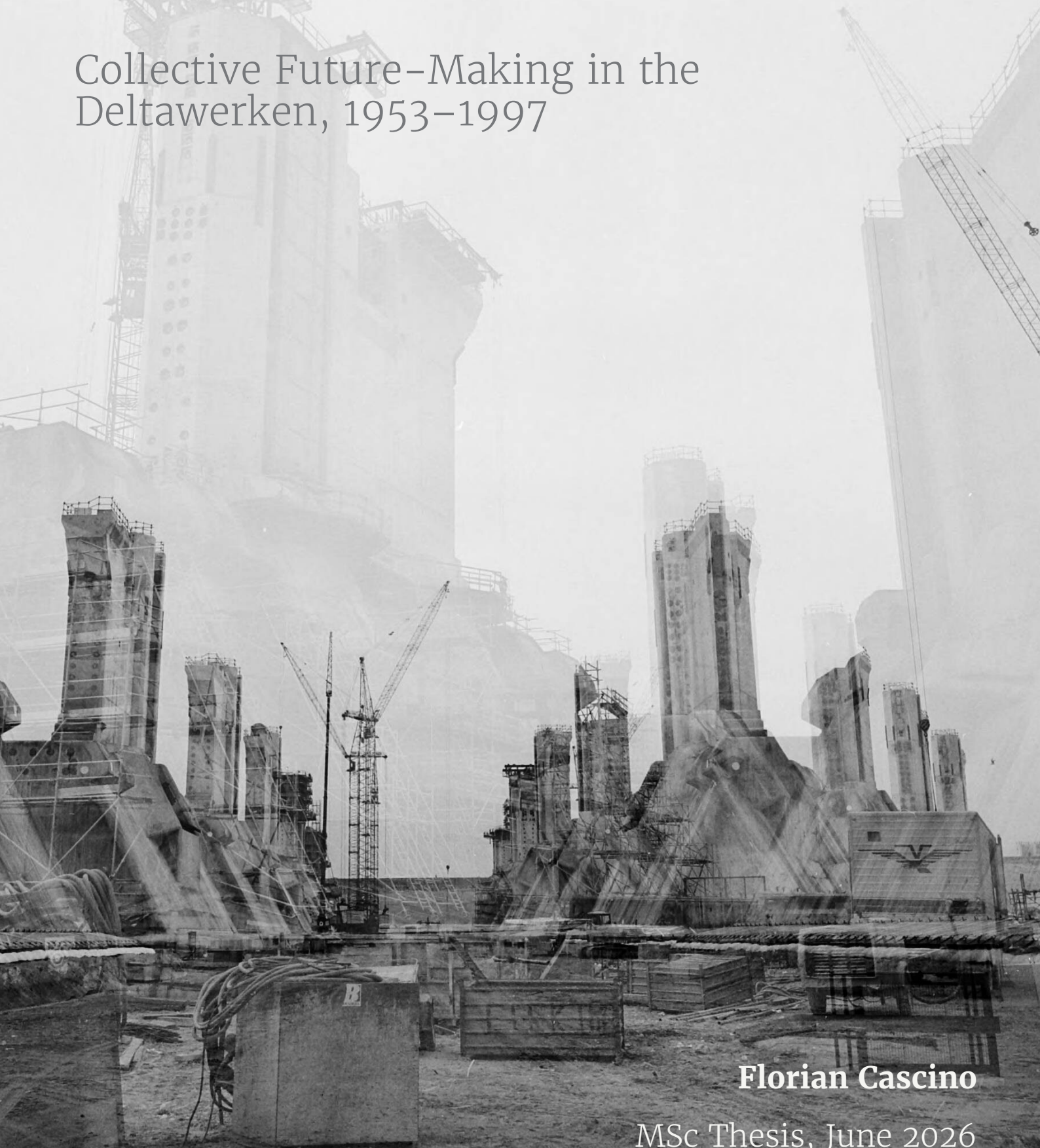


Designing Futures That Could Not Be Foreseen

Collective Future-Making in the
Deltawerken, 1953–1997



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MSc Thesis, June 2026

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Collective Future-Making in the Deltawerken, 1953–1997

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Preface

“Een volk dat leeft, bouwt aan zijn toekomst”

— Hildo Krop, Afsluitdijk monument, 1933

“A nation that lives, builds its future.” The phrase was inscribed on the Afsluitdijk decades before the Deltawerken began, and it was reappropriated into the Delta programme’s symbolic repertoire as if it had been written for the occasion. It captures, in a single line, what this thesis is about: the collective work of making futures under conditions where the outcome remains uncertain.

My fascination with this topic started in the third year of the IDE bachelor’s, when I followed the course of Frido Smulders, emeritus professor in Design, Innovation & Entrepreneurship. He enthused me for diving deep into the topic of future-making and, when it came to choosing a graduation subject, put me onto the Deltawerken as a case that had shaped the physical landscape of the country I grew up in. His work on innovation theory runs through every chapter of this thesis, and I am grateful for his generosity throughout.

I want to thank Bregje van Eekelen and Emile Mazerant for their supervision. Bregje’s sharp eye and Emile’s conceptual imagination made this a better thesis at every turn. Bert Toussaint and Jeroen Gijselhart at Rijkswaterstaat opened the doors that gave the thesis its practical grounding. And I am grateful to the practitioners and historians who gave their time and experience to this project.

Florian Cascino

Delft, June 2026

Executive summary

The Netherlands faces a convergence of long-horizon challenges in water safety, climate adaptation, and infrastructure renewal that demands the collective capacity to construct futures under deep uncertainty. Rijkswaterstaat, the organisation historically responsible for this work, has seen its in-house design capacity erode over decades of outsourcing and efficiency-driven reform. The result is a structural mismatch: the challenges require collective future-making, while the institutional architecture has been optimised for production.

Approach

This thesis investigates how collective future-making works in practice by re-reading the Deltawerken (1953–1997) through a lens assembled from pragmatist epistemology, practice-based futuring theory, and design and innovation theory. Where the Deltawerken is conventionally told as a story of Dutch engineering mastery, this thesis reads it for the moments where the capacity at stake was something different: the collective ability to hold a design process open while the brief itself was still forming. The thesis calls this capacity design-ability, and distinguishes it from engineerability as the execution of a settled design within validated practice.

Analysis

The analysis proceeds chronologically across six phases of the programme, from the pre-1953 knowledge landscape through to the institutional dismantling of the 1980s. Each phase is read twice: once through the vocabulary of future-making (Andersson, 2018; Wenzel et al., 2025) and once through the design-theoretic vocabulary of C-K theory, IDER, path dependence, learning theory, and boundary work. This dual reading reveals a recurring pattern: knowledge sufficient to change the programme's direction existed well before it became consequential. What determined whether knowledge could reshape the programme's trajectory was the configuration of institutional conditions, boundary-spanning actors, and legitimacy architectures that enabled or prevented it from crossing community boundaries.

Findings

The chronological reading yields ten lessons of collective future-making, organised across three capacity domains: perceptive capacity (what the

programme can see), connective capacity (how the programme relates to difference), and generative capacity (how the programme organises for the unknown). These lessons are recomposed into six reflection axes, each structured as a tension between two poles:

1. *Engineerability or design-ability*
2. *Decision-postponing doubt or generative doubt*
3. *Bounded rationality or bounded imagination*
4. *Knowledge containment or boundary spanning*
5. *Crisis-dependency or non-crisis generativity*
6. *Monitoring that confirms or monitoring that reveals*

Four confrontational interviews with Rijkswaterstaat practitioners (a senior water safety adviser, two innovation professionals, and a former programme director) confirmed that all six tensions are recognised as present and consequential in contemporary practice. The interviews converged on a shared core problem: the deferral of decisions under conditions where deferral progressively narrows the space for future action.

Output

The axes are translated into the Collective Design Compass: a diagnostic instrument built around six questions, organised across the three capacity domains. Programme teams articulate the future their programme is currently enacting, formulate collective answers to each question in their own words, and then read those answers against the analytical spectra derived from the Deltawerken analysis. The Compass orients rather than prescribes: it helps practitioners see where they stand and gives direction to where they could be heading, while leaving the judgement to the team.

Contribution

The thesis contributes a design-theoretic reading of a historical case that reveals conditions for collective future-making invisible from the engineering narrative alone, an empirical demonstration that these conditions remain active in contemporary practice, and a practitioner-facing instrument grounded in both.

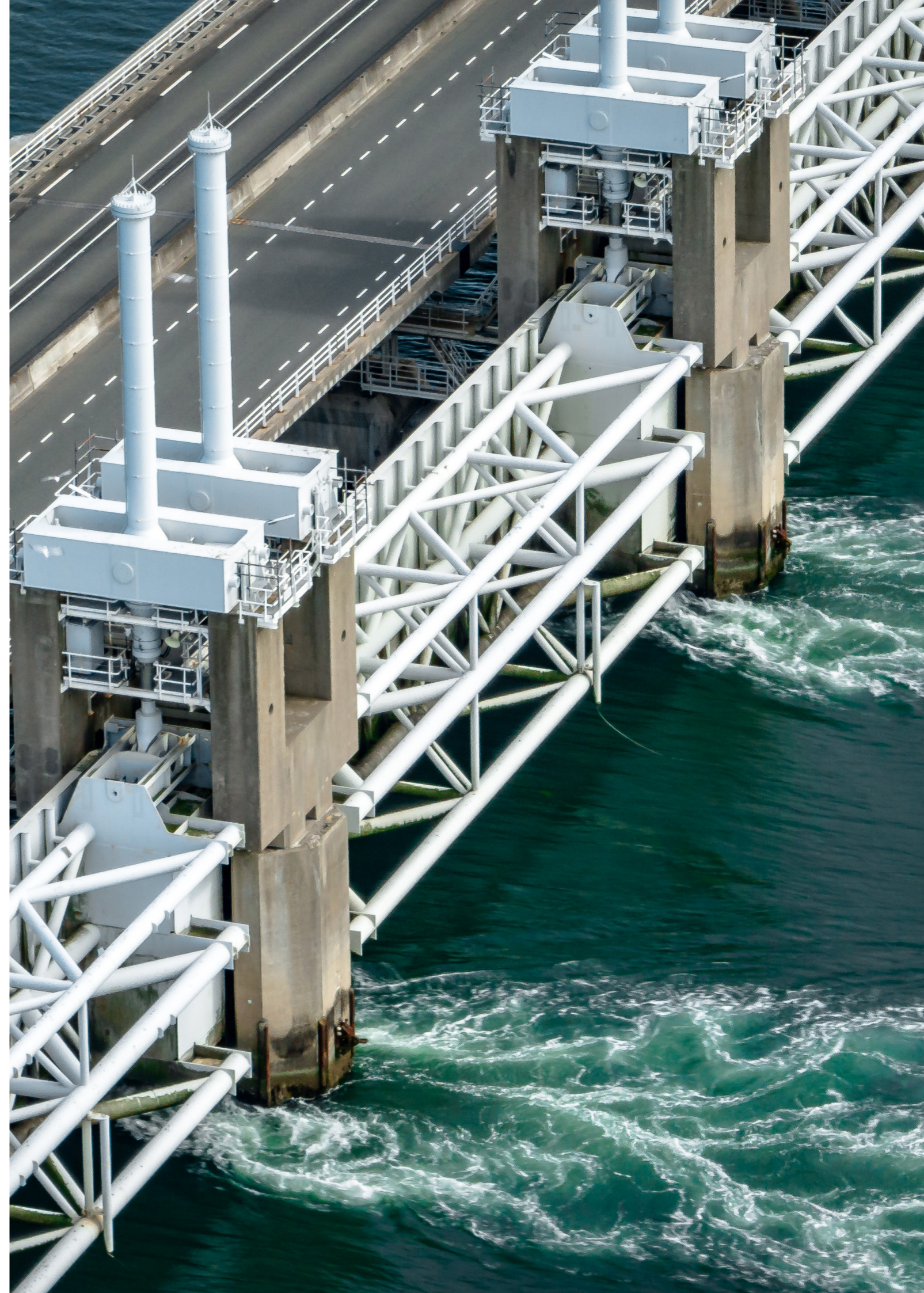


Figure: Sea water rushing through the Oosterschelde storm surge barrier

Terminology

Begrepen ervaring

“Understood experience.” The Deltadienst’s principle that experimental results must be explained against a theoretical prediction before being accepted.

Boundary object

An artefact or method flexible enough to serve different communities while maintaining a shared identity across them (Star & Griesemer, 1989).

C–K theory

Concept–Knowledge theory (Hatchuel & Weil, 2003). Describes interaction between a Concept space (undecided propositions) and a Knowledge space (decided propositions).

Deltacommissie

The Delta Committee, established in 1953 under Ir. A.G. Maris to advise on the closure of the southwestern delta.

Deltadienst

The dedicated Rijkswaterstaat division established in 1956 to execute the Delta Works.

Deltaschool

The informal learning community through which a generation of hydraulic engineers built shared technical knowledge during the Deltawerken.

Deltawet

The Delta Act (Wet van 8 mei 1958, Stb. 246), giving statutory force to the closure programme.

Design–ability (“ontwerpbaarheid”)

The collective capacity to sustain an open design process across communities while the brief itself is still being formed. Contrasted with engineerability.

Engineerability (“maakbaarheid”)

The capacity to execute a settled design within validated practice. Contrasted with design–ability.

IDER

Initiating, Designing, Engineering, Realising. A model identifying four recurring phases in innovating activities (Smulders, 2014).

Oosterscheldekering

The Eastern Scheldt storm surge barrier, completed in 1986.

Path dependence

The process by which self–reinforcing dynamics progressively narrow the scope of action, potentially leading to lock–in (Sydow, Schreyögg & Koch, 2009).

Performed future

A future that is actively enacted through institutional commitments, legal codification, and material investment.

RWS

Rijkswaterstaat, the Dutch executive agency for national water and road infrastructure.

Zandhonger

“Sand hunger.” The progressive erosion of tidal flats caused by reduced tidal energy after partial closure of the Oosterschelde.

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1 INTRODUCTION

1.1 The topic of future-making

There is something quietly remarkable about the fact that the physical world we inhabit was, at some point, a set of possibilities being worked toward by people who could not be certain they would succeed. Every piece of infrastructure, every institution, every policy framework was once a future. These futures, in their time, were contested, uncertain, and dependent on the efforts of actors who had to commit before the outcome was clear. What drew me to the study of Strategic Product Design was, in part, this question: how do people, organisations, and societies actually do that work? How do they move from a problem that is only partially understood toward a future that is still to be constructed?

Strategic product design, as practised and taught at the Faculty of Industrial Design Engineering at TU Delft, sits at the intersection of design thinking, innovation science, and organisation theory. In essence, the discipline is about this space: the gap between a problem frame and a solution, and the socially situated, practically enacted work of iteratively moving between them. Design, in this understanding, is inherently about futures. Designers and design-minded organisations learn to work under conditions of uncertainty. They are comfortable with holding questions open long enough for knowledge to accumulate, to build coalitions across disciplines and interests, and to give emergent possibilities enough institutional form that they can become real. Researchers in organisation studies and design have come to call this collective future-making. This thesis adopts this definition for the process through which actors generate, contest, and stabilise possible futures under conditions that do not yet determine which of those futures will prevail.

This kind of collective capacity is increasingly demanded at a scale that formal design disciplines

have rarely confronted. The decarbonisation of industrial economies demands that engineers, policymakers, financiers, and communities redesign energy and production systems around physical principles whose full implications remain to be worked out in practice. The governance of artificial intelligence, as it becomes embedded in systems of medicine, law, and democratic participation, calls for conceptual and institutional frameworks that practitioners across many fields are still in the process of developing together. The transformation of cities under conditions of intensifying heat, drought, and demographic pressure requires actors spanning planning, infrastructure, ecology, and community life to construct futures that none of them can specify alone. Each of these is as much an organisational challenge as a technical one. Addressing them calls for something that reaches beyond the deployment of known solutions: the collective capacity to move from a problem that is only partially understood toward futures that are still to be constructed. In the vocabulary that will be further developed in this thesis, this is the domain of designability: the capacity to design together, across disciplines, under unresolved assumptions, rather than to execute a settled plan. That capacity is not uniformly available. It can be built, and it can be eroded. Understanding how it works, what mechanisms sustain it, what conditions contract it, is both an academic question and a practical one.

This graduation project sits at the intersection of that scholarly question and a live institutional challenge. For the scholarly question, it looks at the Dutch Deltawerken, the large-scale programme of water management infrastructure executed between the 1950s and 1980s in response to the catastrophic 1953 flood disaster. Considered as a Modern Wonder of the World, it stands as one of the most richly documented historical instances of this kind of collective future-making conducted at extraordinary scale. At its most consequential moments, the programme required engineers,

Figure 1.1: Sluice gate of the Haringvliet, one of the Deltawerken

ecologists, politicians, and regional communities to construct a future together that none of them had been able to specify in advance.

