for inviting participants to experience Delft water smellscapes directly. Rather than discussing microbial change through images or environmental information alone, participants were asked to move through the water environment, smell, pause, compare, describe, and reflect.

Smellwalks are useful in this project because they treat smell as a spatial and bodily experience. Smell is encountered through walking, breathing, distance, weather, and memory, making the method suitable for exploring microbial noticing in place. This approach builds on smellwalk methodologies developed in sensory and urban studies, where walking is used as a way to attend to and document the olfactory dimensions of everyday environments (Henshaw, 2013; McLean, 2013).



Smellwalk map and route iterations

PROBE DESIGN AND VALIDATION TESTING

Before developing the full smellwalk, individual probes were designed and tested to evaluate specific design elements. These probe tests focused on tools such as the route map, smell noticing probes, smell vocabulary prompts, and reflection activities.

The first version was more structured and included laboratory-inspired elements, such as small containers suggesting smell collection with the intention of using these smell samples as reminders of their experiences, but it did not work that well as assumed. However, they do like the feeling of being 'scientists', which brought some excitement for the activity.

As a result, the probes were redesigned as attention tools rather than just sampling tools. Their purpose became supporting curiosity, slowing participants down, and encouraging engagement with the environment.

Smellwalk sensitising probes



SMELL VOCABULARY AND REFLECTION PROMPTS

A smell vocabulary sheet was initially included because water smells can be difficult to describe. It offered a rating scale for crossmodality, utilizing descriptors categorized into sensorial, interpretive, affective, and performative levels in accordance with the experiential characterization framework (Camere & Karana, 2018).

Initial testing showed that participants often preferred using their own words, memories, and associations rather than selecting predefined categories. Open descriptions generated richer reflections and revealed personal and cultural meanings that structured vocabularies sometimes overlooked.Another finding was that participants occasionally switched to their mother tongue when describing subtle smell experiences. Rather than enforcing a fixed vocabulary, the smellwalk encouraged participants to express themselves in whichever language felt most meaningful.

Reflection prompts are guided from the four material experience levels, which invites people to write down the keywords after their walk.

EXPERT CONSULTATION

Expert consultation helped shape the project. A conversation with Kate McLean, a smellwalk and smellscape mapping researcher, provided guidance on facilitating smellwalks and highlighted that participants often underestimate their ability to smell. Her insights encouraged an approach focused on attentiveness rather than accurate smell identification.

A second consultation with Natarsha Bates, who has a molecular biology background and works with Scentsory Foraging, helped clarify the project's scientific boundaries. Her input on smell capturing and scent materials reinforced the positioning of the work as a design research inquiry rather than a molecular biology study, using smell as a medium for noticing, reflection, and speculation.







Validation tests

PILOT TEST AND ITERATION

After the probe tests, two pilot tests of the complete smellwalk was conducted to evaluate the route, activities, timing, and participant experience. The following table shows the details.

Design Element	***Issue Found***	***Change Made***
Briefing	The information is a bit too overwhelmnig to comprehend with limted time	Handed out zines with essential information 3-5 days before
Timing	Participants are fully having fun in the walk leading to the delay of the next activity	Set time limits for the overall walk
Route	Original route was a bit too long and time-limited	Shortened route and selected more familiar water places
Smell sample	Sampling is not attracting to everyone, and also become dominant	Moved sample collection to a side activity
Experience record structure	Participants struggled to follow a strict structure while walking	Shifted to a semi-structured interview style
Sensitising tools	Lab tools were interesting but a bit missing the sensing part	Provide semi-constructed tools as attuning probes using materials from nature, leaving some flexibility for recreation
Smellscape experience level descriptions	Helpful, but too many words could feel overwhelming	Kept as a support tool, not a required checklist



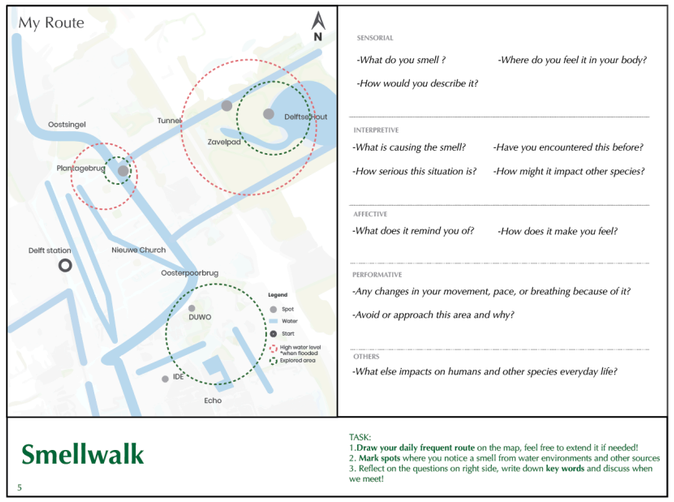
Pilot test 2



Pre-smellwalk preparation



Pilot test 1





TAKEAWAYS

After the validation tests and pilot tests, the smellwalk became more open, conversational, and responsive to the site. This was important because smell itself is unstable. The final smellwalk therefore accepted uncertainty, interruption, and weather as part of the method.

SMELLWALK DEPLOYMENT: *EXPERIENCING DELFT WATER SMELLSCAPES*

The final smellwalks were conducted with 11 participants at selected Delft water sites on around Mid of May in 2 separate groups. Participants are mainly students from TU Delft with different backgrounds. The smellwalk aimed to explore how people perceive and interpret aquatic smells in urban environments and whether these sensory experiences could support awareness of microbial life in water systems. Weather conditions played an important role throughout the activity, influencing how smells appeared, disappeared, and travelled through the environment. Factors such as wind direction, humidity, and temperature affected participants' ability to detect and describe smells, highlighting the dynamic nature of smellscapes.

PROCESS

(3-5 days) Before

Briefing

Daily walk with attention on smell

Reflect with zine

During

Recap

Guided smellwalk with discussions

Use smell capture probes

Share experience

After

Co-speculation

The smellwalk was designed as a gradual process that guided participants from everyday sensory awareness toward a more focused exploration of urban water environments. Before the walk, participants received a zine that introduced the concept of smellscapes and microbial life. They were invited to reflect on the smells they encounter in their daily routines and consider how smell influences their perception of places.

The sensitising exercise encouraged participants to become more attentive to smell before entering the field. During the guided smellwalk, participants followed a route that included water-related environments such as canals and urban edges. They were encouraged to pause, observe, smell, and forge smell samples at different locations using the smell probes. After the walk, participants discussed their observations collectively before moving into a co-speculation workshop where they reflected on possible futures of urban water and microbial life.

MEMO - Smellwalk 1
Right after rain - Along canal water

"The weather is very complicated... but we are lucky to get the some sunshine after a very heavy rain. Subtle fresh smell is everywhere, but hard for us to pinpoint/capture exact smells."

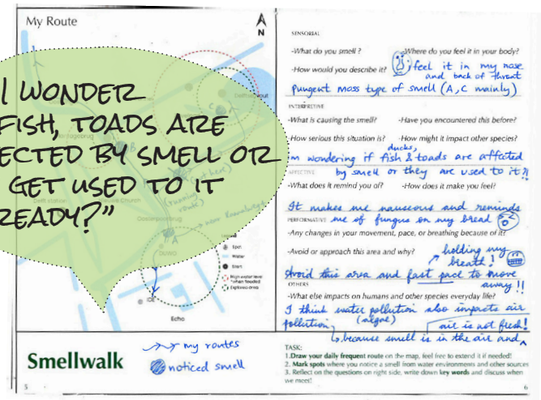
MEMO - Smellwalk 2
Cloudy and windy - Along stagnant water

"It's a cloudy day, a little breezy. But everyone seems to be really happy to stay outside after a whole day indoors."

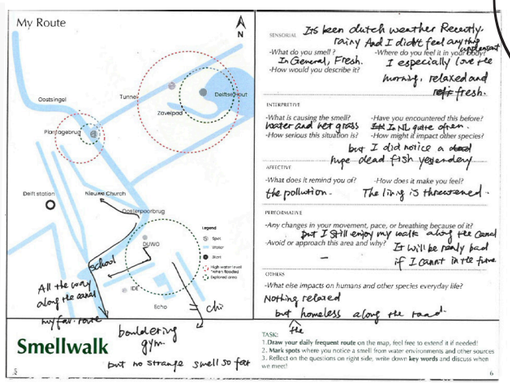


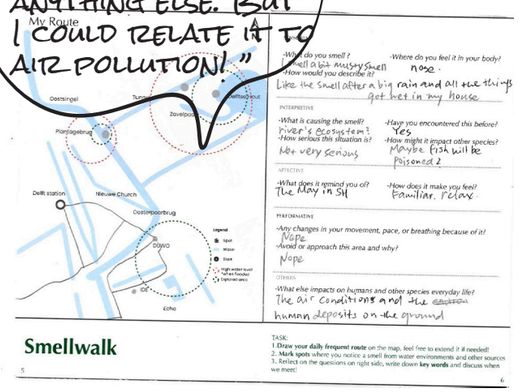
The Zine handed out to participants

PRE-SMELLWALK ACTIVITIES

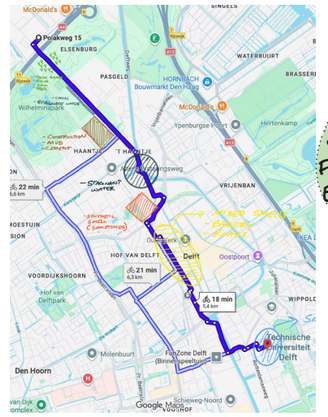


"I WONDER IF FISH, TOADS ARE AFFECTED BY SMELL OR THEY GET USED TO IT ALREADY?"

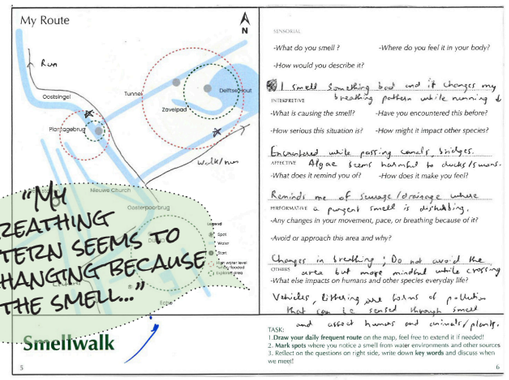




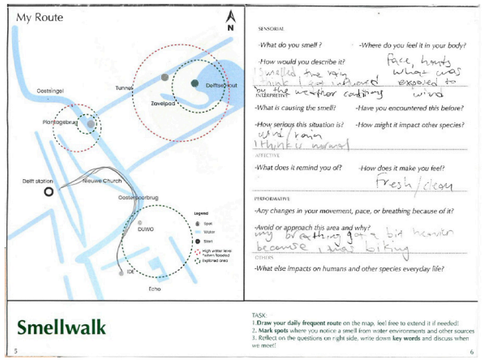
"NEVER THOUGHT OF IT'S RELATED TO ANYTHING ELSE. BUT I COULD RELATE IT TO AIR POLLUTION!"

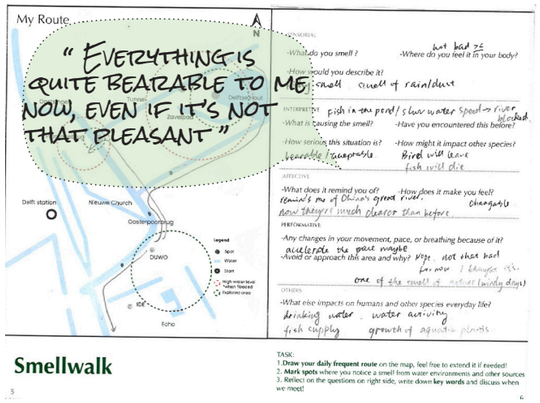


"EVEN THOUGH I AM NOT LIVING IN DELFT, BUT I NOTICE QUITE A LOT OF SMELL ON MY WAY FROM MY SPACE TO THE UNI. EVERY ROUTE BRINGS A DIFFERENT MOOD TO ME... QUITE A MIXTURE!"



"MY BREATHING PATTERN SEEMS TO BE CHANGING BECAUSE OF THE SMELL..."

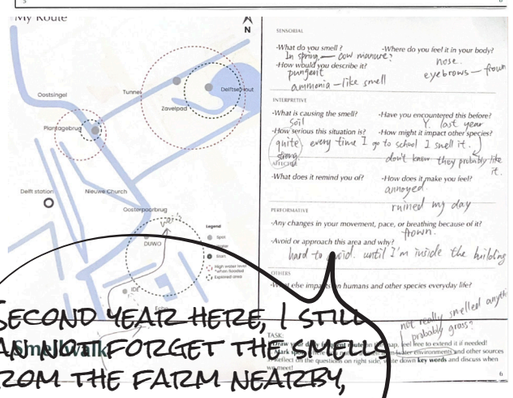




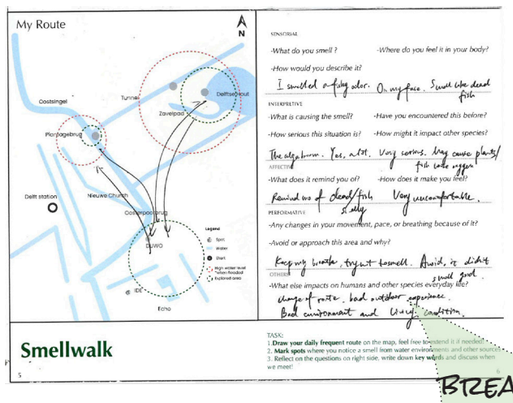
"EVERYTHING IS QUITE BEARABLE TO ME NOW, EVEN IF IT'S NOT THAT PLEASANT"

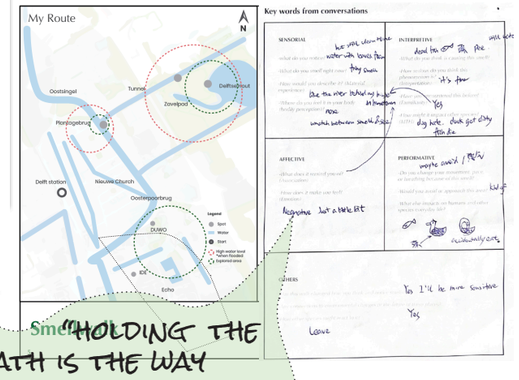


"I AM JUST SURPRISED THAT I HAVE NEVER PAID ATTENTION TO THESE SMELLS..."



"SECOND YEAR HERE, I STILL CAN NOT FORGET THE SMELLS FROM THE FARM NEARBY, IT JUST STRUCK ME SO MUCH THAT I HAVE NEVER WALKED THERE ANY MORE"





"HOLDING THE BREATH IS THE WAY THEY WOULD DO TO SURVIVE IN THESE SMELLY ZONES"

Participants also described smell as affecting mood, memory, and bodily response. Different routes produced different emotional atmospheres, while unpleasant smells could change breathing patterns, lead to holding one's breath, or even shape avoidance of certain places. At the same time, several participants realised that they had rarely paid attention to these smells before. This suggests that the self-smellwalk helped make everyday smellscapes more noticeable and meaningful, turning smell from a background condition into a prompt for reflection.

The self-smellwalk reflections showed that participants became more aware of smell as part of everyday movement and environmental experience. Some participants connected smell to wider ecological relations, wondering how animals such as fish or toads might experience or adapt to smell. Others related smell to familiar environmental issues such as air pollution, suggesting that smell helped them link personal sensory experience with larger environmental concerns.

PRE-SMELLWALK FINDINGS

An interesting observation emerged even before the walk began. Once participants were informed that the project focused on smell, many immediately started reflecting on and assessing their own sensitivity to smell. Some described themselves as having a “good nose,” while others expressed uncertainty about whether they would be able to detect subtle smells. This self-reflection indicated that smell was not only a sensing activity during the walk but also a topic that prompted participants to think about their own sensory abilities.

The zine also played an important role in the briefing phase. Participants were often intrigued by its content and asked questions about microbial life, water quality, algae blooms, and the role of smell in environmental perception. Rather than functioning solely as an informational booklet, the zine acted as a conversation starter that helped participants become more engaged with the topic before entering the smellwalk. This early engagement contributed to a stronger sense of involvement and curiosity throughout the experience.

These findings suggest that smell can function as a valuable medium for engaging people with ecological processes that are otherwise difficult to perceive. Rather than providing direct evidence of microbial activity, smell encouraged participants to become curious, ask questions, reflect on their own sensory perception, and reconsider their relationship with urban water systems. Together, the smellwalk and zine demonstrated how sensory design approaches can foster deeper participant involvement, environmental awareness, and microbial noticing.



The Zine front and back page

"... REALLY DON'T WANT TO GO THERE, WE SHALL CHANGE A SPOT ..."

"I SMELL LIKE A BLOOM NOW..."

"LOVE THE SMELL, BUT DON'T WANNA TOUCH IT..."

"IT MAKES ME THINK OF MY EXCURSION IN MY PRIMARY SCHOOL ..."

"I DID NOT SMELL ANYTING..."













Hesitation and Distance

Ecological concern emerged

Smell as Unstable, Intermittent, and Difficult to Capture

Visual Olfactory Mismatch



"I JUST DISLIKE THE SMELL SO MUCH, I AM SORRY..."

"I LOVE THIS FISHING SMELL ROD... BECAUSE I DONT NEED TO GET CLOSE TO IT "

"HANG ON... I SMELL SOMETHING HERE, BUT IT'S GONE NOW..."

AFTER THE RAIN, SMELLS BECOME MORE CONFUSING TO US. JUST FEEL FRESH

PARTICIPANT PRE-SMELLWA

"THEY MIGHT STINK AFTER DRINKING BLOOM WATER..."



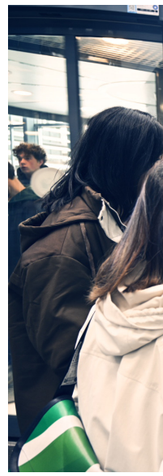
"PLEASE WAIT WE HAVE CLEAN WATER AT HOME..."













" IT MAKES ME FEEL LIKE A RITUAL"



"I WANNA MAKE MY OWN TOOLS..."



"IT'S SO EYE-CATCHING.. I WOULD LOVE THIS BE IN MY HIKING BAG.. "



"THIS SMELL JUST RE-MINDS ME OF THE RIVER BACK IN MY HOMETOWN "





Collective Sensing & Social Confirmation

S SHARED THEIR ALK EXPECTATIONS



Excitement brought by tools

"...YOU EVEN GOT PETRI DISH FOR US, IT MAKES ME FEEL LIKE WE ARE DOING FIELD RESEARCH HAHAH...."



Memory and Associations

SUCH NICE TIME TO CHILL OUT WITH FRIENDS...







Smell sample 2026 - Delft

Annotated portfolio analysis was used to examine moments from the smellwalk that were not fully captured through audio transcripts alone. Following an initial thematic analysis of smellwalk reflections and participant discussions, photographs were annotated to further explore how these themes appeared through embodied and situated interactions. In these annotations, I focused on participants' body movements, facial expressions, gestures, hesitation, distance from the water, interactions with probes, and relations with the surrounding environment.

These visual traces helped reveal how microbial smellscapes were noticed, approached, avoided, questioned, and emotionally interpreted during the walk. I selected photographs that captured significant interaction moments, including clear bodily movement or expression, strong participant reactions, interaction with water, tools, or other participants, and visible connections between the participant and the surrounding environment.

Each photograph was annotated with short phrases, participant quotes, and my own interpretive notes. Some annotations described what was visibly happening, while others captured emerging meanings such as hesitation, curiosity, discomfort, ecological concern, or remembered experiences. The annotations were kept short and situated, allowing each image to communicate both the concrete moment and its broader design implication. Through this process, annotated portfolio analysis complemented thematic analysis by making themes visible through situated moments and embodied experiences.

THEME

Unstable Smell Experience:

Participants often needed to slow down, move closer, bend their bodies, or actively sniff to detect aquatic smells. This shows that microbial smellscapes are not always immediately obvious; they require attention, posture, and effort.

Hesitation, Distance, and Water Avoidance

Some participants were hesitant to approach the water or preferred to keep a certain distance from it. This reveals that aquatic environments are not experienced as purely natural or pleasant; they can also feel dirty, risky, or uncomfortable.

Smelling with probes as a Ritual

The tools made the smellwalk feel more playful, focused, and ceremonial. Participants became more willing to explore smells because the probes gave them a reason and a method to do so.

Ecological concern emerged through interaction

Participants questioned whether the tools might disturb aquatic life, whether swans or fish would be affected, and whether toxins from algae might move through the ecosystem. This is a strong theme.

Memory and Personal Association

Some participants connected the smell or action of smelling water to memories of rivers, hometowns, childhood, or previous outdoor experiences.

Sensory Mismatch

Participants sometimes expected certain smells based on how the water looked, but the actual smell did not match their visual expectations. This mismatch helped them realise that smell reveals something different from sight.

Collective Sensing and Social Confirmation

Participants often checked with each other, shared their first impressions, compared whether they could smell the same thing, and adjusted their own perception after hearing others' reactions. Because aquatic smells were sometimes weak, unstable, or difficult to name, social confirmation helped participants decide whether a smell was "really there" and how it should be interpreted.

EMERGING INSIGHTS:

SMELL AS SITUATED ECOLOGICAL NOTICING

The findings suggest that smell can support ecological noticing not by providing stable or objective information, but by drawing attention to relations that are otherwise easily overlooked. Across the smellwalks, smells were experienced as intermittent, uncertain, and shaped by weather, movement, surrounding activities, visual cues, memories, and social responses. Participants often hesitated, compared impressions, moved closer, or searched for possible sources, showing that smelling was not an isolated sensory act but a situated process of interpretation. In this sense, smell did not reveal microbial conditions directly. Instead, it created moments of pause and heightened attention through which participants became more aware of water, plants, animals, infrastructures, atmospheric conditions, and human activity as part of a shared ecological situation. Smell therefore became a means of tuning into environmental change through partial, embodied, and relational experience rather than through certainty or detection.

Chapter 5

SPECULATING MICROBIAL FUTURES

Chapter 4 revealed that water smells are unstable, subjective and often overlooked until people are encouraged to attend to them. Chapter 5 extends these present-day encounters into possible futures, exploring how intensified microbial smellscapes might become feared, avoided, remembered, valued, commercialised or integrated into everyday life.

Source: The vibrant colour of the hot spring due to the microbes which includes Synechococcus bacteria but also Chloroflexus bacteria, https://lonemountainranch.com/Yellowstone-vacation-packages/

BUILDING THE BLOOM FUTURE

FROM PRESENT TO FUTURE SMELL

The co-speculation tools were developed by translating the present-site findings from Chapter 4 into future-making prompts. The smellwalk showed that aquatic smell is intermittent, hard to name, dependent on body and weather, and surrounded by uncertainty. Future microbial smellscapes are also difficult to imagine because microbes are mostly invisible and future bloom conditions are not fully present yet. To support participants in engaging with these uncertain conditions, the workshop used a set of prompts adapted from The Thing From The Future (Candy & Watson, 2015).

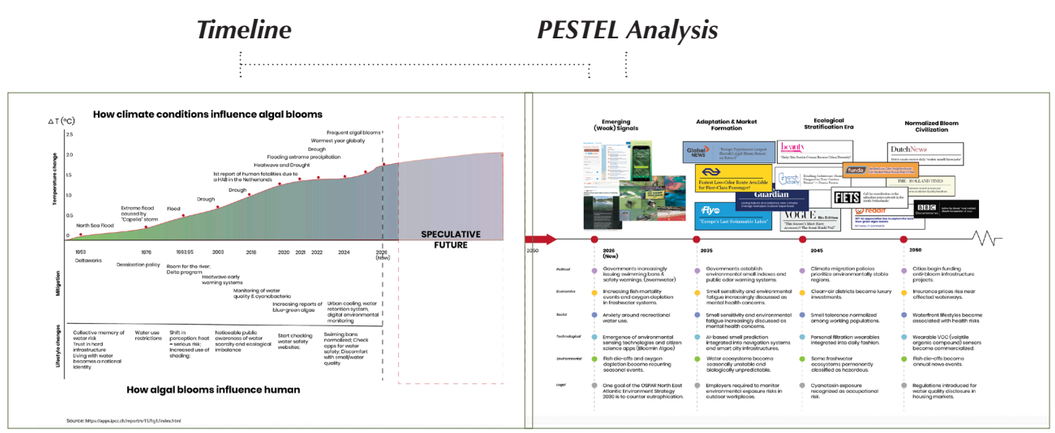
The future-making process included four main components, inspired by the method used in Design Fiction (Coulton et al., 2017; Bleecker, 2009) PESTEL analysis, a future timeline, speculative news headlines, a collage, Bloom Future cards and template. Each tool played a different role in helping participants move from present sensing toward future imagination.

Connected present smellwalk observations to possible future developments

Timeline

Expanded the future beyond environmental change alone by considering political, environmental, social, technological, economic, and legal drivers

PESTEL Analysis



Gradual transition from current Delft water smell to intensified bloom conditions

Broader future context for microbial smellscapes

Made the future concrete, public, and discussable

Speculative news headline

Collage





A shared event or conflict that participants could respond to

Helped participants build future contexts using places, things, characters, and relations

Bloom future cards

Facilitate the construction of the future scenarios

World building template





Future scenarios, sketches, discussion, and design implications

Shape the wider future conditions — ***Enter the future*** — ***Develop future scenarios***

FUTURE - BUILDING PROMPTS



Future collage: Living with water, bloom, and smell

This collage is made to visualise a speculative flood-and-bloom future in which microbial water conditions become part of everyday urban life. It does not claim to predict a specific future, but translates present observations of Delft water, green surface traces, flood risk, and smell uncertainty into an atmospheric future scenario. The image acts as a prompt for imagining how people might live with, adapt to, and sense intensified microbial smellscapes.

LIVING WITH BLOOM

The speculative future developed for the workshop imagines an urban water condition in which microbial blooms have become more frequent, more noticeable, and more entangled with everyday life. In this future, aquatic smell is no longer limited to the canal edge. It drifts into streets, homes, clothing, public spaces, windows, balconies, and bodily routines. People no longer encounter water smell only when they intentionally approach the canal; instead, smell becomes part of how they move through and understand the city.

This future is not presented as a scientific prediction. It is a designed scenario based on three sources: current ecological concerns around harmful algal blooms, smellwalk findings from Delft, and speculative extrapolation. The aim was to create a future condition that was plausible enough to discuss, while still open enough for participants to interpret, question, and transform. The Bloom Future therefore acted as a shared starting point for imagination rather than a fixed future world.

The Bloom Future created a shared speculative condition for the workshop. Participants were not asked to solve harmful algal blooms or design scientific monitoring devices. Instead, they were invited to imagine what kinds of lives, objects, rituals, memories, fears, adaptations, and forms of care might emerge when microbial smell becomes more present in the city.

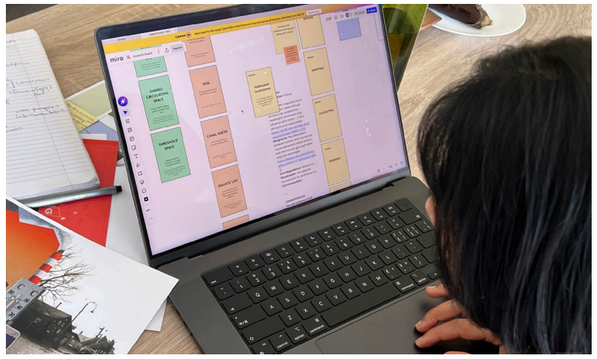
DEVELOPING AND VALIDATING THE CO-SPECULATION TOOLS

The co-speculation tools were developed through several iterations to make future microbial smellscapes more concrete and discussable.

The first iteration focused on the future cards. Initially inspired by The Thing From The Future, the cards encouraged participants to imagine speculative objects. Testing revealed that this led to overly object-focused ideas, such as devices and warning systems. To support more relational thinking, the cards were expanded to include Place, Thing, Character, and Relation prompts, helping participants consider where futures occur, who or what is involved, and what relationships emerge.

The second iteration focused on the workshop template. Additional instructional information are given to faciliate their imagination to float like an example, and visual hints.

The final card set was organised into four categories: Place, Thing, Character, and Relation. Participants could select and combine cards to generate future scenarios.



Quick Validation Tests with 3 participants

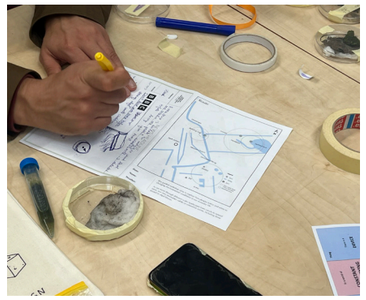
Test type	***Element tested***	***Issue Found***	***Change Made***
Pilot test 1, Validation tests	Future cards v1	Participants were unsure how to start or pick the card they familiar with	Give a brief explannation for each card, provide examples, and prompts; Assign cards to participants
Pilot test 1, Validation tests	Template v1	Participants needed repeated reminders and explanations	Details see the next page
Pilot test 1	Planning (from smellwalk to co-speculation)	Smellwalks took up the time of the co-speculation part	Shortened the outdoor exploration
Pilot test 1 & 2	The transition flow from the walk to co-speculation	Transition from present to future was too sudden	Give a brief when handing out zines; Reintroduce the future world before the co-speculation part

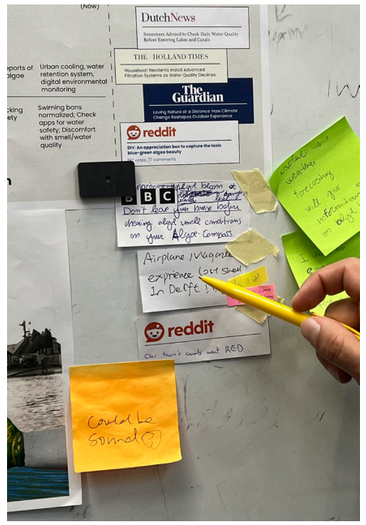
The iterative testing process helped refine the balance between structure and openness. Early versions provided a useful starting point, while later iterations offered additional prompts that helped participants explore care, uncertainty, memory, warning, and coexistence in greater depth. The final workshop materials therefore functioned as scaffolds that guided imagination without prescribing outcomes.

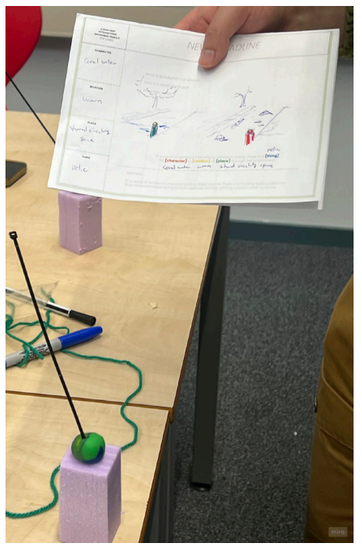


Pilot test results

Pilot test 2 with 3 participants







Pilot test 1 with 2 participants





The pilot tests showed that participants could engage with both the smellwalk and the future-making activity, but the transition between them was not yet smooth. In the first pilot, participants tended to lose focus on smell and needed repeated reminders that the speculative world should be built around microbial smellscape experience. The outdoor exploration also felt too long, which reduced the time and attention available for future speculation.