This thesis research is conducted in close collaboration with Rijkswaterstaat, the Dutch executive agency responsible for the design, construction, and management of national water and road infrastructure. That embedding serves two related purposes. The first is empirical: Rijkswaterstaat holds, in its archives and in the professional knowledge of its practitioners and

1.2 Rijkswaterstaat in the present: a convergence of challenges

Rijkswaterstaat (RWS) is among the world's most technically accomplished water management organisations. The physical record of its achievement remains visible in the Dutch Delta region. The Haringvlietsluizen, the Oosterscheldekering, the Maeslantkering are structures that have protected the southwestern Netherlands from catastrophic flooding for decades. The professional standing and technical culture that produced them are internationally recognised. An assessment conducted by the OECD (2014) confirmed this standing, while simultaneously identifying public awareness as considered the organisation's most significant vulnerability. The very success of the Dutch water safety system has rendered it cognitively invisible to the population it protects, and that invisibility carries political and budgetary consequences (Van Waveren, 2026, March 23). Harold van Waveren, a senior water safety specialist (Topadviseur Waterveiligheid) at RWS who has advised on the organisation's strategic direction for decades, put the asymmetry in concrete terms. Multi-billion-euro additions to the defence budget have passed parliamentary debate without substantial resistance in recent years, while shortfalls of comparable magnitude in water safety investment attracted little sustained political attention. The implication is that the safety of a delta country rests on a public and political consensus that requires continuous renewal. This renewal is needed as the very effectiveness of the system erodes the cognitive conditions under which it gets sustained.

This awareness problem appears within a context of accumulating pressure. A substantial portion of the Dutch infrastructure built in the post-war decades (bridges, tunnels, locks, sluices, viaducts, and road structures) was designed for a lifespan of roughly thirty to fifty years. Those lifespans are now expiring simultaneously across multiple object types and networks. RWS's own Innovation Agenda

historians, the most detailed available record of the Deltawerken programme. Being embedded within the organisation has provided access to those archives and to the network of engineers, researchers, and managers whose knowledge informs this thesis. The second purpose is analytical: this collaboration allows for the historical findings to be reflected upon together with experts familiar with the current context, with the aim of translating mechanisms from their historical setting and connecting them to contemporary challenges.

for 2030 describes the resulting replacement and renovation obligation as the largest maintenance and renewal task in the organisation's history (Rijkswaterstaat, 2023). Hundreds of major structures requiring intervention within a single planning horizon, at a moment when the labour market for specialised construction and engineering is under exceptional pressure, material availability is constrained, and public budgets are contested (Rijkswaterstaat, 2023). As Yvette Entius and Annelies Nagtegaal observed, the replacement and renovation challenge is recognisable in principle, because maintenance and replacement have always been part of infrastructure governance. What is new, they say, is the convergence of multiple major replacement cycles across different object types at precisely the same moment (Entius & Nagtegaal, 2026, April 1). This convergence occurs alongside, rather than separately from, the demands of climate adaptation and energy transition. A further dimension complicates the task. Which future should the renewed infrastructure be designed for? Sea level rise projections diverge sharply across emission trajectories, and the choice of a design horizon is itself a programme-level decision that shapes both cost and adaptability.

The physical conditions behind those demands are well established in their broad direction, while remaining substantially uncertain in their precise magnitude. The Deltascenario's 2024, compiled by Deltares and the staff of the Delta Commissioner based on updated KNMI climate projections, provides the most recent quantitative foundation for Dutch water policy (Staf Deltacommissaris & Deltares, 2024). Across four scenarios, depicted in figure 1.2, spanning a range of global emission trajectories and socio-economic futures, the document arrives at a shared conclusion: water challenges in the Netherlands will become larger and more complex in every plausible future. Sea level rise of 24 to 27 centimetres is projected by

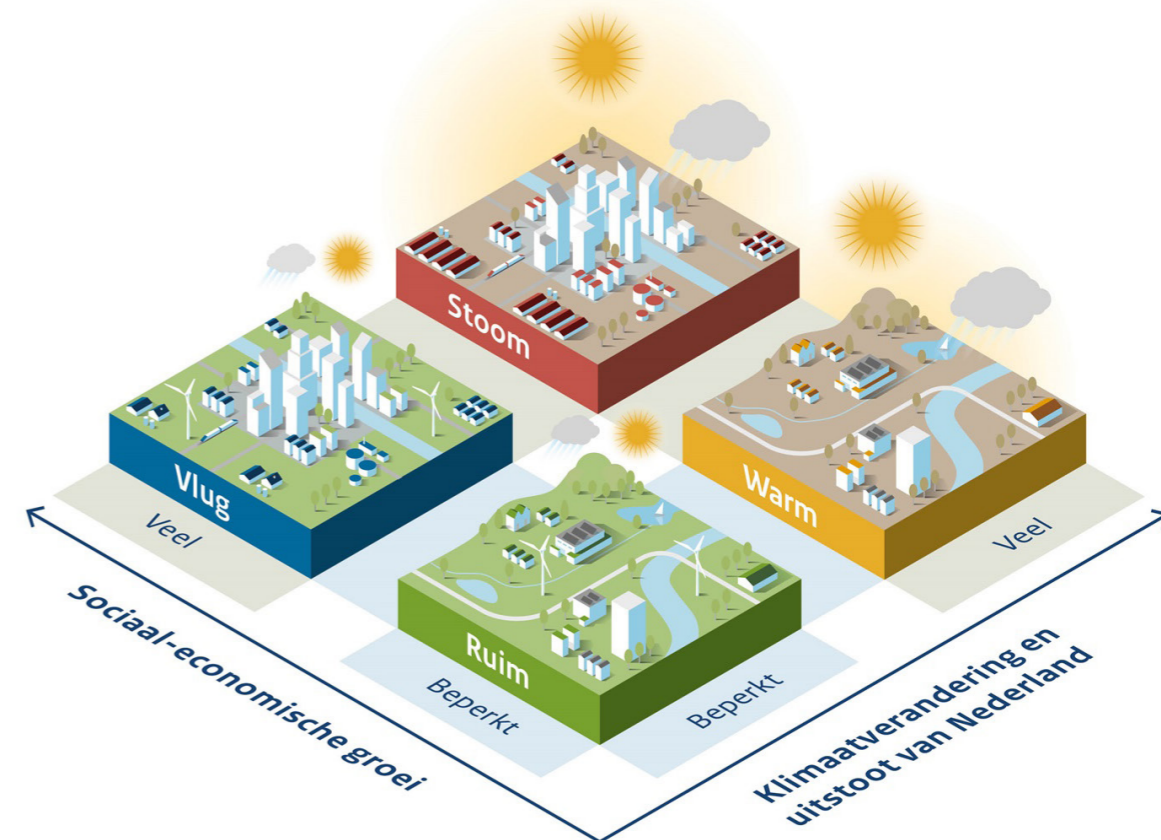


Figure 1.2: Deltascenarios 2024, four climate scenarios for the Netherlands covering sea level rise and freshwater challenges (Deltares / Staf Deltacommissaris)

2050 across all four scenarios; by 2100, the range diverges more sharply, from 44 centimetres in the lowest-emission trajectory to 82 centimetres in the highest. The current rate of rise, approximately 3 millimetres per year, is projected to accelerate to between 3 and 5 millimetres per year by 2050, and to as much as 11 millimetres per year toward the end of the century in high-emission scenarios (Staf Deltacommissaris & Deltares, 2024).

These projections bear on three structurally distinct but interrelated challenges (Staf Deltacommissaris & Deltares, 2024):

1. "Freshwater availability under pressure from lengthening drought periods, intensifying saltwater intrusion, and growing demand from agriculture and industry."
2. "Flooding from intense precipitation, amplified by the increasing imperviousness of urbanised surfaces."
3. "Safety from coastal and river flood events, shaped by rising sea levels and changing river discharge patterns."

The scenario report identifies the "stacking" of these challenges within the same territories as a particularly demanding condition: many parts of the Netherlands will face all three simultaneously, within a spatial landscape where competing claims from housing construction, energy infrastructure,

and agriculture leave diminishing room for water management solutions (Staf Deltacommissaris & Deltares, 2024). Cross-domain coordination is, in this framing, a fundamental requirement rather than an organisational aspiration.

Beyond the physical dimensions of renewal and climate, a set of institutional tensions bears directly on the capacity to address them. The most prominent, in the analysis of a practitioner close to the organisation, is a structural mismatch between the temporal horizons of political decision-making and those of infrastructure planning. Richard Jorissen, who directed the Hoogwaterbeschermingsprogramma (HWBP), the largest dike reinforcement programme since the Deltawerken, for approximately six years, has described this mismatch as a recurrent feature of the planning environment. The mismatch between short political decision cycles and the fifty-to-one-hundred-year lifespans of major water infrastructure creates a structural tendency to defer important decisions. By the time intervention can no longer be postponed, the available solution space has narrowed considerably (Jorissen, 2026, April 10). The Delta Programme, established in 2010 following the second Deltacommissie's recommendations, was designed in part as a structural counterweight to this tendency. Doing so by providing a continuous planning framework

that obliges successive administrations to engage with long-term water safety commitments. In practice, the programme has performed as a decision-forcing mechanism with less consistency than its architects anticipated, and the political reflex toward deferral has persisted even within the framework it provides (Entius & Nagtegaal, 2026, April 1). The consequences run beyond the political. Each year of deferral reduces the technical solution space available, and at the point where intervention finally proceeds, the remaining options are both more expensive and more constrained.

Beneath this temporal mismatch sits a second tension that concerns the organisation's knowledge base. From the 1980s onward, under the influence of New Public Management doctrine, Rijkswaterstaat underwent a gradual shift toward outsourcing, governed by the principle of *markt-tenzij* (market-unless). This shift accelerated from 2004, when the principle was formalised as organisational policy (Berkers, 2018). Activities that the private sector could perform were progressively transferred to contractors, and in-house technical staff was reduced accordingly. Marcel Veenswijk, whose study of innovation capacity at Rijkswaterstaat traces the organisation's post-war development through successive institutional phases, characterises the *markt-tenzij* period as the most consequential erosion of institutional knowledge in the organisation's history. Technical expertise that had been held as a common professional resource was externalised or simply lost as experienced engineers retired without institutional succession (Veenswijk,

Figure 1.3: Storm surge barrier Oosterschelde seen from the beach of the Veerse Gatdam (2019)



2021). Van Waveren identifies the consequences as still visible in the organisation's current situation: storm surge barriers designed by one generation of engineers are maintained by an organisation whose grasp of the original design assumptions is incomplete, and whose relationship with the contractors who hold critical technical competences has shifted from collaborative partnership toward procurement (Van Waveren, 2026, March 23). Rijkswaterstaat is currently engaged in rebuilding this capacity: dedicated in-house design teams have been re-established, and structured knowledge communities tied to the organisation's strategic priorities are under construction, with a projected horizon of four to five years before the investment reaches operations (Entius & Nagtegaal, 2026, April 1). The asymmetry is worth noting. The investment that aims to rebuild capacity is measured in years, while the institutional knowledge it seeks to recover accumulated over decades.

Taken together, this cluster of challenges produces a situation for which the existing institutional repertoire of Rijkswaterstaat provides only partial direction. The capacity to work under conditions of genuine uncertainty, simultaneous multi-domain pressure, and knowledge bases still under reconstruction requires more than technical confidence. The question this thesis approaches through a new reading of the Deltawerken's history is the following: **How did actors in the Deltawerken build and sustain the capacity for collective future-making, and what lessons does that historical practice hold for contemporary practitioners?** This question will be further elaborated as research question in section 1.4.

1.3 A new reading of the Deltawerken: design theory and the practice of future-making

This thesis proposes a new analytical reading of the Deltawerken's history. The historical record has been richly documented by engineers, institutional historians, policy analysts, and by people whose memoirs and testimonies add emotion to the archival material. A detailed picture of the events, decisions, and actors that shaped the programme already exists. What this thesis adds is a different analytical lens: one drawn from the domain of design theory and directed at the question of how the collective work of future-making happened inside the programme's most consequential moments.

The primary case within the Deltawerken is the Oosterschelde redesign of 1968 to 1976. In those years, a programme committed to closing the Oosterschelde with a conventional dam underwent a fundamental transformation. This change opened the question of what the engineering task was, what knowledge was relevant, who had a say in the design process, and what the future of the southwestern delta should look like. Engineers, ecologists, politicians, and regional actors eventually worked together toward a solution that was specified through the very process of finding it.

The question focuses on the situated practice of collective future-making rather than on the historical outcomes it produced. What the existing literature addresses less completely is the mechanics underneath the historical narrative: how, at specific moments in the programme's history, did the actors involved collectively work toward the future?

What were the concrete, socially situated activities through which possibilities were generated, contested, and stabilised? What happened inside the moments when the programme shifted from executing a settled design to collectively designing an open brief? These are questions that design theory is equipped to address.

The futuring that occurred during the Deltawerken programme has been covered by scholars. Jenny Andersson (2018), in her history of futures studies, traces the management of the future as a constitutively modern practice. She frames the management of the future as a domain of expertise, institutions, and contested authority that developed across the twentieth century. Her analysis situates large-scale state infrastructure programmes within a broader history of how modern societies learned to govern the future, and it explains the political and cultural dimensions of that process. At its centre sits a struggle over who holds the authority to define what is possible, and over the institutional conditions under which particular futures become thinkable. This thesis builds on that foundation while adding a deeper layer. Where Andersson's description follows anthropological and historical lines, this thesis adds the design-theoretical perspective. Its focus is not only what futures were made, and in what political context, but how the making happened at the level of practice. And, based on that, what that practice can teach practitioners working in similar situations today.

1.4 Research question and thesis structure

The preceding sections have established both a practical challenge and an analytical opportunity. The practical challenge is the convergence of pressures that Rijkswaterstaat faces: infrastructure renewal, climate adaptation, knowledge reconstruction, and the structural mismatch between political decision cycles and engineering time horizons. The analytical opportunity lies in the Deltawerken's historical record, which offers a case richly documented enough to support the kind of practice-level reading that design theory makes possible. What remains is to formulate the

questions that connect the two. The thesis pursues a primary question directed at the historical case and a secondary question directed at contemporary practice. The primary question asks what the Deltawerken can teach about how collective future-making works. The secondary question asks what that teaching can offer practitioners who face similar challenges today. Together, the two questions trace the arc of the thesis: from the present to the past and back to the present. The primary research question guiding this thesis is:

How did actors working on the Deltawerken build and sustain the capacity for collective future-making?

The primary research question is approached through five sub-questions, each tied to a phase of the Deltawerken's history that Chapter 4 covers in detail:

- 1. What was the configuration of knowledge, institutional authority, and future-making capacity in the pre-1953 landscape, and why did a technically articulated plan for the delta's protection fail to become a performed programme? (§4.1)*
- 2. How did the 1953 crisis produce the conditions under which a single performed future could be formed and codified at institutional scale? (§4.2)*
- 3. How did the programme learn and innovate at the level of practice while holding the strategic concept stable? (§4.3)*
- 4. How was the closure frame destabilised, and through what mechanisms did an alternative future acquire institutional traction? (§4.4 and §4.5)*
- 5. How were the institutional conditions that made collective designing possible subsequently eroded, and what does that erosion show about the durability of future-making capacity? (§4.6)*

The primary question asks, at specific moments in the programme's history, what the concrete socially situated activities were through which futures were generated, contested, and stabilised. The Deltawerken has been extensively documented by engineers, historians, and policy analysts. What is less well examined is the futuring practice beneath the historical narrative. It is important to note

that this thesis does not aim at a new historical discovery. Rather, it goes through the historical case for analytical re-reading. As one of the thesis's supervisors formulated the core of the inquiry: the thesis is about the 'how' of future-making, not the 'what' of history. The secondary question connects the historical analysis to the present.

How can the findings of this thesis' analysis guide practitioners that are engaged in contemporary collective future-making?

This secondary research question is approached through three sub-questions, each corresponding to a step in the translation from historical analysis to practitioner-facing instrument:

- 1. How can the lessons identified in the historical analysis be recomposed into tensions that practitioners can recognise and locate themselves within? (§5.1)*
- 2. Do practitioners at Rijkswaterstaat recognise these tensions as present and consequential in their own work, and how do they experience the position of their organisation along the axes? (§5.2)*
- 3. What form should a practitioner-facing instrument take so that these axes become operational for programme teams engaged in collective future-making? (§5.3)*

The secondary question is deliberately kept open, though the thesis develops a clear direction. Bound by a scope of twenty weeks, the thesis stays close to its historical analysis while extending it through which practitioner interviews at Rijkswaterstaat. The output takes the form of six orientation axes for diagnosing programmes that work on collective future-making, accompanied by a conversational instrument through practitioners can engage with these axes. The goal is to offer practitioners both recognition of tensions they already sense, and a grounded orientation for navigating them.

This thesis re-reads a well-documented historical case through a design-and-innovation-theory lens. The method is interpretive: it offers defensible readings supported by careful argument and primary sources, and it treats its contributions as open questions as much as settled answers. The application of the analytical framework is goal-directed. Episodes are selected because they are analytically illuminating, and the framework is applied where it yields interpretive findings. Vignettes in Chapter 4 carry this approach forward as short, illustrative fragments focused on a single analytical observation, placed alongside the running argument to make the evidential basis of each claim visible while keeping the claim modest in its reach beyond the case. Several conclusions in the analysis, including claims about the deliberateness of certain institutional decisions, rest on sources that allow for plausible interpretation. The tone throughout claims plausibility rather than certainty.

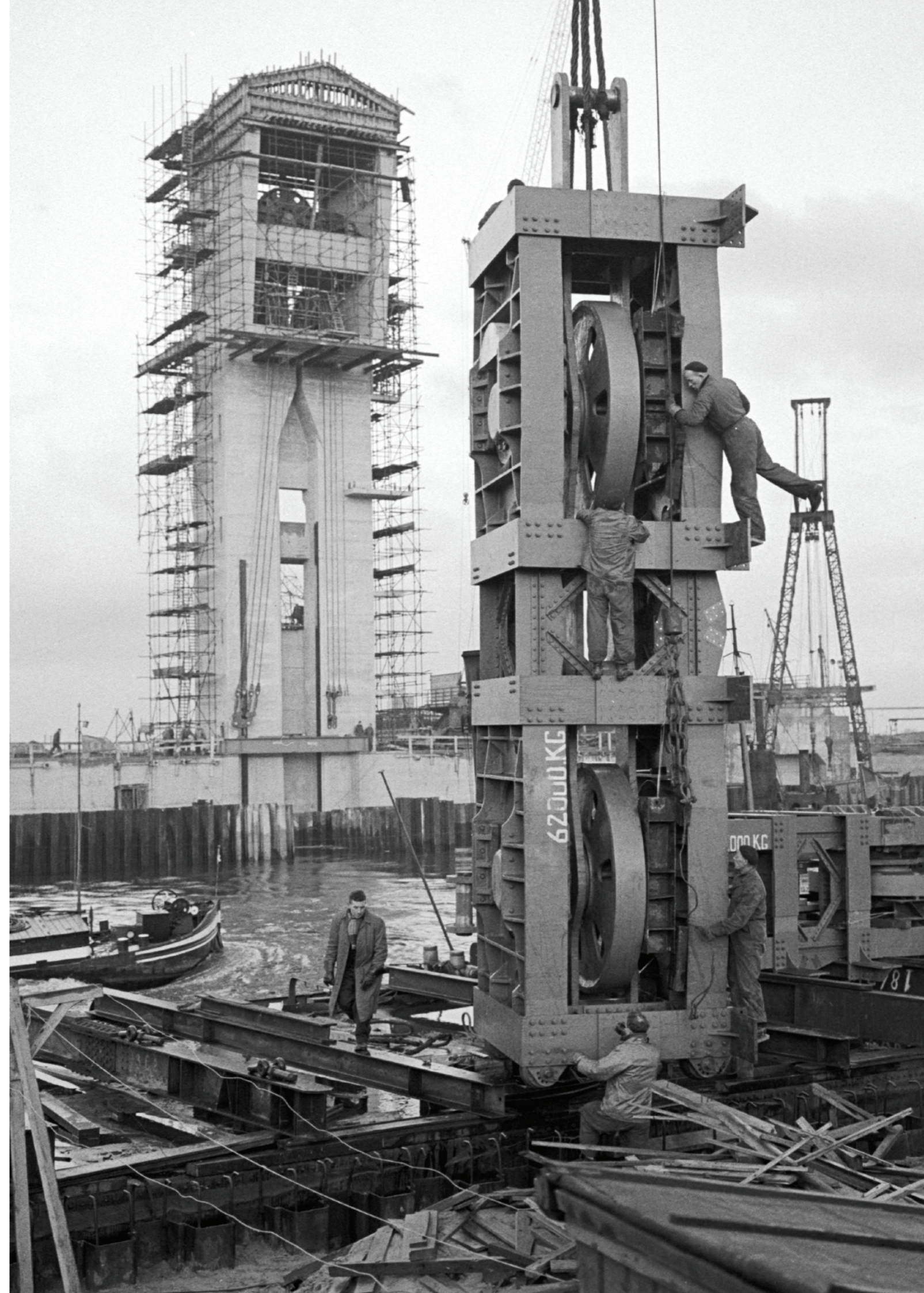
The thesis is structured to follow these questions. Chapter 2 gives a short history of the Deltawerken, from the pre-1953 landscape through to the bedrijfsmatige wending of the 1980s. It supplies the empirical material on which the analytical chapters draw. Chapter 3 addresses the question of which conceptual lens is best suited to reading collective future-making at the level of practice, and assembles the theoretical framework. Chapter 4 applies that lens to the historical case and answers the primary research question through ten lessons of collective future-making. Chapter 5 takes up the secondary question through its three sub-questions. Section 5.1 recomposes the ten lessons into six reflection axes structured as tensions between two poles. Section 5.2 confronts these axes with the experience of four Rijkswaterstaat practitioners, asking whether the tensions are recognisable and consequential in their daily work. Section 5.3 translates the axes into the Collective Design Compass: a diagnostic instrument through which programme teams can assess and monitor the conditions for collective design within their own practice. The temporal backbone of the thesis runs from the present to the past and *back to the future*. The opening locates the challenge in contemporary Rijkswaterstaat practice, the body works through the historical case, and the final chapter returns to the present to reflect on the future through the past.

A BRIEF HISTORY 2 OF THE DELTAWERKEN

This chapter provides the empirical foundation of the thesis. It tells a concise version of what happened before, during, and after the construction of the Deltawerken. Analytical vocabulary is largely absent here. Before this thesis goes into that, the reader is given the events, actors, decisions, and turning points as historically described.

This version of the history of the Deltawerken is pragmatic and selective, not exhaustive. It weights the narrative toward the periods of greatest conceptual turbulence: 1953–1958 (crisis and initial framing) and 1968–1976 (ecological reframing and the Oosterschelde redesign).

Figure 2.1: Construction of the Hollandse IJsselkering (1957)



2.1 Water and the Dutch engineering tradition

Water management has been constitutive of Dutch state-formation. The reclamation of land from sea and river delta, polder by polder, dike by dike, produced distinctive institutional forms. The earliest of these were the *waterschappen* (water boards), the oldest participative administrative bodies in the Low Countries, predating national government by centuries. By the twentieth century, a culture of hydraulic engineering had developed that combined technical virtuosity with a strong ethos of collective risk-management (Disco, 2000). This tradition had a scientific dimension that ran alongside the practical one: the *Koninklijk Instituut van Ingenieurs (KIVI)* functioned as a forum in which engineers subjected each other's work to open critical debate, a culture of structured inquiry that distinguished Dutch hydraulic expertise from simple craft (Van der Ham, personal communication, 7 April 2026).

Johan van Veen, depicted in figure 2.2, was the most important figure in this tradition during the interwar period. A hydraulic engineer at Rijkswaterstaat, he was known within the organisation as a *ruziemaker* (troublemaker). His warnings about flood risk were persistent, his methods unconventional, and his institutional standing perpetually contested. What is less commonly noted is that Van Veen was less a builder than a scientist. His credo, as confirmed by colleagues, was “investigate everything”, and the conceptual foundations he

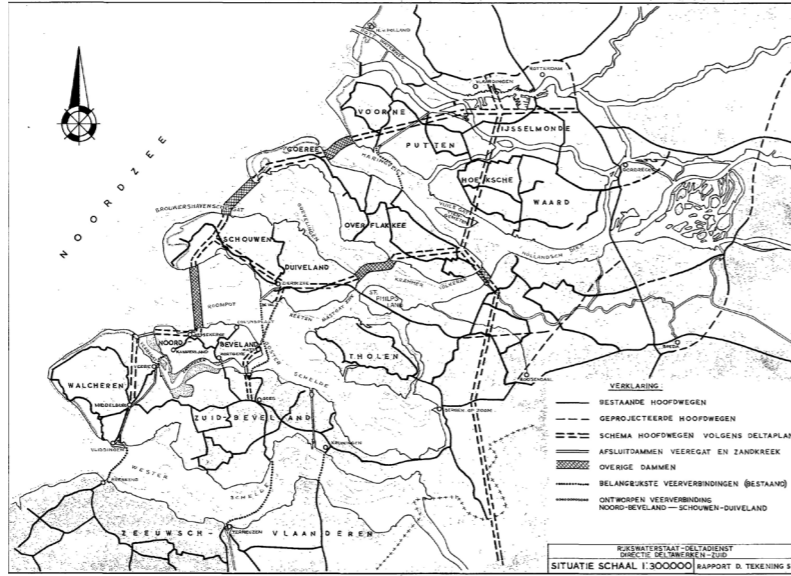


Figure 2.3: Plan of Van Veen for the Deltawerken (1954)

laid pointed simultaneously in two directions. His closure plans for the southwestern delta were grounded in hydraulic calculation. At the same time, one of his most far-reaching schemes, *het Verlandingsplan*, worked with natural sediment dynamics rather than against them (Van der Ham, personal communication, 7 April 2026). Van Veen was, in a sense, the intellectual father of both the hard closure paradigm and a predecessor of the “building with nature” approach.

In 1939, Van Veen's colleague Wemelsfelder introduced probability calculus to storm surge analysis, demonstrating for the first time that the highest historically observed water level was essentially arbitrary and that higher stands always carry a small but non-zero probability of occurring (Wemelsfelder, 1939). Van Veen had estimated the human cost of a catastrophic storm surge in the southwestern delta, and his warnings circulated in successive memoranda through the 1940s. On 7 January 1948, the newspaper *Het Vrije Volk* even published the outlines of Van Veen's delta plan (figure 2.3), so the risk was publicly visible. The combination of rising sea levels, subsiding land, and deepening tidal channels made the danger legible to those who examined the numbers. Yet the political and institutional infrastructure to act on them remained absent: sea dike management was fragmented in Zeeland across 263 separate water boards, each managing its own stretch, with minimal national coordination (Van der Ham, 2018a).

The suppression of risk knowledge was not confined to the institutional sphere. Van de Poel (2009)

documents that in the years before 1953 there was no public disclosure whatsoever about the possible deficiency of the existing sea dikes. The inhabitants of Zeeland were left entirely without warning. The asymmetry extended to the press. In late 1952, weeks before the flood, journalist Herman Looman submitted an article to Elsevier documenting the deficient state of the Zeeland sea dikes. His editor, De Keizer, rejected the piece, arguing that a

population still recovering from the war should not be burdened with the prospect of drowning (Van de Poel, 2009). The article went unpublished. The 1953 flood arrived shortly after. Technical knowledge of catastrophic risk had reached the threshold of public attention and was withheld. Not by malice, but by a cultural logic that placed the management of collective mood above the management of physical risk.

2.2 The 1953 flood and the formation of a mandate

The Watersnoodramp of 1 February 1953 created the political conditions for an unprecedented programme. On the night of 31 January to 1 February 1953, a combination of spring tide and northwesterly storm surge breached the dikes of Zeeland, South Holland, and North Brabant. 1,836 people drowned.

Some 9% of Dutch agricultural land was inundated. The disaster produced political conditions for a programme of unprecedented scale. In Zeeland, the physical memory remained literal for decades: families could point to the watermark on the walls of their homes.



Figure 2.2: Portrait of Johan van Veen, hydraulic engineer at Rijkswaterstaat, architect of the Delta Plans



Figure 2.4: Nieuwerkerk op Duiveland, two months on water still at roof height

Within weeks, the government established the Deltacommissie (Delta Committee) under the chairmanship of Ir. A.G. Maris, Director-General of Rijkswaterstaat, with Van Veen as its secretary. Van Veen's long-ignored warnings now carried the weight of prophecy. The commission's mandate was extensive: shorten the Dutch coastline by closing the southwestern river delta inlets, reducing the storm-surge-exposed dike length from approximately 800

to 80 kilometres. The emergency character of the political moment compressed what might otherwise have taken decades of institutional negotiation into months of decision.

The commission's analytical foundation rested on Wemelsfelder's prewar probability calculus. The working group on safety, chaired by De Blocq van Kuffeler, established at the outset that

“absolute safety is unattainable” and that the degree of protection was a matter for governance to determine rather than engineering to prescribe (Van der Ham, 2018a). The delta of central Holland, the commission settled upon, should be protected against a storm surge with a probability of once in 10,000 years, corresponding to a design water level of 5 metres above NAP at Hoek van Holland (Deltacommissie, 1960). This probabilistic safety norm, combined with an economic analysis by Jan Tinbergen demonstrating a favourable cost-benefit ratio, provided the technical and economic foundation for the programme (Deltacommissie, 1960). The final report recommended closing the major sea inlets of the southwestern delta by means of dams and sluice complexes (figure 2.5), keeping only the Westerschelde and Nieuwe Waterweg open for shipping. The legal foundation followed on 8 May 1958, when the Deltawet gave statutory force to this mandate, committing successive governments and parliaments for decades (Deltawet, 1958).

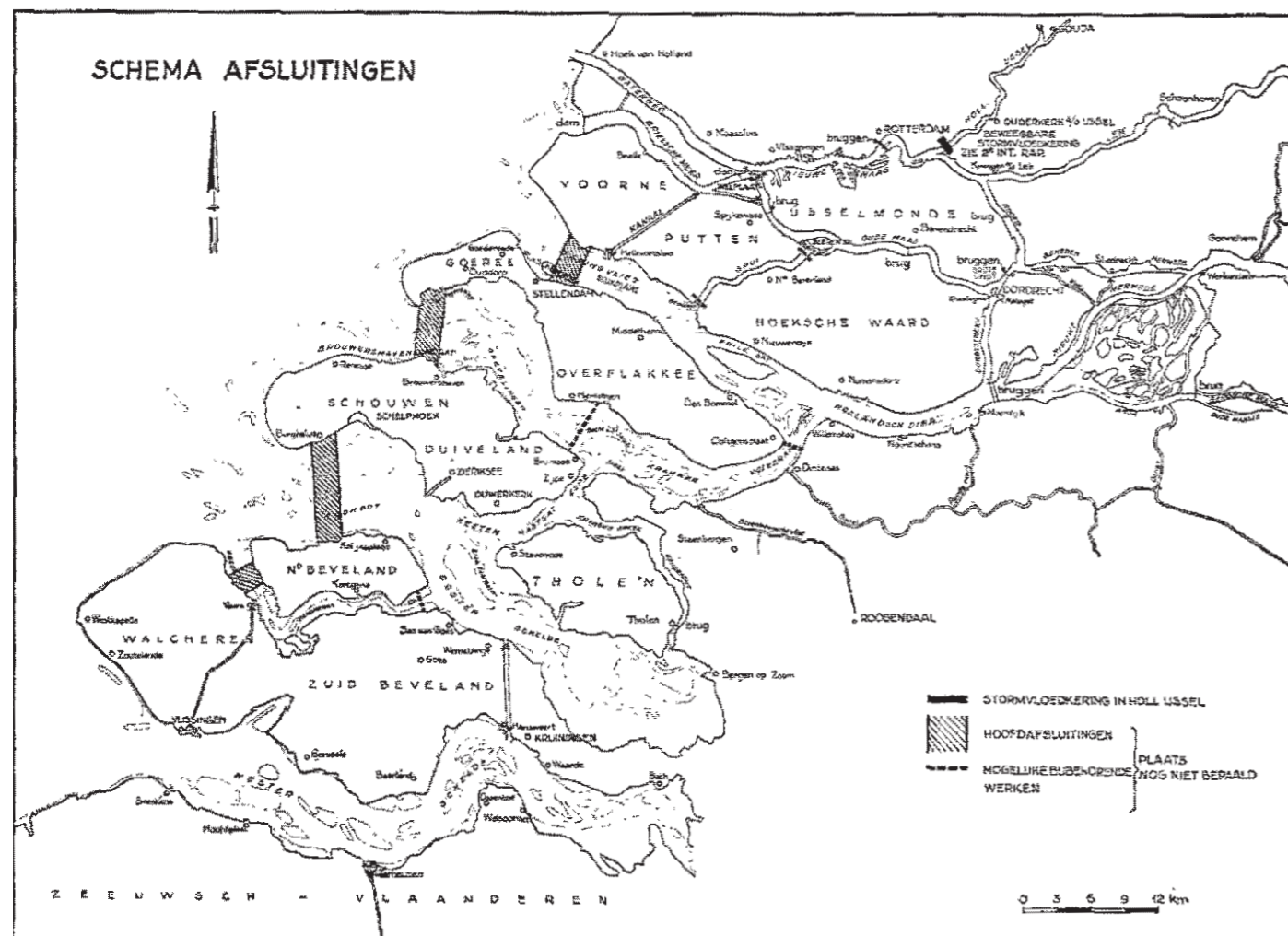
The earliest ecological warning within this institutional process came in 1955, when biologist H.N. Mörzer Bruijns presented evidence to the parallel Stormvloedcommissie that closing the sea inlets would destroy the tidal ecosystems of the southwestern delta. His warning was registered and set aside. The hydraulic engineering imperative was dominant. The institutional vocabulary to weigh an

ecological objection alongside a safety norm was still absent from the programme’s structure (Van Heezik, 2018).



Figure 2.5: Johan van Veen presenting the Deltaplan as the advice of the Deltacommissie in 1954

Figure 2.6: Schematic overview of the presented closure map



2.3 Programme execution and the first signs of tension (1958–1968)

The Deltadienst, the dedicated Rijkswaterstaat division established to execute the Delta Works, was formally constituted in 1956 and began full operations from 1958. The programme was deliberately sequenced as a learning trajectory: the earlier closures were to serve as preparation for the greater challenges ahead, with the Deltadienst establishing a dedicated unit for developing new working methods from the outset (Berkers, 2018). The early closure works proceeded with relative technical and political straightforwardness: the Veerse Gatdam (1961), the Grevelingendam (1965), the Volkerakdam (1969), and the vast Haringvliet sluice complex (1970). The Deltadienst operated as a formidable institution: the hydraulic research institute De Voorst ran up to 25 simultaneous scale models of delta dynamics, producing a knowledge base without close equivalent elsewhere in Europe (Berkers, 2018).

The Oosterschelde was different from the beginning. A parallel body, the Commissie Zuidwest, was tasked with assessing the socio-economic implications of the closures for the southwestern region. Its findings were potentially inconvenient: the commission concluded that full closure of the Oosterschelde would cause irreversible harm to the regional shellfish economy. The way these findings were handled within the broader planning process, characterised by one participant as a “gentle death” for an inconvenient conclusion and facilitated in

part by Rijkswaterstaat’s selective presentation of its own data, became a critical source of later contestation (Westerheijden, 1988). Crucially, a first internal discussion of a storm surge barrier had already occurred within the Deltacommissie in January 1955. The option was assessed, deemed technically feasible in principle, but set aside as “probably too costly”: an economic judgement that shelved the concept for two decades (Van der Ham, 2018a).