Another key issue was that participants struggled to imagine richer future scenarios without clearer relational prompts, so the Relation cards were added and refined. These findings lead to the refined version of the workshop template

FUTURE CARD ITERATION

Worldbuilding

Insights from smellwalks

Added after pilot test 1

The Thing from The Future (Candy & Stuart, 2018)

THEME
Intensifying microbial smellscape

CHARACTER
The character cards were not limited to human actors, but also included non-human entities such as water, canals, wind, algae, and other environmental agents. This was intended to shift the perspective from a purely human-centered view toward a more-than-human understanding of smellscapes, acknowledging how environmental conditions and non-human actors actively shape sensory experiences and ecological relations.

Participants reacted bodily and socially; animals and microbes were also part of concern

(from smellwalk 1&2)

RELATION
Experiences of environmental change are not only individual but relational, involving connections between humans, non-humans, infrastructures, and ecosystems. Therefore, the relation cards were selected to encourage reflection on care, dependency, conflict, adaptation, and coexistence within changing aquatic environments.

Smell created uncertainty: danger, care, disgust, curiosity, memory

(from smellwalk 1&2 and pilot tests)

PLACE
The perception of smell is often shaped by context and spatial conditions. Therefore, the categories “Enclosed Everyday Space,” “Shared Circulating Space,” and “Threshold Space” were selected to explore how different environments influence the way smells are noticed, interpreted, and emotionally experienced.e”

Smell is place-based and changes across canal edges, bridges, plants, and paths

(from self smellwalk practice & other smellwalks)

THING
Smell is often encountered through objects, materials, and tools that mediate bodily interaction with the environment. Therefore, the thing cards were selected to provoke thinking about how everyday artefacts, sensing devices, protective objects, or speculative tools might shape future interactions with microbial environments and aquatic smells.

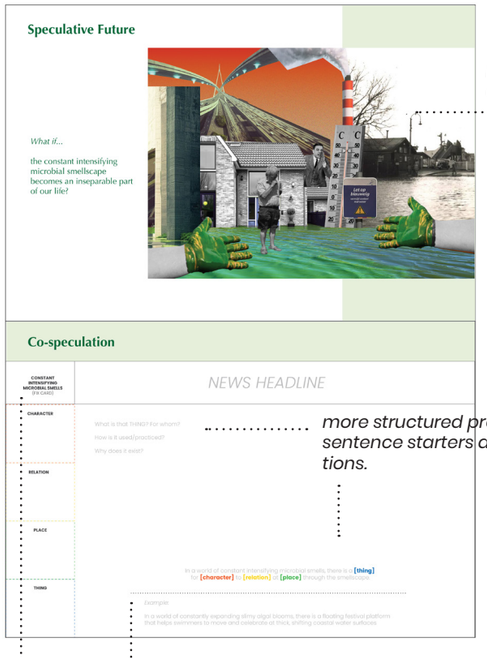
The cards therefore worked as generative scaffolds rather than fixed instructions. They helped participants move from broad future conditions into situated stories, objects, rituals, and relationships. Importantly, they also prevented the workshop from becoming too solution-driven. By including Place, Character, and Relation prompts alongside Thing prompts, the workshop encouraged participants to imagine not only future devices, but also future forms of coexistence, uncertainty, memory, and care.

TEMPLATE ITERATION

Template v1



Template v2



Future world Collage

more structured prompts, including sentence starters and guiding questions.

A fixed theme card

An example

Designated area for card placement

CHANGES MADE OF THE TEMPLATE

A fixed theme card was added to keep microbial smellscapes at the centre of the activity. More structured prompts, including sentence starters and guiding questions, helped participants connect the four card categories and develop complete scenarios rather than isolated ideas.

An example showing how a Place, Thing, Character, and Relation card could be combined was added to make the task easier to understand. A designated card placement area was also introduced to provide a clearer visual structure and support scenario development.

Finally, the speculative future prompt changed from a news website format to a more open collage format. This encouraged multiple interpretations and allowed participants to respond through atmosphere, emotion, and imagination rather than a fixed narrative.

CO-SPECULATION WORKSHOP AND FUTURE WORLDBUILDING

The co-speculation workshop aimed to explore how participants imagine future relationships with intensified microbial smellscapes, and how these futures could inform the final design. The workshop did not ask participants to design scientifically accurate solutions to harmful algal blooms. Instead, it invited them to speculate on how microbial smell might affect everyday life, memory, bodily routines, public spaces, domestic environments, animal relations, and more-than-human care.

The workshop was held with 11 participants in 2 separate group at IDE faculty and the DUWO shared kitchen and lasted approximately 2 hours. Participants joined the co-speculation workshop after the smellwalk.



Workshop setup

The workshop space was arranged as a shared making table with all the materials. It included a speculative Bloom Future scenario, a fictional news headline, a future timeline, Place–Thing–Character–Relation prompt cards, sketch templates, simple making materials, a zine-style worksheet, smell references, and reflection prompts. Together, these materials helped participants move between sensory memory, future imagination, and material expression.

PROCESS

Before

Smellwalk

During

Sharing smellwalk experiences

Introducing the Bloom Future scenario

Choosing one card from each category

Sketching future scenarios & making speculative things

Presenting things & news headlines

Sharing & discussion

After

Analysis

Speculative probes

Timeline & Collage

Future cards & template

News headlines















Presenting future 'Thing' and promoting with its news headline

ANNOTATED PORTFOLIO ANALYSIS: *SYNTHESISING THEMES THROUGH FUTURE 'THINGS'*

This annotated portfolio gathers speculative design fragments developed through the co-speculation workshop and related pilot activities. In this project, "future things" refers to speculative objects, tools, services, media, rituals, or material fragments that participants imagined in response to future microbial smellscapes.

Across the portfolio, microbial and algae futures were imagined in multiple ways: as warning, memory, luxury, contamination, protection, ritual, commerce, and coexistence. Some future things attempted to block, clean, or control smell, while others translated, aestheticised, archived, or stayed with it. These different responses showed that microbial smell was not understood only as an unpleasant environmental problem, but also as something that could become social, emotional, cultural, and material.

Each future thing was annotated according to its motivation, imagined use, relation to microbial smell, and possible design implication. By comparing annotations across the portfolio, recurring patterns and concerns became visible. These patterns informed a set of broader themes that illustrate how participants imagined future relationships with microbial smell through speculative things.

Thing's annotations

Shared annotations

Family resemblance

- *Translation*
- *Protection*
- *Transformation*
- *Commodification*
- *Others*

Transformation:
Microbial conditions are repeatedly translated into other forms. This suggests that smell often needs mediation to become socially legible

Protection:
Many 'future things' try to protect bodies, objects, or animals. This shows that future smellscape is frequently imagined as something risky or excessive.

Transformation:
Some artifacts transform microbial conditions into beauty, ritual, or value. This suggests a desire not only to remove pollution, but to reinterpret it.

Commodification:
A recurring tension is turning algae crisis into business. This raises critical questions about greenwashing and ecological extraction.



Futuristic fashion item

Escape from bloom smell



Making space for aquatic life



Luxury lotions for protection

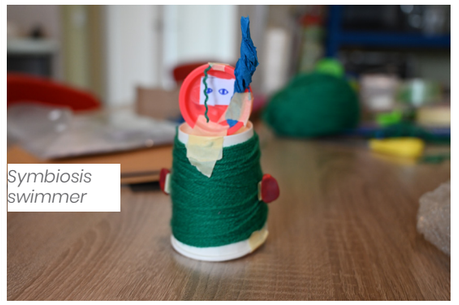
Blocking traces



Negotiating safe water boundaries



Bloom as a new energy source



Symbiosis swimmer



Mitigation for toxin illness

Bloom traces tell a story

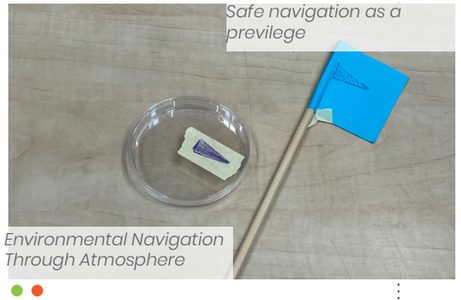
Protection and bodily coping

Warning and environmental signal



Ambient Ecological Communication

Environmental data made tangible



Safe navigation as a previlege

Environmental Navigation Through Atmosphere



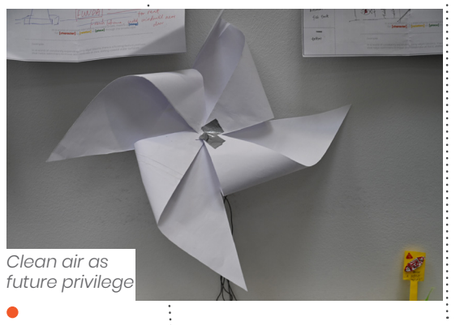
Communicating warning through wind

Living under toxic smell weather



Aquatic life signal as warning

Commodity and urban value



Clean air as future privilege

Reinterpretation of bloom



Greenwashing & touristification of bloom crisis

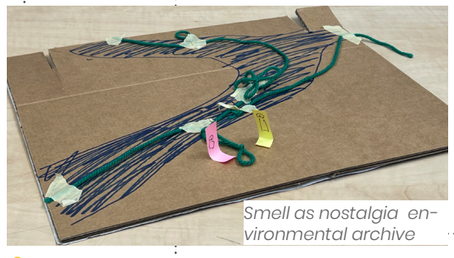
Weaponising unpleasant smell

Ritualising microbial smell

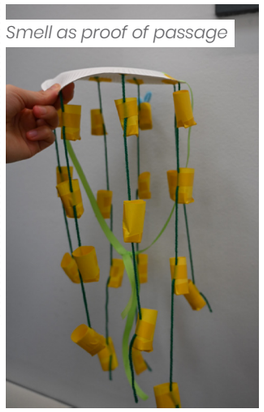


From pollution to care

Coexisting with engineered nature

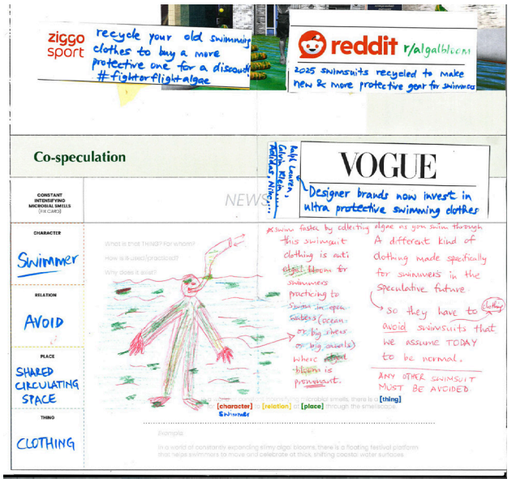


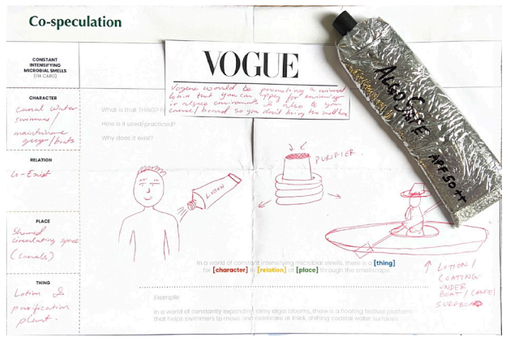
Smell as nostalgia environmental archive

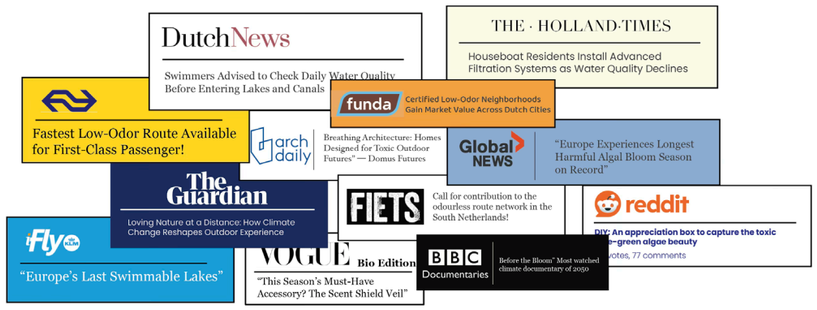


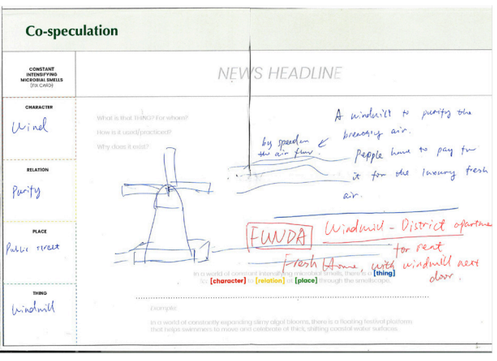
Smell as proof of passage

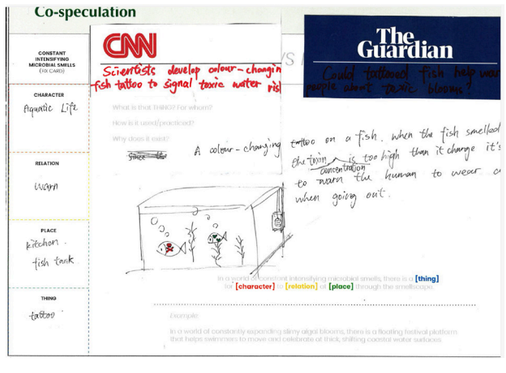
Memory and place

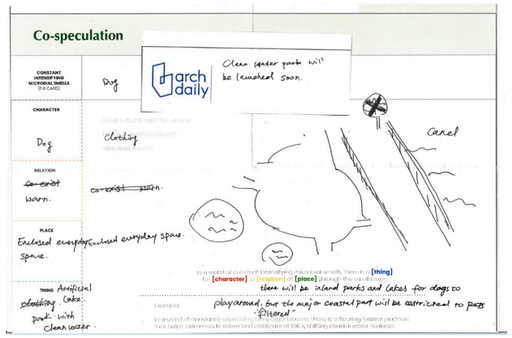


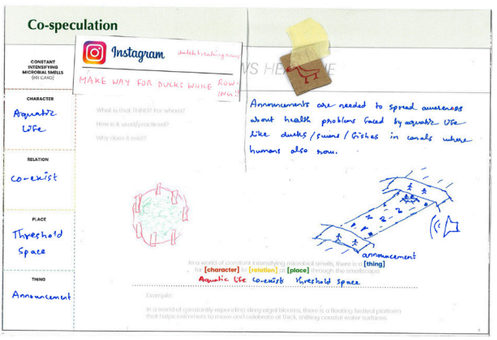


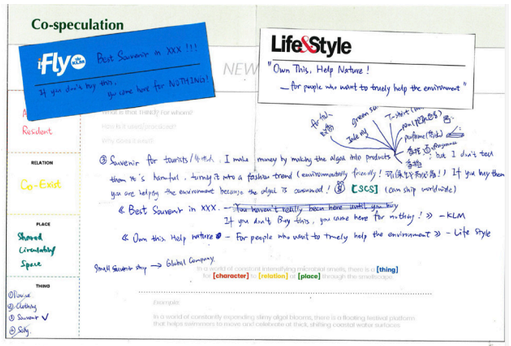


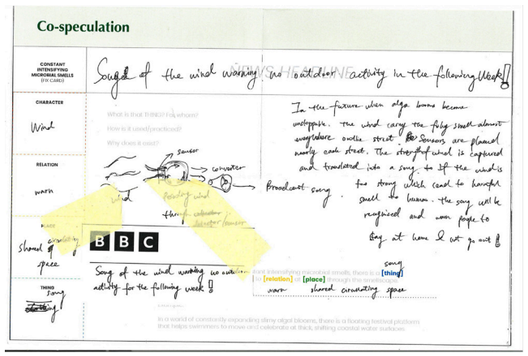


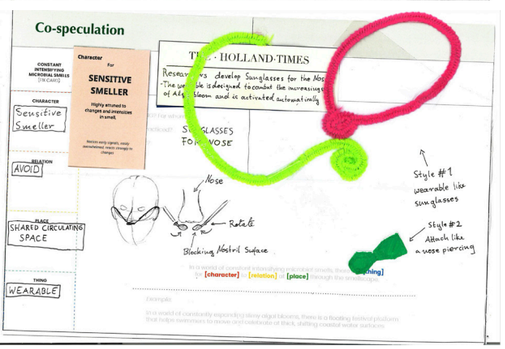


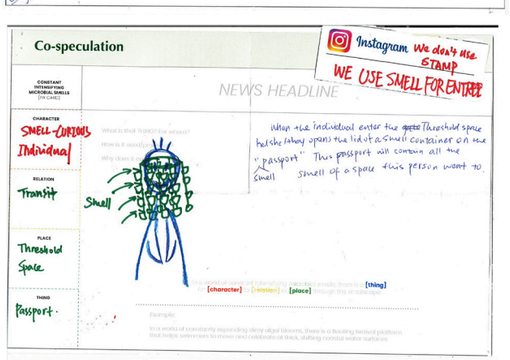


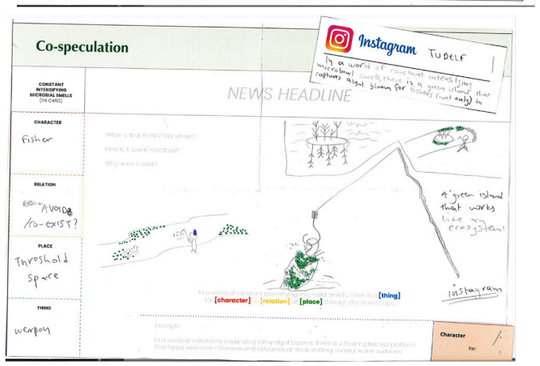












Sketches from co-speculation workshop

FINDINGS FROM THE NEWS HEADLINE ACTIVITY

The speculative news headline activity helped participants enter the Bloom Future through familiar media formats. Participants could choose from channels such as social media, local and international news, housing platforms, fashion magazines, travel media, and daily news formats. These options highlighted how future microbial smellscapes might affect many areas of everyday life.

A clear finding was that many participants were drawn to social media formats. While the activity did not directly ask why, several mentioned that social media felt faster, more immediate, and better suited to spreading information. This suggests that participants imagined the Bloom Future not only through official communication, but also through informal and everyday forms of sharing.

Participants also showed interest in cultural media formats such as fashion magazines, lifestyle zines, and Vogue-like visual language. This suggested that microbial futures could be communicated not only through risk or crisis, but also through aesthetics, atmosphere, and cultural trends. In these responses, the "bloom" was imagined as something visible, discussable, and socially circulated.

These findings informed the final design direction. Rather than focusing only on warning systems or scientific detection, participants' media choices pointed toward a softer and more atmospheric approach. This supported the development of final ideas Bloom Breath, which explores microbial futures through smell, walking, wearable interaction, zine reflection, and sensory storytelling. See chapter 6 for details.



THEME

Smell as Commodity and Urban Value

This theme describes how participants imagined microbial smellscapes, bloom, and clean air as future forms of value. In several workshop ideas, algae or bloom-related materials were transformed into commercial objects, such as souvenirs, perfume, incense, green salt, fabric, or other lifestyle products. These ideas suggest that future ecological conditions may not only be understood as environmental problems, but could also be absorbed into markets, tourism, and urban branding.

This theme was also visible in the idea of the Windmill Fresh-Air District, where clean air was imagined as a desirable urban resource that could increase the value of housing and neighbourhoods. In this future, smell and air quality become part of how a place is evaluated, marketed, and experienced. The theme therefore raises a critical question:



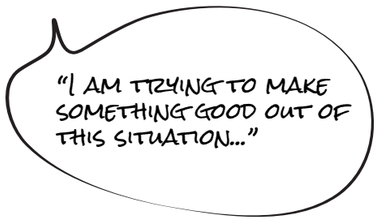
If clean air and pleasant smell become valuable urban assets, who gets access to them, and who remains exposed to unpleasant or polluted smellscapes?

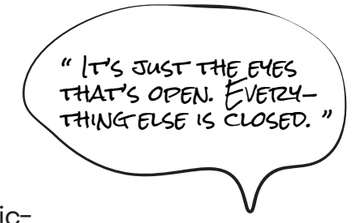


Reinterpretation of Bloom

This theme captures how participants re-imagined algal bloom beyond its usual association with pollution, danger, or ecological damage. Instead of only seeing bloom as something to avoid, participants explored how it could become material, aesthetic, useful, or cared for. For example, the algae-absorbing swimsuit imagined bloom as something that could be absorbed by the body or clothing while also improving swimming performance and cleaning the water. Other ideas turned algae into souvenirs, materials, or designed products.

In the second workshop, the canal filtering island with seasonal flowers continued this reinterpretation by transforming polluted canal water into something visible, cared for, and even beautiful. Rather than hiding the bloom, the design made microbial change part of a public and aesthetic landscape. This theme indicates their intentions of treating bloom only as a negative environmental issue towards understanding it as a complex ecological phenomenon that can be noticed, interpreted, and designed with.

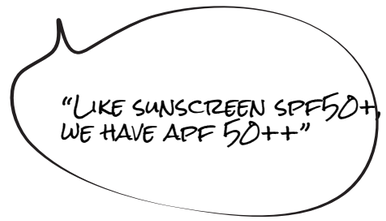




Protection & Bodily Coping

This theme focuses on the ways participants imagined protecting the body from intensified microbial smellscapes. Many speculative ideas responded to the feeling that smell, microbes, pollution, or bloom could come too close to the body. Participants imagined protective clothing, breathing equipment, canal-safe coatings, smell-blocking objects, and other forms of bodily defence. These ideas suggest that microbial smell is experienced not only as something in the environment, but as something that may stick to skin, clothes, pets, objects, and domestic space.

In the first workshop, participants imagined future situations where people might need full-body swimming clothing, controlled water areas, or artificial clean-water parks for dogs. In the second workshop, this concern appeared through ideas such as canal-safe lotion/coating and sunglasses for the nose, which helped people cope with smell or microbial exposure. It shows that a certain level of boundary is needed for them to engage with the microbial smellscape.



Smell as Memory and Place Attachment

This theme describes how smell was connected to personal memory, movement, and the identity of place. During the workshops, participants did not only respond to smell as a chemical or environmental signal. They also connected it to previous experiences, childhood memories, hometown rivers, seasonal changes, and emotional associations with water. This shows that smell perception is situated and personal: the same smell can be unpleasant, nostalgic, familiar, or strange depending on a person's background and experience.

The smell passport from the second workshop strongly expressed this theme. It imagined smell as something that could mark movement between places, almost like a stamp or record of passing through different environments. In this way, smell becomes a way of documenting transition, atmosphere, and belonging. This theme suggests that microbial smellscapes are not only future environmental conditions, but also sensory experiences that shape how people remember and relate to urban water places.

"I WILL HAVE A PASSPORT FULL OF SMELLS FROM ALL OVER THE WORLD, LIKE SMELL TREASURE HUNTING"

Smell as Warning & Environmental Signal

This theme frames smell as a way of communicating invisible environmental change. Microbial processes, pollution, and bloom conditions are often difficult to see directly, but participants imagined different ways these changes could become noticeable through smell, colour, sound, or bodily signals. In the first workshop, the Wind Warning System translated wind and smell conditions into public warnings or sound-based signals. Other ideas imagined announcements, boundaries, or warnings to protect humans and aquatic life from contaminated areas.

In the second workshop, this theme appeared through the colour-changing fish tattoo, where aquatic life became a warning signal for toxic water, and through bacteria-visualising sunglasses, which made invisible microbial danger visible. These ideas suggest that future microbial smellscapes could become part of an environmental communication system. However, this theme is not only about creating alarms or safety instructions. It also points to a more reflective possibility: design can help people become more attentive to subtle ecological changes that are normally ignored.

"SCIENTISTS DEVELOPED COLOUR-CHANGING FISH, TATTOOITY SIGNAL, TOXIC WATER RISK. AND I HOPE THIS IS NOT HARMFUL TO THE FISH."

"AND I WONDER IF THERE ARE A WAY TO KIND OF LIKE EMBRACE IT AS WELL."

Cross-cutting Concern: More-than-Human Relations

Across the five themes, a more-than-human concern also appeared repeatedly. Participants considered how fish, swans, ducks, dogs, algae, microbes, wind, and water might be affected with the prompts card. Some participants questioned whether human tools could disturb aquatic life, whether animals might be harmed by toxic algae, or whether future interventions would protect humans while ignoring other species.

THREE POSSIBLE MICROBIAL FUTURES

Building on the themes identified through the annotated portfolio analysis, three possible microbial future worlds were developed. These worlds were not created as separate predictions, but as design synthesis directions that emerged from recurring workshop themes. Each world combines different aspects of the analysis, such as warning, atmosphere, memory, care, uncertainty, and human–microbial relations. Together, they helped clarify which future direction was most relevant for the final design.

What if microbial smell became part of a public warning network for invisible water changes?



WORLD 1 - **MICROBIAL WARNING NETWORK**
GOING AGAINST

Microbial smell becomes part of a public environmental warning system in the our every day future lives. Smell is treated as a signal that something invisible is happening in the water. Canals, streets, public spaces, animals, and sensing infrastructures work together to communicate changes in microbial activity, water quality, pollution, or ecological imbalance.

What if microbial smell became a way to remember changing waters, seasons, and places?



WORLD 2 - **BLOOM HERITAGE AND LIVING MEMORY**
COLLECTIVE MEMORY-MAKING

In this future, microbial smell becomes part of cultural memory, place attachment, and care rituals. Smells are collected, archived, exchanged, or cultivated as traces of changing water environments. People use smell to remember past canals, seasonal changes, childhood water experiences, lost freshness, or changing relations with urban nature.

What if microbial smell was no longer located only at the canal edge, but travelled through clothes, homes, streets, and breath?



WORLD 3 - **EVERYDAY BLOOM ATMOSPHERE**
CARE AND ENGAGEMENT

In this future, microbial smell is no longer limited to the canal edge. It drifts into streets, clothing, homes, balconies, public transport, skin, and breath. Microbial smell becomes part of everyday urban atmosphere: something people encounter while walking, wearing, opening windows, entering rooms, or moving through the city.

**The three collages are created with AI and photoshop*

SELECTING DIRECTION

Among the three microbial futures, Future World 3: Everyday Bloom Atmosphere was selected as the basis for the final design because it connected most strongly with both the smellwalk findings and the co-speculation themes.

The smellwalk showed microbial smell as an unstable, situated experience shaped by wind, movement, distance, and attention. Participants engaged through bodily reactions, memory, uncertainty, and comparison with others. Everyday Bloom Atmosphere extends these insights by imagining a future where microbial smell spreads beyond the water edge into everyday urban life.

This direction also aligned most closely with the research question. Rather than detecting or solving harmful algal blooms, the project explores how design can support people in noticing and experiencing future microbial smellscapes in the present. It therefore focuses on attunement rather than diagnosis.

The co-speculation workshop reinforced this choice by highlighting themes of instability, bodily encounter, ritualised noticing, ecological concern, memory, and living with bloom.



Co-speculation workshop finished templates

Personal goal...

Provocative, Humour, Experiential

DESIGN DIRECTION:

A situated smell attunement probe

Based on the analysis, I moved toward designing a situated smell attunement probe. Rather than masking unpleasant smell or translating it into a clear warning signal, the probe explores how microbial smell can be encountered through distance, instability, bodily awareness, and reflection.

Chapter 6

Designing for Situated Attunement

Chapter 5 generated several possible microbial smellscape futures through participatory speculation. Chapter 6 translates insights from chapter 4 and 5 into a situated design outcome: a wearable smell probe, zine and smell archive that bring possible future microbial smells into present-day encounters with Delft's water environments.



Source: Delftse Hout, 2018, Google 3D map

FROM THEMES TO DESIGN GOAL AND CRITERIA

The smellwalk revealed microbial smell as an unstable and situated experience, shaped by wind, distance, movement, and attention. Participants engaged with water through bodily reactions, memory, uncertainty, and social comparison, while the probes turned smelling into a ritual that fostered ecological awareness. The co-speculation workshop expanded these present experiences into possible future relations with microbial smellscapes. Participants imagined smell as a warning signal, a source of memory and place attachment, a commodity, a reinterpretation of bloom, and a means of bodily coping. Among the three future worlds developed from these themes, the project chose Future World 3: Everyday Bloom Atmosphere as the background world for the final design. This world imagines a future in which intensified microbial smell is no longer limited to the water edge, but becomes part of everyday urban atmospheres, bodily routines, and ways of living with water.

The final design direction emerged from the overlap between the smellwalk findings, the co-speculation themes, and this selected future world. Rather than focusing on warning systems or commodification, the project emphasizes instability, bodily encounter, ritualised noticing, ecological concern, and living with bloom. This led to a wearable speculative probe that supports situated smellscape attunement by helping people notice and experience future microbial smellscapes in present water environments.

Present Encounter

THEME from Smellwalk

Unstable Smell Experience

Hesitation, Distance, and Water Avoidance

Smelling with probes as a Ritual

Ecological concern emerged through interaction

Memory and personal association

Sensory Mismatch

Collective Sensing and Social Confirmation

Future Speculation

THEME from Co-speculation

Smell as Commodity and Urban Value

Smell as Memory and Place attachment

Smell as Environmental Signal

Smell as Protection & Bodily Coping

Reinterpretation of Bloom

DESIGN PRINCIPLES

Work with smell Instability

Make smelling bodily and situated

Turn noticing into a ritual

Leave space for memory and interpretation

Invite Ecological care

Research goal

How can design support people in noticing and experiencing future microbial smellscapes in the present?

Design goal

Create a situated and embodied smell encounter

Design principles ..... ***Themes***

Final design

A Speculative Attunement Set

for future microbial smellscapes

The Wearable — GPS-triggered smell release near the body

Smell Archives — microbial-inspired scent cartridges used in the wearable

The Zine — walking prompts and smell reflection guide

EXPLORING EMBODIED DESIGN DIRECTION

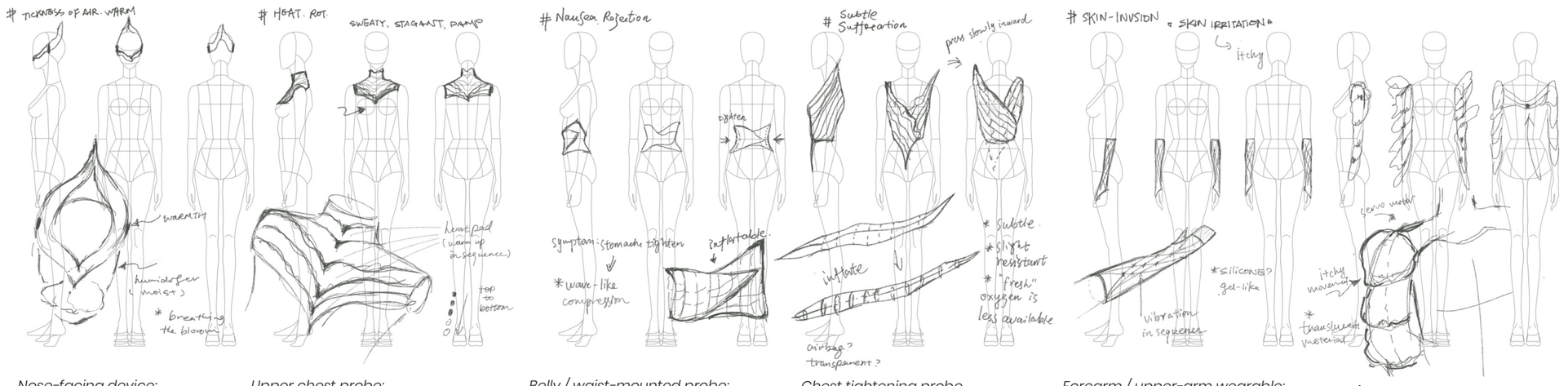
The co-speculation workshop generated several themes around microbial smellscapes, including warning signals, bodily protection, memory and place, reinterpretation of blooms, and urban value. These themes were brought together into one selected future world: Everyday Bloom Atmoshpere

Everyday Bloom Atmosphere imagines a near future in which microbial blooms become part of ordinary urban life. People still walk, cycle, eat, and rest near water, but bloom-related smells gradually enter everyday routines. In this world, microbial smell is not only environmental information. It becomes bodily, social, and emotional: something people may notice, avoid, normalise, or learn to live with.