The ecological consequences of the programme’s first closures were rapidly visible. The Veerse Meer, created by the Veerse Gatdam closure in 1961, demonstrated what full closure would mean: within years, the tidal ecosystem collapsed into an ecologically degraded brackish lake. The deterioration was observable but lacked the institutional weight to alter the programme’s course (Disco, 2000). Systematic documentation of what was being lost was underway: from 1958, the KNAW’s Delta-Onderzoek unit at Yerseke recorded the changes entirely outside the Deltadienst’s institutional range. Its director, Karel Vaas, described the work as writing a necrologie, an obituary, of the delta’s tidal ecosystems (Van Heezik, 2018). The knowledge was accumulating and the question was when it would enter the political arena.

Figure 2.7: Completion of the Veerse Gatdam, one of the first Deltawerken (1961)



2.4 The Oosterschelde reframing (1968–1976)

The years between 1968 and 1976 constitute the most consequential period of the Deltawerken. Three overlapping processes drove a fundamental transformation of the programme's logic: a broad societal shift in environmental consciousness, the formation of a politically effective coalition opposed to full closure, and the gradual emergence of new technical possibilities.

The shift in public sentiment was rapid and surprised nearly everyone, including Rijkswaterstaat itself. The late 1960s brought critical questioning of unlimited economic growth and the authority of technical experts. The Club of Rome report (1972) landed, in the words of one observer, "like a bolt from the blue." The Aktiegroep Oosterschelde Open, founded around 1969, gave the opposition a public face and



Figure 2.8: Protest against the closing of the Oosterschelde (Paul de Schipper)

political access. Its importance was especially the coalition it helped assemble. The shellfish industry, whose livelihood depended on the tidal estuary, aligned with environmentalists and progressive political parties around a shared position, despite starting from very different premises (Meijerink, 2005). The Keerpunt '72 coalition agreement of the left-wing parties committed the incoming Den Uyl government to environmental protection as a first-order priority, giving this coalition formal political representation.

Within Rijkswaterstaat, the response was quick. W.T. Ferguson, Chief Engineer and Director from the mid-1960s and a former colleague of Van Veen, had an instinctive sensitivity to the shifting social context.

He had initiated early environmental services within Rijkswaterstaat and was already uncomfortable with the trajectory of the Oosterschelde even before the public debate reached its peak (Van der Ham, personal communication, 7 April 2026). In his memoirs, Ferguson described the earlier closures as a leerschool (school of learning), positioning the Oosterschelde as its eindexamen (final examination). When the ecological requirement entered the picture, he acknowledged that "the examination requirements had suddenly been made heavier" (Ferguson, 1981). A cohort of younger engineers within the Deltadienst saw the ecological challenge

not as a threat but as an opportunity: the question of whether a tidal estuary could be protected while also being protected from surge opened technical possibilities that a straightforward closure dam had foreclosed.

The political path toward an alternative was opened partly from an unexpected group. In 1972, an interdisciplinary group of students from TU Delft, combining engineering, biology, landscape architecture, and urban planning, produced a detailed report proposing a storm surge barrier as a workable alternative to full closure. At a public conference, Ferguson acknowledged that the proposal was "no science fiction" but technically feasible (Van Heezik, 2018). D66 parliamentary leader Jan Terlouw seized on this public admission and pressed the minister for a formal study of the alternative. The chain from student report to parliamentary intervention to ministerial mandate illustrated how knowledge produced outside the engineering establishment could travel into the political arena through communicative acts at key junctures. Terlouw was also important as public intellectual who, alongside the environmental movement, argued for dike-strengthening instead of dam-building. He did so, for example, as the author of the children's book *Windkracht 10*, in which he writes about the 1953 disaster and contemporary water safety considerations.

The formal institutional response was the Stafgroep Totaalontwerp (Total Design Task Force) established under Frank Spaargaren, charged with assessing the full range of alternatives to the closed dam (Van Heezik, 2011). Its composition was deliberately cross-domain, including engineers, ecologists, economists, and regional planners. At its peak the group assessed approximately 360 design variants. The scope was exploratory rather than systematic: the design space itself had to be constructed before it could be searched. Ferguson describes the broader shift in terms of patient consent: the original plan had been agreed, but "the patient no longer agreed to the operation." He made a pivotal institutional move: the appointment of biologist Henk Saeijs to Rijkswaterstaat (Berkers, 2018). Saeijs held formal training in civil engineering alongside his biological expertise, which gave him standing within the technocratic culture of the Deltadienst. He could address hydraulic engineers in their own epistemic language. His role was to make the ecological dimension legible to an organisation whose knowledge base had been almost exclusively hydraulic and structural, and his published work on ecopragmatisme translated ecological values into terms an engineering community could engage (Saeijs, 1999).

The political decision came before the engineering solution had been found. The November 1974 cabinet decision to pursue a storm surge barrier rather than a full closure dam, issued under prime minister Den Uyl, committed the programme to an outcome whose technical realisation remained uncertain (Westerheijden, 1988). The conceptual solution came from two directions simultaneously. Provincial Governor Jan Klaasesz, who chaired the commission tasked with finding a solution, was a jurist with no engineering background. Van der Ham (2018a) describes him as someone who knew nothing about technology. It was precisely this distance from engineering convention that allowed him to propose a barrier with movable sluice gates, open by default and closeable only during storm surge. The new Den Uyl cabinet had also mandated that the commission include biologists, ecologists, and economists alongside engineers, a



Figure 2.9: Henk Saeijs as he explains the Deltawerken to a visiting foreign prime minister (1993)

structural difference from the composition of the original Deltacommissie (Van Heezik, 2018). Age Hoekstra, a Rijkswaterstaat engineer, reached the same conclusion independently through a six-week feasibility study that drew on the organisation's full technical resources. When Hoekstra's study confirmed viability, the solution rapidly gained institutional traction. The RAND Corporation was subsequently commissioned to conduct the POLANO study, an independent policy analysis of the barrier option. The choice of an external research organisation was politically deliberate: Rijkswaterstaat sought an analysis that would appear independent of its own institutional interests (Van Heezik, personal communication, 6 March 2026).

2.5 Construction, completion, and institutional turn (1976–1997)

The decision to build the Oosterscheldekering required engineering solutions without precedent. None of the specialised ships deployed in its construction had existed before. The foundation caissons, each weighing approximately 15,000 tonnes, were constructed in a dry dock excavated within the estuary itself, as can be seen in figure 2.10. The methods for placing them in swift tidal currents, the steel gate coating systems, and the hydraulic drive mechanisms were all first applications of principles developed specifically for this project. The bouwteam model, a construction-team structure in which contractor and Rijkswaterstaat engineers worked jointly from the earliest design phases, was developed partly in response to the complexity of the task. On 4 October 1986, Queen Beatrix operated the last sliding gate. The formal declaration that followed announced the completion of the Delta Works.

The Oosterscheldekering came with an ecological cost that the programme’s designers had partially anticipated. The phenomenon of *zandhonger* (sand hunger) describes the process by which the partial closure of the estuary, allowing tidal exchange to continue at reduced volume, disrupted the sediment balance of the intertidal flats. The tidal flat ecosystem the barrier was designed to protect began to erode, because the tidal energy available to transport sand onto the flats had diminished. Zandhonger remains an ongoing challenge, a consequence of the engineering solution that the ecological models of the 1970s had registered but not fully resolved (Disco, 2000).

Figure 2.10: Each foundation caisson needed almost 7000m³ of concrete. Between 1979 and 1983, 450.000m³ of concrete was processed in the dock.



During the 1980s and 1990s, Rijkswaterstaat progressively externalised engineering work and adopted privatisation-oriented reforms. From 2004 onward, these trends consolidated into what is commonly described as the “bedrijfsmatige wending” (business-like turn). This entailed a full organisational shift toward contracting out, project-execution logic, and cost-driven procurement. The institutional infrastructure of the Deltaschool, the informal learning community through which a generation of hydraulic engineers had built shared technical knowledge over decades of collective work, was progressively dismantled. Technical expertise that had been held as a common institutional resource was externalised to contractors or simply lost as engineers retired under early-exit schemes

(Van der Ham, personal communication, 7 April 2026).

The Maeslantkering, the floating storm surge barrier on the Nieuwe Waterweg completed in 1997, was constructed in this new way of working. Its construction was awarded through a design-and-construct contract to a private consortium, transferring both design responsibility and construction risk to the private sector. The safety standard was a failure probability of 1 in 1,000,000 per year, ten times more stringent than the Oosterscheldekering’s design norm (Van der Ham, 2018a). On 10 May 1997, Queen Beatrix opened the completed Maeslantkering. The Delta Works programme was now formally complete.

2.6 Legacy: A transformed landscape and changed relationship with water

The Deltawerken transformed the Netherlands’ relationship with flood risk in ways that were extraordinary in scale and lasting in consequence. The southwestern delta’s coastline was shortened by approximately 700 kilometres. The programme cost approximately five billion euros. It advanced hydraulic engineering techniques studied and applied worldwide. The American Society of Civil Engineers designated the Deltawerken as one of the seven wonders of the modern world (Toussaint, 2018). The regional transformation was equally significant. The economic geography of Zeeland had changed. Isolation, agricultural dependence,

and demographic decline, a characteristic of 1953, were fundamentally altered by forty years of infrastructure investment and freshwater management (Brusse, 2018).

In 1988, the Wet op de Waterkering (Water Management Act) gave constitutional force to flood safety norms across the country for the first time. It required dike rings be tested against applicable standards. It established administrative mechanisms for financing water safety. The Act came into force in 1996. The number of water management authorities (waterschappen) was reduced from about 3.000 small bodies in 1953 to 22 professionally equipped organisations by 2018. These organisations were far better resourced and technically capable (Van der Ham, 2018a).

The Deltawerken changed the approach to engineering, safety, and nature. The Oosterschelde controversy left its marks. Environmental consciousness continued shifting through the second and third phases. From the early 1990s, a new paradigm emerged: “bouwen met de natuur” (building with nature). This approach sought to harness natural processes rather than simply overcome them. In 2008, a second Deltacommissie was established to address climate change implications. It concluded that existing protection levels would require substantial upgrading (Toussaint, 2018). In this sense, the Deltawerken did not close a chapter in Dutch water management. They opened a new one. They established institutional capacity and engineering precedent for continued engagement with a future that the original Deltacommissie set in motion in February 1953.

Figure 2.11: Overview map Delta Works



Figure 2.12: Queen Beatrix visits the Deltawerken (1964), the programme attracted political attention at the highest levels

3 THEORETICAL FRAMEWORK



This chapter develops the lens through which Chapter 4 will re-read the historical case. It does so in three layers. The first layer is epistemological: pragmatism shapes how the thesis treats inquiry, knowledge, and action. The second layer is the lens of future-making, approached first through Andersson's (2018) intellectual history and then through Wenzel, Cabantous, and Koch's (2025) practice-theoretical reading. The third layer reaches into design and innovation theory for the descriptive vocabulary that the practice perspective

makes available: Smulders' (2014) IDER model, C-K theory (Hatchuel & Weil, 2003), and a set of supporting frames covering learning, coordination across communities, legitimacy, and path dependence.

In each section, the theoretical material is presented on its own. The Deltawerken enters fully in Chapter 4, where the lens is put to work on a sequence of episodes drawn from the historical record.

Figure 3.1: The Deltar (Delta Getij Analogon Rekenmachine) was an analogue computer that simulated tidal behaviour in the delta by exploiting the physical analogy between water flow and electrical circuits, enabling engineers to predict the hydraulic consequences of each closure roughly one hundred times faster than real time. Operational from 1960 to 1984, it was purpose-built for the Deltawerken.

3.1 Epistemological ground: pragmatism

This thesis works from a pragmatist epistemology, which treats knowledge as an instrument that actors construct while dealing with situations rather than as a fixed mirror of an external reality. Pragmatism, as developed by Dewey (1938) and applied to professional practice by Schön (1983), holds that inquiry begins when a situation has become indeterminate, and proceeds through directed action that aims to render the situation determinate again. The outcome of inquiry is itself an intervention in the situation.

Building on this foundation, Schön (1983) extends the pragmatist position into a theory of how professionals act. His vocabulary of knowing-in-action and reflection-in-action describes the

situated, partly tacit knowing that practitioners bring to the situations they work in, and the capacity to restructure understanding when those situations push back. Stomppff, van Bruinessen, and Smulders (2022) extend this pragmatist position into the domain of design inquiry, demonstrating how knowledge is produced through practice, tested through action, and made warranted through communal reflection.

For a thesis that traces collective future-making across decades, this foundation is important. The analysis should be focused on what actors knew, did, and reframed at specific moments rather than judging that against a vantage point they themselves did not possess.

3.2 Futuring as anthropological, political, and technocratic concept

Jenny Andersson's (2018) intellectual history of futures studies traces how the future became a domain of expertise, institution, and contested authority across the twentieth century. Where the future had previously been a moral and philosophical category, the post-1945 period turned it into something to be modelled, scenarised, planned for, and increasingly governed. Scenarios, systems models, and forecasting tools became the instruments through which modern states and corporations attempted to bring the future into the orbit of policy.

Andersson's reading moves across several levels. At the anthropological level, the future operates as a category through which modern societies make sense of themselves. It is a horizon of expectation, in Koselleck's formulation, as taken up by Andersson (2018), that gives shape to present action. At the political and geopolitical level, the future appears as a site of struggle. The Cold War in particular institutionalised competing futures (capitalist, socialist, technological, ecological) as objects of study and as instruments of statecraft. Particular institutions, from the RAND Corporation to the Club of Rome, turned the future into a contested professional terrain with its own actors, methods, and stakes. At the technocratic level, futurology grew up as a domain of expert authority, with its own journals, methods, and elite bodies. Andersson shows that this technocratic mode was always accompanied by, and frequently in tension with, more value-driven and politically mobilised forms of future-making (Andersson, 2018).

A further insight concerns performativity:

predictive instruments such as scenarios, cost-benefit analyses, and quantitative models did more than describe possible futures. They intervened in the present, making certain futures appear feasible, necessary, or rational, and casting others out of view. Beckert (2021) reflects on this insight: designing and controlling images of the future is an instrument of governance as much as of prediction. Political struggle over which futures appear feasible is therefore also a struggle over which possibilities are cognitively foreclosed.

The construction of the Deltawerken sits head-on inside Andersson's description of mid-century technocratic futuring. Reading the case through Andersson is revealing, though for this thesis it is also the limit of what she can reach. Andersson works at the level of intellectual and political history. The practices through which actors made these futures (the day-to-day, situated work of building scale models, debating across disciplines, and lobbying ministers) fall outside her description. To enter that practice, the chapter turns to a second body of work.

3.3 The practice turn: futuring as situated activity

Wenzel et al. (2025) re-present futuring as a socially enacted, practically situated activity that takes place inside organisations and across the relationships that bind them to their environments. Their practice-based framework gives the analysis four sensitising dimensions.

1. *Performativity.* Futuring is an active shaping of what becomes possible. The utterance of a future in a plan, a scenario, a commission report, or a piece of legislation does more than describe a possible state of affairs. It generates commitments, mobilises resources, and forecloses alternatives. Wenzel et al. (2025) use the term in a stronger sense than Andersson, drawing on practice theory: futures come into being through the performance of practices that produce and enact them. The Deltawet of 1958 is performative in this stronger sense. Construction had already begun before the law was passed. The Act did not initiate the programme but formalised and committed successive governments and parliaments to its completion.

2. *Situationality.* Futuring practices are always embedded in specific institutional, temporal, and material contexts. The same future-claim does different work in different settings. What can be imagined, who is entitled to imagine it, and which imaginations carry institutional weight are all conditioned by where and

when the imagining takes place.

3. *Heterogeneity.* Multiple, often competing futures coexist in any programme. The work of future-making involves the negotiation, selection, and eventual stabilisation of one future among several. Furthermore, it entails the corresponding marginalisation of its alternatives. The Oosterschelde debate of the early 1970s is the case's clearest expression of this dimension: at least three futures (closure, full openness, a barrier with movable gates) were institutionally present at the same time, each carried by different actors and supported by different bodies of knowledge.

4. *Relationality.* Futures are made in and through relationships, between actors, between disciplines, between organisations, between present and anticipated conditions. Futuring is irreducibly social. It can only be analysed as a structured practice; reducing it to the cognitive act of an individual loses the structure that gives it its shape.

Together, Wenzel et al.'s (2025) contribution opens what Andersson largely keeps closed: the black box of futuring practice. With the surface texture of the practice described, this thesis attempts to describe its inner mechanics with design theory.

3.4 Design theory to take a look under the hood of future-making practice

The remainder of the chapter assembles the design-theoretic vocabulary that the analysis in Chapter 4 will use. The components are presented in the order in which they are most likely to appear in the case: a temporal backbone, a vocabulary for the interaction of knowledge and concept, the pragmatist stance of generative doubt, the design-theoretic concepts of design-ability and DfX, and the literature on coordination and legitimacy across communities.

3.4.1 IDER as framework for innovating on a temporal axis

Smulders' (2014) IDER model identifies four phases that recur across innovating activities (Initiating, Designing, Engineering, and Realising) assembled from a long programme of empirical work on innovation processes. The phases are not stages in a stage-gate sense. They describe qualitatively different relationships between actors and the unknown they are working with, and the model holds that they recur at every level of the social dimension, from the individual through the inter-subjective to the collective (Smulders, 2014).

For a multi-decade infrastructure programme, IDER fits in two ways. The first is its temporal flexibility. The phases can be mapped onto the long arc of a programme as well as onto the small cycles that nest inside it: a single experiment, a single committee, a single design decision can be read as its own IDER cycle. The second is its allowance for parallelism. Smulders' (2014) explanations include cases in which Designing and Realising activities ran simultaneously, with realisation

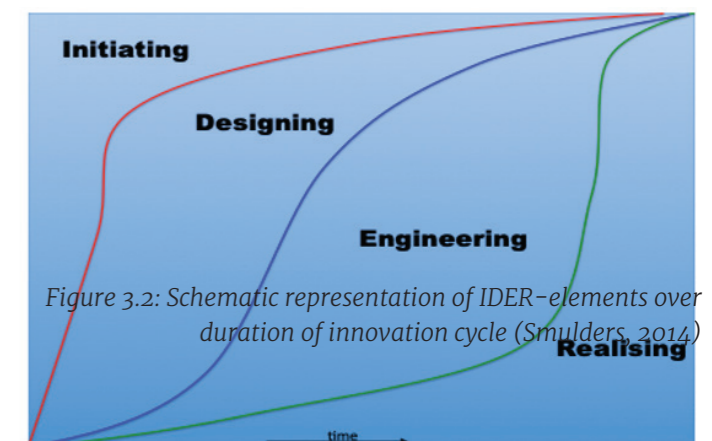


Figure 3.2: Schematic representation of IDER-elements over duration of innovation cycle (Smulders, 2014)

underway while design was still being completed. Read against the Deltawerken, this insight holds. The Oosterscheldekering was under construction while the design of the gates was still being finalised, and embedded experimental cycles, the Noordoostpolder test landscape among them, ran inside the programme as smaller IDER episodes inside the larger one.

The model also resists a particular misreading of innovation as the development of a new object or technology. Innovation, in Smulders' (2014) working definition, is a behaviour that introduces something new into a context such that the context itself changes. The appointment of Saeijs as first biologist in the Deltadienst, is innovation in this sense. The introduction of an actor that changed the discourse of the institution he entered.

3.4.2 Concept-knowledge theory: a precise vocabulary, applied lightly

Hatchuel and Weil's (2003) Concept-Knowledge (C-K) theory describes the interaction between two epistemic spaces. The Knowledge space (K) contains propositions with a definite logical status, either true or false within the current state of knowledge held by a community. The Concept space (C) contains propositions whose logical status within K is undecided, well-formed but unproven. Design proceeds through interactions between these spaces: concepts can be elaborated by adding properties, tested against knowledge, opened by an expansion of knowledge, or refined within knowledge itself. Three points are worth flagging about how C-K theory is used in this thesis.

First, the framework was developed to describe designing at the level of a single project. Its deployment in a multi-actor, multi-decade public programme stretches it considerably beyond its original setting. This is acknowledged here as a limit. C-K theory is used as background support and to provide a vocabulary that helps describe with some precision what happened at specific moments of conceptual shift.

Secondly, the principle of K-relativity recurs throughout the case as an important phenomenon. What counts as knowledge for one actor or community can still be open concept-space for another. Van Veen's hydraulically grounded closure plans were knowledge for his Rijkswaterstaat colleagues and concept-space for political audiences who lacked the standing to treat them as established propositions.

Thirdly, certain formulations in C-space function as generative questions: structurally open propositions that invite concept-space expansion. "Can we close the Oosterschelde and preserve the tidal ecosystem?" is analytically distinct from "Close the Oosterschelde." The former opens a partition that the latter forecloses. In addition, the thesis lightly applies an Alpha-Beta-Gamma classification (Smulders, 2024). By adopting Alpha (meaning-making), Beta (technical-scientific), and Gamma (socio-interactive), the analysis can indicate where asymmetries between communities run. It is only used where the configuration of knowledge domains is itself the analytical point.

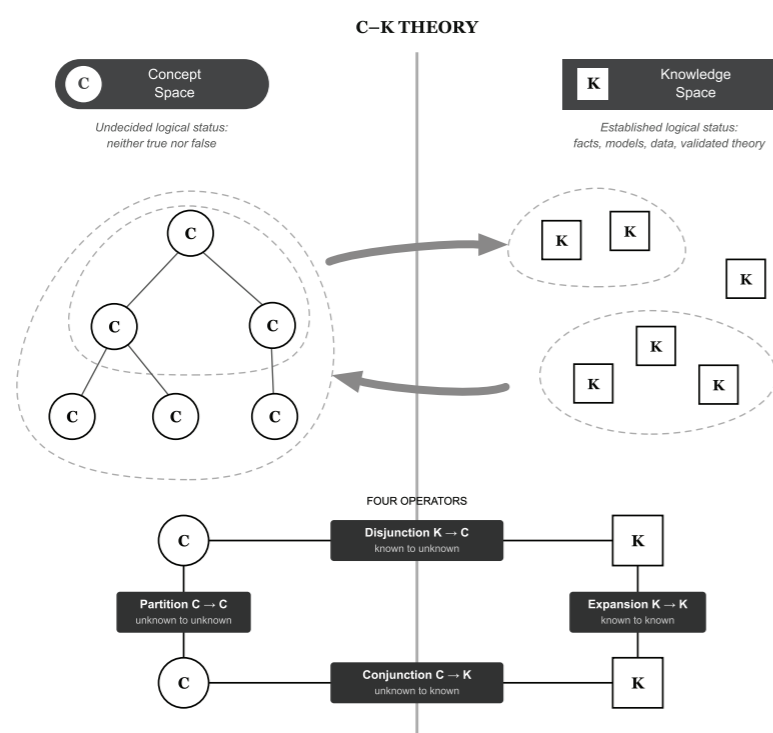


Figure 3.3: C-K theory diagram, adapted from Hatchuel and Weil (2003)

3.4.3 Path dependence: how a concept develops in a fixed direction

Path dependence gives the C-K vocabulary a temporal axis that this thesis lightly applies at programme level. The assumption is that concepts being developed do so on a path, and the adherence to that path describes what happens when self-reinforcing dynamics carry a concept in a fixed direction. Sydow, Schreyögg, and Koch (2009) provide the foundational framework for organisational path dependence, distinguishing three phases: preformation (scope of action is open and historically conditioned but not determined), formation (self-reinforcing dynamics progressively narrow the range of viable alternatives), and lock-in (a dominant pattern gains quasi-deterministic character and the organisation can no longer readily shift to an alternative). Their model translates directly onto the C-K framework: preformation corresponds to an open concept space with multiple available partitions, formation to the progressive dominance of restrictive partitions as self-reinforcing loops channel knowledge expansion along a single branch, and lock-in to a state in which the concept has hardened into knowledge and alternatives have left active consideration. Camuffo, Gambardella, and Kazemi (2025) extend this line of inquiry by shifting attention from the organisational mechanisms that sustain a path

to the cognitive conditions that initiate one: the theories and priors through which decision-makers frame their situation determine which paths become visible in the first place, and which remain outside the consideration set. The thesis maps these stages onto the C-K framework in figure 3.4.

March's (1991) exploration-exploitation distinction describes the underlying dynamic. Exploitation as an activity happens in restrictive partitions, refining and validating the existing concept. Exploration as an activity happens in expanding partitions, opening new branches. March's central insight is that exploitation tends to be systematically favoured because its returns are nearer and more certain, a structural explanation of why concept space narrows during the formation phase.

In the Deltawerken case, two distinct exemplary phases will be read. The persistence of the "water buiten" paradigm into the late 1960s illustrates compulsive lock-in, in which an inherited concept is maintained because revision has become institutionally costly. The construction of the Oosterscheldekering after 1976 illustrates productive lock-in, in which commitment to a well-formed concept channels resources toward realisation. Chapter 4 attempts to distinguish these two forms, and to identify the conditions under which a programme can manage the transition between them.

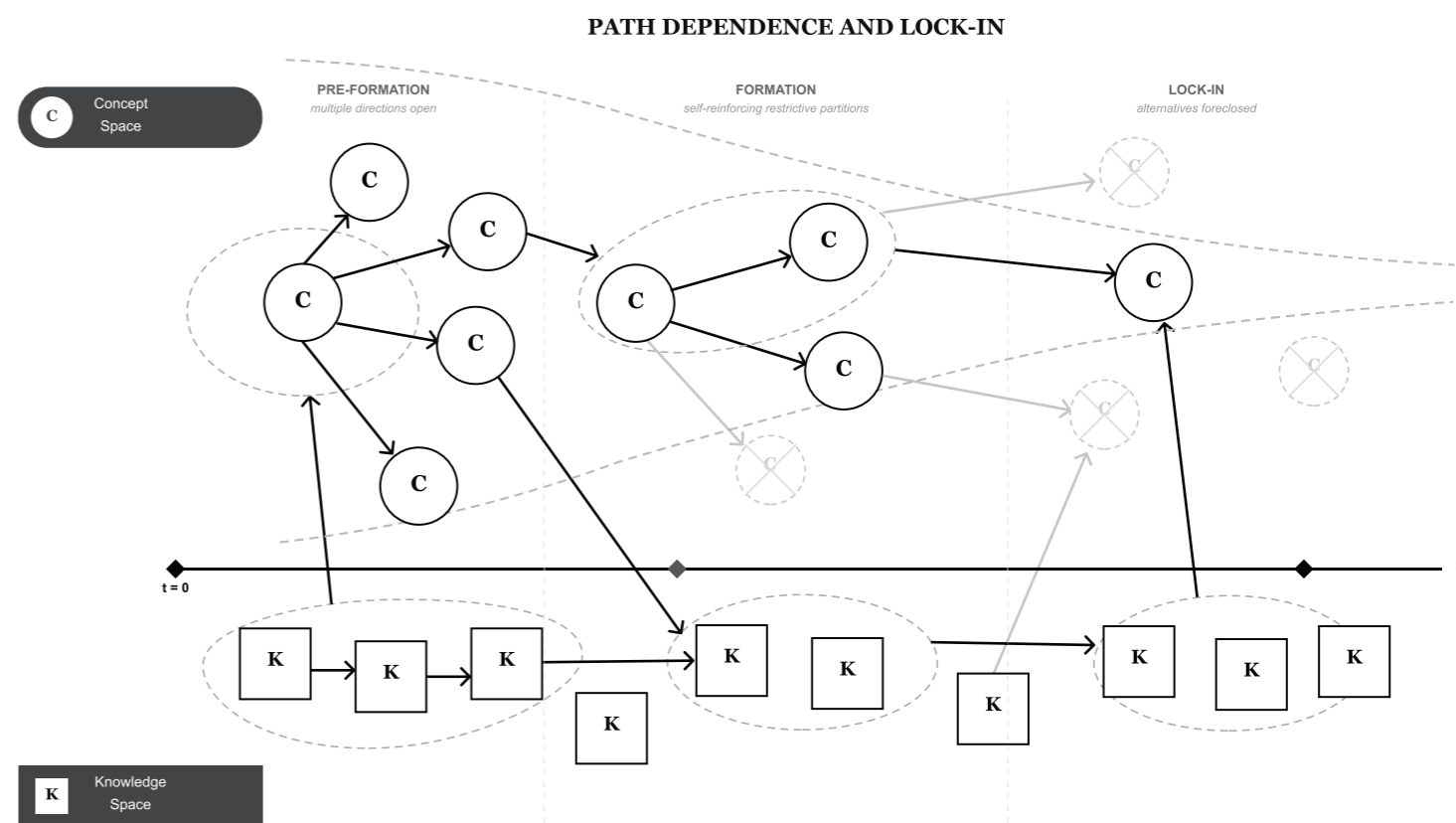


Figure 3.4: Path dependence and lock-in on a C-K diagram (adapted from Sydow, Schreyögg & Koch, 2009; Camuffo et al., 2025; Hatchuel & Weil, 2003)

3.4.4 Learning and expertise

Two concepts are introduced here to understand episodes in which the question is what actors knew, what their organisations let them learn, and how that learning translated back to practice. Argyris and Schön's (1978) distinction between single-loop and double-loop learning provides a concise vocabulary for situations in which the governing premises of a programme are themselves at stake. Single-loop learning detects and corrects errors within an existing framework; double-loop learning revises the framework itself. The Oosterschelde redesign required double-loop learning: the governing premises were revised, not just the actions taken within them.

As actors in an organisation learn, they develop expertise. The Dreyfus and Dreyfus (1980) five-stage model of skill acquisition gives the analysis a precise way to characterise the role played by actors at specific moments. The cohort of younger engineers inside the Deltadienst during the early 1970s, for instance, were advanced beginners working in a field that was itself blossoming. Their position closer to C-space, less shaped by the routines that were in place, made them generatively productive. They were given space to experiment on the condition that the experiments fed back into a body of knowledge under construction. This was action research in the pragmatist sense, elevated to a deliberate institutional mode (Dewey, 1938; Argyris & ers & Gür, 1978).

3.4.5 Generative doubt and the pragmatist stance

Generative doubt is the productive holding-open of the problem frame so that new knowledge can enter. It stands in contrast to decision-postponing doubt, which involves the risk-averse contraction of the solution space. Both forms involve not-deciding; the distinction lies in what the doubt does to the design space. Generative doubt expands it: new knowledge enters, new options become legible, the brief is enriched. Decision-postponing doubt contracts it: options are foreclosed by inaction, the window for course correction narrows, and the eventual decision is made under conditions of fewer rather than more possibilities.

Dewey's (1938) description of doubt as the trigger of inquiry sits underneath this distinction: doubt opens inquiry because it reveals that the current frame has become inadequate. The Deltawerken displayed sustained generative doubt at several key moments. The 25 simultaneous scale models running at De Voorst in the 1960s were the institutional expression of a programme that had committed to learning before committing to specific designs (Berkers, 2018). The *Stafgroep*

Totaalontwerp's exploration of approximately 360 design variants in the early 1970s was the same logic deployed under far more politically charged conditions (Van Heezik, 2018).

3.4.6 Design-ability and Design for X

Engineerability (“*maakbaarheid*”) and design-ability (“*ontwerpbaarheid*”) are analytically distinct, and that distinction is at the heart of this thesis's argument about the Deltawerken. Engineerability describes the execution of a settled design in the K-space of validated practice. It operates within what Disco, Rip, and Van der Meulen (1992) characterise as a technological regime: a self-reproducing configuration of university training, professional socialisation, and codified design practice that defines what counts as relevant knowledge and competent performance. The dominant narrative about Dutch hydraulic engineering has long been about engineerability. That narrative was sustained by the cosmopolitan technical regime of hydraulic engineering that Disco et al. describe. The thesis coins Design-ability as contrasting capacity: the social capacity to sustain a collective design process across communities of practice while the brief itself is still being formed. An organisation operating in engineerability mode tends to read challenges as problems of execution; the same challenge in design-ability mode appears as an open design question. The reframing argued here is that the truly consequential moment of the programme, around the Oosterscheldekering, sat one step upstream: it required stepping outside the technological regime's perimeter.

Design for X (DfX) gives a further description of what happens at the requirements end of a design-ability episode. In the DfX literature, X is a placeholder for any activity or goal that a design process must treat as a primary driver from the outset, rather than as a downstream constraint (Arnette et al., 2014). The logic of DfX is that incorporating a new X restructures the entire design brief. In the Oosterschelde reframing, the addition of an ecological dimension was not an ‘just an extra requirement added to a list.’ This episode is, in this reading, a Design for Ecology (DfE) episode. The label gives the analytical observation a vocabulary that design practitioners will recognise.

3.4.7 Knowing across communities: boundary objects, spanning, legitimacy

Futuring is made in and through relationships across actors, disciplines, and organisations (Wenzel et al., 2025). What counts as settled knowledge in one community can remain in concept-space for another, so the movement of knowledge across

communities is a practical problem that futuring programmes must solve at every consequential stage. Star and Griesemer (1989) define boundary objects as artefacts, methods, and institutions that are “plastic enough to adapt to local needs and constraints” and “robust enough to maintain a common identity across sites.” Boundary objects allow collaboration without face-value consensus, holding the meaning each community needs while preserving enough shared form to keep communication going.

Carlile (2002, 2004) extends the framework by distinguishing three boundary types. A syntactic boundary exists where actors share a lexicon and information can be transferred straightforwardly. A semantic boundary exists where actors share information but interpret it differently, so that translation is required. A pragmatic boundary exists where actors interpret differently and have vested interests in their interpretations, and where transformation of knowledge bases on both sides is required. The Oosterschelde process, as Chapter 4 will show, moves across all three.

3.5 How the lens reads the case

The framework assembled across sections 3.1 to 3.4 is layered, and the layers are not equal in reach. Pragmatism sets the epistemological ground. Andersson's (2018) intellectual history and Wenzel et al.'s (2025) practice-based dimensions form the primary lens, positioning the Deltawerken within the broader history of modern futuring and supplying the vocabulary of performativity, situationality, heterogeneity, and relationality. The design and innovation theory components (IDER, C-K theory, path dependence, learning theory, design-ability, boundary work) do not provide a second lens. They provide the vocabulary with which to describe what happens inside the practice at specific moments, under conditions that the futuring lens has identified as analytically interesting.

The analytical force of this combination lies in a tension the framework makes legible. The Deltawerken, in its dominant retelling, is a story of engineerability: Dutch technical mastery applied to a well-defined problem. The lens assembled here reads for the moments where the programme exceeded the boundaries of its own technological regime (Disco et al., 1992), where the capacity at stake was not execution of a settled plan but the collective ability to hold a design process open while the brief itself was still forming. These are the moments at which engineerability gives way to design-ability, and they reveal conditions not visible from the engineering narrative alone.