The design development explored how this future smellscape could be translated into bodily encounters. Some concepts transformed smell into haptic signals, stomach discomfort, or chest pressure. The final direction became an upper-chest / choker-like wearable because it connects smell most closely to breath, body distance, and situated walking.

After finalising the upper-chest direction, I tested how smell behaved at different upper body locations. It shall not be too close to be compulsory nor too far to be just neglected.

This testing helped clarify why the final direction should not be handheld or waist-mounted. The upper-chest / choker position was selected because it keeps the smell close to the breathing zone without forcing it directly into the nose. It also allows the smell to appear and disappear through walking, wind, and body movement.



Nose-facing device:

A bit too direct and medical device feeling but still valuable to explore

"JUST LIKE SUNGLASS PROTECTING YOUR NOSE."
– W6

Upper chest probe:

Close to throat, chest, nose, and breath; more embodied and intimate

"IT'S SUFFOCATING AROUND MY NECK..."
– W3

Belly / waist-mounted probe:

Smell translated into stomach discomfort or repulsion. Connected to disgust and nausea, but no exact smell was involved

"THIS MAKES ME DISGUST, SOMETHING REPULSIVE"
– P2

Chest tightening probe

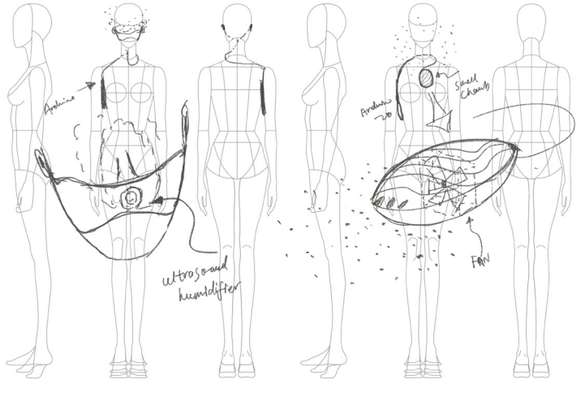
Smell translated into pressure or breathing tension
Strongly linked to bodily reaction, but risked feeling too restrictive

"I COULD FEEL MY CHEST TIGHTENED" – W1

Forearm / upper-arm wearable:

Smell translated into skin or haptic feeling. Useful for exploring bodily signals, but too far from breathing and smelling

"I HAVE FELT CHILLY AND SLIMY STANDING NEAR THE STAGNANT WATER...." P1



Pendant (mid-chest)

Familiar and wearable, creating a subtle presence on the body, but less directly connected to breathing and smell perception

"THE SMELL ACTUALLY IS GOING UP AND REACHING TO MY NOSE..." – P5



Smell behaved at different upper body locations indoors and outdoors

BODY PLACEMENT EXPLORATION

** Pilot test participant = P, Smell Walkshop participant = W*

MATERIALISING THE WEARABLE PROBE

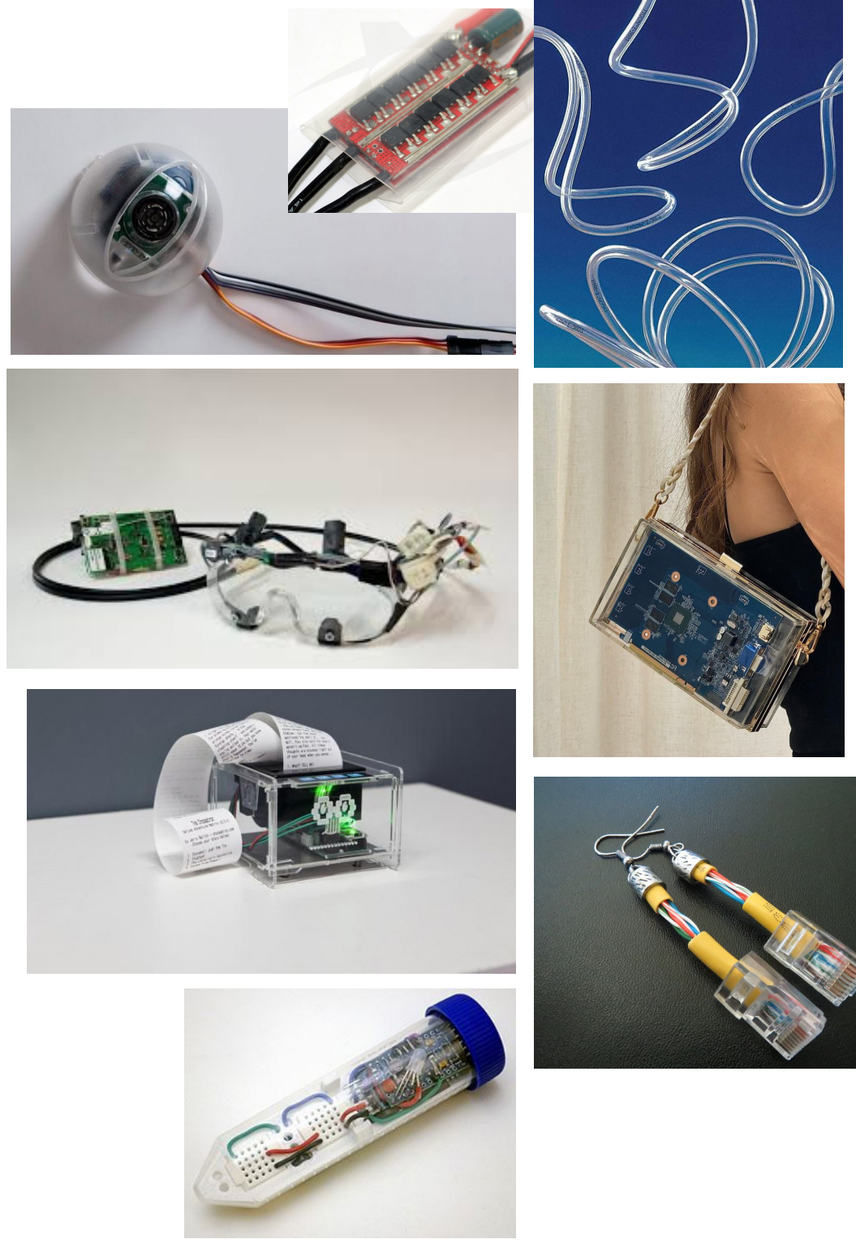
To create the effect of a future microbial smell probe, the wearable was crafted with simple translucent and visible materials. The aim was not to produce a polished product, but to make a speculative field object that feels slightly organic, experimental, and from a near future.

Craft quality	*Design intention*
Translucent PVC	Create a future-oriented, see-through, experimental appearance
Visible circuit and wires	Shows the prototype as a research probe, not a consumer product
Simple replaceable	Allows different smell materials to be tested



Smell chamber structure prototyping and exploration

MOODBOARD



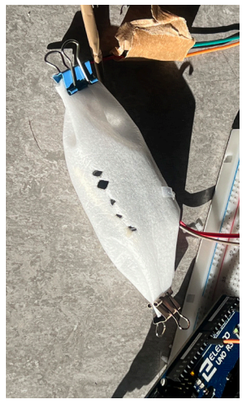
The Second version of the wearable probe

ITERATION

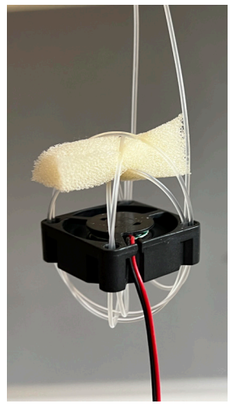
The wearable probe was developed through a series of iterations that moved from testing basic functionality to creating a more integrated speculative object. Each version addressed a key question: how to release the smell, contain and direct it, and make the probe wearable.

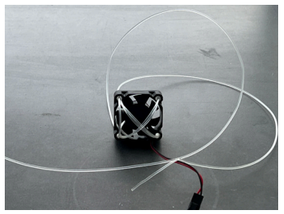
Iteration focus	*Making*	*Reflections*
Establishing function	Fan, smell material, and string attachment	Confirmed smell could be directed towards the breathing zone
Improving containment	Moist air made the smell stronger, more diffuse, and more bodily	Reduced leakage and improved wearability
Organising the system	The smell appeared as subtle traces that were easier to follow	Improved component arrangement and access
Integrating form and function	3D-printed enclosure	Created a more stable wearable system
Aligning with the scenario	Translucent, organic construction	Connected the probe to the selected microbial future

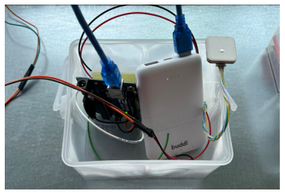
First version

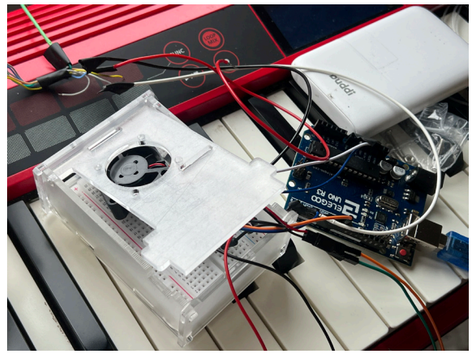


Iteration 1





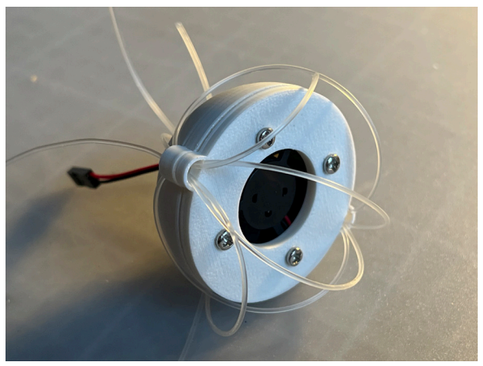


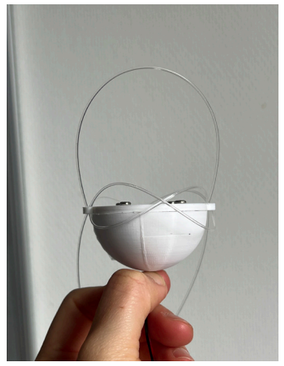


Iteration 3

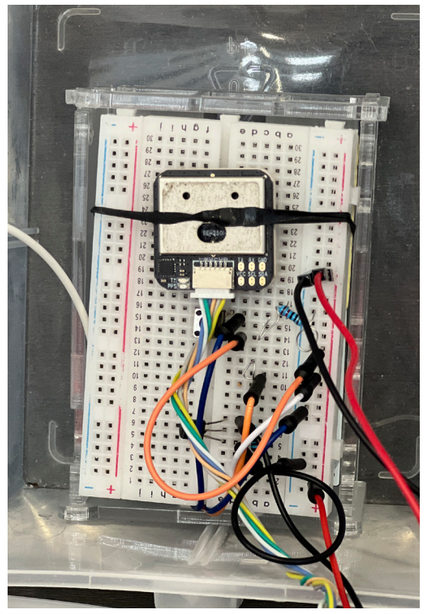


Iteration 2





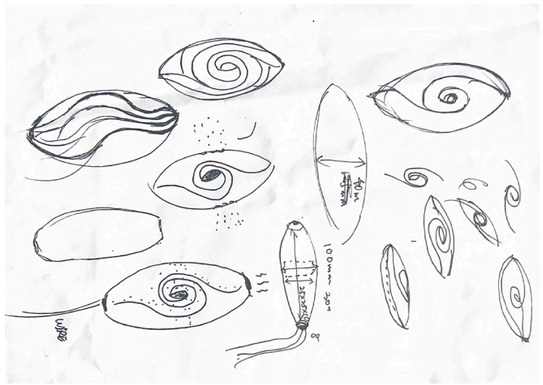
Iteration 4

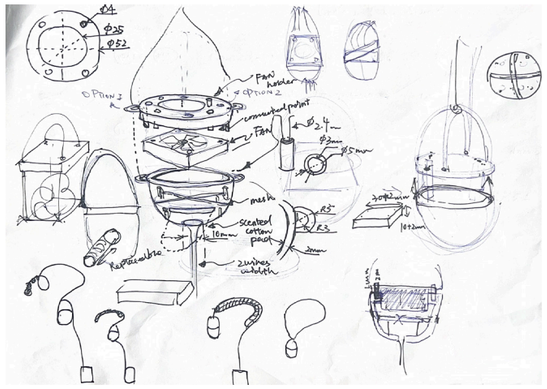


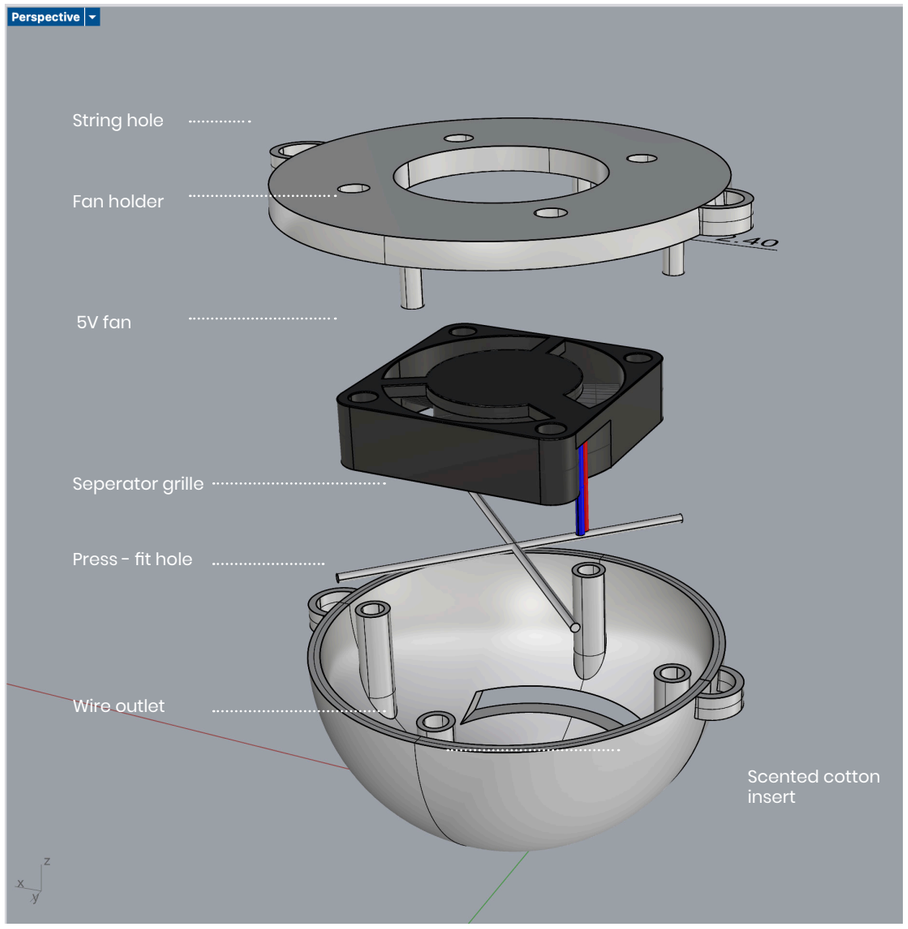
GPS, electronics, and power supply in frosted laser-cut plexiglass box



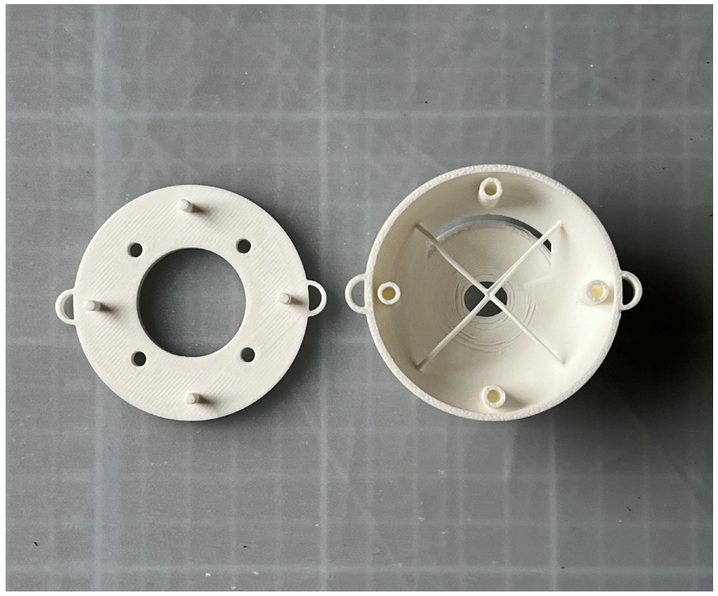
The wearable probe on







Modeling components in Rhino









Modeling components in Rhino

SYSTEM STRUCTURE: GPS-TRIGGERED SMELL RELEASE

The current prototype combines GPS location sensing, Arduino control, smell diffusion, and a wearable chamber.

System structure

The GPS module receives the current latitude and longitude. ..... *Arduino compares the current location with three selected canal locations.* ..... *When the participant enters a location zone, the smell release is activated.*

⋮

The drift zine helps the participant connect the smell moment to the surrounding water environment. ..... *The smell exits the chamber near the wearer's shoulder, neck, or breathing zone.* ..... *Air or mist moves through the smell material.*

The GPS trigger turns the wearable from a general smell object into a place-responsive probe. Smell is not released randomly. It appears at selected locations along the route, making the smellscape feel situated.

THREE - LOCATION LOGIC

The route is organised around three selected smell moments. These are not scientific classifications of the canal environment. They are design decisions based on the smellwalk route, field observations, and the project's interest in how microbial smell might shift across different urban water situations.

For this reason, the table does not describe fixed user "experiences". Individual responses to smell are personal and unpredictable. Instead, the table describes the intended role of each smell moment in the walking experience.

Smell moment/ Location type	***Smell release logic***	***Reflective cue***
Faint trace (L1)	A short and subtle smell release	Smell as something easy to miss
Transition point (L2)	A more noticeable smell release	Constantly changing conditions of water
Stagnant threshold (L3)	A stronger smell release	Unease and future microbial intensification

Smell release definition

Fan airflow	***Potentiometer (v1)***	***GPS (v2)***
Low (PWM: 90)	0 - 250 ADC	L1 Latitude, Longitude (Trigger radius: 35m)
Medium (PWM: 160)	250 - 65 ADC	L2 Latitude, Longitude (Trigger radius: 45m)
High (PWM: 255)	>650 ADC	L3 Latitude, Longitude (Trigger radius: 55m)

** PWM: Pulse Width Modulation, ADC: Analog-to-Digital Converter*

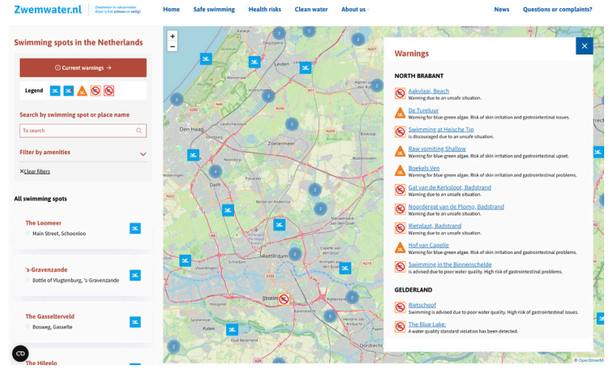
Corresponding technology triggers

The three moments are therefore better understood as speculative smell cues rather than environmental measurements. They help structure the walk and support reflection, but they do not predict how each participant will feel.

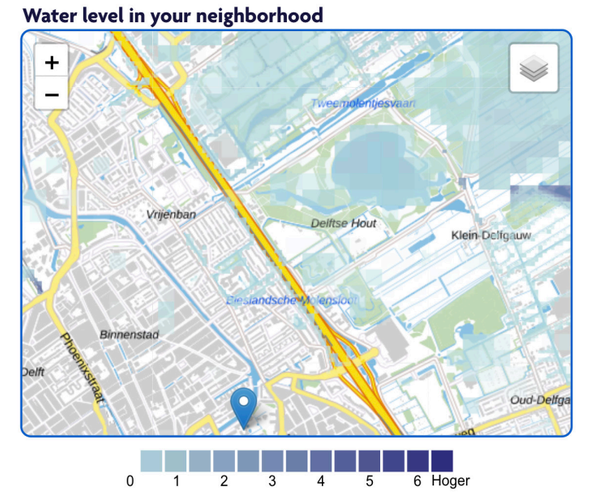
TRIGGER

The GPS version changed the role of the prototype. In the potentiometer version, smell release was manually controlled, so the interaction mainly focused on whether different airflow levels could be noticed. In the GPS version, smell release became more situated. The smell appeared suddenly at specific points along the route, making the experience feel more immersive and place-based.

The selected GPS locations were informed by field observations and public environmental data. Zwemwater.nl was used to understand official swimming-water locations and existing forms of public water-quality communication, while Overstroomik.nl helped situate Delft's water environments within broader Dutch water-risk conditions. These sources did not determine the smell release as scientific evidence of microbial activity. Instead, they provided contextual grounding for choosing water-related sites where the speculative smell encounter could become meaningful. The GPS trigger therefore acts as an experiential invitation rather than a detection system.



Screenshot of Zwemwater.nl, it provides the up-to-date information on the hygiene and safety of official outdoor swimming locations

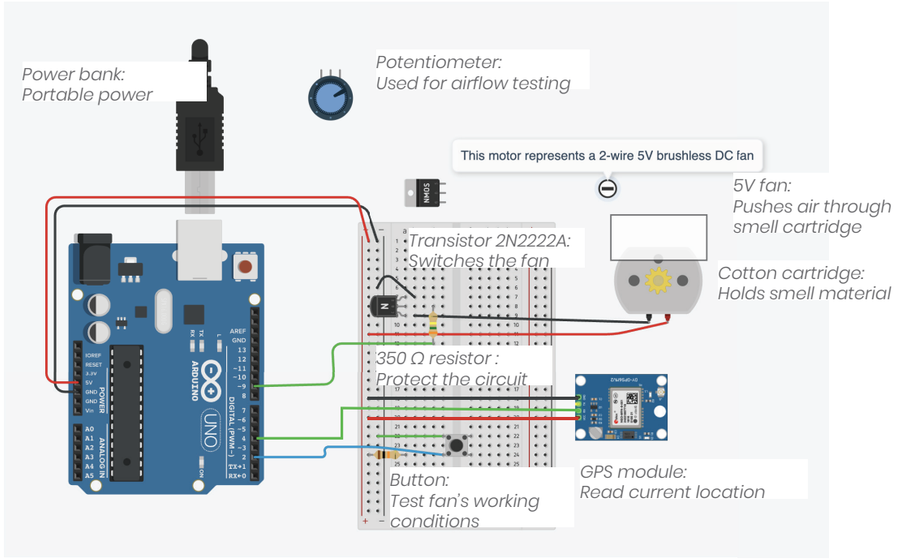


These blue colors—from light to dark—show in meters how high the water can rise: from 0 to 6 meters and higher.

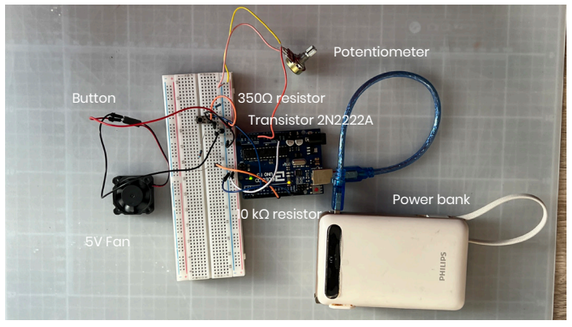
Screenshot of Overstroomik.nl, it provides the prediction of the water level rise during a flood

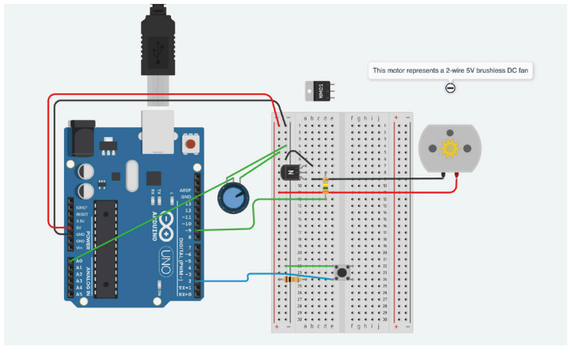
ELECTRONICS SETUP

The electronic system uses an Arduino, GPS module, output control circuit, power source, and smell diffusion component.



Wiring schematics and roles



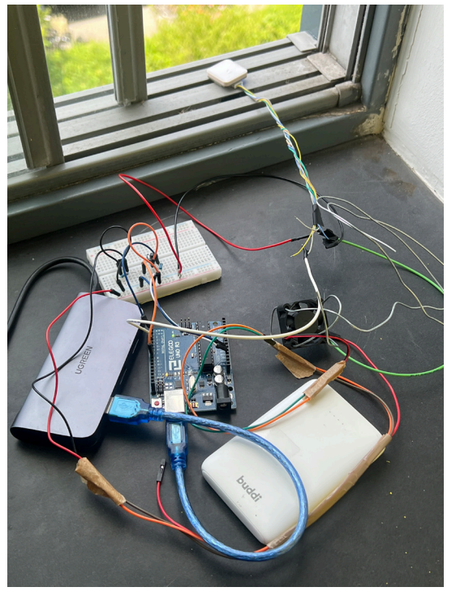


Initial fan-based smell release test with potentiometer

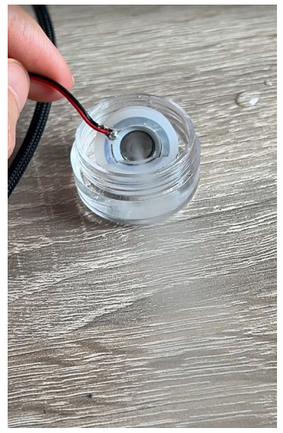
FAN - BASED AS OUTPUT

There are various way of olfactory display explored in VR environments (Tewell & Ranasinghe, 2024). The fan-based system is the main prototype direction. It is simple, dry, lightweight, and suitable for a wearable object. When the participant enters a GPS-triggered zone, the Arduino activates the fan for a short period. The fan moves air through the smell material, allowing the smell to escape through the wearable chamber.

This setup is not intended to create a strong or precise smell signal. Instead, it supports a subtle and intermittent smell encounter. The smell may fade, return, or mix with the surrounding air, which reflects the unstable nature of smellscape itself.



Smell release test with GPS module



Ultrasound humidifier test

ULTRASONIC HUMIDIFIER AS AN ALTERNATIVE DIFFUSION EXPERIMENT

An ultrasonic humidifier was also explored as an alternative to the fan. Compared with the fan, the humidifier can create a more visible, moist, and breath-like release. This could conceptually fit the idea of Blooming Breath, because the smell would appear almost like a small atmospheric cloud.

Technically, the humidifier can also be controlled by GPS. The Arduino can switch the humidifier on when the participant enters a selected location zone and switch it off after a set duration. However, in the current stage, it is more realistic to control release timing rather than precise intensity. Many small ultrasonic humidifier modules are easier to control as on/off outputs, while smooth intensity control would require further testing, power management, and safe scent formulation.



```
smell_future.ino

const int fanPin = 9;
const int buttonPin = 2;
const int potPin = A0;

// ====== Values to play around ======
const int LOW_SPEED = 90;     // weak airflow
const int MED_SPEED = 160;    // medium airflow

#include <TinyGPS++.h>
#include <SoftwareSerial.h>

TinyGPSPlus gps;

// GPS TXD -> Arduino D4
// GPS RXD can be left unconnected
Soft

void loop() {
  // Read GPS data continuously
  while (gpsSerial.available() > 0) {
    gps.encode(gpsSerial.read());
  }

  int buttonState = digitalRead(buttonPin);

  int fanSpeed =
  String levelNam
  String activeLo

  // Button overr
  if (buttonState
    fanSpeed = BU
    levelName = "
    activeLocatio
  }

  // GPS location
  else if (gps.lo
    double curren
    double curren

    double closes
    int closestIn

    // Find close
    for (int i =
      double dist
        currentLa
        currentLn
        locations
        locations
      );

      if (distanc
        closestDi
        closestIn
      }
    }

    // Check if i
    if (closestIn
      fanSpeed =
      levelName =
      activeLocat
    } else {
      fanSpeed =
      levelName =
      activeLocat
    }
  }

  // No valid GPS
  else {
    fanSpeed = 0;
    levelName = "
    activeLocatio

  // Print debugging info once per second
  if (millis() - lastPrint >= 1000) {
    lastPrint = millis();

    Serial.println();

    Serial.print("Chars processed: ");
    Serial.println(gps.charsProcessed());

    Serial.print("Passed checksum: ");
    Serial.println(gps.passedChecksum());

    Serial.print("Satellites: ");
    if (gps.satellites.isValid()) {
      Serial.println(gps.satellites.value());
    } else {
      Serial.println("Unknown");
    }

    if (gps.location.isValid()) {
      double currentLat = gps.location.lat();
      double currentLng = gps.location.lng();

      Serial.print("Current Latitude: ");
      Serial.println(currentLat, 6);

      Serial.print("Current Longitude: ");
      Serial.println(currentLng, 6);

      Serial.println("Distances to smell zones:");

      for (int i = 0; i < numberOfLocations; i++) {
        double d = TinyGPSPlus::distanceBetween(
          currentLat,
          currentLng,
          locations[i].lat,
          locations[i].lng
        );

        Serial.print(" - ");
        Serial.print(locations[i].name);
        Serial.print(": ");
        Serial.print(d);
        Serial.println(" m");
      }
    } else {
      Serial.println("Waiting for GPS fix...");
    }

    Serial.print("Active zone: ");
    Serial.println(activeLocation);

    Serial.print("Fan level: ");
    Serial.print(levelName);

    Serial.print(" | PWM: ");
    Serial.println(fanSpeed);

    Serial.println("----------------------------------------");
  }
}
```

Code from Arduino IDE

DEVELOPING SMELL MATERIALS AND THE BLOOM ARCHIVE

Smell is the main material of the speculative probe set. However, the project does not use real harmful microbial material. Instead, it uses safe, edible, and semi-simulated smell references.

Scientific literature on cyanobacterial blooms and water taste-and-odor problems often discusses compounds such as geosmin and 2-methylisoborneol (MIB), which are associated with earthy and musty smells in water (Watson, 2003). Research on cyanobacterial volatile organic compounds (VOCs) has also identified compounds such as β-cyclocitral and β-ionone, which are linked to bloom conditions, cell degradation, and characteristic odor events in freshwater environments (Jüttner & Watson, 2007). These references do not mean that the prototype reproduces the chemistry of harmful algal blooms. Instead, they support the design direction towards earthy, musty, green, aquatic, and stagnant olfactory qualities.