Slob and Duijn (2014) identify three components of effective knowledge integration: boundary objects, boundary spanners, and legitimate boundary-spanning processes. Boundary-spanning requires both knowledge of two communities and standing in the dominant one. In the case, this will be illustrated by the appointment of Henk Saeijs, whose civil engineering training gave him standing in the Deltadienst's dominant community. The acting force that holds these dynamics together is legitimacy. Suchman (1995) distinguishes three types: pragmatic (the organisation serves the interests of its audiences), moral (it conforms to socially constructed norms), and cognitive (its activities are taken for granted as natural). Legitimacy is given by audiences rather than possessed by actors. The Deltawerken's founding phase carried strong cognitive legitimacy: building hydraulic infrastructure after a catastrophic flood sat in the cultural register of the obvious. The reframing of the Oosterschelde required the programme to actively reconstruct a legitimacy it had previously been able to assume.

What the lens surfaces is a recurring pattern: knowledge sufficient to change the programme's direction existed well before it became consequential. Van Veen's closure plans were hydraulically grounded decades before the 1953 flood. Ecological knowledge accumulated through the 1960s without entering the decision space. The analytical question is not whether knowledge was available but what had to change for it to cross from one community's knowledge space into another's concept space, acquire institutional standing, and restructure the programme's trajectory. The lens reads each episode for the conditions that enabled or prevented this crossing: boundary spanners with standing in the dominant community, the legitimacy architecture holding the prevailing future in place, and the institutional arrangements that channelled or suppressed generative doubt. Legitimacy, in its pragmatic, moral, and cognitive forms (Suchman, 1995), is not a separate concern running alongside the analysis. It is the force that determines whether knowledge can travel and whether concepts can survive long enough to be tested.

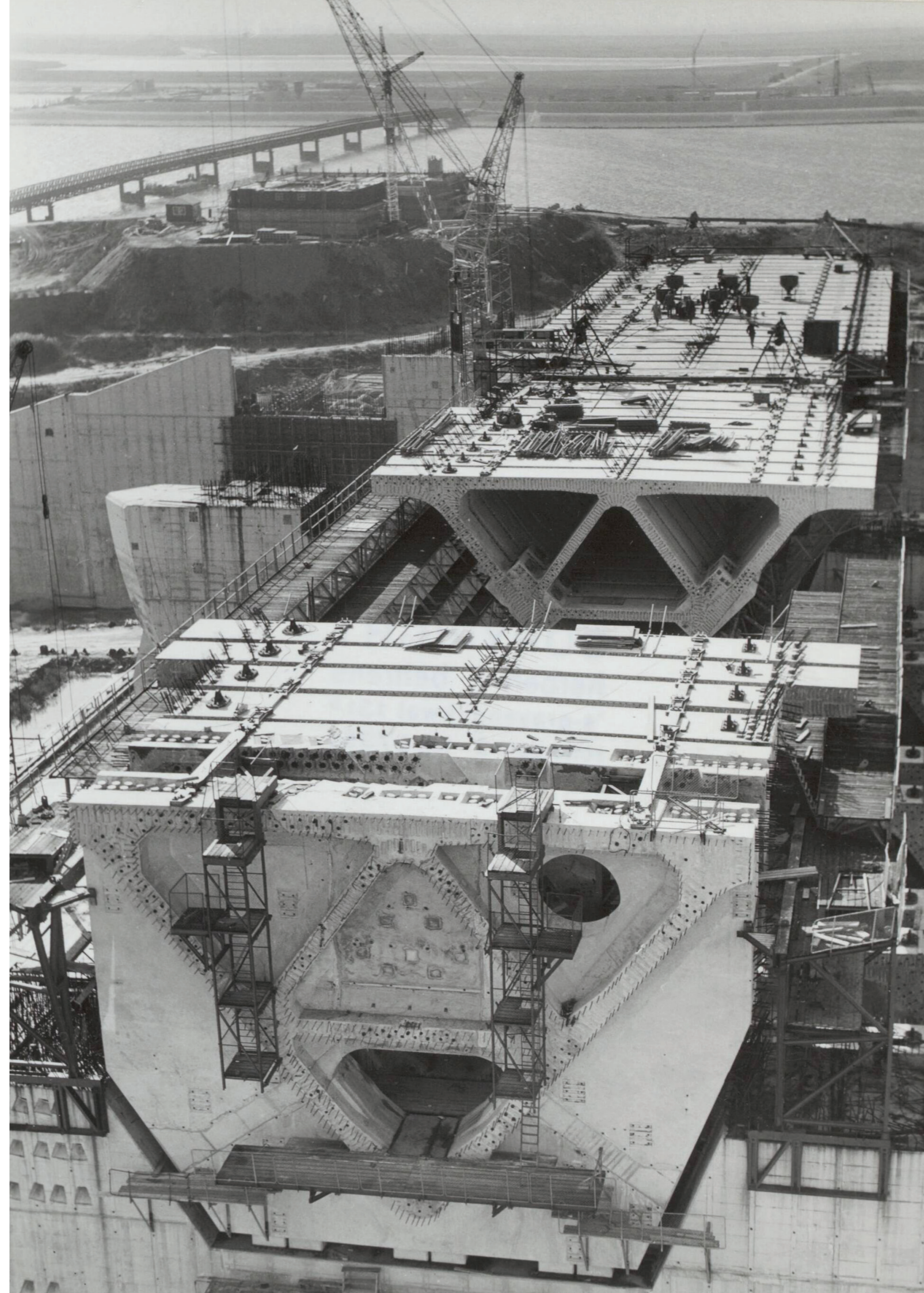
4 DELTAWERKEN AS CASE OF FUTURE-MAKING

This chapter re-reads the Deltawerken through the lens assembled in Chapter 3. Where Chapter 2 told the historic narrative of what happened, this chapter asks how the collective work of future-making happened at the level of practice. The reading is chronological and selective, and it follows the historical arc of the programme. It does so from the knowledge landscape that preceded the 1953 flood all the way through to the loss of in-house engineering capacity from the 1980s onward. For each phase, reading for what made future-making possible and what foreclosed it. Within that arc, illustrative examples are drawn from the historical record and from interviews conducted for this thesis. These vignettes are placed alongside the running analysis to make the evidential basis of each claim visible.

Each phase is read twice. The first reading, labelled 'future-making reading', uses the vocabulary of Andersson (2018) and Wenzel et al. (2025) to describe the dynamics of the period at the level of futures performed, contested, and stabilised. The second reading uses the design-theoretic vocabulary of Chapter 3 to describe the concrete practices and institutional mechanisms through which those futures were made. The two readings are complementary: the first locates the case within the broader history of modern future-making, the second opens the practice underneath.

The chapter closes with a set of lessons that gather what the chronological reading has shown. The lessons prepare the move into Chapter 5's translation of insights back to present-day.

Figure 4.1: Nabla girders under construction, Haringvliet. The triangular profile, named after the ancient Greek word for a harp, was engineered to withstand the exceptional current forces of the combined Rhine and Meuse discharge. Each of the seventeen sluice gates was suspended from this framework.



4.1 Before the flood: knowledge waiting for a mandate (pre-1953)

The Deltawerken did not begin with the 1953 flood. The knowledge from which the programme would emerge had been accumulating for decades, carried by a tradition of hydraulic engineering and institutional structures that shaped what could and could not be thought about the delta's future. Chapter 2 introduced the principal actors and events of this period. The analysis here asks a different question: what was the configuration of knowledge, institutional authority, and future-making capacity in the pre-1953 landscape, and why did a technically articulated plan for the delta's protection fail to become a performed programme?

Johan van Veen's closure plans were hydraulically grounded and technically articulated by the late 1930s. His successive proposals (the Vier-eilandenplan of 1938, the Vijf-eilandenplan of 1942) were designed to shift what was institutionally thinkable (Van der Ham, 2018a, p. 30). In parallel, his colleague Wemelsfelder introduced probability calculus to storm surge analysis in 1939, showing that the highest historically observed water level was essentially arbitrary and that higher stands always carried a non-zero probability (Wemelsfelder, 1939). The combination of rising sea levels, subsiding land, and deepening tidal channels made the danger legible to anyone who examined the numbers.

Yet the institutional conditions for translating this knowledge into a programme were absent. Regional sea dike management was fragmented across 263 separate water boards with minimal national coordination (Van der Ham, 2018a, p. 42). The Stormvloedcommissie, established in 1939, was internally divided. A split between the 'group Van Veen' (worried about flood risk, urging immediate action) and the 'group Thijsse' (cautious, awaiting more observational data before committing to a method) divided the commission's methodological choices. Van Veen's group used Wemelsfelder's probability calculus to argue for immediate intervention against rare but catastrophic surge events; Thijsse's group held that more observational data should accrue before such probabilistic estimates could ground policy (Van der Ham, 2018a, p. 43). Ministers were not even required to inform parliament about emerging Delta plans. When Member of Parliament S.A. Posthumus (PvdA) asked about published press reports, he was denied information (Van der Ham, 2018a, p. 42). The knowledge infrastructure was guarded rather than merely passive.

This institutional guarding extended beyond the

expert sphere. As the Herman Looman episode recounted in section 2.1 illustrates, even press coverage documenting the deficiency of Zeeland's sea dikes was suppressed before publication (Van de Poel, 2009). What Van Veen knew in the 1930s, and what the Stormvloedcommissie continued to debate through the 1940s, never crossed the threshold into the societal sphere from which a political mandate might have emerged. The knowledge infrastructure was not just fragmented, it was actively closed to the public deliberation that could have converted technical insight into political demand.

In the ecological domain, knowledge was present but structurally invisible to the actors who controlled infrastructure decisions. Someone who did publish about the domain was Charlotte Noë. As editor of *De Kampioen*, she published about ecological observations of the southwestern delta. The KNAW maintained biological research stations. Landscape architects at Staatsbosbeheer practised "constructive engagement with nature" (Van der Ham, 2018b). What Disco, Rip, and Van der Meulen (1992) describe as a "cosmopolitan technical regime," reproducing itself through university training, professional socialisation, and codified design practice, defined the institutional perimeter of what counted as relevant knowledge for water safety decisions. Ecological and spatial knowledge sat outside that perimeter.

4.1.1 Future-making reading

This phase 1 shows future-making in a peculiar way: the institutional absence of a performed programme-level future. No mechanism existed to translate Van Veen's technically articulated plans into a collective commitment. The dominant "future" of the pre-1953 period was what Andersson (2018, p. 216), drawing on Adam (2005), would call a present future: a status quo reproduced by default rather than by deliberation, sustained by the fragmented regional dike management of 263 separate water boards and stable until a mandate-creating event could supply the conditions for an alternative. In Wenzel et al.'s (2025) terms, the situationality of future-making was defined by the absence of conditions under which a collective future for the delta could be performatively enacted. The political mandate, delegated authority, and public legitimacy that a programme-level future required were all absent, and Van Veen's knowledge alone could not supply them.

What the futuring literature adds to this reading is a further layer of explanation for why expert knowledge

failed to generate public momentum. Van der Ham (personal communication, 7 April 2026) notes that the majority of the Dutch population in this period understood safety from water as fundamentally a matter of divine providence rather than of technical intervention. In Andersson's (2018, p. 3) terms, this constitutes what she identifies as the pre-modern mode of engaging with the future: before the post-1945 transformation of the future into "an object of social science," the future had been "discussed as a moral and philosophical category since the seventeenth century." In the pre-1953 Netherlands, the absence of public demand for intervention reflected more than a deficit of information. It reflected a mode of future-making in which large-scale, programme-level anticipation of catastrophe lay outside the culturally available repertoire. Local interventions such as dike maintenance and polder management were of course active, carried by communities that had developed collective forms of water governance over centuries. What was absent at this period was the conceptual move from local responsibility to a centralised, national-scale anticipation of catastrophic flood risk. The flood risk was therefore doubly foreclosed: institutionally, by the fragmentation and secrecy of the expert system, and epistemologically, by a broader societal framework that constituted the future of the delta as a matter for providence rather than as a problem open to collective human design.

Within this conservative landscape, Van Veen's successive closure proposals, Wemelsfelder's probabilistic method, and the Stormvloedcommissie's internal divisions were signals of a future that could not yet acquire institutional traction. The 1953 disaster would create the conditions under which the institutional foreclosure of that future could no longer be maintained.

4.1.2 Design-theoretic reading: knowledge domains, institutional architecture, and the conditions for concept formation

Van Veen himself is an analytically interesting figure when read through the design-theoretic lens. Van der Ham (2018a, p. 30) portrays him as a ruziemaker (troublemaker) who combined scientific knowledge with institutional manoeuvring but lacked the diplomatic skill and positional authority that Lely had possessed a generation earlier. Van der Ham, in an interview, described Van Veen as "more scientist than builder," whose credo was "investigate everything" and whose conceptual foundations pointed simultaneously in two directions: the formal closure plans and an earlier scheme called the *Verlandingsplan*, which worked with natural sediment dynamics rather than against them (Van

der Ham, personal communication, 7 April 2026). In C-K terms, Van Veen's sustained knowledge expansion held multiple conceptual paths open simultaneously. The eventual dominance of one path over the other was a product of institutional selection rather than of the knowledge itself. The *Verlandingsplan* sat in C-space without institutional conditions to carry it forward.

The failure of the Stormvloedcommissie to reach consensus illustrates a failed instance of boundary spanning within an expert body. The epistemic gap between Van Veen's group and Thijsse's group was not a syntactic problem (they shared a technical vocabulary) but a semantic one in Carlile's (2002) sense. The same data were interpreted differently, and no institutional mechanism existed to bridge the interpretive gap. The commission lacked what Slob and Duijn (2014) identify as a legitimate boundary-spanning process: neither the actors nor the institutional architecture could carry knowledge across the interpretive divide. The commission's limited institutional authority compounded the problem. It could produce knowledge, but it could not translate that knowledge into a mandate for action (Meijerink, 2005).

The culture of the KIVI, where engineers subjected each other's work to structured critical inquiry (Van der Ham, personal communication, 7 April 2026), is recognisable in Stompff, van Bruinessen, and Smulders' (2022) pragmatist explanation of design inquiry. Warranted knowledge emerges from joint reflection, and the quality of the community's deliberative practice shapes the quality of its knowledge. This tradition would prove fundamental for the programme's later capacity to learn.



Figure 4.2: Dike construction near Vlissingen after wartime destruction (1945)

4.2 Crisis, mandate, and the formation of a performed future (1953-1958)

The Watersnoodramp of 1 February 1953 killed 1,836 people and inundated 9% of Dutch agricultural land. Chapter 2 recounted the political response: the establishment of the Deltacommissie, the development of Tinbergen's cost-benefit analysis, the probabilistic safety norms, and the passage of the Deltawet on 8 May 1958. This section reads those events through the lens of the framework, asking how the programme's founding constituted an act of future-making with specific institutional, epistemic, and legitimacy characteristics.

The crisis was, in IDER terms, an initiating factor in the programme's history. A situation rendered indeterminate (Dewey, 1938) by catastrophe, in which the first actions were improvisational, and the resources were whatever could be found. What followed was a rapid transition from initiating to concept formation at an institutional scale that had no precedent in Dutch water management. The closure of the breach at Ouwerkerk, described in the vignette 1, illustrates this initiating logic in its most literal form: the actors improvised from the means at hand because the situation permitted nothing else.

4.2.1 Future-making reading

Phase 2 is the thesis's clearest empirical illustration of what Andersson (2018) describes as technocratic future-making: the production of a collective future through quantification, legal codification, and expert delegation, operating without contestation of the underlying premises. The futuring reading surfaces two observations that the design-theoretic vocabulary alone leaves underdeveloped.

First, the instruments of the formation phase functioned as what Andersson (2018) terms technologies of prediction: instruments that performatively constituted the closure concept as the only viable future for the delta. Tinbergen's 1954 cost-benefit analysis (adapted by Bos & Zwaneveld, 2017; see Table 4.1) compared two alternatives: shortening the coastline through barrier dams versus raising and strengthening dikes along the existing waterways. The analysis encoded a set of assumptions that made the closure future economically compelling and every alternative economically irrational, before construction had begun. In direct safety costs, the two options were comparable: 720 million euro for dike reinforcement against 820 million for the Deltawerken. The decisive shift came from the supplementary benefits. Tinbergen quantified gains from land reclamation, reduced travel times,

decreased salination damage, and freshwater access that together amounted to 200 million euro for the Deltawerken versus only 25 million for the dike alternative (Bos & Zwaneveld, 2017). Beyond what the numbers captured, Tinbergen also listed benefits he considered real but unquantifiable: a stimulus for hydraulic science, the spreading of industrial activity beyond the congested Rotterdam area, the unlocking of isolated island economies, and a boost for national prestige. Ecological loss, the transformation of tidal salt water estuaries into freshwater lakes, was a cost beneath pricing. The analysis thus encoded assumptions about which futures were worth quantifying and which were not, making the closure concept economically self-evident.

The probabilistic safety norms developed by the Deltacommissie, building on Wemelsfelder's storm surge analysis and Van Dantzig's mathematical optimisation, gave the programme further quantitative foundation. This foundation coupled Beta-domain technical authority to a

	Raising dikes	Deltawerken
Costs		
A. Costs for increasing safety	720	820
Construction costs	680	750
Other costs (e.g. loss of salt water fishing)	40	70
B. Costs not related to increasing safety	15	70
C. Total costs	735	890
Benefits		
A.1 Saving in costs of maintenance	10	40
A.2 Residual: extra safety and other benefits	720	780
B. Supplementary benefits	25	200
Reclamation of land	10	60
Time saved in transport	10	60
Reduction of salination damage	0	70
Benefits for fishing and public utilities	5	20
C.1 Total benefits solidly quantified (A.1 + B net)	35	240
C.2 Net benefits agriculture from less dehydration (tentative)	0	90
C.3 Net benefits from leisure activities (tentative)	—	45
C.4 Residual: net costs for extra safety and non-quantified benefits	700	515

Table 4.1: Tinbergen's cost-benefit analysis (1954 prices translated to million euros in 2017)

Vignette 1: Bird in hand under crisis

The first breach at Ouwerkerk was closed using the ship *de Twee Gebroeders* and a set of Phoenix caissons repurposed from the Second World War. Nothing about the closure was designed for the purpose; everything was improvised from what was available. The logic was effectuation in Sarasvathy's (2001) term: actors worked from the means at hand, under extreme time pressure, toward an outcome that was shaped by what they had rather than by what they had planned.

In the days following the 1 February disaster, hundreds of breaches remained open across Zeeland. Seawater continued to flood the polders with every incoming tide, and the immediate priority was to close the most dangerous gaps before the next spring tide. The largest breach, at Ouwerkerk on Duiveland, was over 100 metres wide and several metres deep, with tidal currents running through it that conventional equipment could not resist. Military engineers, Rijkswaterstaat personnel, and civilian volunteers converged on the site without a coordinated plan (Van der Ham, 2018a, pp. 22–23).

The Phoenix caissons, originally built by the British for the Normandy invasion and subsequently stationed at Vlissingen, were the only structures large enough to withstand the current. They were towed into position and sunk across the breach in a sequence improvised on site. The operation succeeded, but it succeeded through resourcefulness rather than through planning. Van der Ham (2018a, p. 23) describes the scene as one in which technical knowledge and military discipline converged under conditions where the standard procedures of both institutions were inoperative. The episode prefigures a pattern that the programme would revisit at larger scale: the capacity to act under genuine uncertainty, drawing on whatever knowledge and material resources happened to be available, was the first condition of future-making.



Figure 4.3: Aerial photograph of the closure of the breach at Ouwerkerk using Phoenix caissons (1953)

powerful national narrative of self-protection that worked across the Alpha and Gamma domains simultaneously. Designing and controlling images of the future like this is an instrument of governance, and the struggle over which futures appear feasible or necessary is also a struggle over which possibilities are cognitively foreclosed (Beckert, 2021).

Second, the Deltawet of 8 May 1958 was a performative act in the stronger sense that Wenzel et al. (2025) give the term. It enacted the closure future into the institutional fabric of the Netherlands through binding legal commitment, allocating decades of resources and foreclosing alternatives through obligation. The heterogeneity of the futuring landscape was correspondingly compressed: the technocratic repertoire suppressed alternative futures so effectively that none could achieve institutional legibility.

4.2.2 Design-theoretic reading: concept formation, multi-domain bundling, and the architecture of foreclosure

The Deltacommissie operated as what Van der Ham (2018c) calls a *besluitvormingselite*: a select decision-making elite with delegated authority over the programme's direction. The population had, in Van der Ham's characterisation, "boundless confidence" in this elite. This governance model

was itself a form of concept-space architecture: it determined who could introduce propositions into the programme's design space and whose knowledge counted as relevant.

The commission was far from the unified expert body as it is sometimes portrayed. Members disagreed about the closure of the Volkerak, about flood risk safety standards, and about the commission's own role. The final report appeared only in 1960, seven years after the disaster, partly because of these internal divisions (Van der Ham, 2018a, pp. 43, 47). Despite this, the commission rapidly assembled a multi-dimensional justification architecture around the closure concept. Tinbergen's cost-benefit analysis estimated a net positive balance of over 800 million guilders (Van der Ham, 2018a, pp. 51–53). Tinbergen also emphasised something beyond economics. The reputation and goodwill of the Netherlands in the world would be enhanced by such an impressive feat (Van der Ham, 2018c, p. 375). The slogan "*Een volk dat leeft, bouwt aan zijn toekomst*" (A people that lives, builds its own future), originally inscribed on Hildo Krop's 1933 Afsluitdijk monument, captured the performed future in a single phrase (figure 4.4). Its reappropriation from the Zuiderzeewerken into the Delta programme's symbolic repertoire is itself evidence of the multi-domain bundling at work. The Deltacommissie did not only construct a technical and economic justification but plugged into an existing cultural

narrative of national construction.

This multi-dimensional bundling accomplished something analytically distinctive. It transformed a Beta-domain engineering concept into a proposition supported by knowledge expansions across all three ABG domains simultaneously. Tinbergen's analysis coupling Gamma-domain economic authority, the Expo '58 narrative providing Alpha-domain cultural prestige. This gave the concept extraordinary stability: challenging any single dimension would leave the other justifications intact.

The exclusions of the formation phase are at least as analytically significant as the inclusions. The Commissie Zuidwest was actively obstructed by Rijkswaterstaat through data withholding, ultimately leading to its "gentle death" (Van der Ham, 2018b, p. 345). Ecological knowledge was similarly present but institutionally inoperative. Morzer Bruijns' 1955 warning about irreversible ecological loss was registered and set aside. This was a pragmatic boundary problem, in Carlile's (2004) terms, because the ecological claim threatened the governing premises of the design itself, and the actor who carried it lacked standing in the community whose premises it challenged.

Remarkably, the Deltacommissie itself discussed the possibility of building a storm surge barrier as early as January 1955. A sluice complex preserving half the tidal movement was deemed "probably too costly" (an extra 100 million guilders) and was filed away alongside "other possible solutions aimed at maintaining the oyster industry at its current location" (Van der Ham, 2018a, p. 74). The concept that would reverse the programme two decades later thus already existed in early form within the system, filtered out through a single economic evaluation. This illustrates a central mechanism of the institutional conditions shaping what is thinkable, and a concept's fate depending on when



Figure 4.4: The Afsluitdijk monument by Hildo Krop (1933)

and by whom it is introduced.

The programme's legitimacy at formation was overwhelmingly cognitive in Suchman's (1995) terms. Constructing hydraulic infrastructure after a catastrophic flood was taken for granted as the right approach. The conditions identified as producing, in the terms of Camuffo, Gambardella, and Kazemi (2025), formation-phase lock-in were all present and mutually reinforcing. Crisis legitimation of a single dominant response pathway, rapid coalition assembly across multiple interest domains, legal codification in preparation, and expert authority trusted and delegated. The speed of formation meant that alternatives were foreclosed by urgency rather than deliberated. The dike-raising alternative received minimal serious consideration, not because it was technically inferior, but because it could not deliver the road connections, freshwater supply, and symbolic modernisation that the multi-dimensional bundling required (Van der Ham, 2018a, pp. 51–54).

Vignette 1: Bird in hand under crisis

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4.3 The Deltaschool: learning inside a stable frame (1958-1968)

Between 1958 and 1968 the Deltawerken executed its programme of closures while holding the strategic concept stable. The analytical interest of this phase lies in a contradiction beneath that stability: at the level of execution the programme was anything but linear. With the Deltawet in force, the Deltadienst began executing the programme through a deliberately sequenced series of closures. The distinction between the strategic level (where the concept was fixed) and the execution level (where continuous innovation was required) is central to reading this phase accurately.

4.3.1 Future-making reading

Phase 3 shows future-making in its most stable form through the sequential reproduction of a performed future that has achieved institutional closure. A dominant present future (Andersson, 2018) of the extrapolated closure programme was so institutionally stable that alternatives were structurally unthinkable. The "Deltaboys," a working group of Zeeland-based regional actors, elaborated the closure concept without challenging it. They were articulating the performed future, not producing alternatives (Brusse, 2018, pp. 274–275). Meanwhile, the Deltadienst's monitoring

architecture was itself a futuring device in Wenzel et al.'s (2025) definition of performativity: by monitoring hydraulic performance and overlooking ecological consequences, it reproduced the performed future as the only institutionally legible reality.

4.3.2 Design–theoretic reading: the institutional architecture of learning

Within the stable performed future described above, the programme operated as an institutional architecture for learning. The analysis now turns to that architecture.

The sequencing of the closure works was itself a pedagogic architecture. Ferguson described the earlier closures as a *leerschool* (school of learning), with the Oosterschelde designated as *het eindexamen* (the final examination) (Van der Ham, 2018a, p. 70; Ferguson, 1981). This framing carried an important cognitive function. By describing the programme as a learning trajectory rather than a construction schedule, Ferguson made adaptation linguistically available. The possibility that what was learned might require changing direction was embedded in the institutional vocabulary from the beginning.

In IDER terms, this phase was an iterative cycle of initiating, designing, engineering, and realising at the execution level. The strategic concept was held stable while the knowledge required to realise it was produced through structured experimentation. The Deltadienst had explicitly acknowledged by 1957 that “business as usual” construction methods could not meet the programme’s demands (Berkers, 2018, p. 199). The establishment of the “*Afdeling Ontwikkeling Nieuwe Werkmethoden*” (department for development of new ways of working) formalised what an institutional architecture for continuous knowledge production within the Beta domain: the “*Deltaschool*” (Berkers, 2018). The physical infrastructure of this learning commitment is captured in vignette 2 on *De Voorst*: up to 25 scale models running simultaneously, each testing a hypothesis about the delta’s behaviour and feeding its findings forward into the next design decision.

The institutional culture was characterised by a specific relationship to uncertainty. Vrijling described the Deltadienst’s guiding principle as: “Everything we understand, we contract out. Everything we do not understand, we do ourselves” (Vrijling, personal communication, 31 March 2026). This inverted the logic that would later prevail under New Public Management. In March’s (1991) terms, the programme was deliberately balancing exploitation (executing known closure methods) with exploration (developing new methods for the unknown), and the institutional design protected the exploration side. Ferguson himself described

each closure as “*essentially an experiment.*” He later acknowledged that the process involved *natte vingerwerk* (guesswork) and that “there was undoubtedly also a lot of luck involved” (Van der Ham, 2018a, p. 70). The Haringvlietluizen required what Ferguson called “*een grote, plotselinge sprong buiten de ervaring*” (a sudden leap beyond experience), as they lacked “the possibility of a gradual, escalating preparation” (Berkers, 2018, p. 235). Ferguson’s metaphor names a futuring stance as much as an engineering one: a deliberate step into a future that the programme would itself produce, with knowledge that would have to accumulate during the very act of producing it.

The Deltaboys, the working group of Zeeland-based regional actors elaborating the closure concept, did so primarily in the Gamma domain. In 1956 they produced a scheme of “study objects” outlining ambitions closely tied to the Delta Works plans. New polders expanded agricultural land, and a large harbour–industrial complex between Terneuzen and Vlissingen (Brusse, 2018, pp. 274–275). Tourism planners and landscape architects planned recreational development around the new freshwater bodies, planning tourism for closure, not questioning it (Buiten, 2018). The Haringvlietdam’s location was determined entirely by hydraulic requirements, with road connections treated as a “happy accident” rather than a co–equal design criterion (Van der Ham, 2018b). This exemplifies the structural hierarchy of knowledge domains in the programme. Beta criteria were primary, everything else was secondary.

While the programme’s formal architecture remained focused on closure, knowledge that would eventually destabilise it was accumulating outside the system. The Veerse Meer, created by the Veerse Gatdam in 1961, deteriorated rapidly: algae blooms, foul smells, ecological collapse (Van Heezik, 2018; Buiten, 2018). From 1958, the KNAW’s *Delta-Onderzoek* unit at Yerseke documented the changes entirely outside the Deltadienst’s institutional orbit, describing the work as writing an obituary of the delta’s tidal ecosystems (Van Heezik, 2018). The evidence was accumulating, but the institutional channels through which it could reach the programme’s decision-makers were absent. The existence of knowledge does not guarantee its institutional legibility: the Veerse Meer’s ecological deterioration was visible, but it had no place in the programme’s monitoring architecture, was not mentioned in official communication channels, and was not politically salient until society amplified it. In Argyris’ (1977) terms, this was a single-loop regime: errors were detected and corrected within the existing framework of assumptions, while the governing premise that “water buiten” was the goal stayed in place.

Vignette 2: Twenty–five models running at once

At the Waterloopkundig Laboratorium De Voorst in the Noordoostpolder, up to 25 physical scale models of delta dynamics ran simultaneously through the late 1950s and 1960s (Berkers, 2018, pp. 203–206). The central Deltamodel, inspired by the US Army Corps of Engineers’ Mississippi model, reproduced the entire southwestern delta at scale. This was the material expression of a programme that had committed to learning before committing to specific designs. In the vocabulary of §3.4.5, this is the institutional expression of generative doubt: the productive holding–open of the design space while knowledge accumulated. Each model tested a hypothesis about tidal flow, sediment transport, or closure sequence, and the knowledge produced fed forward into the next project.

The scale of the operation at De Voorst was itself a statement about how the programme understood its own knowledge requirements. A single model could answer a question about a specific closure. Twenty–five models running simultaneously meant that the programme was pursuing entire families of questions in parallel, acknowledging that the interactions between closures were as consequential as each closure considered individually. Berkers (2018, p. 205) describes how the Deltadienst remained the laboratory’s most important client throughout this period, and how the research agenda was driven by operational need rather than by academic curiosity. The hydraulic findings from De Voorst entered the design process directly, forming the evidential basis for decisions about closure sequences, caisson dimensions, and sill depths.

The experimentations also served a less visible function. It was a training ground for the generation of engineers who would later lead the Oosterschelde project. Vrijling, who would bring the probabilistic loading approach to the programme in 1976, described the Deltadienst’s research culture as one in which experimentation was governed by the principle of “*begrepen ervaring*” (understood experience): every experiment had to be preceded by a theoretical prediction, and every result had to be explained against that prediction before it was accepted (Vrijling, personal communication, 31 March 2026). A favourable result that could not be explained was treated with the same suspicion as an unfavourable one. This epistemological discipline, cultivated at De Voorst, would later prove essential when the programme entered territory where no precedent existed.



Figure 4.5: Scale models of the Deltawerken, Waterloopkundig Laboratorium Delft



Figure 4.6: Scale models at Waterloopkundig Laboratorium De Voorst (1960s)

A concrete illustration of this institutional invisibility is provided by the driemaandelijks bericht Deltawerken, the official quarterly report through which the programme communicated its progress. The ecological deterioration being documented by the KNAW's Delta-Onderzoek unit at Yerseke did not appear in these reports. The findings from outside the Deltadienst's institutional orbit were simply not communicated through the official channels of the programme, even when they concerned the direct consequences of its own closures. The driemaandelijks bericht

4.4 The future contested: ecology enters the programme (1968-1976)

In this phase, the performed future of full closure, which had carried overwhelming institutional weight for fifteen years, was destabilised, contested, and eventually replaced. Chapter 2 laid out the events: the societal shift, the formation of the Aktiegroep Oosterschelde Open, Ferguson's internal reforms, the Stafgroep Totaalontwerp's work, the Klaasesz commission, and the political decisions of 1974 and 1976. This section reads those events through the framework, attending to the mechanisms of frame destabilisation, boundary crossing, legitimacy transformation, and the opening of design space.

4.4.1 Future-making reading

For the first time, multiple institutionally articulated futures coexisted in open competition: the engineering future (close the Oosterschelde as planned) and the ecological future (preserve tidal dynamics). These were incompatible visions of what the delta should become, each backed by different actors, different knowledge claims, and different legitimacy resources. In Wenzel et al.'s (2025) terms, this is the heterogeneity dimension in practice: multiple futures in play simultaneously. The relationality dimension is equally visible: the ecological future could only acquire institutional traction through the coalition between Saeijs' positioned authority, the Aktiegroep Oosterschelde Open, and the shellfish industry. No single actor could have produced this future alone.

Two concepts from the futuring literature show the dynamics accurately. First, the futures present of the previous phase (Mörzer Bruijns' 1955 warnings, the Veerse Meer's degradation, the Studiegroep Zeeuws Meer's 1968-1971 work) became institutionally visible because two conditions aligned: Saeijs brought the ecological future inside the system with sufficient credibility, and societal mobilisation gave it political traction. The ecological signal had existed for a decade, what

functioned as a technology of selective visibility as it reproduced the performed future precisely because it only represented what was monitored within the programme's own architecture. Knowledge that existed outside that architecture, even knowledge that was directly programme-relevant, had no pathway into the official record. 'Not reporting in official channels' could also very well have been a policy decision. Still, it shows a structural consequence of how the programme defined the boundaries of its own accountability.

changed was its institutional legibility. Second, the generative question "Can we preserve the Oosterschelde's ecology while maintaining safety?" was simultaneously a concept-space expanding question and a claim for a rival future. This claim was that the performed future of closure was not the only legitimate answer to the 1953 mandate. As Beckert (2021) captures, the political struggle over which futures appear feasible is also a struggle over which possibilities become cognitively available. In this phase, the struggle worked toward opening a future that the closure paradigm had previously kept out of view.

The 1976 pijlerdam decision resolved the contestation through design synthesis: a new performed future produced through creative resolution of competing claims. The RAND Corporation's POLANO study simultaneously functioned as a boundary object (Carlile, 2004), a legitimation device (Suchman, 1995), and a technology of prediction (Andersson, 2018). In its third function, POLANO reopened a foreclosed future: the very tools of the technocratic paradigm were repurposed to legitimate a challenge to that paradigm.

4.4.2 Design-theoretic reading: destabilisation, boundary spanning, and the opening of concept space

The reading identifies three distinct processes that drove the transformation that happened in this phase.

1. Societal mobilisation and coalition formation
2. The entry of ecological knowledge inside the institutional system
3. The legitimacy transformation and the opening of design space

This section walks through those points in more detail.