For the current prototype test, edible seaweed or algae powder is used as a safe olfactory reference. These materials suggest green, aquatic, organic, and slightly unfamiliar qualities. They do not reproduce actual harmful algal blooms. Instead, they provide a practical and safe way to test whether a microbial-inspired smell can move through the wearable probe and support situated reflection.



The ocean smell perfume making workshop with Mediamatic



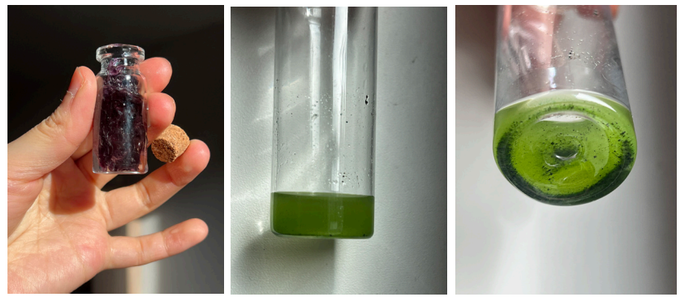
FUTURE BLOOM SMELL ARCHIVES

The bloom smell archive is proposed as a future smell series. It could be developed in collaboration with perfumers, smell artists, or environmental scientists. Rather than making random strong smells, the archive would translate microbial smellscape conditions into safe and layered olfactory compositions.

In the current graduation project, only the seaweed, dissolved algae powder smell and a ocean-inspired perfume sample are tested and developed physically. The three selection of loom smell Archive is a future development direction. It suggests how future versions of the probe could use different smell cartridges at different GPS-triggered locations.

Archive sample	*Sensory reference*	*Design meaning*
01 Faint Trace	Geosmin, wet soil, dampness	A subtle early trace of microbial presence
02 Green Bloom	Algae-related VOCs, aquatic materials	A more noticeable smell of biological growth
03 Stagnant Threshold	Mustiness, decay, still-water	A heavier smell suggesting intensification

Smell archives narratives



Seaweed in ethanol *Edilble algae powder dissolved in ethanol*

SIMULATED SMELL ARCHIVES

Real algae and canal water were not used in the archive samples, in order to avoid biological risk, uncontrolled degradation, and misleading claims of scientific detection. The samples are constructed speculative materials, not environmental measurements.

Smell sources:
Edible seaweed, algae powder, the ocean smell perfume sample made during a workshop



Smell holders:
Sponge, cotton



Smell source materials and diffuser medium

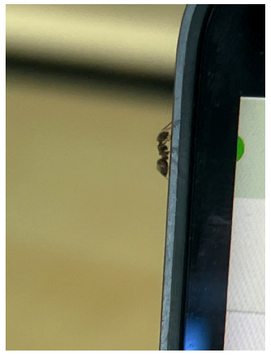
RELATING THE TEMPORAL ARCHIVE TO RESEARCH GOAL

Although the smell archive includes references to 1975, 2025 and 2050, this does not change the project's primary focus on experiencing possible future microbial smellscapes. The historical and recent entries function as temporal anchors through which the speculative future can be encountered relationally rather than in isolation. The 1975 entry emerged from the co-speculation workshop theme of bloom heritage and living memory, where participants imagined microbial smells becoming connected to nostalgia, cultural value and collective remembrance. This theme was retained because it revealed that people may understand environmental futures not only through projections of what is to come, but also through comparisons with what is remembered, lost or reinterpreted from the past.

The three smells therefore form a temporal sequence. The 1975 one introduces an imagined historical reference, the 2025 one grounds the experience in conditions close to the period of the project, and the 2050 smell extends these relations into a possible future. Their juxtaposition makes environmental change more perceptible by allowing the wearer to compare different imagined moments rather than encountering 2050 as an abstract or disconnected scenario.

Here, speculation is not treated as being exclusively concerned with the future. It is used as a way of rearranging relationships between past, present and possible futures in order to question how environmental change may be remembered, experienced and valued. The historical smell is therefore not presented as an accurate reconstruction of water in 1975, just as the 2050 smell is not presented as a prediction. Both are speculative material references. However, the past and recent entries ultimately remain in service of the central research goal: supporting people in noticing and experiencing a possible future microbial smellscape in the present.

CALIBRATING IN THE NATURE BROUGHT ME A LITTLE FRIEND :)



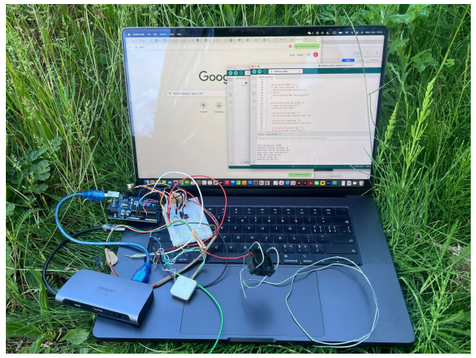
Serial monitor output

```
Chars processed: 6341
Passed checksum: 62
Satellites: Unknown
Current Latitude: 52.002014
Current Longitude: 4.369405
Distances to smell zones:
 - Location 1 - Canal edge: 3.87 m
 - Location 2 - Bridge: 439.07 m
 - Location 3 - Plant water zone: 670.08 m
Active zone: Location 1 - Canal edge
Fan level: LOW | PWM: 70
-------------------------------------
```

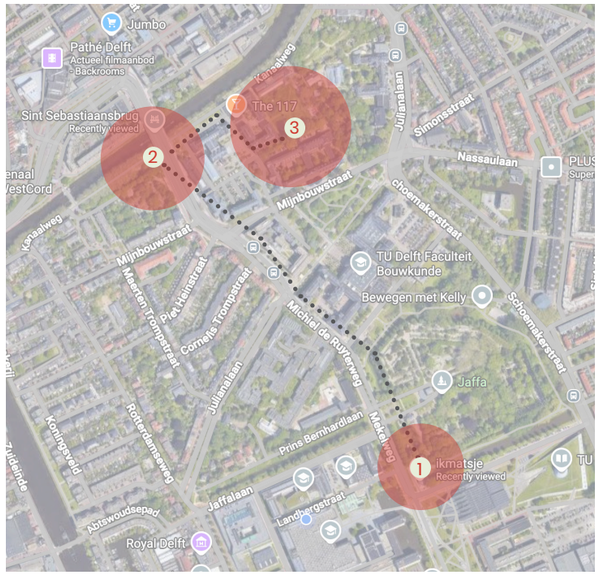
```
Chars processed: 27383
Passed checksum: 260
Satellites: 12
Current Latitude: 52.007999
Current Longitude: 4.368093
Distances to smell zones:
 - Location 1 - Canal edge: 663.37 m
 - Location 2 - Bridge: 270.33 m
 - Location 3 - Plant water zone: 6.31 m
Active zone: Location 3 - Plant water zone
Fan level: HIGH | PWM: 150
-------------------------------------
```

PROTOTYPE CALIBRATION AND TESTING

Calibration



Before enacting the final probe, I conducted a series of technical and material tests to understand smell diffusion, body placement, GPS triggering, and outdoor performance. These tests did not aim to make smell fully controllable. Instead, they helped establish a sufficiently functional system for first-person enactment.



Location 1:

Name: Clear water edge near TU Delft Library
Latitude: 52.002539
Longitude:4.371995
Fan level: LOW
PWM: 70
Trigger radius: 35m

Location 2:

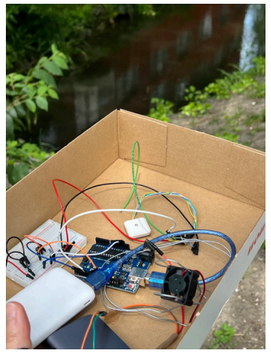
Name: Bridge near Sint Sebastiaansbrug
Latitude: 52.007612
Longitude: 4.366196
Fan level: MEDIUM
PWM: 90
Trigger radius: 45m

Location 3:

Name: Plant / stagnant water area near DUWO housing
Latitude: 52.007977
Longitude: 4.368008
Fan level: HIGH
PWM: 150
Trigger radius: 55m

Within the wearable probe, different GPS-defined locations activated the fan at different pulse-width modulation (PWM) settings. PWM rapidly switches the electrical output on and off, with a higher duty cycle supplying power to the fan for a greater proportion of each cycle and generally producing a higher fan speed. In the prototype, PWM values of 70, 90 and 150 represented low, medium and high fan settings. Increasing the fan speed generated stronger airflow through the scented material, carrying more scented air towards the wearer and making the release potentially more noticeable. Lower settings produced a subtler release. These settings represented relative experiential differences rather than calibrated smell concentrations, because perceived intensity outdoors also depended on wind, weather, body position, competing environmental smells and olfactory adaptation.

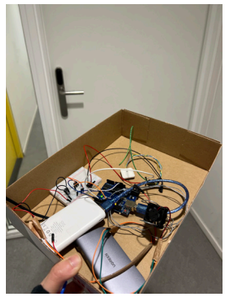
Sunny day testing at Location 3

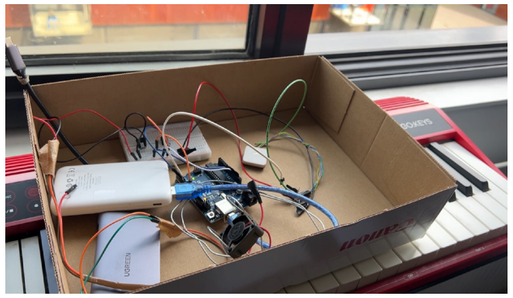




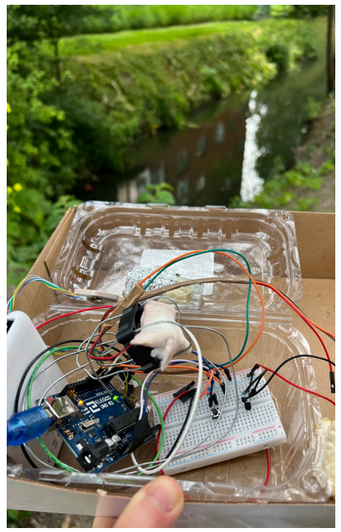
Sunny day testing Location 1

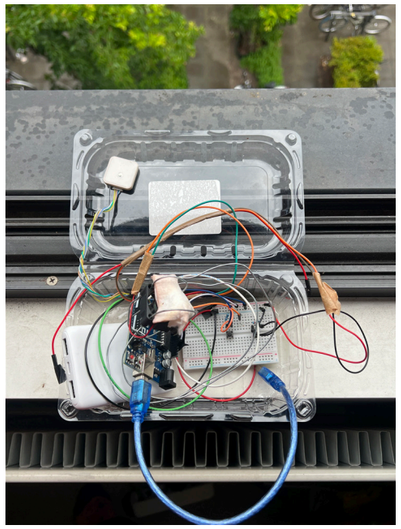
A TRUCK CAME AND WATERED THE TREES NEAR ME, BRINGING MUDDY AND EXHAUST SMELL TO ME





Sunny day testing Indoors





THE SMELL WAS STILL LINGERING AROUND WITH ME TO MY DORM

Rainy day testing Location 3

Rainy day testing Indoors

The most significant technical shift was from the potentiometer version to the GPS-triggered version. The potentiometer framed the interaction around controlling airflow. GPS instead connected smell release to movement through place. This established the conditions for the following first-person enactments.

KEY LEARNINGS

The detailed technical setup has been explained in the electronics and system structure sections. This section briefly summarises the main prototype learnings and how they shaped the final design

Test	***Main Learning***	***Design decision***
Body placement	Smell was less noticeable around the arm and waist, but clearer near the upper chest and breathing zone	The probe was positioned near the collarbone and upper chest
Fan and potentiometer test	Differences between three airflow levels were difficult to perceive consistently	Smell levels were treated as qualitative moments rather than precise intensities
Ultrasonic humidifier test Moist	Visible release is possible, but harder to integrate into a wearable and control precisely	Keep as alternative / future development
GPS triggering	Location-triggered release felt more situated than manually controlling the fan	The final interaction used three GPS-triggered smell moments
GPS radius	A radius of approximately 35 metres worked as a proof of concept, but sometimes triggered abruptly or inconsistently	Further radius calibration remains necessary
Rain and moisture	Humidity sometimes intensified the smell, but the prototype enclosure became wet	Future versions require better water resistance
Indoor and outdoor smell diffusion	Smell travelled more predictably indoors, while outdoor wind rapidly altered its direction and intensity	Outdoor instability was accepted as part of the smellscape encounter
Smell test	Safe organic materials can suggest aquatic smell, but fresh seaweed, edible algae mix (Spirulina and other algae) in water can spoil quickly	Use as temporary olfactory reference; develop stable smell archive in future

ENACTING THE PROBE: *FIRST-PERSON ENCOUNTERS*

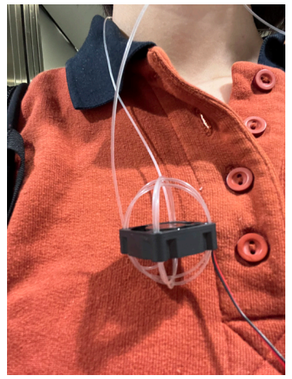
After completing the GPS-triggered prototype, I wore the probe during repeated walks in different locations, weather conditions, and social situations within two and a half weeks. These walks were not formal user tests. Instead, they allowed me to temporarily inhabit the speculative scenario and observe how the probe altered my movement, attention, and relationship with the surrounding smellscape.

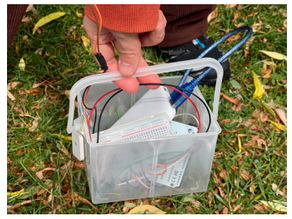
I documented these enactments through photographs, videos, and audio memos. The following encounters focus not on whether the device performed consistently, but on what happened when its smell entered an already active environment.

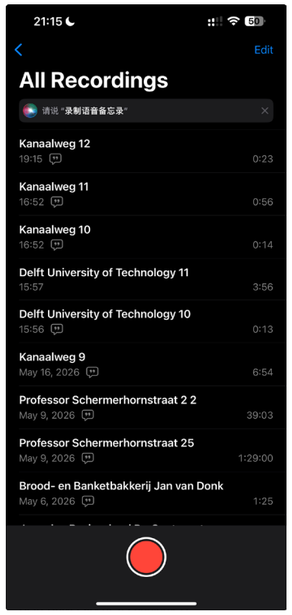
CONDITIONS OF ENACTMENT

The probe was tested across different weather and spatial conditions. Rather than treating these conditions as external variables, I began to understand them as part of the smellscape itself.

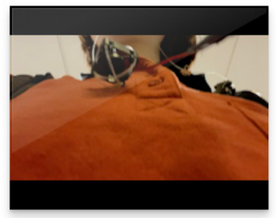
Condition	*Notes*	*Reflections*
Windy outdoor walk	The wind quickly carried, distorted, or erased the smell released by the fan	The probe could not control smell; it only introduced a trace into a stronger atmospheric system
Rainy walk	Moist air made the smell stronger, more diffuse, and more bodily	Smell became atmospheric, creating a feeling of being soaked into the smellscape
Cloudy day	The smell appeared as subtle traces that were easier to follow	Subtle smell created curiosity without becoming immediately overwheliming
Balcony	The smell felt more contained and controllable	Semi-outdoor space made the probe feel protected, but less connected with the actual canal environment
Moving from indoor to outdoor	Smells changed suddenly with wind, traffic, water and food	The smellscape shifted quickly, almost "in a blink of the nose"
Longer outdoor walk	My nose became tired and less sensitive to the surrounding smells	Smell fatigue became part of the experience, showing the need for short smell moments





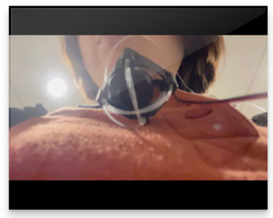


Audio memo



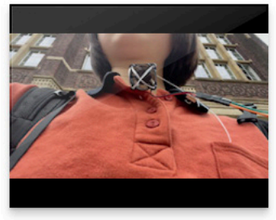
Low airflow

IMG_5904.MOV



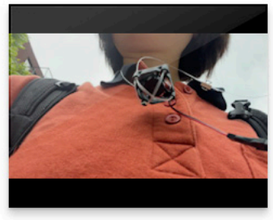
No airflow

IMG_5903.MOV



Medium airflow

IMG_5900.MOV



High airflow

IMG_5902.MOV

LEARNING 1: WHEN THE ATMOSPHERE TOOK OVER

During one windy canal walk, the fan seemed almost irrelevant:

> "WALKING NEAR CANAL, THE WIND IS SO STRONG THAT MY FAN BARELY PLAYS ITS ROLE. NATURE IS JUST WAY MORE POWERFUL AND UNPREDICTABLE..."

On some days, wind dispersed the smell before I could recognise it. On others, it carried the seaweed smell around my body without much assistance from the fan. In calmer conditions, the same material appeared only as a subtle trace.

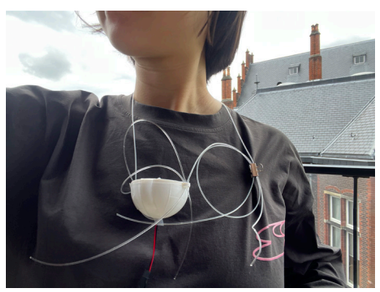
Rain produced a different experience. Moisture seemed to spread the smell through the surrounding air rather than direct it from a single source. I felt less like I was smelling the device and more like I was standing within a diluted mixture of rain, canal water, vegetation, air, and body. I described this as being soaked into the smellscape.

Transitions between environments also became noticeable. On a balcony, the smell felt protected and comparatively controllable. Moving from indoors to outdoors could produce sudden changes as water, traffic, food, smoke, and vegetation appeared almost "in a blink of the nose". During longer outdoor walks, olfactory fatigue made the smell gradually less perceptible.

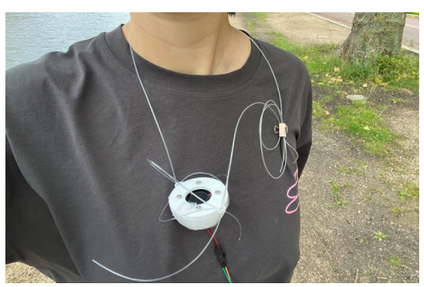


Cloudy day testing outdoors

> "A PASSERBY LOOKED AT ME WHEN I TOOK A DEEP BREATH, THEN ALSO SNIFFED AROUND..."



Test the smell chamber on the balcony



Test on a near canal

LEARNING 2: A SITUATED AND ANTICIPATED INTERRUPTION

The GPS-triggered release changed the rhythm of walking. Instead of deciding when to activate the smell, I began anticipating it as I approached the programmed locations.

> "I START HOLDING MY BREATH WHEN I AM APPROACHING THE GPS-TRIGGERED ZONE."

This reaction happened before I clearly perceived the released smell. The mapped zone had already begun to influence my breathing and bodily preparation. The probe therefore did not only produce a sensory response after activation; it also created an anticipatory choreography of slowing down, preparing, inhaling, or holding breath.

This revealed a tension within the experience. The GPS trigger could invite attention, but it could also frame the approaching location as something threatening. For this reason, the selected points should not be described as "high-risk zones", since the prototype does not measure microbial risk. They are speculative smell moments intended to support noticing rather than communicate danger.

When the fan activated, I often searched for where the smell might belong:

> "THE SMELL APPEARS UNEXPECTEDLY AT CERTAIN LOCATIONS. IT MAKES ME SLOW DOWN AND WONDER."

Was it coming from the probe, the canal, the vegetation, or an imagined future condition of the place? The smell did not resolve this question. Instead, it made the familiar location temporarily uncertain.

The released scent also mixed immediately with existing urban odours:

> ""THE WIND BRINGS A MIXTURE OF SMELLS AND SMASHES INTO MY FACE. I SMELL 'FISHY CIGARETTE' RIGHT AFTER A SMOKER WALKED PAST.""

Rather than arriving as an isolated microbial smell, it became part of a shifting mixture of smoke, food, traffic, water, vegetation, rain, and bodies moving through the city.

LEARNING 3: SMELL SPREADING BEYOND THE WEARER

Although these enactments began as first-person explorations, the experience quickly became social. Friends accompanying my evening walks became curious and asked to try the probe, even when I had not planned to involve them.

The revised version allowed the smell to travel further from the body:

> "With this new version, I could sense more smells, and it even drifted away and became noticeable to my friends."

Their reactions were immediate. Facial expressions changed, bodies moved closer or further away, and conversations followed about whether the smell was natural, artificial, pleasant, repulsive, or connected to the water.

The probe also affected people who did not directly smell from it. During one enactment, a passer-by saw me taking a deep breath and then began sniffing the surrounding air as well. This moment suggested that smelling could become socially contagious. My bodily gesture acted as a cue, encouraging another person to attend to an environment they might otherwise have passed through without noticing.

The wearable itself also attracted attention because its function was unclear:

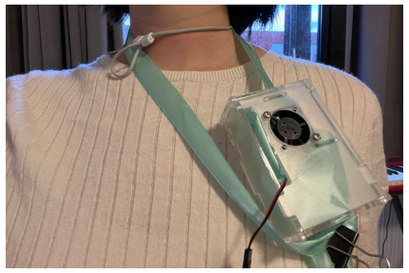
> "This version attracted a lot of attention from people. They thought it might be a tape playing sound."

This misinterpretation revealed the ambiguity of the object. Its visible electronics and unfamiliar upper-body placement signalled that something was happening, but did not clearly explain whether it sensed, sounded, or released smell. This ambiguity generated curiosity and conversation, although the Drift Zine remained important for situating the object as a smellscape probe rather than an environmental detector.

During filming, the photographer commented:

> "Staying with you for the whole filming, I feel like I could smell more than before, seriously."

Together, these encounters suggest that the probe did not only heighten the wearer's attention. Smell, bodily gestures, and the visible object circulated socially, inviting others to sniff, question, interpret, and discuss the surrounding environment.



Test indoors

> "Dogs seem like the seaweed from the smell cartridge, they approach me... So am I smell like a bloom now?"



Gusty winds with friends near the stagnant water

LEARNING 4: ATTUNEMENT LINGERING AFTERWARDS

After several walks, the most significant shift occurred when I was no longer concentrating on the probe itself. I began walking more slowly, pausing more often, and taking deeper breaths near water, even when I was not wearing it.

> "I got used to pausing, sniffing, and looking around. It started to become subconscious."

The 35-metre GPS zone initially acted as a reminder to prepare for a smell moment. Over time, however, I began noticing smells before entering the programmed area. I became more familiar with the changing olfactory character of different locations and how they varied with weather, time, vegetation, animals, and surrounding activity.

This attentiveness also travelled beyond the original route. When I later encountered a similar aquatic smell in my hometown, I approached rather than immediately stepping away. I searched for its source and wondered whether wet wooden posts near the water were absorbing and diffusing it.

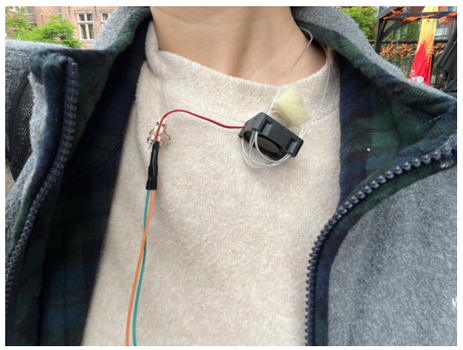
The smell also lingered through memory. When I later noticed an insect in my room, I briefly wondered:

> "Did I bring the smell in home?"

The question was speculative rather than factual, but it showed that the enactment continued beyond the moment when the fan stopped.



Floating dead fish on a walk



Sunny day testing from inddors to outdoors



"THE WIND BRINGS A MIX-TURE OF SMELLS AND SMASHES INTO MY FACE. I SMELL 'FISHY CIGARETTE' RIGHT AFTER A SMOKER WALKED PASS.

I EAGER TO FIND TRACES OF THE BLOOM AND START IMAGINING LIVES IN THE FUTURE..."



"I KIND OF GET USED TO PAUSE, SNIFF AND LOOK AROUND EVEN JUST WEARING IT FOR A DAY... IT BECOMES SUBCONSCIOUS NOW..."

REFLECTION ON ENACTMENTS

The enactments revealed that the probe did not operate as an independent smell-delivery device. Its effect was co-produced by GPS location, wind, humidity, rain, surrounding odours, body movement, animals, and other people. The probe could introduce an olfactory trace, but it could not determine how that trace travelled or what it became once released.

This changes how the probe can be understood. It did not make a future microbial smellscape clearly or consistently present. Instead, it made the instability of smellscape perceptible. The same cartridge could feel faint, intense, aquatic, muddy, mouldy, or repulsive according to place and circumstance. Smell speculation therefore became situated in both space and time rather than contained within the object.

The GPS trigger also transformed smell from an output into an interruption. Because the smell appeared without manual activation, it disrupted habitual movement and encouraged searching, comparing, and questioning. Its ambiguity, whether it belonged to the device or the environment, was central to this effect. Rather than communicating a fixed environmental message, the probe created an opening for speculation.

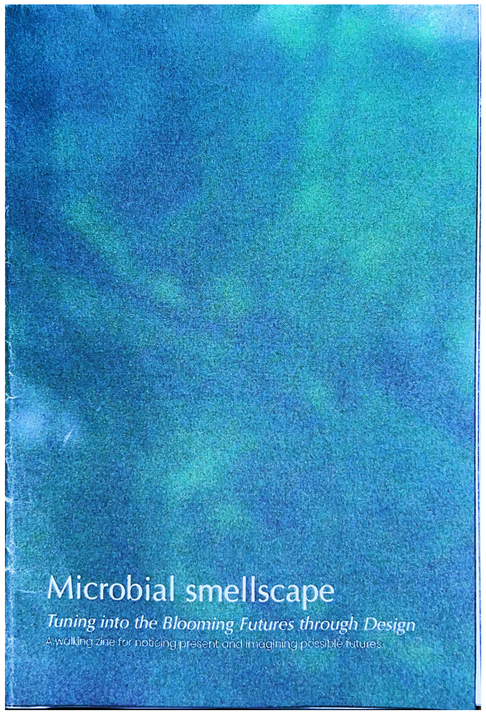
The social encounters showed that smell could not be restricted to one wearer. It circulated through air, attracted curiosity, provoked bodily reactions, and generated conversations. Encounters with dogs, insects, ducks, fish, water, and vegetation also complicated the assumption that the probe addressed only human perception. Its smell entered a wider field of relations that could not be completely anticipated.

Most importantly, repeated enactment produced an effect that continued without the device. Pausing, sniffing, approaching, comparing, and remembering gradually became habitual. The probe temporarily introduced a future microbial trace, but its longer effect was to alter how present environments were noticed.

The value of the probe therefore lies less in accurately simulating a future bloom smell and more in supporting a process of situated attunement. It creates a temporary disturbance in ordinary perception through which the surrounding water environment may become less familiar, less passive, and more open to interpretation.

FINAL PROBE SET AND TUNING EXPERIENCE

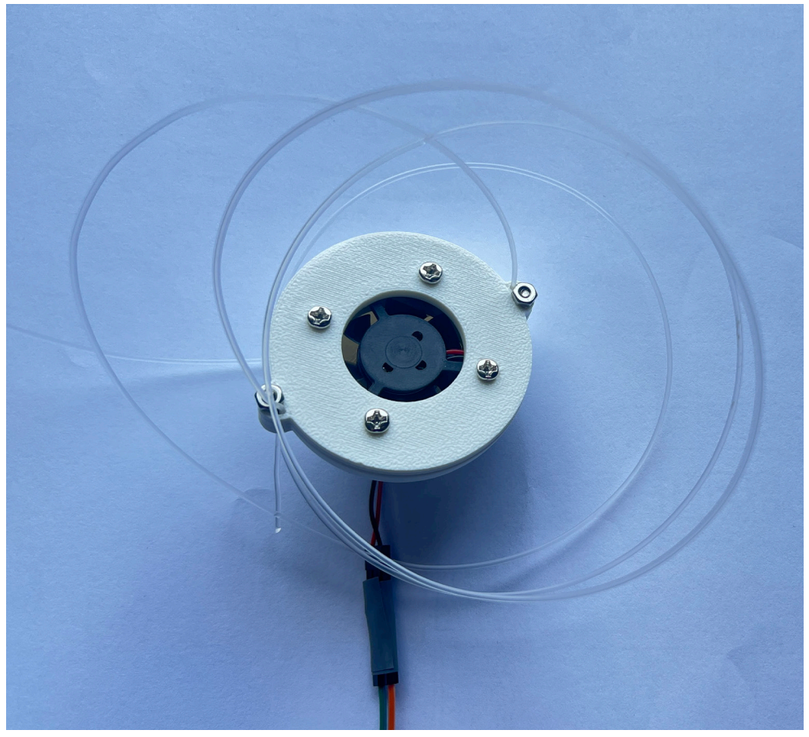
The final outcome of this project is not a single object, but a speculative probe set. It combines a wearable smell probe with GPS-triggered electronics, a zine, and bloom smell archives. Together, these elements create a situated encounter with future microbial smellscapes.



The final zine



Smell archives: 1975, 2025, 2050 (from the left to the right)



Final version of wearable smell probe

ZINE

The zine was adapted from the earlier smell-walk and co-speculation workshop materials. It guides the participant through a situated walk while also framing the smell released by the wearable as a speculative “sniff from the future”.

SMELL ARCHIVES

The speculative smell archive provides safe olfactory references for microbial smellscape futures with the collaboration with perfumers. It consists of three smell samples: Faint Trace from 1975 , Green Bloom from 2025, and Stagnant Threshold from 2050.

WEARABLE SMELL PROBE

The smell probe holds the smell and releases it near the breathing zone. And the GPS-triggered Arduino system activates smell release at selected points along the route.

Bloom Archive 01

Rare archival edition First Bloom Reserve

A delicate aquatic trace: soft, nostalgic and almost too subtle to notice. Notes of quiet water, early algae and a time before every environmental change came with a notification.

1975

Tuning note:

Luxury is having enough attention to notice what is barely there.

Year: 1975

Source: Pond in front of IDE Faculty

1975

Bloom Archive 02

Last Year's Signature Edition Everyd

A delicate aquatic trace: soft, nostalgic and almost notice. Notes of quiet water, early algae and a time environmental change came with a notification.

2025

Tuning note:

Notice what is already growing arou

Year: 2025

Source: Ca

2025

Bloom Archive 03

Long-lasting formula Lingering Waters

A heavier still-water scent: dense, humid and slow to disappear. It settles into the air and stays slightly longer than expected—re- maining present long after most people expected it to fade.

2050

Tuning note:

Stay with ecological change, ev

Year: 2050

Sourc

2050

Microbial smellscape

Insights into the Blooming Future Through Design

The Final Speculative Pprobe Set near the canal platform

CONTEXTUAL CONDITIONS

PLACE · WEATHER
BODY · MOVEMENT ·
EXISTING SMELLS ·
ECOLOGICAL RELATIONS

ENTERING THE ENCOUNTER

Put on

Move through the environment

Enter a selected location

TUNING ATTENTION

Encounter smell

Pause and notice

Use the zine

Speculate with smell

LINGERING AND RIPPLING OUTWARD

Remove

Re-encounter

Reflect

Share

The interaction begins when a person positions the wearable near the collarbone and moves through an everyday water environment. The encounter is not produced by the device alone, but is shaped by place, weather, bodily movement, existing smells, and surrounding ecological and infrastructural relations.

When the wearer enters a selected location, identified and contextualised using publicly available environmental information, the wearable releases a subtle bloom-inspired smell close to the body. The introduced smell does not represent or diagnose the actual condition of the water. Instead, it functions as an olfactory interruption that may prompt the wearer to pause, orient themselves, and tune their attention to the surrounding environment. The fan's airflow varies according to a predefined intensity assigned to each location, creating shifts in the perceptibility of the introduced smell rather than communicating a precise environmental measurement.

The zine supports this process of attunement by inviting the wearer to notice the present smell environment, consider the ecological relations participating in the atmosphere, and imagine how the familiar place might be experienced under possible future microbial conditions.

After removing the wearable, the person encounters the environment again without the introduced smell. Although the technological intervention has ended, attention may continue to linger or resurface later through an unexpected smell, memory, or moment of reflection. Observations, associations, and imagined futures may also be shared with others, allowing the individual encounter to ripple outward through informal conversations and subsequent moments of environmental noticing.

The interaction flow describes the intended experiential sequence of the toolkit rather than the literal events shown in the fabulated storyboard(see page 72). The wearable introduces a subtle olfactory interruption, while the zine and smell archive support noticing, reflection, and speculation across different temporal references. "In a smell time machine" describes an imaginative shift through smell, memory, and future speculation; it is not a technical function of the wearable.

1

"This one is from 2050. Try it carefully. It has future notes."



Join the blooming future smellwalk

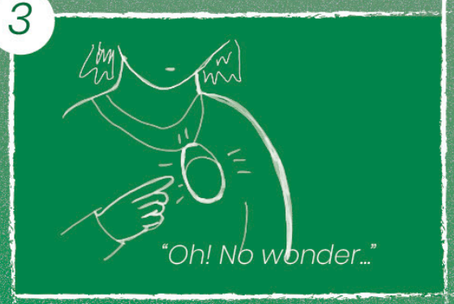
2

"Anything interesting to notice here?"



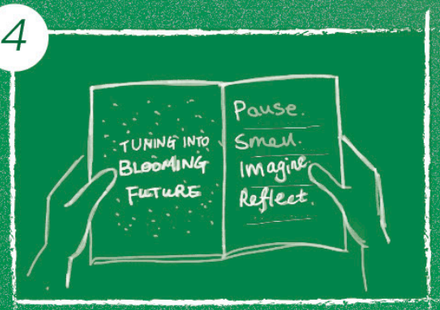
Pass without noticng:
Unexpected smell intervention

3



Realise that the
wearable releases smell

4



"Instruction: pause, sniff, do not panic..."

Read and reflect on the zine

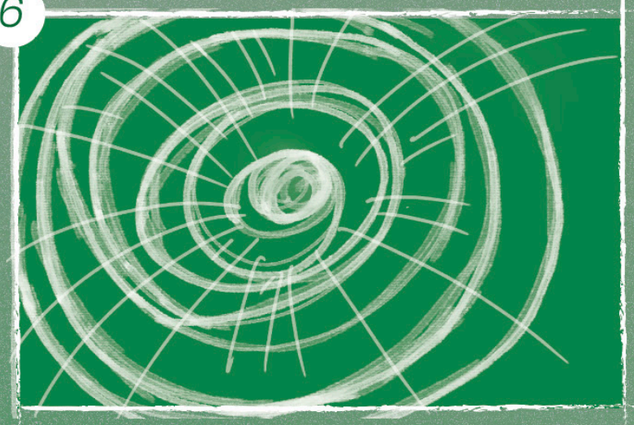
5

"The canal looks calm. Suspiciously calm."



Look again at the canal, sniff again and start imagining

6



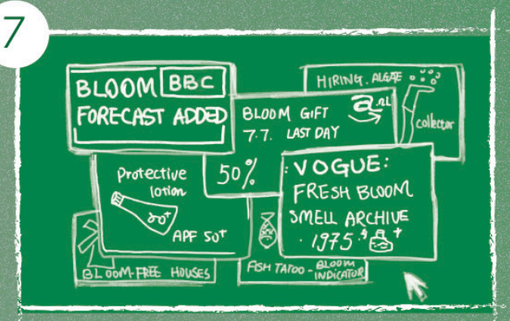
The smell opens a speculative
transition to the future

"I am in a smell time machine."

This storyboard presents a fabulated scenario rather than a literal use case. It begins with a plausible encounter: a passerby notices a smell, pays closer attention to the canal, and engages with the zine and smell archive, before shifting into more fantastical moments like olfactory time travel and speculative headlines. (scene 6 - 8)

These scenes exaggerate the toolkit's imaginative and temporal possibilities. The "smell time machine" is not a real function, but a metaphor for how smell and storytelling can move participants between past, present, and possible future smellscapes. Through this, the storyboard explores how a simple sensory interruption can lead to reflection, speculation, and discussion.

7



Blooming news are spreading quickly

8

"It smells like history!" "Take my money!"



People go crazy with the lost fresh bloom smell

9



Back to the present. The speculative detour
leave a trace in the present

10



Take off the probe. It is just temporary, invitational

11

"After removing the probe, the canal does not feel exactly the same."



Sniff intentionally after removing the probe

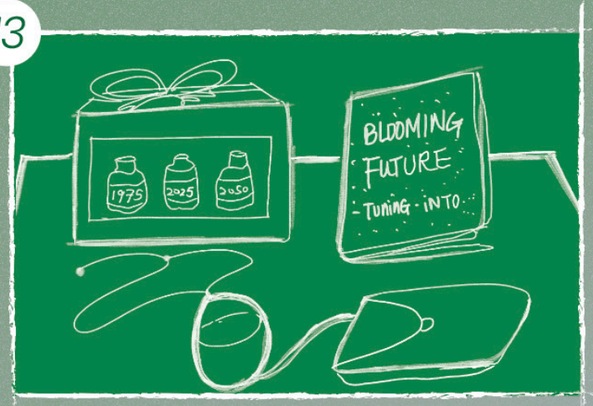
12

"Try this out, what's your speculation on the future"



Share and discuss

13



An invitation to notice, experience and reflect
through smell

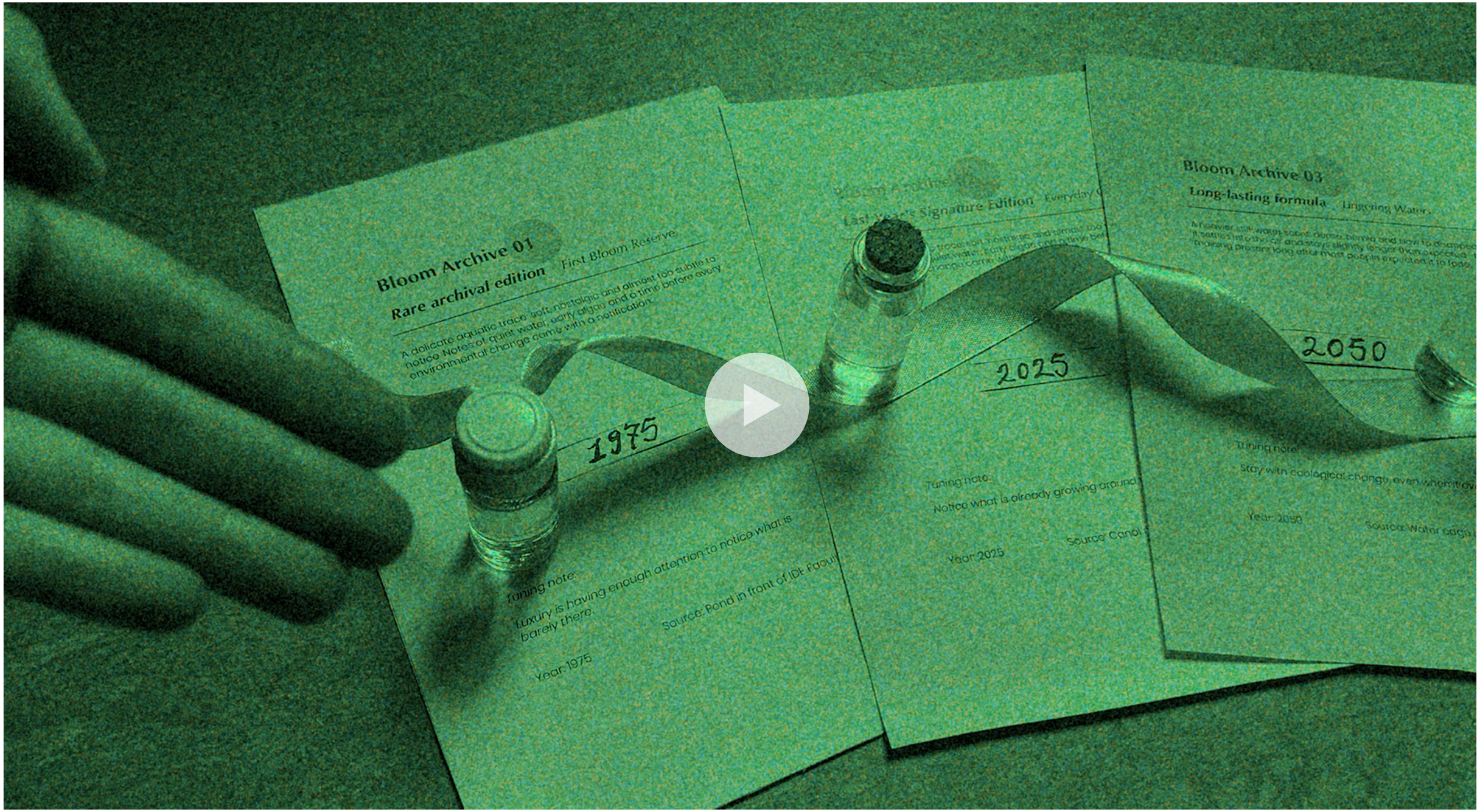
TUNING ACROSS TIME:
A FABULATED USE SCENARIO

Scenes 1–5: Situated interaction
Scenes 6–8: Fabulated temporal expansion
Scenes 9–13: Return to the present and continued attunement

VIDEO

The video presents the fabulated scenario as a short speculative narrative, shifting from a plausible encounter to a more expressive sequence. The “smell time machine” functions as a metaphor rather than a literal device, making the wearer’s imaginative movement between past, present, and possible future smellscapes visible. The narrative then returns to the unchanged canal, highlighting a shift in how the wearer notices and experiences the present environment.

This approach also incorporates elements of corporate storytelling, framing the speculative scenario in a way that aligns with structured, communicative narratives often used in professional contexts.



FURTHER DEVELOPMENT

The current prototype remains an exploratory wearable rather than a finished system. Further development should focus on the physical form, olfactory material, duration of enactment, participation of others, and relationship between sensory experience and environmental information.

DEVELOPMENT 1: SOFTER WEARABLE STRUCTURE

The translucent PVC, transparent tubing, and visible wiring communicate the prototype's experimental character, but the current form is relatively rigid and concentrated around the upper body. A future version could combine a rigid internal smell chamber with softer body-contact materials.

Possible directions include:

- a padded textile or spacer-mesh shoulder piece;
- an adjustable harness positioned around the collarbone rather than tightly around the throat;
- a flexible TPU or silicone outer layer; fabric pockets or magnetic attachments for removable electronics and chamber;
- a smaller electronics module distributed across the shoulder or upper back;

The structure should keep the smell close to the breathing zone while avoiding a restrictive or medical appearance.

DEVELOPMENT 2: WEATHER RESISTANCE

Rain produced some of the richest atmospheric experiences, but it also exposed the vulnerability of the electronics. Future iterations require protected wiring, water-resistant enclosures, and a clear separation between the airflow chamber, scent material, and electronic components.

DEVELOPMENT 3: MORE STABLE SMELL MATERIALS

Seaweed and spirulina worked as accessible olfactory references, but fresh organic materials changed over time and could spoil. Future versions could use dried materials, replaceable absorbent cartridges, hydrosols, diluted smell materials, or perfumer-developed accords.

Collaboration with a perfumer, smell artist, microbiologist, or water scientist could support safer and more stable translations of earthy, musty, aquatic, stagnant, and bloom-related qualities without claiming to reproduce an actual harmful bloom.

DEVELOPMENT 4: SEASONAL AND REPEATED ENACTMENT

Further enactments should take place across different seasons and over a longer period. Repeated walks could examine how the same location changes through winter dampness, spring vegetation, summer heat, and autumn decay.

The aim would not be to produce a consistent experience, but to document how relationships with a familiar route accumulate and shift over time.

DEVELOPMENT 5: ENACTMENT WITH OTHERS

The curiosity of friends suggests potential for a small participant enactment. Rather than testing whether participants correctly identify a smell, future work could explore:

- how their walking pace changes;
- whether they approach or avoid water;
- what memories and associations emerge;
- how they interpret the source of the smell;
- what conversations develop between participants;
- whether attention continues after removing the probe.

Because smell can cause discomfort, nausea, headaches, or strong associations, future enactments would require careful consent, low starting intensity, clear stopping mechanisms, and an unscented alternative.

DEVELOPMENT 6: RELATING SENSORY EXPERIENCE TO ENVIRONMENTAL CONTEXT

The enactments sometimes prompted questions that could not be answered through sensory observation alone. For example, encountering unusual smells, water colour, or dead fish led me to wonder whether these conditions were connected to microbial bloom activity. However, the probe and first-person observations cannot establish such ecological relationships.

Future versions could therefore offer official water-quality information as an optional contextual layer after the sensory encounter. Participants could first notice, record, and speculate through smell, and then compare their observations with available environmental information. Presenting the data afterwards would preserve the openness of the sensory experience while clarifying that ecological interpretation also requires scientific knowledge.

This layer should support comparison rather than verification: it should not suggest that a particular smell, animal behaviour, or visual condition was caused by a bloom unless this is supported by appropriate environmental evidence.

Chapter 7

DISCUSSION

Chapter 6 materialised speculative microbial futures through the wearable smell probe, zine and smell archive. Chapter 7 critically reflects on this design process, its practical and methodological limitations, its ethical implications and the possibilities for developing the approach through wider participation and scientific collaboration.

Source: Gradation of colors purple-blue-green-yellow-red-pink in ocean areas shows increasing chlorophyll concentration towards the coast. Satellite data courtesy of NASA Ocean Biology Processing Group and LAADS-DAAC.

CRITICAL REFLECTIONS ON THE DESIGN APPROACH

This project investigated how design can support people in noticing and experiencing future microbial smellscapes in the present. Across the three research phases, smell was approached not as a reliable indicator of water quality, but as a situated and relational medium through which people might become more attentive to ecological change. The smellwalk examined how microbial smellscapes are currently encountered or overlooked; the co-speculation workshop explored how people imagine living with intensified smellscapes; and the materialisation phase investigated how these futures might be made bodily and experientially accessible.

Taken together, the findings suggest that the contribution of the project does not lie in producing a new environmental monitoring instrument. Instead, it lies in developing a sequence of design approaches through which ecological change can become **noticeable, imaginable and experientially discussable**:

Smellwalking sensitises people to overlooked environmental conditions;
Co-speculation enables possible relations with microbial futures to be imagined collectively;
Material speculation allows these imagined conditions to be encountered through the body.

The following sections discuss what these approaches contribute to ecological and more-than-human design, how they might be extended into art, education, exhibitions and laboratory collaborations, and where the limitations of the project remain.

SMELLWALKING AS ECOLOGICAL SENSITISATION

The smellwalk demonstrated that smelling is not necessarily an automatic or passive activity. Participants often needed to slow down, approach the water, change their breathing, search for words and compare perceptions with others. Through these actions, water environments that might otherwise function as unnoticed backgrounds became temporarily present as changing sensory environments.

Smellwalk research similarly describes walking as a deliberate reorientation of attention towards olfactory information that is normally processed only peripherally. Allen (2023), for example, used smellwalks to examine small, mundane and difficult-to-articulate changes in everyday environments. Parker et al.'s (2024) methodological review further shows that smellwalks can document smell sources, intensity, duration, associations and comfort, while also attending to weather, time of day and seasonal conditions. These qualities make smellwalking useful for investigating environmental phenomena that are spatially dispersed, intermittent and difficult to represent visually.

Within this project, the smellwalk can therefore be understood as a sensitising practice. It did not teach participants how to diagnose microbial activity. Instead, it created conditions in which they could notice environmental uncertainty: the absence of an expected smell, a mismatch between visual appearance and odour, a smell carried intermittently by wind, or hesitation about moving closer to the water. These moments matter because microbial water change is not always experienced as a clearly identifiable event. It may emerge through unstable combinations of smell, colour, surface texture, weather, animal activity, public warnings and personal memory.

Allen's later work specifically considers smellwalking as an educational method and conceptualises smelling as a multisensory activity that emerges through relations between bodies, materials and landscapes rather than through the human nose alone (Allen, 2024). This supports the more-than-human orientation of the present project: the smellwalk did not provide direct access to microbial experience, but it helped participants recognise that environmental perception was being shaped by water, weather, microorganisms, plants, animals, infrastructures and their own moving bodies.

The project should not claim that this sensory awareness produces ecological regeneration by itself. However, it may support a regenerative orientation by encouraging closer attention to the living relations and changing conditions of a specific place. Sensory attentiveness can be an initial condition for care and inquiry, although noticing does not automatically lead to ecological understanding or action

Opportunities for ecological education and public engagement

Existing educational research indicates that smellwalking can support forms of learning that are embodied, place-based and attentive to more-than-human material relations. Allen (2024), for example, trialled smellwalks in educational contexts in coastal Aotearoa New Zealand, while Leemans et al. (2023) show how smelling, reconstructing and discussing historical odours can help students develop sensory vocabulary and reflect critically on how knowledge is produced through the senses. These studies suggest that smell can contribute to learning not simply as an entertaining addition, but as a method for questioning what normally counts as observable or legitimate knowledge.

Building on these precedents, the smellwalk developed in this project could be adapted for ecological education around canals, ponds, wetlands and other water environments. A workshop might ask participants to: Encounter a site through smell and bodily attention; Document words, memories, uncertainties and visible conditions; Compare observations within the group; Examine ecological or water-quality information afterwards; Discuss where sensory interpretation and scientific information correspond or differ.

This sequence is important. Beginning with the sensory encounter prevents environmental learning from being reduced immediately to measurements or predetermined scientific categories. Introducing ecological information afterwards would help participants distinguish personal observation from scientific evidence.

The method could be adapted for use by schools, universities, environmental organisations, water authorities, and community groups to support situated attunement to ecological change. Participants could be encouraged to notice environmental variability, articulate sensory observations, and remain attentive to uncertainty in how water environments are experienced. The purpose would not be to identify pollution or microbial activity through smell. Rather, the smellwalk could provide an embodied and situated starting point for environmental inquiry (Allen, 2023). These sensory observations could then be discussed alongside scientific information and environmental monitoring, supporting broader forms of ecological and sustainability literacy (Campbell et al., 2021; McBride et al., 2013).

Smellwalks may also contribute to citizen sensing. Xiao et al. (2021) identify citizen science, smell archives and databases as important future directions for smellscape research. Smellwalk observations could therefore be recorded alongside photographs, weather, time, visible water conditions and available environmental measurements. The resulting records would remain subjective accounts rather than diagnostic data, but repeated observations could help reveal changes that merit further scientific investigation.

A future version of this project could consequently function as a starting point for ecological inquiry. Participants would first notice and describe a changing environment, while ecological specialists would subsequently help interpret which observations can be investigated scientifically. This preserves the openness of the smellwalk while preventing uncertain smells from being treated as proof of a bloom, contamination or health risk

CO-SPECULATION AS COLLECTIVE ECOLOGICAL IMAGINATION

While the smellwalk began from present experience, the co-speculation workshop moved towards possible microbial futures. It enabled participants to ask not only what future water environments might smell like, but also how people, infrastructures, customs, technologies and nonhuman life might reorganise around intensified microbial conditions.

Speculative design is often used to make alternatives available for reflection rather than to predict a single likely future. Participatory speculative approaches extend this process by involving people in constructing and negotiating future situations. Within this project, the workshop revealed several possible relationships with future microbial smellscapes: smell as warning, shared memory, commercial resource, ordinary urban atmosphere, undesirable pollution or a condition requiring bodily adaptation.

The workshop therefore contributed by pluralising the future. It showed that microbial change would not necessarily produce one universal social response. People might resist, normalise, commodify, memorialise or develop new practices of coexistence around it. These differences are important because ecological futures are shaped not only by biological processes, but also by values, habits, governance, infrastructures and unequal forms of environmental exposure.

At the same time, the workshop remained a human interpretation of more-than-human relations. Participants could speculate about microbes, algae, water and animals, but they could not directly represent the perspectives of these beings. The method should therefore not claim to “give microbes a voice.” Its more defensible contribution is to encourage participants to examine how human futures depend on ecological processes that exceed human control and complete understanding.

Opportunities for participatory ecological futures

Participatory scenario-making is already used in biodiversity and sustainability research to bring different values and forms of expertise into conversations about environmental futures. Pereira et al. (2020), for example, describe the Nature Futures Framework as an iterative participatory process for generating plural scenarios of human–nature relations. Rather than producing one preferred environmental future, the framework helps participants consider intrinsic, instrumental and relational ways of valuing nature.

The co-speculation approach developed in this thesis could contribute to such work by adding a sensory and everyday dimension. Large-scale ecological scenarios are often presented through maps, models, statistics or written narratives. The smell-based workshop instead begins from questions such as:

1. What might an intensified microbial future feel and smell like in everyday life?
2. Which routines, spaces and social relationships would change?
3. Who would be protected from these conditions, and who would be more exposed?
4. Would microbial smell be treated as pollution, heritage, warning, commodity or ordinary atmosphere?
5. How might animals, water systems and microorganisms be affected by the imagined interventions?

These questions could complement scenario frameworks by making future ecological relations more concrete and experientially situated. The project's cards, future headlines and imagined "things" could be adapted for workshops involving local residents, ecologists, water managers, policymakers, designers and educators. The objective would not be consensus. Instead, the workshop could reveal conflicting interpretations, values and responsibilities surrounding a shared environmental future.

The method could also be used as an intermediary activity between public engagement and ecological planning. For instance, participants might first imagine multiple future water conditions; scientists could then identify which aspects are plausible, uncertain or scientifically unsupported; and designers could materialise selected tensions for further public discussion. Such a process would allow speculation to open questions while ecological expertise provides necessary grounding.

A repeated format would be more valuable than a single workshop. Participants could first generate scenarios, later encounter materialised versions of them, and finally reflect on whether their attitudes or interpretations changed. This would also address a limitation of the present study, which documents immediate workshop outcomes but cannot determine whether co-speculation produced sustained ecological reflection.

MATERIAL SPECULATION AS AN EXPERIENTIAL BRIDGE

The materialisation phase translated speculative scenarios into bodily encounters. The wearable probe, zine and scent references did not attempt to reproduce a scientifically accurate future bloom. Instead, they created an experiential approximation through which a possible smellscape could enter an ordinary walk.

This aligns with material speculation, in which artefacts function as sites for critical inquiry rather than only as proposed solutions. The wearable created uncertainty about whether a smell came from the water, weather, another person or the device. That uncertainty encouraged the wearer to pause, search the environment and reconsider the relationship between the artefact, body and site.

Smell was especially appropriate for this material speculation because it is difficult to contain. It drifts, fades, mixes with existing odours and changes according to wind, humidity, distance and bodily sensitivity. These properties produced technical limitations, but they were also conceptually significant. A completely stable and controlled smell would have contradicted the unstable and relational quality of the smellscape investigated in the project.

Opportunities for material and olfactory interaction design

Kapur (2019) shows how textile interactions such as pressing, rubbing and movement can produce changing smell experiences, while Maggioni et al. (2020) identify spatial, temporal, chemical and affective qualities as central to olfactory interaction design. Nerlich et al. (2024) extend this into living materials by demonstrating how different textiles influence the character and duration of bacteria-produced smells. Together, these studies suggest possibilities beyond the current fan-operated wearable, including responsive textiles, passive diffusion, reusable smell carriers and installations that connect smell release with bodily action or environmental data.

Future development should not focus only on making the smell stronger or more technically precise. Instead, it should explore how intensity, duration, uncertainty and bodily participation can support attention to a place without becoming intrusive or suggesting false environmental accuracy.

CONNECTIONS TO ART, EXHIBITIONS AND EDUCATION

Olfactory art and exhibition

Olfactory artists demonstrate how smell can operate as a primary cultural and investigative medium rather than merely as decoration (Henshaw et al., 2017). Sissel Tolaas has developed smell archives and site-specific olfactory works that collect, analyse and reconstruct smells associated with bodies, cities, materials and social environments (Astrup Fearnley Museet, 2021). Her work for the Metropolitan Museum of Art's Sleeping Beauties: Reawakening Fashion exhibition, for example, used scent alongside other sensory technologies to provide additional forms of access to historical garments and their material lives (The Metropolitan Museum of Art, 2024).

Frank Bloem's practice combines perfumery, artistic research and public workshops. His work at Mediamatic's Aroma Lab demonstrates how participants can learn about natural and synthetic scent materials through practical experimentation, blending and composition (Mediamatic, 2024). Maki Ueda has similarly created olfactory labyrinths, games and educational activities in which visitors navigate, play or communicate through smell (Ueda, 2019). These practices show how olfactory exhibitions can temporarily displace visual dominance and invite visitors to rely on proximity, movement, memory and bodily interpretation.

Museum exhibitions such as The Art of Scent 1889–2012 have also presented scent itself as an artistic medium rather than displaying only bottles or visual representations of perfume. The exhibition presented twelve fragrances as works of olfactory art and deliberately minimised visual and commercial information so that visitors could concentrate on smelling (Museum of Arts and Design, 2012).

These precedents are relevant to the present project because its artefacts could be developed into an olfactory exhibition rather than presented only as finished product prototypes. A future exhibition could combine:

1. A map or archive of changing water smells;
2. Wearable or handheld smell interventions;
3. Accounts from local residents and ecological experts;
4. Speculative future headlines and objects;
5. Environmental measurements presented after the sensory encounter.

Placing scientific information after the smell experience could preserve open-ended sensory attention while helping visitors distinguish speculation from scientific evidence.

Olfactory education

Smell-based activities also offer educational value. Designing with Smell brings together practices related to olfactory learning, vocabulary, cultural interpretation and the use of smell within artistic and design research, demonstrating the growing relevance of smell within art and design education (Henshaw et al., 2017). Ueda's olfactory courses and games further demonstrate how practical activities can help participants learn to distinguish, describe and communicate through smell (Ueda, 2019).

In schools, universities or public workshops, the project's methods could be adapted into a sequence of sensing, recording and imagining. Participants might first undertake a smellwalk around a water environment, create individual smell maps, compare their observations, examine environmental information and then construct future scenarios. Such an approach could make environmental learning more situated, participatory and connected to direct experience.

However, olfactory education should not assume that everyone smells or describes smells in the same way. Olfactory ability varies, and some people experience anosmia, hyposmia, or other forms of olfactory dysfunction (Schäfer et al., 2021). The language used to identify and categorise smells is also shaped by linguistic and cultural experience rather than being universal (Majid, 2015). Activities should therefore acknowledge differences in olfactory capacity, sensory sensitivity, cultural background, and personal association. Verbeek (2025) demonstrates how working with scent can contribute to more inclusive and multisensory forms of cultural engagement for people with different abilities. However, an inclusive activity should not replace visual dominance with dependence on another single sense. In this project, participation should therefore not depend entirely on a person being able or willing to smell. Visual, textual, tactile, and environmental-data elements could instead provide complementary ways of encountering, interpreting, and discussing the water environment.

CONNECTIONS TO ECOLOGICAL SCIENCE, LABORATORY RESEARCH AND BIOTECHNOLOGY

This project approached smell as a situated environmental experience rather than as scientific evidence. No chemical or microbiological analysis was conducted, and the project cannot determine whether a particular smell was caused by algae, bacteria, sediment, decomposing vegetation, sewage, animals or other urban sources. This limitation also points towards opportunities for collaboration between design and ecological science.

Ecologists and laboratory researchers could help relate sensory observations to water temperature, weather, dissolved oxygen, nutrient conditions, microbial communities or volatile compounds. Design could contribute methods for making such ecological processes more bodily, situated and publicly discussable. The purpose of this collaboration would not be to turn human smelling into an environmental monitoring instrument, but to investigate how sensory experience and scientific measurement might inform one another while retaining different evidential roles.

A concrete opportunity has emerged through initial contact with the Netherlands Institute of Ecology (NIOO-KNAW), which expressed interest in discussing the project further. NIOO could provide an appropriate context for exploring how smellwalking, co-speculation and material encounters might contribute to ecological research or public science communication. For example, sensory observations could be placed alongside ecological explanations or environmental measurements, allowing visitors or participants to compare what they notice with what can be scientifically established. This should currently be described as a possible direction rather than an established collaboration.

Biotechnology would become relevant only if future iterations involved living microorganisms, biological samples or microbial volatile compounds. Such work would require suitable laboratory facilities, scientific supervision, risk assessment, containment, decontamination and waste-management procedures (World Health Organization, 2020). For public-facing workshops and exhibitions, non-living scent references remain more appropriate unless living material is necessary to answer a specific research question.

The connection to laboratory and biotechnology practices therefore does not mean transforming the project into a biotechnology project. Instead, it identifies how scientific collaboration could contextualise the speculative smells, test environmental relationships and clarify the boundaries between sensory interpretation and ecological evidence.

Research on textile–bacteria hybrids also shows how collaboration between textile design, microbiology and chemical analysis can investigate the emergence of microbial smells through living materials (Nerlich et al., 2024).

LIMITATIONS

Timeframe and seasonal conditions

The project was conducted within the limited timeframe of a graduation project, from late winter to early summer of 2026. This period did not fully overlap with the warmer conditions in which algal and microbial blooms are often more visible or intense. As a result, the water sites did not always show obvious bloom conditions, and bloom-related smells were not consistently noticeable during the fieldwork.

This seasonal limitation shaped the research in an important way. Participants often encountered subtle, intermittent or uncertain smells rather than clearly identifiable bloom smells. Although this supported the project's interest in noticing environmental uncertainty, it also meant that the study could not examine how people respond during a more intense blooming period.

Water smells are influenced by temperature, rainfall, wind, water movement, vegetation, decomposition, nearby human activities and microbial processes. The observations made during this project should therefore not be treated as stable characteristics of the selected locations. Repeating the smellwalks during late summer and across multiple seasons could reveal how smells become stronger, disappear, move or change in relation to environmental conditions.

The limited timeframe also restricted the number of design iterations, smellwalks, workshop sessions and long-term evaluations that could be conducted. The final design was mainly evaluated through first-person enactments and a small number of situated encounters. Further testing would be needed to understand how different people experience the design and whether it supports continued noticing after the immediate encounter.

Absence of laboratory validation

No chemical or microbiological analysis was conducted to identify the sources of the smells encountered during the fieldwork. It is therefore not possible to conclude that a particular smell was produced by algae, bacteria or a specific bloom condition. Sediment, decomposing vegetation, animals, sewage, nearby activities and mixed urban smells may all contribute to the experience of a water environment.

The term microbial smellscape is therefore used as a design framing for exploring how microbial water change might be sensed and imagined. It is not a scientifically verified classification of every smell encountered. The findings concern how people notice, interpret and speculate through uncertain environmental smells, rather than whether their interpretations are biologically accurate.

Participant and site limitations

The smellwalks and co-speculation workshop involved a limited number of participants within the specific context of Delft. Smell perception is influenced by individual sensitivity, health, memory, language, cultural background and previous experience. Participants familiar with design or speculative activities may also respond differently from local residents, children, ecological researchers, water professionals or people with limited ability to smell.

The findings should therefore be understood as situated rather than generalisable. Applying the methods in other cities or water environments would require attention to local ecological conditions, cultural associations, infrastructures and relationships with water.

Limits of more-than-human representation

Although the project adopted a more-than-human perspective, its methods and interpretations remained primarily human. Microbes, algae, water, weather, animals and materials shaped the conditions of the research, but they could not participate in the smellwalk or workshop in the same way as human participants.

The project therefore does not claim to represent microbial experiences or interests. Instead, it draws attention to human dependence on and relationships with microbial processes, while recognising that these ecological relations cannot be fully accessed through human senses or speculation.

Prototype and smell-related safety

The release and perception of smell were affected by wind, humidity, body movement, distance and individual sensitivity. Repeated exposure may also result in habituation, making the smell less noticeable over time. Strong or unfamiliar smells may cause discomfort, particularly for participants with allergies, smell sensitivities or respiratory conditions.

Future public testing would therefore require clear information about the materials used, voluntary participation, opportunities to stop or avoid the smell encounter, and careful consideration of allergies and sensory accessibility. Replaceable smell carriers and procedures for preventing the mixing or contamination of smell samples would also be necessary.

The material lifecycle of the prototype presents a further limitation. Its electronics, batteries, 3D-printed components and disposable smell cartridges may conflict with the ecological concerns addressed by the project. Future development should consider repairability, reuse, material sourcing and disposal rather than focusing only on the performance of the smell release.

ETHICAL RESPONSIBILITIES OF SPECULATIVE SMELLSCAPE DESIGN

While Chapter 3 addressed the ethical procedures of the research activities, this section reflects on the responsibilities that emerged from the final design and its speculative framing. Because the project concerns harmful algal blooms, microbial change and possible environmental futures, it was necessary to balance imagination with ecological and scientific responsibility.

One consideration was **how microbial change was communicated**. The project avoided relying primarily on fear, alarm or environmental threat. Warning signs and risk communication remain necessary in situations involving public health, but they may also distance people from an environment by framing it only as dangerous. The project instead explored whether an embodied smell encounter could support noticing and reflection. At the same time, harmful blooms should not be romanticised as merely poetic, mysterious or aesthetically interesting. They may be associated with ecological imbalance, warming water and risks to humans and other forms of life. The design therefore approached microbial smellscapes as complex ecological conditions requiring attention and care rather than either fear or celebration.

A second responsibility concerned **the distinction between speculation and scientific evidence.** The smells used in the project were constructed references rather than samples taken directly from harmful algal blooms. The wearable smell probe also did not measure microbial activity or water quality. It should therefore be understood as a speculative probe rather than a monitoring or warning instrument. This distinction is especially important in public contexts, where people might otherwise interpret the released smell as evidence of pollution, danger or bloom intensity. Future presentations would need to communicate clearly what is speculative, what is simulated and what is supported by ecological research.

Speculative futures also influence how people understand possibility and responsibility. Presenting intensified microbial smellscapes as inevitable could make participants feel powerless, while presenting them too lightly could reduce the seriousness of ecological change. The scenarios in this project were therefore framed as possibilities for reflecting on present relationships with water, smell and microbial life, rather than as predictions of what will happen.

Finally, **smell requires particular ethical care** because it enters the body through breathing and may trigger discomfort, nausea, memories or personal associations. Smell perception also differs according to health, sensitivity and previous experience. The smell encounters in this project were mild, temporary and primarily explored through first-person enactment. Any further testing with participants would require informed consent, clear opportunities to withdraw or avoid exposure, transparent information about the smell materials and consideration of allergies, asthma, respiratory conditions and reduced or heightened smell sensitivity.

FUTURE WORK

The first priority for future research would be **a longitudinal and seasonal study.** The same smellwalk route could be repeated across different seasons and weather conditions, supported by consistent documentation of wind, temperature, rainfall and visible water conditions. This would establish a richer account of smellscape variability without treating smell as scientific proof.

Second, future work could **develop a sensory–scientific collaboration**. Smell observations, participant descriptions and personal associations could be compared with environmental measurements and, where appropriate, laboratory analysis. The purpose would be triangulation: understanding how different ways of knowing a water environment overlap and where they remain incompatible.

Third, the **participant group could be expanded** to include residents, ecologists, water managers, artists, educators, children and people with different olfactory capacities. This would allow the research to examine how expertise, familiarity, age and sensory difference affect interpretations of microbial smellscapes.

Fourth, the **co-speculation workshop could become a repeated process** rather than a one-time activity. Participants could first develop scenarios, later encounter materialised versions of them and finally reflect on how their interpretations changed. This would make it possible to evaluate whether speculative encounters produce more durable ecological reflection.

Fifth, the **material design could be expanded through textiles, passive scent structures and spatial installations**. Evaluations should consider intensity, duration, ambiguity, emotional response, accessibility and environmental impact rather than focusing only on technical reliability.

Finally, exhibitions and educational settings **offer opportunities to share the method** without presenting the artefact as a finished solution. The project could become an open sensory platform through which communities document changing smells, compare interpretations and discuss possible water futures. Its future value may therefore lie less in reproducing one wearable device and more in adapting the combination of **situated smelling, collective speculation and material encounter to different ecological contexts**.

Chapter 8

CONCLUSION

Chapter 7 examined what the project achieved and where its approach remained limited. Chapter 8 brings together the knowledge generated through attuning, speculating and materialising, returns to the research questions and discusses the project's contributions to sensory, speculative and more-than-human environmental design.

Source: Intensifying phytoplankton blooms, credits: Lian Feng

REVISITING THE RESEARCH GOAL AND RESEARCH QUESTIONS

This project aimed to explore: how design can support people in noticing and experiencing future microbial smellscapes in the present.

The first research question asked how microbial smellscapes are currently experienced, ignored or made sense of in everyday water environments. The smellwalks showed that these smells are often subtle, intermittent and uncertain. People noticed them through slowing down, changing distance, comparing impressions and relating smell to memory, visual cues and ecological concern.

The second research question asked how people imagine living with intensified microbial smellscapes in possible futures. The co-speculation workshop revealed multiple responses, including warning, adaptation, memory, protection, commercialisation and everyday coexistence. These futures showed that microbial change may be understood differently depending on people's values, habits and relationships with water.

The third research question asked how design can make future microbial smellscapes experientially accessible in the present. The wearable smell probe, zine and smell archives created a situated encounter in which future conditions could be sensed through the body rather than only described. The design did not predict or reproduce a real bloom, but supported reflection on possible ecological change.

CONCLUSION

Together, the project shows that design can support a process of tuning into blooming futures through situated attunement, participatory speculation and material experience. Smell cannot diagnose microbial activity or determine water quality, but it can make overlooked ecological changes more noticeable, imaginable and discussable. Tuning into blooming futures therefore means learning to notice what is already changing in the present while using design to bring possible futures closer to experience.

PERSONAL REFLECTIOIN

BECOMING ATTENTIVE: SMELL, IMAGINATION, AND ECOLOGICAL BELONGING

From Sensitivity to Ecological Attunement

Before beginning this project, I was already sensitive to smell, although I had never explored it deliberately as a medium for design. I often felt saturated by vision and sound and was drawn instead to smell's quieter and more pervasive presence. It could linger without being clearly identifiable, shaping my experience of a place before I consciously understood why. Working on Microbial Smellscapes allowed me to develop this sensitivity into a more deliberate form of attention. Smell became not only the focus of the research, but also a companion through which I learned to experience my surroundings and my own place within them differently.

Through repeated walks, observations, and experiments, I became increasingly aware of how alive and changeable an atmosphere can be. The same canal never smelled exactly the same twice. On some days, it carried damp and earthy traces; on others, it felt green, stagnant, sharp, or almost metallic. Weather, water, plants, traffic, infrastructure, human activity, and unseen forms of life continuously reshaped what could be sensed. A familiar route was therefore never entirely familiar. Each walk offered another atmospheric condition to encounter.

Over time, I realised that I was not standing outside these environments and observing them from a distance. Every breath placed me within them. I was sensing the atmosphere, but I was also participating in it through my movement, attention, and bodily presence. This awareness changed my relationship with Delft. It was no longer only the city in which I studied and lived; it became a place I was gradually learning to feel. I became more attached to it through ordinary canals, seasonal changes, unexpected smells, and small moments of attention. I did not simply feel connected to the environment. I began to recognise that I already belonged within it.

The walks also became personal in ways I had not anticipated. Certain smells brought me back to my first summer in Delft, when the city still felt unfamiliar and full of possibility. Other smells recalled warm evenings with friends near Delftse Hout or walks beside the river in my hometown with my sister. In these moments, different places and times seemed to overlap briefly. Smell did not simply remind me of a place; it returned me to how that place once felt.

Imagination and More-than-Human Relations

While walking, I often found myself wondering about the lives and processes taking place around me. I watched water, plants, insects, birds, and changing surfaces while imagining the invisible presence of microbes. I became curious about forms of life whose rhythms and signals are not easily available to human perception. Smell began to feel like a trace of these relations—not a clear language or scientific explanation, but a subtle indication that something was present and happening.

These reflections emerged naturally through my first-person encounters rather than through a deliberately selected research method. They allowed me to stay with uncertainty and consider what might exist beyond the limits of my own perception. I could not know or represent microbial experience directly, but this way of thinking helped me reflect on how humans might become more attentive to environmental relations that often remain unnoticed.

Facilitating the co-speculation workshop further showed me how imagination could open different ways of approaching ecological change. I became interested not only in the future scenarios that emerged, but also in how imagining together could loosen familiar assumptions and make space for unfamiliar relations and possibilities. Later, the video allowed me to express this imaginative quality through the metaphor of a "smell time machine." Storytelling was therefore not a formal method throughout the project, but an expressive way of making temporal and ecological reflection more visible.

For me, imagining other times and ecological possibilities became a way of returning to the present differently. It did not provide certainty about microbial futures. Instead, it encouraged me to pay closer attention to what might already be changing within the present environment.

Learning through Uncertainty

My relationship with unpleasant smells changed during the project. Previously, my first response was often to move away. Gradually, I learned to pause before escaping and ask what might be happening behind the smell. It could be connected to stagnant water, vegetation, microbial activity, waste, infrastructure, weather, or human behaviour. Smell could never provide a complete or reliable explanation by itself, but it could initiate curiosity. It encouraged me to look again, listen differently, and become more aware of the relations shaping an atmosphere.

At times, I deliberately allowed my nose to guide my movement while reducing my reliance on sight. This did not make smell a replacement for other senses. Instead, it revealed how strongly the senses complement and sometimes contradict one another. Working with biodesign materials further deepened this awareness. As I handled and experimented with organic substances, I became more attentive to how smell emerges from processes such as fermentation, decay, and growth. These materials did not behave as static design elements but as living or changing systems, continuously producing and transforming their own atmospheres. This made me more aware of the multisensory experience brought by the environment and all the living elements within it, where smell, touch, sound, and even subtle visual cues interact and shape perception together. A place that appeared visually fresh could still carry traces of microbial activity, while an unremarkable-looking material could release a complex and evolving scent. These experiences expanded my understanding of multisensory design and showed how smell, especially when linked to biological processes, can reveal hidden temporal and ecological dimensions that remain unnoticed when environmental experience is dominated by vision.

At the same time, the project did not lead me to romanticise complete closeness or the disappearance of boundaries between humans and other species. Ecological belonging does not mean that all bodies should exist without distance or protection. I continue to value bodily autonomy, safety, and personal boundaries. This is particularly important when working with smell because it enters the body through breathing, spreads beyond the designer's control, and cannot always be avoided by the person encountering it.

For me, attunement is therefore only a beginning. Noticing does not automatically produce understanding, responsibility, mitigation, or harmonious coexistence. However, without noticing, it becomes difficult to recognise that something is changing, ask what relations are involved, or imagine how we might respond. Attunement creates an opening, but it must be followed by careful interpretation, scientific knowledge, ethical reflection, and respect for different bodies and perspectives.

The research process required me to stay with many forms of uncertainty. I began with limited experience in olfactory design and had to learn unfamiliar methods while discovering which approaches suited my research goal, personality, and capacity. Smell continually resisted control. It shifted with the wind, faded unexpectedly, lingered longer than intended, and was experienced differently across bodies and environments. The prototypes therefore often produced encounters that did not match what I had planned.

This became especially clear when I tried to control the intensity of the smell released by the wearable probe. Initially, I wanted each intensity level to be clear, accurate, repeatable, and easily distinguishable. I became frustrated when changes in fan speed did not result in equally clear changes in the perceived smell. I kept trying to improve the airflow and scent output because I assumed that a successful interaction depended on precise control. Yet even when the device operated consistently, the smell experience remained unstable. Wind, temperature, bodily movement, distance, existing environmental smells, and individual sensitivity continually altered how strongly it was perceived.

Looking back, I realised that I had been too eager to control the interaction. I was approaching smell as if it should behave like a visual or digital signal: stable, measurable, and reproducible. However, smell does not remain inside clearly defined levels. It drifts, mixes, disappears, returns, and becomes entangled with the atmosphere already present.

Gradually, I learned not only to design with this instability, but also to live with it. Instead of seeing every fluctuation as a technical failure, I began to recognise intermittence, uncertainty, and relationality as part of smell's character. Sometimes the introduced smell appeared suddenly; sometimes it was barely detectable; at other times it was overtaken by wind, water, plants, traffic, or another passing smell. These variations made each encounter different.

I began to see this unpredictability not only as a limitation, but also as part of the beauty of working with smell. Its instability made the interaction feel situated and alive rather than completely scripted. This changed my role as a designer. Rather than trying to command exactly what someone should smell and where, I learned to create conditions in which an olfactory encounter might emerge. The uncertainty of smell therefore became more than a practical challenge: it became a source of design knowledge and a lesson in letting go of control.

What I Made and What I Learned

One of my main achievements was bringing together an unfamiliar and difficult medium, several research methods, and a complex ecological topic into a coherent design research project. I connected the smellwalk, co-speculation workshop, wearable probe, zine, smell archive, and fabulated scenario into an experiential approach to possible microbial futures.

Each outcome represented a different way of working with attention. The smellwalk helped participants notice present conditions. The co-speculation workshop invited collective imagination. The wearable created a subtle sensory interruption connected to place. The zine guided reflection across ecological relations and time. The smell archive translated past, present, and future references into tangible olfactory encounters. Together, they formed a toolkit that did not attempt to detect or explain microbial change scientifically, but instead created conditions for sensory engagement, speculation, and discussion.

Beyond these outcomes, I developed a personal approach to design research that combines observation, sensory exploration, participation, material experimentation, and reflection. It emerged through trial and error and was shaped by my curiosity, sensitivity to atmosphere, and willingness to stay with uncertainty.

I also learned to move between several roles: researcher, designer, facilitator, maker, observer, and participant. Organising activities independently, analysing different forms of qualitative and sensory material, and translating abstract ideas into tangible experiences required persistence and adaptability. I began to understand that my personality and sensitivities were not distractions from the research. When combined with methodological care and critical reflection, they could become meaningful parts of how I design and investigate.

Becoming More than an Attentive Designer

This project has reshaped how I understand my role as a designer, but it has also changed me beyond that role. As a designer, I no longer believe that design must always offer a clear solution, stable function, or fully controlled experience. It can also create gentle invitations—to pause, sense, imagine, question, and discuss. Rather than eliminating uncertainty, design can make space for people to encounter it.

My role is not to speak for microbial life or claim to make invisible ecological processes fully accessible. Instead, I can create conditions through which people encounter these complexities differently. I can design moments that encourage attention while remaining transparent about the limits of sensory experience, speculation, and representation.

As an individual, I have become more reliant on my nose, more aware of seasonal and atmospheric variation, and more grateful for the ability to smell. As someone who loves nature, I have become more humble about the limits of human perception and knowledge. As a human being within an ecosystem, I have become more conscious that breathing is already a form of participation. The atmosphere is not simply around me; it continually moves through me.

The walks also changed the way I moved through everyday environments. I paid less attention to my phone and became more absorbed in what was happening around me. I felt calmer, more curious, and more present. I learned to stay with unfamiliar or unpleasant sensations for a little longer and to wonder what stories, relations, and changes they might carry.

This project reminded me that we cannot fully separate ourselves from the atmospheres and smellscapes through which we move. We are already sensing them, breathing them, influencing them, and being influenced by them. Since we are already part of these changing environments, design can add a little imagination to the encounter—inviting us to notice what other senses may overlook, attend to the stories carried within an atmosphere, and experience a possible future before it arrives.

Every breath places us within a changing world; becoming attentive is learning to recognise that we already belong to it, and to sense the futures quietly taking shape around us.

- The author

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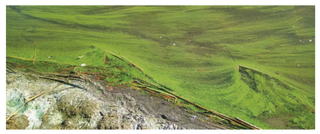
APPENDIX A – SMELLWALK ZINE

What is algal bloom?

Critical to aquatic food webs, algae are photosynthetic organisms—in other words, they derive energy for growth from the sun. An algal bloom is the overgrowth of microscopic algae or algae-like bacteria in fresh, salt, or brackish waters. Depending on the type of algae or bacteria that cause it, an algal bloom may produce bad-smelling scum, foam, froth, or a paintlike slick. Algal blooms can be many colors, including blue-green, yellow, brown, pink, and red.



Algal bloom in Delftse Hout, showing the dead cyanobacteria on the shore and blooming ones in water. photo source: NIOO

Why it matters?

Not all algal blooms are toxic, but research indicates that a growing number are. A harmful algal bloom, or HAB, is a bloom that produces toxins that are dangerous to humans and potentially other organisms

Can we smell HABs?

**HABs: Harmful Algal Bloom*

Some blue-green algae produce a compound called geosmin — an earthy smell often noticed after rain or near stagnant water.

Humans are extremely sensitive to this smell, even at very low concentrations. While the smell itself is not toxic, strong odors can feel unpleasant and may cause discomfort for some people.

As a part of my graduation thesis, the following two activities are interested in **how environmental change might be noticed and experienced through smell.**

Activities Agenda:

- **Brief (Before the walk)**
  Read through this zine
  Finish the task on page 4, 5
- **Smellwalk (20 mins)**
  Opening discussion
  Sensitising outdoors
  Reflect on your sensory experiences
- **Co-speculation workshop (1hr)**
  Share smell experiences
  Sketch the imagined possible futures
  Prototyping 'things'
  Make news headlines
  Discussions

Current situations

Blue-green algae blooms are becoming more frequent in the Netherlands due to warmer temperatures, nutrient pollution, droughts, and stagnant water conditions.These blooms can produce toxins harmful to humans and animals reduce oxygen in water, affect biodiversity and swimming areas, change how waterways smell and feel

Researchers from Netherlands Institute of Ecology found that blooms thrive especially during warm, windless summers: conditions expected to increase with climate change.

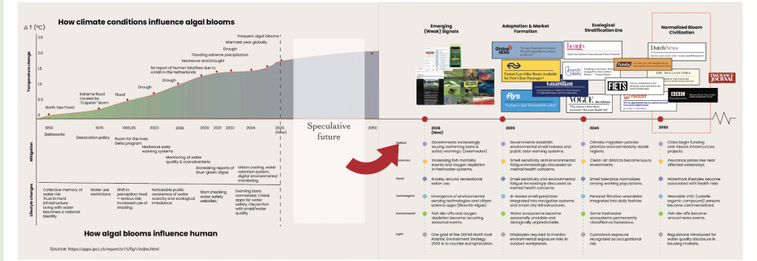
In Delft and across the Netherlands, environmental change may become noticeable not only visually, but atmospherically, through water quality, air, and smell. Periods of heat, drought, and still water conditions make blooms more likely to appear during Dutch summers.

How does it different from what you imagine?

How do you feel about the predicted future?

page 4

Timeline



Contact me for details

Speculative Future

What if...

the constant intensifying microbial smellscape becomes an inseparable part of our life?



Please bring:

This completed zine
& curiosity and imagination :)

Sensitising tools will be provided during the workshop.
You may also borrow one before we begin.

Together, we will explore:

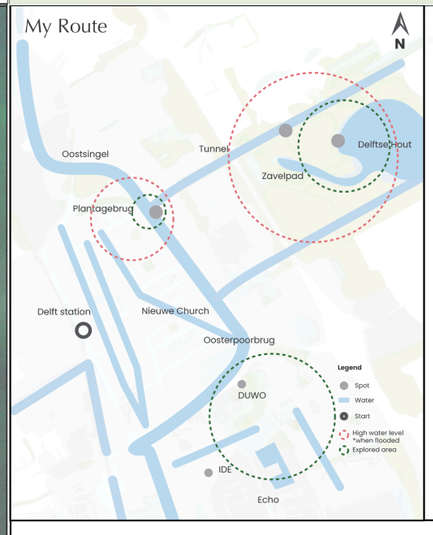
How future environmental change could be sensed, lived with, and imagined through smell.



Thank you for contributing your senses, experiences, and speculations.

The Smell of Blooming Futures

A guide for sensitising smellwalk & cospeculation



Smellwalk

TASK:
1.**Draw your daily frequent route** on the map, feel free to extend it if needed!
2. **Mark spots** where you notice a smell from water environments and other sources
3. Reflect on the questions on right side, write down **key words** and discuss when we meet!

SENSORIAL

-What do you smell ? *-Where do you feel it in your body?*

-How would you describe it?

INTERPRETIVE

-What is causing the smell? *-Have you encountered this before?*

-How serious this situation is? *-How might it impact other species?*

AFFECTIVE

-What does it remind you of? *-How does it make you feel?*

PERFORMATIVE

-Any changes in your movement, pace, or breathing because of it?

-Avoid or approach this area and why?

OTHERS

-What else impacts on humans and other species everyday life?

Co-speculation

CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)	NEWS HEADLINE
CHARACTER	What is that THING? For whom? How is it used/practiced? Why does it exist?
RELATION	
PLACE	
THING	

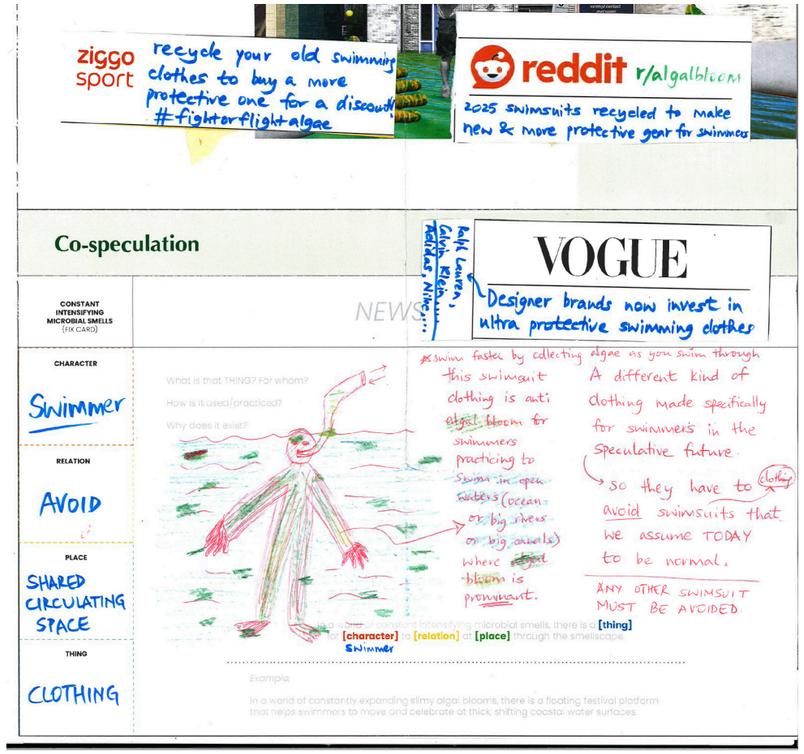
In a world of constant intensifying microbial smells, there is a **[thing]** for **[character]** to **[relation]** at **[place]** through the smellscape.

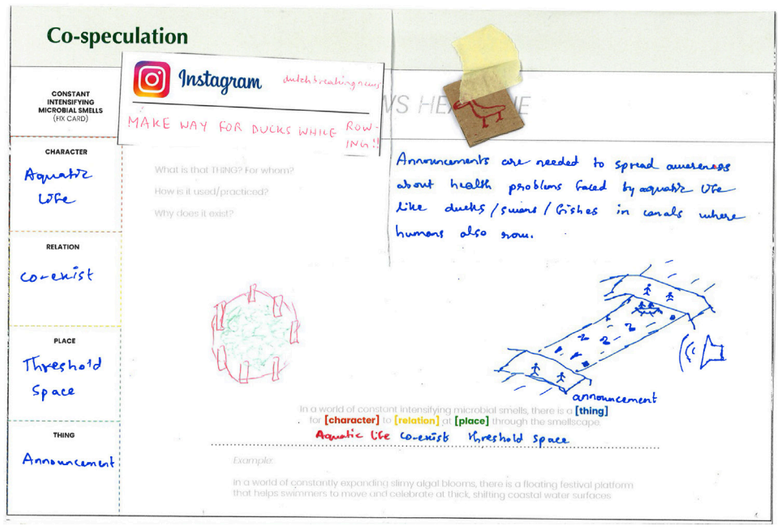
Example:

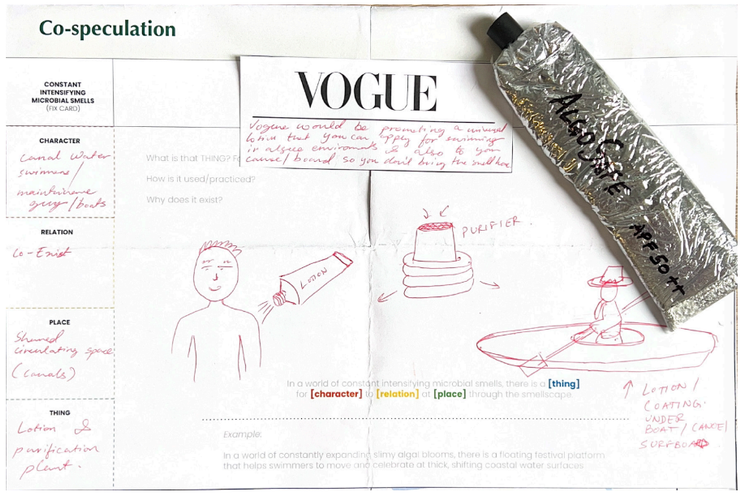
In a world of constantly expanding slimy algal blooms, there is a floating festival platform that helps swimmers to move and celebrate at thick, shifting coastal water surfaces

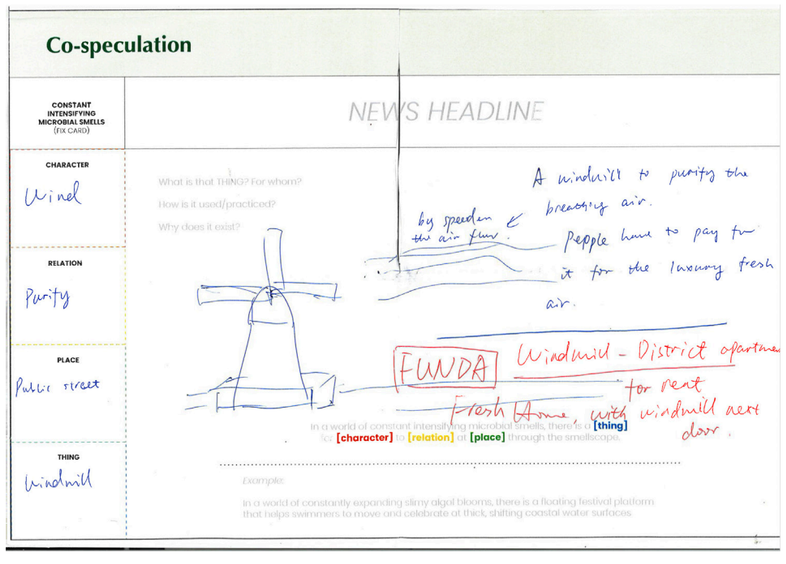
Place At **ENCLOSED EVERYDAY SPACE** Kitchen, bathroom, bedroom, shared student housing *A space of routine, intimacy, and control where smells can linger, accumulate, or be managed.*	**Character** For **WIND** Carries and redistributes smells across spaces *Spreads, connects distant areas, intensifies exposure*	**Relation** To **SENSE**	**Thing** There is a **TUNNEL**	**Thing** There is a **SOUVENIR**	**Theme** In a world of **CONSTANT INTENSIFYING MICROBIAL SMELL**
Place At **SHARED CIRCULATING SPACE** Street, market, campus, public transport, food area *A space of movement, exposure, and negotiation where smells mix, spread, and encounter many actors.*	**Character** For **DOG** Moves through the world primarily through smell *Tracks, detects, reacts to scent trails*	**Relation** To **ADAPT**	**Thing** There is a **CORPORATION**	**Thing** There is a **ANNOUNCEMENT**	**Character** For **ADAPTIVE RESIDENT** Focuses on adjusting and coping with changing environmental conditions. *Modifies behavior, develops habits, finds practical ways to live with conditions*
Place At **THRESHOLD SPACE** Window, balcony, doorway, canal edge, ventilation opening *A boundary space where inside and outside meet, and where smells, air, and entities pass, leak, or transform.*	**Character** For **CANAL WATER** A living medium where microbial activity unfolds *Accumulates, circulates, transforms substances*	**Relation** To **CO-EXIST**	**Thing** There is a **CLOTHING**	**Thing** There is a **TATTOO**	**Character** For **FISHER** Sits near the water and confronted with constant microbial smell *Struggles to maintain the hobby/business and keep themselves safe from toxins in the air*
Character For **SENSITIVE SMELLER** Highly attuned to changes and intensities in smell. *Notices early signals, easily overwhelmed, reacts strongly to changes*	**Character** For **AQUATIC LIFE** Lives within the same water environment but is affected by changing conditions. *Competes, adapts, gets suppressed, or disappears under changing conditions*	**Relation** To **WARN**	**Thing** There is a **RELIC**	**Thing** There is a **PASSPORT**	**Character** For **CYCLIST** Navigate relatively fast in the city and nature *Move fast, quick shift between places, adopt daily biking routes*
Character For **VISITOR** Unfamiliar with local conditions and encountering them for the first time. *Notices contrasts, lacks adaptation, interprets differently from locals*	**Character** For **SWIMMER** Directly immersed in water environments and exposed to their conditions. *Experiences close bodily contact, depends on water quality, senses changes physically*	**Relation** To **AVOIDE**	**Thing** There is a **SONG**	**Thing** There is a **WEAPON**	**Character** For **CITY OFFICAL** Responsible for managing urban systems and public conditions. *Monitors, regulates, responds to complaints, balances competing needs*
Character For **SMELL-CURIOUS INDIVIDUAL** Drawn to exploring unfamiliar or unusual smells. *Approaches, investigates, lingers, seeks new experiences*	**Thing** There is a **LOTION**	**Thing** There is a **BEVERAGE**	EMPTY CARD		

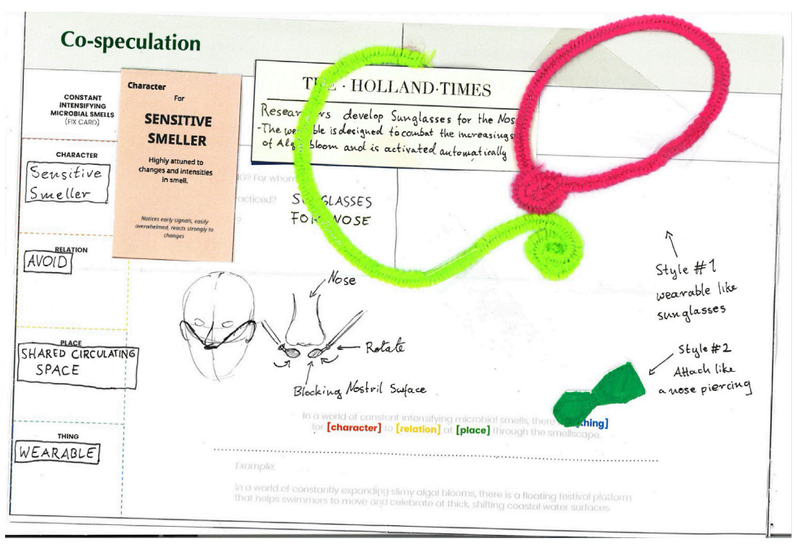
APPENDIX C - FINISHED TEMPLATES

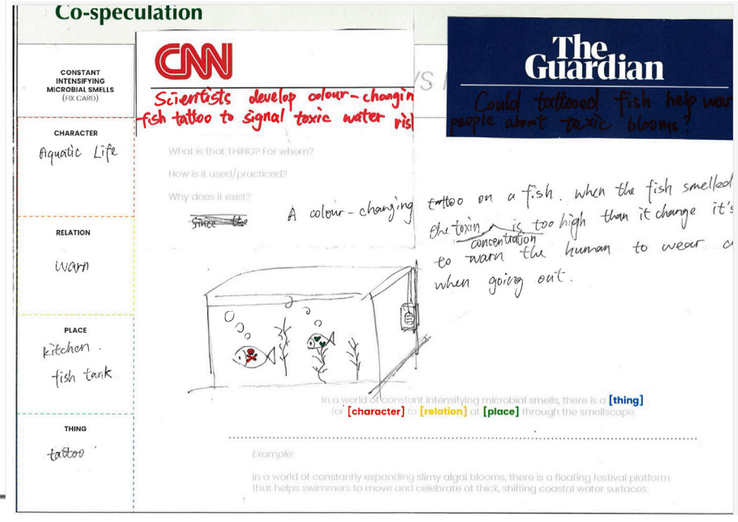


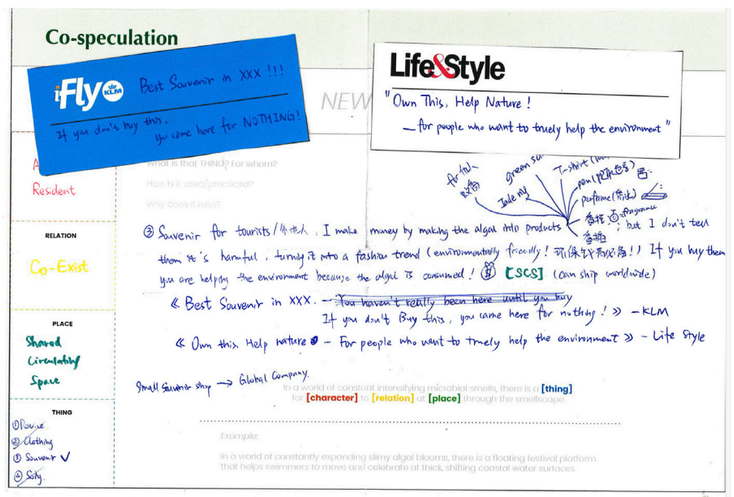


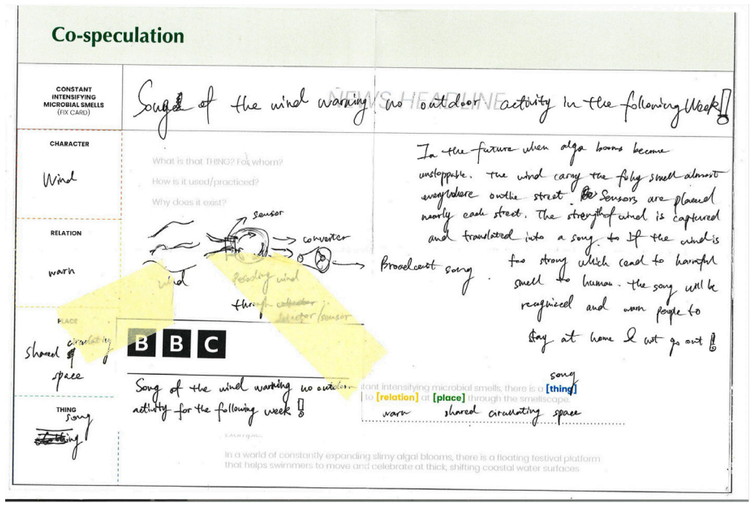


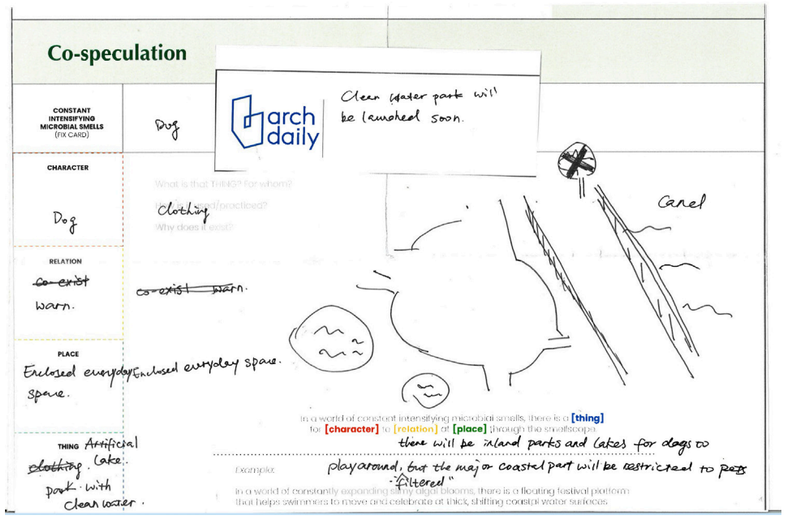


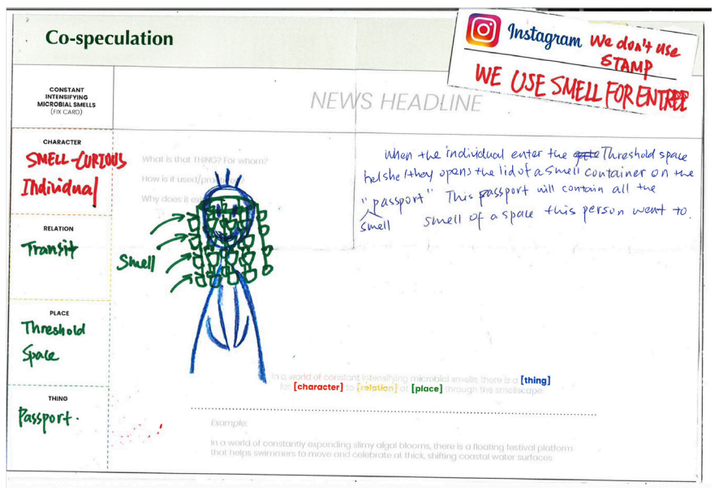


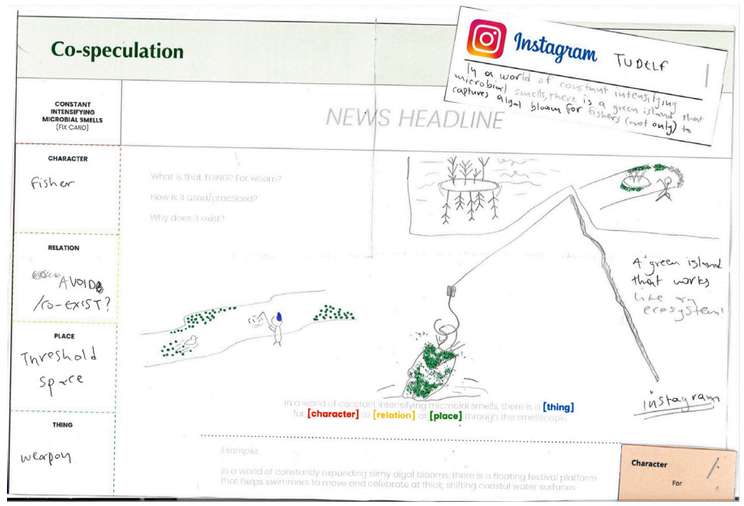



Co-speculation
iFly KLM Best Souvenir in XXX !!!
If you don't buy this, you come here for NOTHING!
Life&Style
"Own This, Help Nature !
— for people who want to truely help the environment"
Resident
RELATION
Co-Exist
PLACE
Shared Circulating Space
THING
Souvenir for tourists / 外地人 . I make money by making the algal into products
Small Souvenir shop → Global Company.
In a world of constant intensifying microbial smells, there is a [thing] for [character] to [relation] at [place] through the smellscape.
Example:
In a world of constantly expanding slimy algal blooms, there is a floating festival platform that helps swimmers to move and celebrate at thick, shifting coastal water surfaces

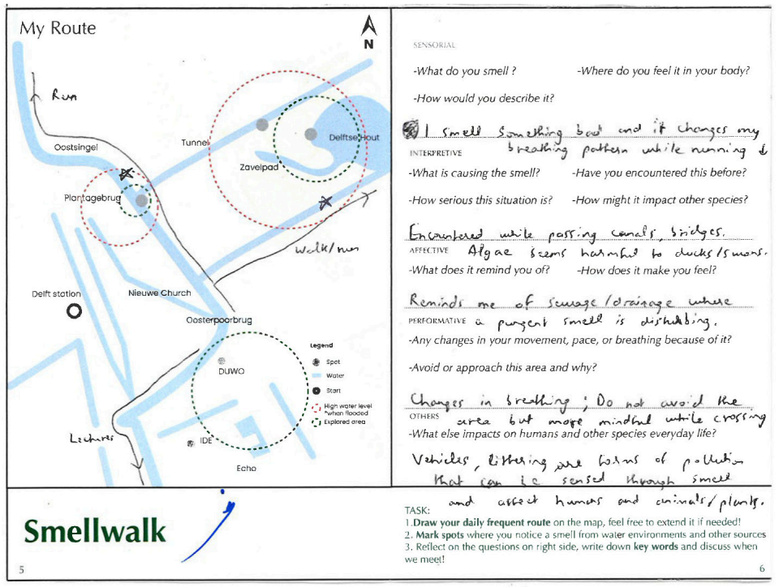

Co-speculation
CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)
Song of the wind warning no outdoor activity in the following Week!
CHARACTER
Wind
RELATION
warn
PLACE
Shared circulating space
THING
Song
In the future when algal blooms become unstoppable, the wind carry the fishy smell almost everywhere on the street. Sensors are placed nearly each street. The strength of wind is captured and translated into a song to if the wind is too strong which cead to harmful smell to human. the song will be recognized and warn people to stay at home & not go out!
Broadcast song
BBC
Song of the wind warning no outdoor activity for the following week!
In a world of constantly expanding slimy algal blooms, there is a floating festival platform that helps swimmers to move and celebrate at thick, shifting coastal water surfaces

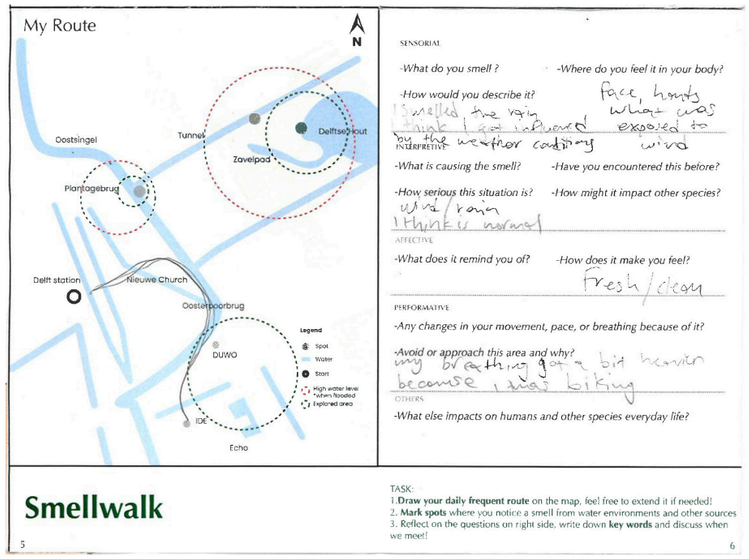

Co-speculation
CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)
Dog
arch daily
Clean water park will be launched soon.
CHARACTER
Dog
RELATION
warn.
PLACE
Enclosed everyday space.
THING
Artificial lake.
Canal
there will be inland parks and lakes for dogs to playaround, but the major coastal part will be restricted to pets "filtered"
In a world of constantly expanding slimy algal blooms, there is a floating festival platform that helps swimmers to move and celebrate at thick, shifting coastal water surfaces

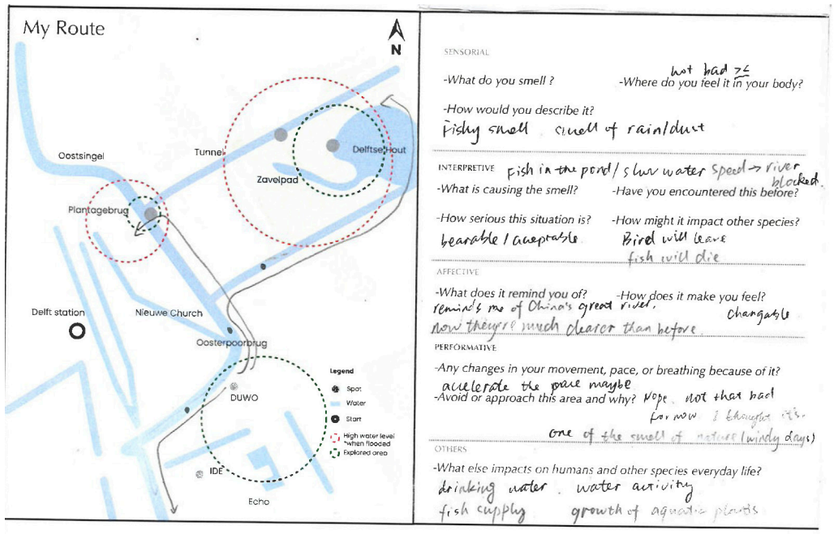

Co-speculation
Instagram We don't use STAMP
WE USE SMELL FOR ENTREE
CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)
NEWS HEADLINE
CHARACTER
SMELL-CURIOUS Individual
RELATION
Transit
PLACE
Threshold Space
THING
Passport.
When the individual enter the Threshold space he/she/they opens the lid of a smell container on the "passport" This passport will contain all the smell of a space this person went to.
Smell
In a world of constantly expanding slimy algal blooms, there is a floating festival platform that helps swimmers to move and celebrate at thick, shifting coastal water surfaces

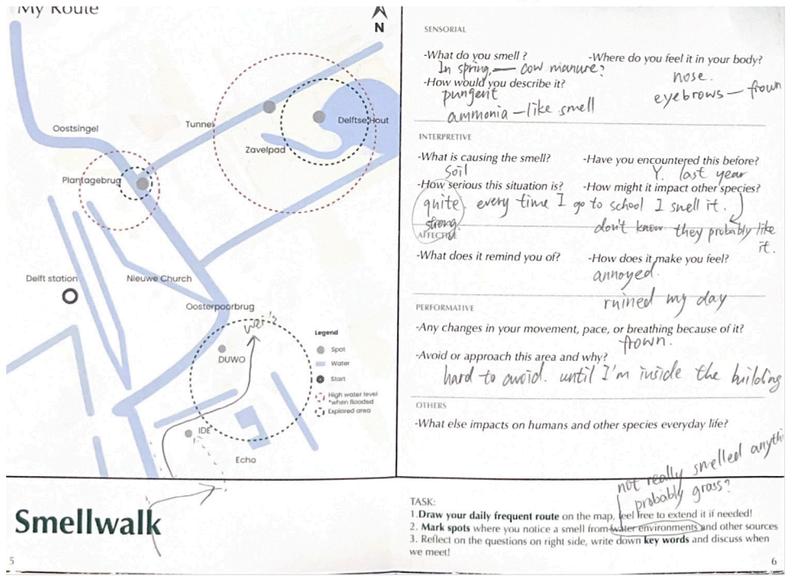

Co-speculation
Instagram TUDELF
In a world of constant intensifying microbial smells, there is a green island that captures algal bloom for fishers (not only) to
CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)
NEWS HEADLINE
CHARACTER
Fisher
RELATION
AVOID /CO-EXIST?
PLACE
Threshold space
THING
weapon
A green island that works like an ecosystem!
instagram
In a world of constantly expanding slimy algal blooms, there is a floating festival platform that helps swimmers to move and celebrate at thick, shifting coastal water surfaces
Character
For

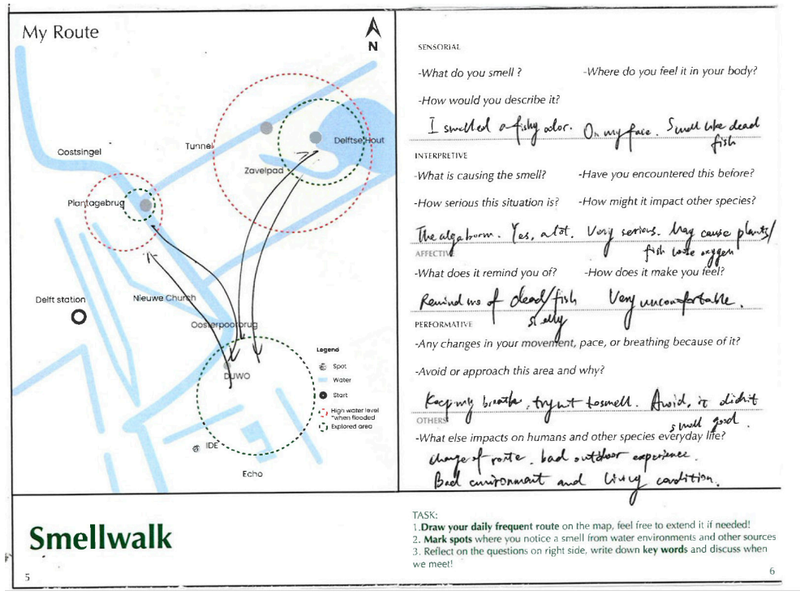
APPENDIX D - SMELLWALK REFELECTIONS

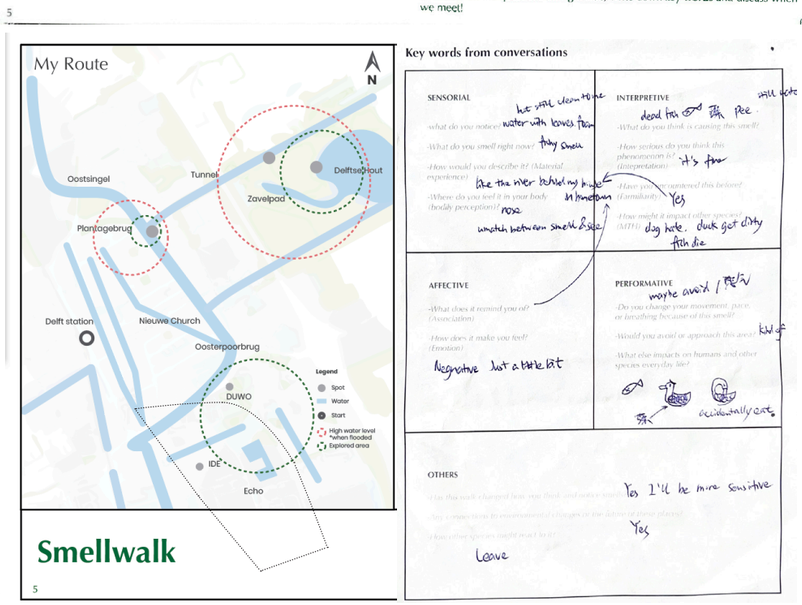


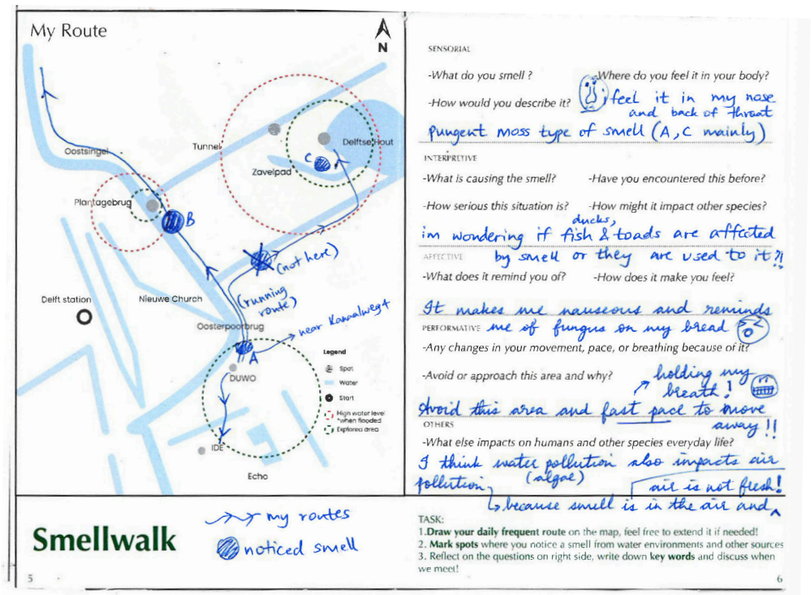


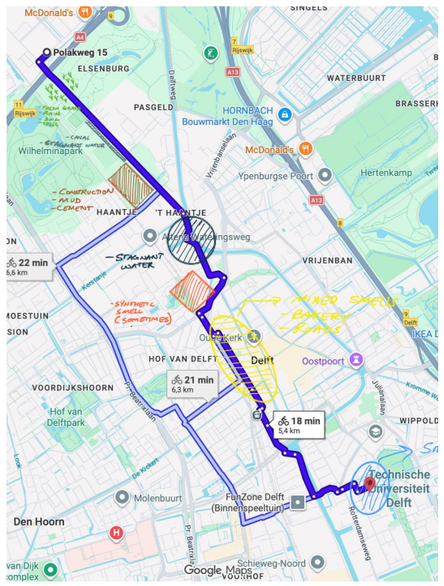


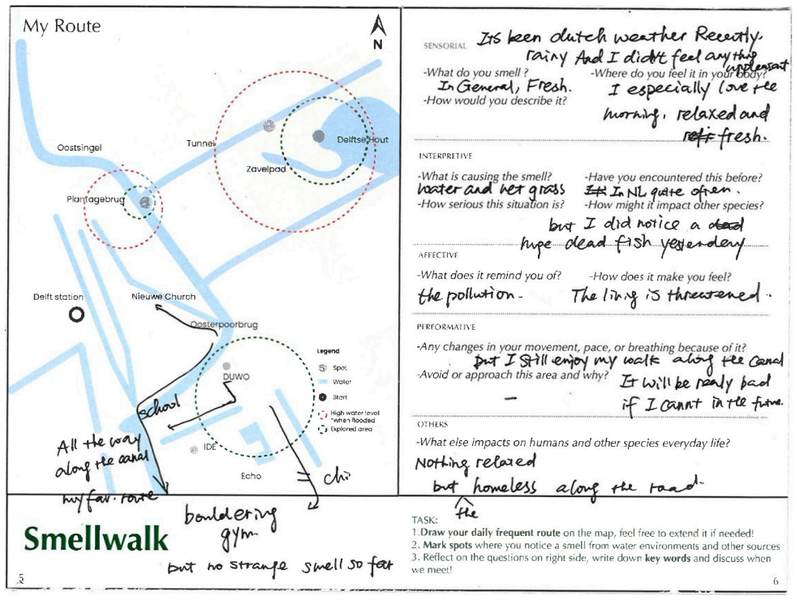


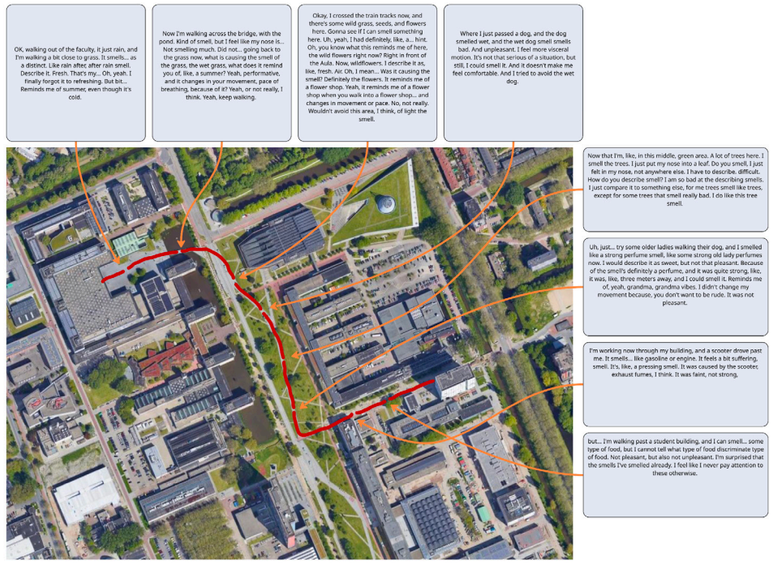


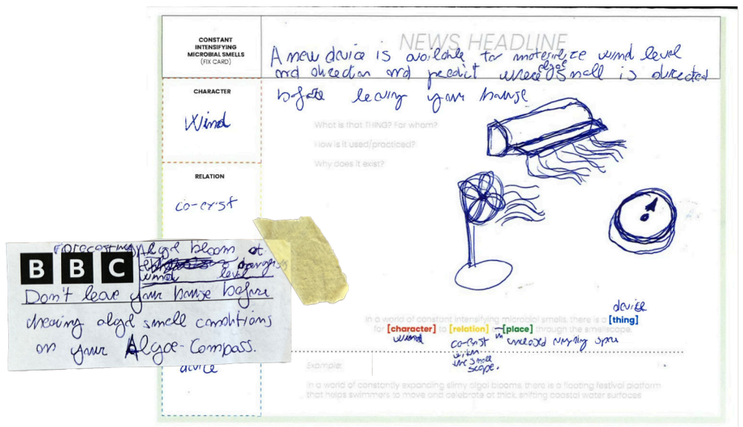


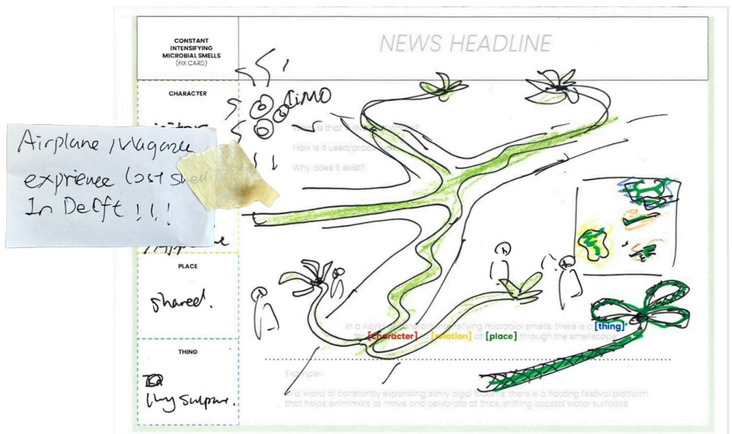

My Route
N
Oostsingel
Tunnel
Delftse Hout
Zavelpad
Plantagebrug
B
A
C
(not her)
(running route)
Delft station
Nieuwe Church
Oosterpoortbrug
how Kanaalweg?
DUWO
IDE
Echo
Legend
Sport
Water
Start
High water level when flooded
Explored area
Smellwalk
my routes
noticed smell
5
SENSORIAL
-What do you smell ?
-Where do you feel it in your body?
-How would you describe it?
i feel it in my nose and back of throat
Pungent moss type of smell (A,C mainly)
INTERPRETIVE
-What is causing the smell?
-Have you encountered this before?
-How serious this situation is?
-How might it impact other species?
ducks,
im wondering if fish & toads are affected
AFFECTIVE
by smell or they are used to it?!
-What does it remind you of?
-How does it make you feel?
It makes me nauseous and reminds
PERFORMATIVE me of fungus on my bread
-Any changes in your movement, pace, or breathing because of it?
-Avoid or approach this area and why?
holding my breath!
stroid this area and fast pace to move away!!
OTHERS
-What else impacts on humans and other species everyday life?
I think water pollution also impacts air pollution (algae)
air is not fresh!
because smell is in the air and
TASK:
1.Draw your daily frequent route on the map, feel free to extend it if needed!
2. Mark spots where you notice a smell from water environments and other sources
3. Reflect on the questions on right side, write down key words and discuss when we meet!
6

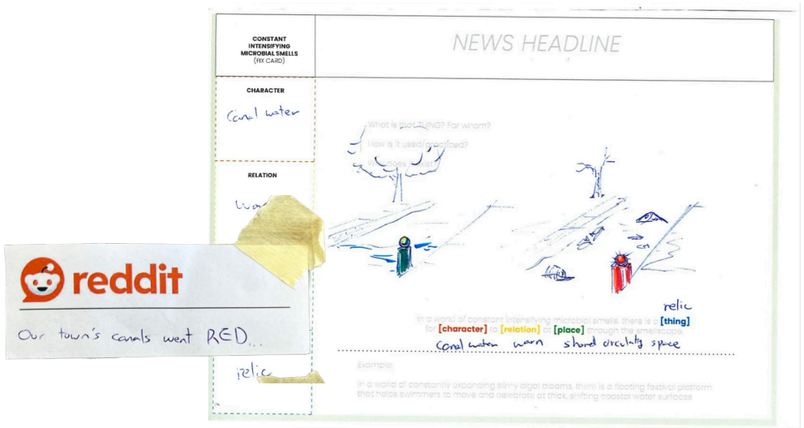

McDonald's
Polakweg 15
ELSENBURG
PASGELD
WATERBUURT
HORNBACH
Bouwmarkt Den Haag
Wilhelminapark
McDonald's
Ypenburgse Poort
Hertenkamp
HAANTJE
'T HAANTJE
VRIJENBAN
22 min
6,6 km
21 min
6,3 km
18 min
5,4 km
HOF VAN DELFT
Delft
Oostpoort
VOORDIJKSHOORN
Hof van Delftpark
WIPPOLD
Molenbuurt
FunZone Delft (Binnenspeeltuin)
Technische Universiteit Delft
Den Hoorn
Schieweg-Noord
Google Maps


My Route
N
Oostsingel
Tunnel
Delftse Hout
Zavelpad
Plantagebrug
Delft station
Nieuwe Church
Oosterpoortbrug
DUWO
IDE
Echo
Legend
Sport
Water
Start
High water level when flooded
Explored area
school
All the way along the canal
my fav. route
chi
Smellwalk
bouldering gym
but no strange smell so far
5
SENSORIAL
Its been dutch weather Recently. rainy And I didn't feel any thing unpleasant
-What do you smell ?
In General, Fresh.
-How would you describe it?
I especially love the morning, relaxed and refr fresh.
INTERPRETIVE
-What is causing the smell?
water and wet grass
-Have you encountered this before?
Eh In NL quite often.
-How serious this situation is?
-How might it impact other species?
but I did notice a dead huge dead fish yesterday
AFFECTIVE
-What does it remind you of?
the pollution.
-How does it make you feel?
The living is threatened.
PERFORMATIVE
-Any changes in your movement, pace, or breathing because of it?
but I still enjoy my walk along the canal
-Avoid or approach this area and why?
It will be really bad if I cannot in the future.
OTHERS
-What else impacts on humans and other species everyday life?
Nothing relaxed
but homeless along the road.
the
TASK:
1.Draw your daily frequent route on the map, feel free to extend it if needed!
2. Mark spots where you notice a smell from water environments and other sources
3. Reflect on the questions on right side, write down key words and discuss when we meet!
6

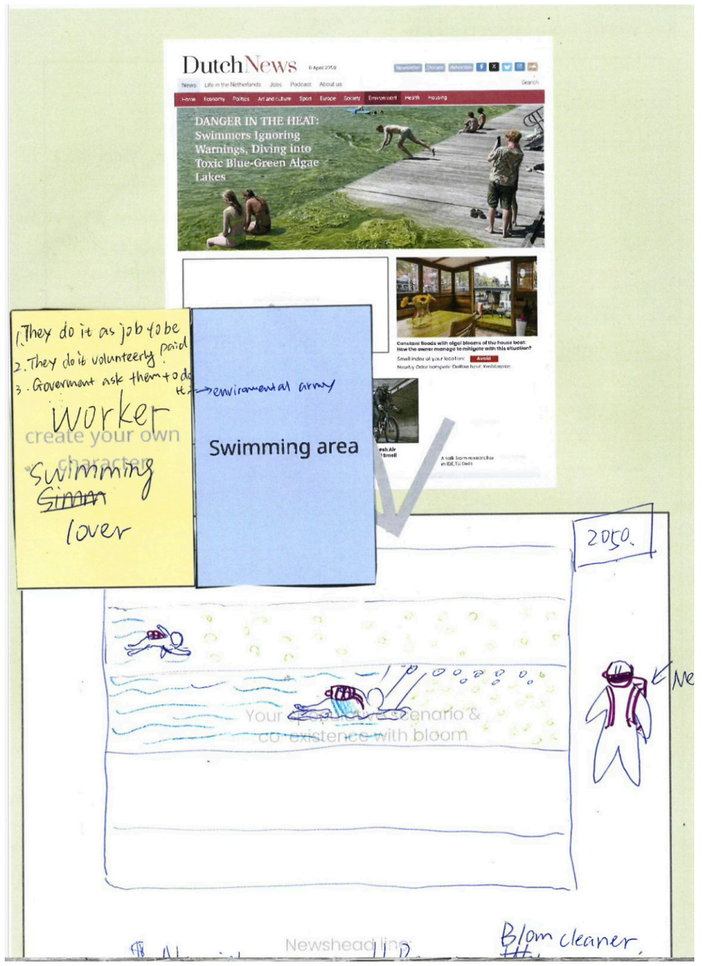

OK, walking out of the faculty, it just rain, and I'm walking a bit close to grass. It smells... as a distinct. Like rain after after rain smell. Describe it. fresh. That's my... Oh, yeah. I finally forgot it to refreshing. But bit... Reminds me of summer, even though it's cold.
Now I'm walking across the bridge, with the pond. Kind of smell, but I feel like my nose is... Not smelling much. Did not... going back to the grass now, what is causing the smell of the grass, the wet grass, what does it remind you of, like, a summer? Yeah, performative, and it changes in your movement, pace of breathing, because of it? Yeah, or not really, I think. Yeah, keep walking.
Okay, I crossed the train tracks now, and there's some wild grass, seeds, and flowers here. Gonna see if I can smell something here. Uh, yeah, I had definitely, like, a... hint. Oh, you know what this reminds me of here, the wild flowers right now? Right in front of the Aula. Now, wildflowers, I describe it as, like, fresh. Air. Oh, I mean... Was it causing the smell? Definitely the flowers. It reminds me of a flower shop. Yeah, it reminds me of a flower shop when you walk into a flower shop... and changes in movement or pace. No, not really. Wouldn't avoid this area, I think, of light the smell.
Where I just passed a dog, and the dog smelled wet, and the wet dog smell smells bad. And unpleasant, I feel more visceral motion. It's not that serious of a situation, but still, I could smell it. And it doesn't make me feel comfortable. And I tried to avoid the wet dog.
Now that I'm, like, in this middle, green area. A lot of trees here. I smell the trees. I just put my nose into a leaf. Do you smell, I just felt in my nose, not anywhere else. I have to describe. difficult. How do you describe smell? I am so bad at the describing smells. I just compare it to something else, for me trees smell like trees, except for some trees that smell really bad. I do like this tree smell.
Uh, just.... try some older ladies walking their dog, and I smelled like a strong perfume smell, like some strong old lady perfumes now. I would describe it as sweet, but not that pleasant. Because of the smell's definitely a perfume, and it was quite strong, like, it was, like, three meters away, and I could smell it. Reminds me of, yeah, grandma, grandma vibes. I didn't change my movement because, you don't want to be rude. It was not pleasant.
I'm working now through my building, and a scooter drove past me. It smells... like gasoline or engine. It feels a bit suffering. smell. It's, like, a pressing smell. It was caused by the scooter, exhaust fumes, I think. It was faint, not strong.
but,... I'm walking past a student building, and I can smell... some type of food, but I cannot tell what type of food discriminate type of food. Not pleasant, but also not unpleasant. I'm surprised that the smells I've smelled already. I feel like I never pay attention to these otherwise.


CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)
NEWS HEADLINE
CHARACTER
Wind
RELATION
co-exist
BBC
Don't leave your house before
checking algal smell conditions
on your Algae-Compass.
device
[character] [relation] [place] [thing]


CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)
NEWS HEADLINE
CHARACTER
Airplane Magazine
experience lost smell
In Delft!!!
PLACE
shared.
THING
My surfaces.
[character] [relation] [place] [thing]


CONSTANT INTENSIFYING MICROBIAL SMELLS (FIX CARD)
NEWS HEADLINE
CHARACTER
Canal water
RELATION
reddit
Our town's canals went RED...
relic
[character] [relation] [place] [thing]
Canal water warn shared circulating space


DutchNews
DANGER IN THE HEAT: Swimmers Ignoring Warnings, Diving into Toxic Blue-Green Algae Lakes
pet
Dogs
"I love drinking water!"
front "yard"
bloom
Near canal Houseboat
Jochem 2100
petri
Many pets falling ill due to bloom near house
DATE 2100 Sept. 14.
STOP DRINKING THAT! WE HAVE CLEAN WATER!
You stink, you must've drunk bloom again!
you need medicine
Your speculative scenario & co-existence with bloom
Newshead line:
Name
Daisy + Ziva


DutchNews
DANGER IN THE HEAT: Swimmers Ignoring Warnings, Diving into Toxic Blue-Green Algae Lakes
1. They do it as job to be paid
2. They do it volunteerly
3. Government ask them to do it → enviramental army
worker
create your own character
Swimming lover
Swimming area
2050.
Your speculative scenario & co-existence with bloom
Newshead line:
Blom cleaner.

APPENDIX E – ARDUINO CODE

```ino
#include <TinyGPS++.h>
#include <SoftwareSerial.h>

TinyGPSPlus gps;

// GPS TXD -> Arduino D4
// GPS RXD can be left unconnected
SoftwareSerial gpsSerial(4, 5); // RX, TX

// ===== Pins =====
const int fanPin = 9;
const int buttonPin = 2;

// ===== Fan speed values =====
const int LOW_SPEED = 70;
const int MED_SPEED = 90;
const int HIGH_SPEED = 150;
const int BURST_SPEED = 255;

// ===== GPS settings =====
const unsigned long GPS_BAUD = 38400;

// ===== Define location data structure =====
struct SmellLocation {
  const char* name;
  double lat;
  double lng;
  double radiusMeters;
  int fanSpeed;
  const char* levelName;
};

// ===== Put your 3 Delft locations here =====
// Replace the latitude and longitude values with your real GPS readings.
// Do not use 52.xxxxxx in real code. It must be real numbers.

SmellLocation locations[] = {
  {
    "Location 1 - Canal edge",
    52.002539,
    4.371995,
    35.0,
    LOW_SPEED,
    "LOW"
  },
  {
    "Location 2 - Bridge",
    52.005935,
    4.370177,
    45.0,
    MED_SPEED,
    "MEDIUM"
  },
  {
    "Location 3 - Plant water zone",
    52.007977,
    4.368008,
    55.0,
```

```ino
void loop() {
  // Read GPS data continuously
  while (gpsSerial.available() > 0) {
    gps.encode(gpsSerial.read());
  }

  int buttonState = digitalRead(buttonPin);

  int fanSpeed = 0;
  String levelName = "OFF";
  String activeLocation = "No GPS fix yet";

  // Button override: intense burst
  if (buttonState == HIGH) {
    fanSpeed = BURST_SPEED;
    levelName = "BURST";
    activeLocation = "Manual button override";
  }

  // GPS location control
  else if (gps.location.isValid()) {
    double currentLat = gps.location.lat();
    double currentLng = gps.location.lng();

    double closestDistance = 999999.0;
    int closestIndex = -1;

    // Find closest location
    for (int i = 0; i < numberOfLocations; i++) {
      double distanceToLocation = TinyGPSPlus::distanceBetween(
        currentLat,
        currentLng,
        locations[i].lat,
        locations[i].lng
      );

      if (distanceToLocation < closestDistance) {
        closestDistance = distanceToLocation;
        closestIndex = i;
      }
    }

    // Check if inside a trigger zone
    if (closestIndex != -1 && closestDistance <= locations[closestIndex].radiusMeters) {
      fanSpeed = locations[closestIndex].fanSpeed;
      levelName = locations[closestIndex].levelName;
      activeLocation = locations[closestIndex].name;
    } else {
      fanSpeed = 0;
      levelName = "OFF";
      activeLocation = "Outside all smell zones";
    }
  }

  // No valid GPS fix yet
  else {
    fanSpeed = 0;
    levelName = "OFF - waiting for GPS";
    activeLocation = "No GPS fix yet";
```

```ino
  // Print debugging info once per second
  if (millis() - lastPrint >= 1000) {
    lastPrint = millis();

    Serial.println();

    Serial.print("Chars processed: ");
    Serial.println(gps.charsProcessed());

    Serial.print("Passed checksum: ");
    Serial.println(gps.passedChecksum());

    Serial.print("Satellites: ");
    if (gps.satellites.isValid()) {
      Serial.println(gps.satellites.value());
    } else {
      Serial.println("Unknown");
    }

    if (gps.location.isValid()) {
      double currentLat = gps.location.lat();
      double currentLng = gps.location.lng();

      Serial.print("Current Latitude: ");
      Serial.println(currentLat, 6);

      Serial.print("Current Longitude: ");
      Serial.println(currentLng, 6);

      Serial.println("Distances to smell zones:");

      for (int i = 0; i < numberOfLocations; i++) {
        double d = TinyGPSPlus::distanceBetween(
          currentLat,
          currentLng,
          locations[i].lat,
          locations[i].lng
        );

        Serial.print(" - ");
        Serial.print(locations[i].name);
        Serial.print(": ");
        Serial.print(d);
        Serial.println(" m");
      }
    } else {
      Serial.println("Waiting for GPS fix...");
    }

    Serial.print("Active zone: ");
    Serial.println(activeLocation);

    Serial.print("Fan level: ");
    Serial.print(levelName);

    Serial.print(" | PWM: ");
    Serial.println(fanSpeed);

    Serial.println("----------------------------------");
  }
}
```

APPENDIX F - OBSERVATION NOTES

April

May

June



Start thriving, bloom? duckweed?



How do they react if surrounded by bloom?



Acquatic plants start thriving



Stagnant water covered by duckweeds



Greenery things accumulated around a canal cafe



Oil spill near boat parking lot



Leaves accumulated offering nutrients



The movements brought up smells from water



Smell barriers?



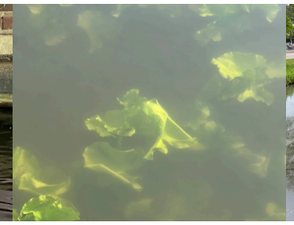
First-time encounter with death fish



Encouter multiple times. By accidents or by bloom?



Flapping wings spread the smell...



Other water plants thrivie



A fish leaped out of turbid water unexpectedly



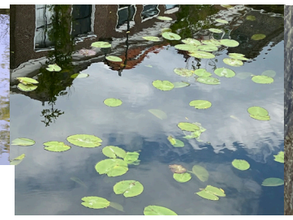
Shocked by this bird landed on my window for fresh smell



Duckweeds canopy



Green mossy plants are settled at the bottom



Acquatic plants start thriving



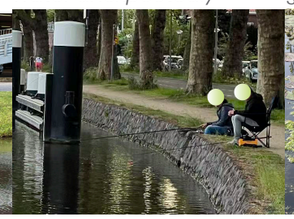
The sewage is pouring water into the canal



Rusty bike pulled out of the water... Nostalgia smell...



Water from a factory poured directly into the canal



Fishing the smell...



Green scum emerges..

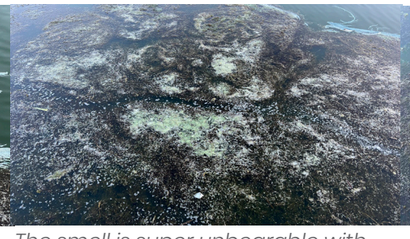


Swimming through floating green plants/algae

July



Interesting branch-like pattern...



The smell is super unbearable with lots of flies





Bloom? or other acquatic plants?



This looks really similar to the bloom image posted by NIOO

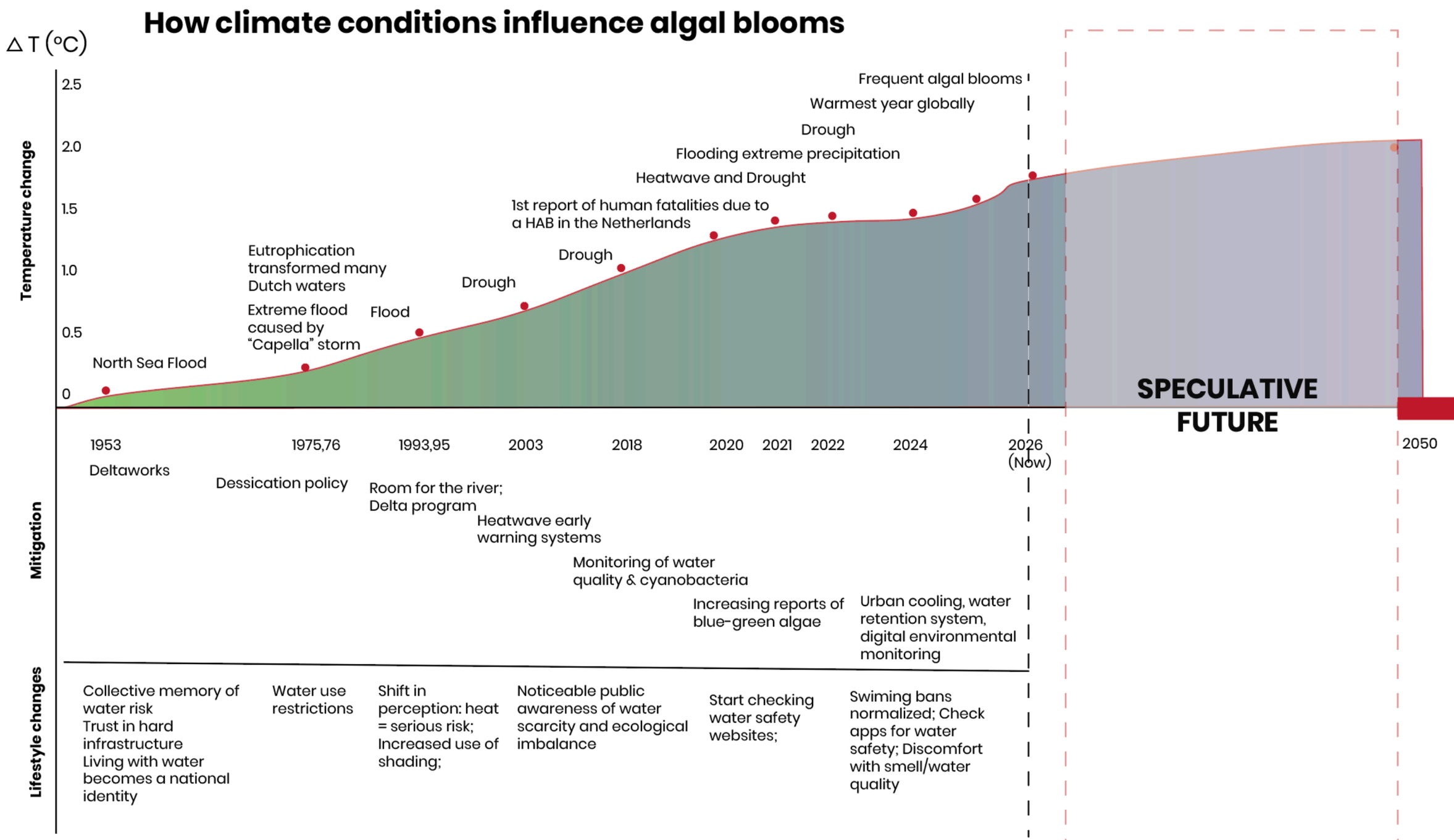






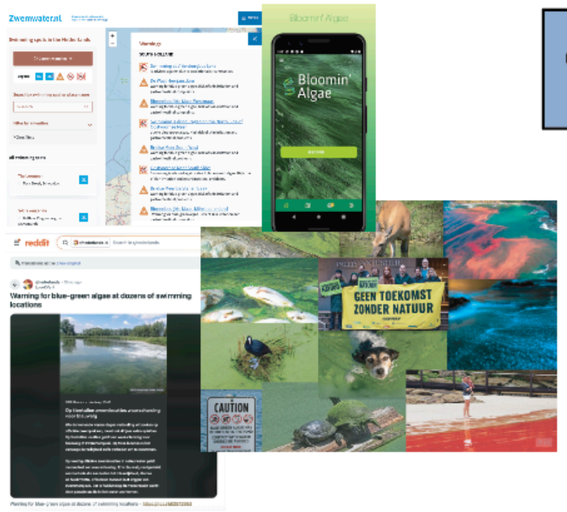
In May and early June, there is quite clear here. But now it changes completely

APPENDIX G - TIMELINE & PESTEL ANALYSIS



Source: https://apps.ipcc.ch/report/sr15/fig1/index.html

Emerging (Weak) Signals



Adaptation & Market Formation

Global NEWS
"Europe Experiences Longest Harmful Algal Bloom Season on Record"

Fastest Low-Odor Route Available for First-Class Passenger!

The Guardian
Loving Nature at a Distance: How Climate Change Reshapes Outdoor Experience

iFly
"Europe's Last Swimmable Lakes"

Ecological Stratification Era

beauty
"Daily Skin Barrier Creams Become Urban Necessity"

archdaily
Breathing Architecture: Home Designed for Toxic Outdoor Futures" — Domus Futures

VOGUE Bio Edition
"This Season's Must-Have Accessory? The Scent Shield Veil"

Normalized Bloom Civilization

DutchNews
Dutch canals receive daily "water smell forecasts"

funda
Certified Low-Odor Neighborhoods Gain Market Value Across Dutch Cities

THE · HOLLAND·TIMES
esidents Install Advanced tems as Water Quality Declines

FIETS
Call for contribution to the odourless route network in the South Netherlands!

reddit
DIY: An appreciation box to capture the toxic blue-green algae beauty
197 votes, 77 comments

BBC Documentaries
Before the Bloom? Most watched climate documentary of 2050

	2026 (Now)	2035	2045	2050
Political	Governments increasingly issuing swimming bans & safety warnings. (zwemwater)	Governments establish environmental smell indexes and public odor warning systems.	Climate migration policies prioritize environmentally stable regions.	Cities begin funding anti-bloom infrastructure projects.
Economics	Increasing fish mortality events and oxygen depletion in freshwater systems.	Smell sensitivity and environmental fatigue increasingly discussed as mental health concerns.	Clean-air districts become luxury investments.	Insurance prices rise near affected waterways.
Social	Anxiety around recreational water use.	Smell sensitivity and environmental fatigue increasingly discussed as mental health concerns.	Smell tolerance normalized among working populations.	Waterfront lifestyles become associated with health risks
Technological	Emergence of environmental sensing technologies and citizen science apps (Bloomin Algae)	AI-based smell prediction integrated into navigation systems and smart city infrastructures.	Personal filtration wearables integrated into daily fashion.	Wearable VOC (volatile organic compound) sensors become commercialized.
Environmental	Fish die-offs and oxygen depletion become recurring seasonal events.	Water ecosystems become seasonally unstable and biologically unpredictable.	Some freshwater ecosystems permanently classified as hazardous.	Fish die-offs become annual news events.
Legal	One goal of the OSPAR North East Atlantic Environment Strategy 2030 is to counter eutrophication.	Employers required to monitor environmental exposure risks in outdoor workplaces.	Cyanotoxin exposure recognized as occupational risk.	Regulations introduced for water quality disclosure in housing markets.

APPENDIX H - SPECULATIVE NEWS

DutchNews 6 April 2050

Newsletter Donate Advertise

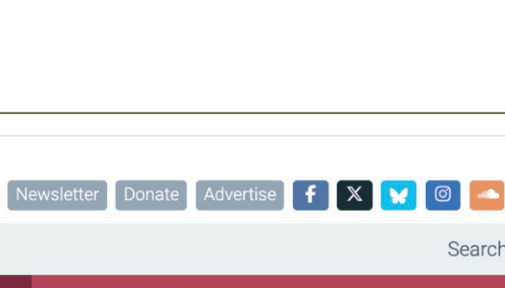
News Life in the Netherlands Jobs Podcast About us Search

Home Economy Politics Art and culture Sport Europe Society Environment Health Housing



Your speculative scenario & co-existence with bloom

Newshead line:



Constant floods with algal blooms of the house boat: How the owner manage to mitigate with this situation?

Smell Index at your location: **Avoid**

Nearby Odor hotspots: Delftse hout, Krabbeplas.

Your speculative scenario & co-existence with bloom

Newshead line:

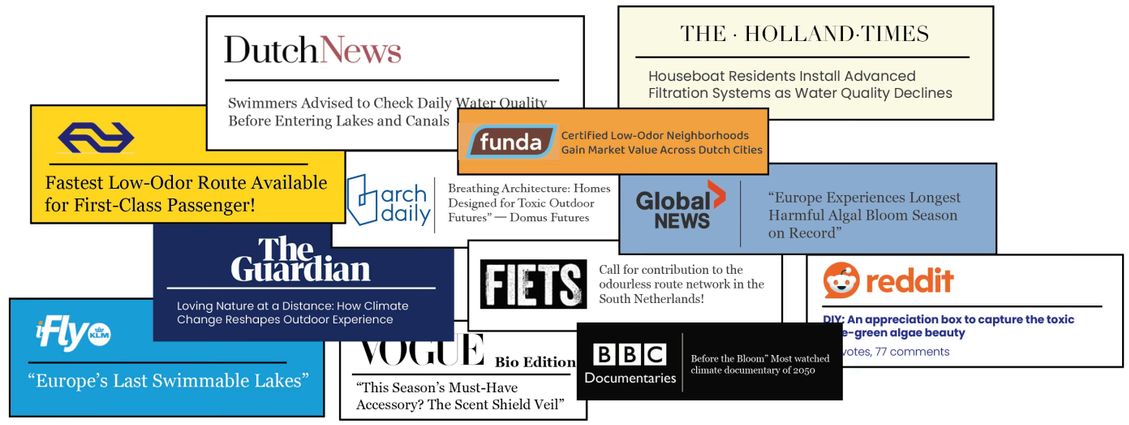


Urban Planning Introduces 'Fresh Air Corridors' to Combat Microbial Smell Build-Up

Your profile

A talk from researcher in IDE,TU Delft

Your name



APPENDIX I - PROJECT PROPOSAL FORM

Project Proposal form
IDE Master Graduation Project

In this proposal the agreements made between student and supervisory team about the student's IDE Master Graduation Project are set out. This document needs to be prepared for the Kick-off meeting and should be submitted in MyCase.

Name student Huiqi Deng **Student number** 6166180

Project title Microbial scents of a warming world

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

MSc programme ☒ Design for Interaction ☐ Integrated Product Design ☐ Strategic Product Design

☐ Other *(in case of a double degree outside IDE):* _____

Introduction

Describe the context of your project in the box below; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

Climate change becomes increasingly subtle, with everyday environmental shifts that often go unnoticed. Phenomena such as algal blooms are frequently perceived as visually stunning or even enchanting: colourful surfaces, shimmering water, and in some cases, bioluminescence. However, these appearances are not neutral aesthetic events; they are ecological warning signals associated with rising temperatures, nutrient overload, and changing aquatic conditions.

Beyond visual change, algal blooms, particularly those involving cyanobacteria (non-toxic and releasing noticeable scents), are accompanied by shifts in volatile organic compounds (VOCs) released into the surrounding environment. These olfactory changes alter the sensory landscape of water bodies, yet remain largely overlooked in both public discourse and design practice.

This graduation project investigates how scent emissions associated with algal-bloom-related cyanobacteria change under simulated climate stress (rising temperature), and how these microbial signals can be translated into a synaesthetic olfactory vocabulary. Using a research-through-design approach, the project explores how different materials

→ space available for images / figures on next page

Introduction (continued): space for images



Figure 1: A Western Lake Erie harmful algal bloom from September 26, 2017. Photo from Landsat-8 (a NASA/USGS satellite).

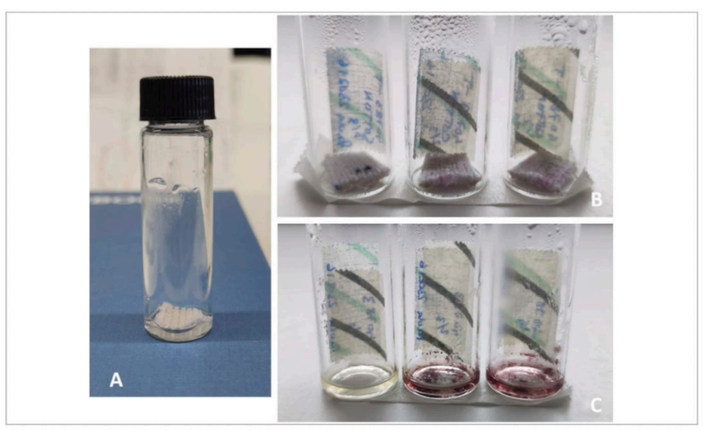


Figure 2: Sensory Textile – Bacterial Hybrids: Textile- Bacteria Fusion to Impart Forest-Associated Scents

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice. (max 200 words)

Algal blooms are among the most pressing climate-change-related environmental challenges, driven primarily by rising water temperatures and eutrophication. In the Netherlands, where water management, sea-level rise, and aquatic ecosystems are critical societal concerns. And these phenomena are particularly relevant.

While extensive scientific research addresses the ecological, chemical, and visual dimensions of algal blooms, far less attention is given to their olfactory dimension and to how microbial scent changes are perceived, interpreted, or communicated to humans. Existing design and public communication efforts tend to prioritize visualization, data representation, and spectacle, leaving smell largely unexplored despite its strong links to

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project (1 sentence. As you graduate as an industrial design engineer, your assignment will start with a verb (Investigate/Design/Validate/Create), and you may use the format:
(Investigate/Design/Validate/Create) ***a*** *(what will be the deliverable → prototype/roadmap/process/intervention /approach/guideline/strategy/…)* ***to*** *(what should it do →(create/understand/evaluate/validate/improve/execute/ analyse/…) (the objective → experience/value/process/product/…)* ***for*** *(whom → target group/client/…)* ***in*** *(what context).*

one sentence format: To create a synaesthetic communication of microbial scents through an immersive olfactory installation, raising public awareness of climate-change-driven temperature impacts on algal-bloom-related cyanobacteria.

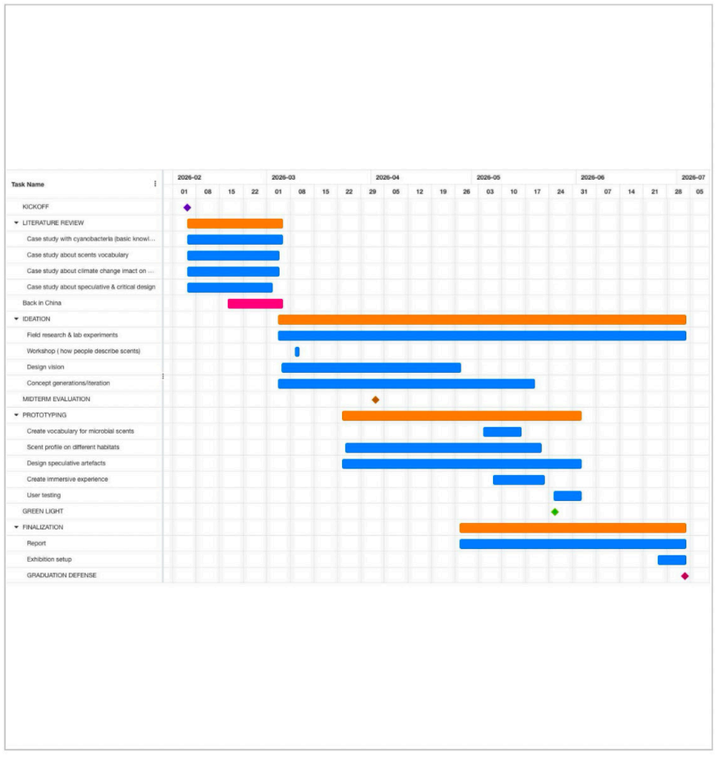
Explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words).

one sentence format: To create a synaesthetic communication of microbial scents through an immersive olfactory installation, raising public awareness of climate-change-driven temperature impacts on algal-bloom-related cyanobacteria.

This graduation project investigates how temperature-driven changes in the scent profiles of algal-bloom-related cyanobacteria can be translated into a synaesthetic, immersive olfactory experience. Through material experimentation across different habitats, the project develops a scent-based vocabulary that communicates microbial responses to climate change.The vocabulary will be applied in an immersive installation that raises public awareness of climate change impacts on aquatic ecosystems in the Netherlands, while bio-sensing data collected during the exhibition is used to validate and iteratively

Project planning

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include the **Kick-off**, **Midterm Evaluation**, **Green Light** and **Finalisation** (ceremony). Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities). Add (an image of) the planning in the box below. If it is not readable, you can add the planning as an attachment to My Case along with this Proposal.*



Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some (max 5) personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology (200 words max).

I consider myself a nature lover, and throughout my studies I have worked on speculative design projects around climate change and more-than-human relationships. However, most of these projects stayed at a relatively conceptual or representational level. I have never really had the chance to work directly with our microscopic companions microbes, even though they are among the most affected by environmental change and most entangled with human life. This graduation project feels like the right moment to finally cross that boundary and collaborate with them in a real, hands-on way.

During my internship, my work was highly focused on visual and auditory experiences. While I learned a lot, I also became aware of how dominant these senses are in design practice. Personally, I am very sensitive to smell, and I often notice how it is ignored or suppressed, even though it strongly shapes how we experience environments. Algal blooms are something I have encountered both in the Netherlands and in my home countries, and they leave a lasting impression—not just visually, but through their smell. For me, they represent a shared suffering of humans and non-humans under rising temperatures and environmental