Societal mobilisation and coalition formation

The destabilisation of the closure frame unfolded with surprising speed. The shift surprised nearly everyone, Rijkswaterstaat included (Van der Ham, personal communication, 7 April 2026). Berkers (2018, pp. 242-243) offers a revealing metaphor for the shift. In 1956, RWS Director-General Maris had described the civil engineer as "de technische lijfarts van de Maatschappij" (the technical physician of society). By the 1970s, in Berkers' formulation, "the patient no longer agreed with the therapy the physician had prescribed". In 1972, the interdisciplinary Studiegroep Zeeuws Meer from TU Delft produced a detailed report proposing a storm surge barrier as a workable alternative. At a public conference, Ferguson acknowledged it was "no science fiction" but technically feasible (Van Heezik, 2018, pp. 136-137). D66 parliamentary leader Jan Terlouw seized on this admission and pressed the minister for a formal study. Van Heezik confirmed that the report reached Terlouw through a deliberate

political route, almost certainly facilitated by the Aktiegroep Oosterschelde Open (Van Heezik, personal communication, 6 March 2026). The coalition that formed was a boundary-crossing alliance of environmental activists, regional shellfish fishermen, progressive political parties, and certain scientific communities. These actors held different belief systems but converged on a shared policy position because it served each of them (Meijerink, 2005). Without this specific political constellation, Van der Ham states, a more conservative cabinet would simply have continued with the dam (Van der Ham, personal communication, 7 April 2026).

The entry of ecological knowledge inside the institutional system

The pivotal institutional event was Ferguson's decision to appoint biologist Henk Saeijs to a senior position within the Deltadienst. Saeijs' biological inventory of the Oosterschelde documented 400 km² of tidal flats, over 800 macro-invertebrate

Figure 4.7.1 & 4.7.2: Demonstration against the closure of the Oosterschelde by mussel farmers at Burghsluis during a boat tour by the Queen's Commissioner and provincial council members (1972)



Vignette 3: The engineered bridge: Saeijs as boundary-spanner

Ferguson's appointment of Saeijs was structurally significant because of the boundary spanning mechanism it enabled. Saeijs held formal training in civil engineering alongside his biological expertise. This dual qualification was the mechanism. He could address hydraulic engineers in their own epistemic language, which meant that his ecological knowledge could enter the Deltadienst's deliberative space without requiring the dominant community to step outside its professional identity to receive it (Van Heezik, 2018). The contrast with Charlotte Noë, who had raised ecological concerns from outside the engineering field as early as 1954, and with Mörzer Bruijns, whose 1955 warning was registered and set aside, illustrates the specificity of the mechanism. What Slob and Duijn (2014) call legitimate boundary-spanning required both knowledge of the bridged domains and standing in the dominant one.

Ecological knowledge about the southwestern delta had been accumulating for over a decade by the time Ferguson made his pivotal appointment. The KNAW's Delta-Onderzoek unit at Yerseke had been documenting the ecological consequences of the closures since 1958. Karel Vaas, leading the unit, described the work as writing a "necrologie" (obituary) of the delta's tidal ecosystems (Van Heezik, 2018, p. 129). Charlotte Noë, writing in *De Kampioen*, had raised concerns about the loss of bird staging areas as early as 1954 (Buiten, 2018, p. 306). Mörzer Bruijns, a nature consultant, had presented what he called an "alarming picture" of irreversible ecological loss in 1955 (Van Heezik, 2018, p. 127). The knowledge was present. What was absent was a carrier who could bring it inside the institutional system with sufficient credibility to be taken seriously. Van Heezik (personal communication, 6 March 2026) confirmed that Ferguson had a personal interest in ecology and biology. He wanted environmental research brought inside Rijkswaterstaat, and he had to "talk like a madman" to overcome internal resistance to the appointment of a biologist (Van Heezik, 2018, p. 131).

species, and the estuary's significance as European ecological heritage (Van Heezik, 2018). This constituted competing Beta-domain knowledge that was now inside the institutional system rather than outside it. The vignette above on Saeijs as boundary-spanner traces the specific mechanism through which this entry was accomplished: his dual qualification in civil engineering and biology allowed him to translate ecological claims into the epistemic language of the Deltadienst's engineering culture. Earlier biological research by Drinkwaard and others had documented biodiversity concerns. The difference is that Saeijs was the first to do so from a senior institutional position within the Deltadienst (Van Heezik, 2018).

The appointment of Saeijs is the thesis's clearest illustration of Carlile's (2002, 2004) escalating boundary types. The ecological challenge was not a syntactic boundary (a shared lexicon was absent), nor merely a semantic one (interpretation differed, but the deeper problem was that the ecological claim threatened the governing premises of the design). It was a pragmatic boundary: actors had vested interests in their interpretations, and transformation of the knowledge bases on both sides was required. Saeijs operated at this pragmatic level because his civil engineering background gave

him standing to propose transformations that an outsider's critique would have been unable to accomplish. This thesis reads Ferguson's act as institutional entrepreneurship: the creation of a new position that restructured who could speak and be heard within the programme's knowledge system. Van Heezik confirmed that Ferguson had a personal interest in ecology and biology but was initially unwilling to sacrifice the Oosterschelde closure for ecological concerns. Under increasing societal pressure, he "began to turn a little" and felt unhappy about it (Van Heezik, personal communication, 6 March 2026). Van der Ham added a complementary reading: Ferguson sensed "de tijdgeest" (the spirit of the times) and had already initiated environmental services within RWS before the public debate reached its peak (Van der Ham, personal communication, 7 April 2026). The question of whether Ferguson's shift was a genuine intellectual reorientation or a political accommodation is interesting, and the evidence supports both readings simultaneously. Regardless, he was a positioned actor responding to societal pressure by creating institutional conditions under which new knowledge could enter the system. Ferguson's own language for this transition, explored in the accompanying vignette, reveals how he managed it institutionally. The ecological

requirement was framed as a harder exam, preserving the engineering programme's identity while acknowledging that its terms had changed.

The legitimacy transformation and the opening of design space

The installation of the Den Uyl cabinet reconfigured the programme's problem space. Minister Westerterp's 1973 mandate introduced a conceptual innovation: milieubescherming (environmental protection) was placed alongside beveiliging tegen overstromingen (protection against flooding). Loss of natural environment could now be characterised as a form of "unsafety" (Van der Ham, 2018a, p. 75). This is a Gamma-domain redefinition that expanded what "safety" meant. The Klaasesz commission's composition explicitly included biologists and ecologists alongside engineers. The first institutional formation in the programme's history to bring ecological knowledge into the formal decision process. Klaasesz himself, a legal expert and former commissaris van de koningin in Zuid-Holland with no engineering background, proposed a concept, a porous block dam preserving tidal flow, that engineers initially dismissed as "political bickering" (Van der Ham, 2018a, p. 76). His distance from engineering conventions may have been precisely what allowed him to see beyond it. In Suchman's (1995) terms, the commission

simultaneously functioned as a legitimacy-production mechanism: by creating an institutional process in which ecological, engineering, and political considerations were formally deliberated, it produced procedural legitimacy for whatever outcome emerged.

The formal institutional response, Stafgroep Totaalontwerp (Total Design Task Force), assessed approximately 360 design variants at its peak (Van Heezik, 2018; Berkers, 2018). The scope was exploratory: the design space had to be constructed before it could be searched. Age Hoekstra was given six weeks to determine whether a storm surge barrier was technically feasible, calling together designers, engineers, and specialists from both the construction industry and RWS (Van der Ham, 2018a, pp. 76–77). This exercise shows pragmatic boundary crossing under extreme time pressure.

The programme's legitimacy base shifted fundamentally during this phase. Where the programme had operated under cognitive legitimacy, it now required active construction of moral legitimacy (ecological preservation as a non-negotiable value) and pragmatic legitimacy (fisheries livelihoods must be protected). The POLANO study functioned as a deliberate legitimacy strategy: Hein Engel chose RAND specifically because its findings would not come "directly from Rijkswaterstaat"

Vignette 4: The examination requirements were suddenly made heavier

Ferguson, in his memoirs, described the earlier closures as a leerschool and the Oosterschelde as its eindexamen. When the ecological requirement entered the picture, he acknowledged that "the examination requirements had suddenly been made heavier" (Ferguson, 1981, p. 142). The metaphor carries more analytical weight than it may appear. By framing the ecological challenge as a harder exam rather than as a cancellation of the exam, Ferguson kept the engineering programme's identity intact while acknowledging that its terms had changed. In design-theoretic terms, this is the distinction between adding a new requirement to an existing list and transforming the brief itself. Ferguson's language made the second option linguistically available without abandoning the first.

Ferguson's choice of metaphor was itself a form of institutional management. The Deltadienst's professional identity rested on the conviction that it could master whatever engineering challenge it encountered. The sequential closures, from the Zandkreekdijk to the Haringvlietdijk, had progressively confirmed this self-image. By the time the ecological challenge arrived, the institutional culture had accumulated enough confidence in its own adaptive capacity to receive the new requirement as a more demanding version of the same exam rather than as a fundamentally different kind of test (Berkers, 2018, pp. 242–243). Berkers captures the period before the shift with the metaphor of D.G. Maris, who in 1956 had described the civil engineer as "de technische lijfarts van de Maatschappij" (the technical physician of society). By the 1970s, in Berkers's formulation, "the patient no longer agreed with the therapy the physician had prescribed" (Berkers, 2018, p. 243). Ferguson's examination metaphor bridged these two positions. It acknowledged that the patient had a say in the therapy while preserving the physician's professional authority to administer it.

Vignette 5: Duisenberg on the boat

The political decision to build a storm surge barrier rather than a closed dam carried a price tag that alarmed even those who supported the ecological argument in principle. The final cost of the Oosterscheldekering would reach approximately three times the original estimate (Vrijling, personal communication, 31 March 2026). The financial dimension was, understandably, a central concern for the cabinet. Among the ministers whose support was required, none occupied a more consequential position on the cost question than the Minister of Finance.

Minister of Finance Wim Duisenberg was initially alarmed by the cost of the storm surge barrier option. His resistance shifted after a visit by boat to the Oosterschelde itself. Confronted with the physical reality of the estuary, Duisenberg gave his support, saying in effect: then we will build the storm surge barrier (Vrijling, personal communication, 31 March 2026). The episode illustrates what Chapter 5 will call bounded imagination: the barrier to action was not a lack of information (Duisenberg had the cost figures) but a failure to make the ecological and spatial reality of the Oosterschelde visceral. The boat trip performed the cognitive work that the policy documents could not.



Figure 4.8.1 & 4.8.2: The Oosterschelde as a living estuary, the landscape that convinced Duisenberg

The shift illustrates a dynamic that the analytical framework captures through the distinction between informational and imaginative barriers. The cost estimates that alarmed Duisenberg were informational: they told him how much the barrier would cost. What the boat trip supplied was something different: a felt understanding of what the Oosterschelde was, and what its closure would destroy. The physical encounter with tidal flats, bird colonies, and the spatial reality of the estuary performed a form of legitimacy work that the POLANO numbers, for all their analytical sophistication, could not replicate.

but through an “objective, scientific method” by an “unsuspected organisation” (Van Heezik, 2018, pp. 144–146). Vrijling notes that the POLANO ecological requirement was accepted by the engineers *voetstoots* (at face value), translated into a single technical specification: a minimum tidal range of 1.5 metres at Yerseke with 95% probability (Vrijling, personal communication, 31 March 2026). This was pragmatic boundary crossing in Carlile’s (2004) sense. The ecological value transformed into an engineering parameter the design team could work with, a working translation rather than a full intellectual integration. Vignette 5 on Duisenberg’s boat visit illustrates a complementary mechanism: where POLANO translated ecological values into engineering parameters, the physical encounter with the Oosterschelde performed the imaginative work that policy analysis alone could not.

Disco and Van den Ende (2003, cited in Berkers, 2018, p. 233) offer a remarkable inversion of the

standard narrative: “It may well have been the environmentalist-inspired protests against the closure of the Oosterschelde in the early 1970s that finally forced the Rijkswaterstaat to take the immense modelling power of digital machines seriously.” Rather than new computers enabling new possibilities, Alpha-domain societal critique created demand for new knowledge tools.

What happened at the Oosterschelde during 1968–1976, read through the design-theoretic vocabulary, was a shift from engineerability to design-ability. The ecological dimension was not an additional requirement appended to an existing list but a force that restructured the entire design brief. As a Design for Ecology episode in which ecology moved from the periphery of the engineering brief to its centre. The shift also required double-loop learning in Argyris and Schön’s (1978) terms: the governing premises of the programme were revised, not just the actions taken within them.

4.5 Building the unknown: construction as continued designing (1976–1986)

The 1976 decision committed the programme to a storm surge barrier whose engineering realisation had no precedent. Chapter 2 described the construction: the 65 concrete piers, the 62 steel slide gates, the specialised ships, the dry dock excavated within the estuary. This section reads the construction phase through the theoretical framework, attending to the institutional conditions under which designing and realising ran in parallel, the culture of generative doubt that sustained the process, and the organisational innovations that made cross-domain collaboration possible.

4.5.1 Future-making reading

This phase shows future-making through the materialisation of a performed future. The design synthesis of the previous phase was turned into physical reality through a construction process that was itself a sustained act of future-making. In Wenzel et al.’s (2025) performativity dimension, every pier placed, every gate installed, every test passed was an enactment of the ecological-engineering future that the 1976 decision had committed the programme to producing. The situationality had shifted: the programme now

operated under political and technical conditions that neither the 1958 Deltawet nor the 1974 cabinet decision could have anticipated in full. The completed barrier also produced a powerful new narrative in the Alpha domain: the government’s ability to “reconcile the irreconcilable” survived even the significant cost overruns (Van der Ham, 2018c). The phase also contained the seeds of a future contest. The phenomenon of *zandhonger* (literally ‘sand hunger’) describes the progressive erosion of the tidal flats the barrier was designed to protect, is an ongoing consequence of the partial closure that the ecological models of the 1970s had registered but could not fully resolve. This is the limit of every performed future: every act of future-making forecloses alternatives whose consequences are only visible retrospectively (Andersson, 2018).

4.5.2 Design-theoretic reading: parallel designing and realising, generative doubt, and institutional innovation

What distinguishes this phase analytically is that the Realising phase of the IDER sequence was

Vignette 6: Everything was new, and the design report came last

No ship used at the Oosterschelde had ever been deployed before. Almost all technology was first-use (Berkers, 2018). The design of the gates was still being finalised while construction was underway. The formal *ontwerpnota* (design report) was completed only after the Kering had been delivered (Van Waveren, personal communication, 23 March 2026). The standard temporal logic of design-then-build was inverted. In IDER terms, this is the parallelism that Smulders (2014) identifies as characteristic of genuinely innovative processes: Designing and Realising are concurrent rather than sequential, and the boundary between the two is managed rather than enforced.

The scale of this parallelism is worth specifying. The Oosterscheldekering required 65 concrete piers, each weighing between 18,000 and 40,000 tonnes, to be constructed in a dry dock excavated on a man-made island, then transported and placed on the seabed. The *Cardium*, the *Macoma*, and the *Mytilus*, three specialised ships built for the purpose, performed operations that had no precedent in maritime engineering (Van der Ham, 2018a, pp. 69–70). While these ships were being designed and built, the barrier’s gate system was still being developed. The engineers who were specifying the construction sequence were simultaneously working out what, exactly, the construction would need to produce. Van Waveren, who participated in the later stages of the project, described the situation with a precision that captures its institutional character: the formal design report, the document that in standard engineering practice precedes construction, was completed only after the barrier was operational (Van Waveren, personal communication, 23 March 2026). The report documented what had been built rather than prescribing what should be built. In a programme operating at the frontier of knowledge, the sequence of knowing and doing was reversed because it could not have been otherwise.

running in parallel with continued Designing. The probabilistic innovation that Vrijling brought to the programme illustrates the institutional culture. Vrijling had developed the conceptual foundation for a probabilistic loading approach during his earlier work in Saudi Arabia, drawing on ideas from an applied mechanics professor outside the civil engineering mainstream entirely (Vrijling, personal communication, 31 March 2026). The result reduced the governing design load, the maximum force the structure must be dimensioned to withstand, by approximately 40%. This made it possible to increase the pillar spacing from 40 to 45 metres. The acceptance process within the Deltadienst took three to four months.

The construction of the Oosterscheldekering required massive Beta-domain knowledge expansion: new construction methods for foundation pits, new caisson designs, pillar dam engineering at a scale that had no precedent (Berkers, 2018). What distinguishes this phase analytically is that the Realising phase of the IDER sequence was running in parallel with continued Designing. The accompanying vignette on the construction process illustrates the depth of this parallelism: every ship was first-use, gate designs were being finalised during construction, and the formal design report was completed only after the barrier had been delivered.

The *bouwteam* (building-team) model that governed the construction was an institutional innovation in its own right. Contractor and client engineers worked jointly from the earliest design phases on an equal footing. Arie Boon of Bitumarin contrasted the earlier Brouwersdam experience, characterised by conflict between contractors and engineers, with the Oosterschelde, where “within a week everyone was on a first-name basis” (Berkers, 2018, pp. 252–253). Bitumarin, a specialist in making underwater asphalt constructions, had been a permanent partner for the Deltadienst. They were operating at the interface between Shell’s laboratory, the Waterloopkundig Laboratorium, and construction practice (Berkers, 2018, p. 224). The *bouwteam* structure was an institutional response to the requirements of design-ability. By integrating contractor knowledge into the design process from the start, it reduced the gap between what was being conceived and what could be built. Berkers (2018, pp. 255–256) traces the shift in organisational form from the Haringvlietsluizen through the Oosterscheldekering, showing how the “organic organisational structure” between RWS and contractors enabled transparent communication and collaborative problem-solving.

Architect Wim Quist’s involvement added yet another knowledge domain. Quist worked with the

Deltadienst to ensure that the structure expressed ecological values in its physical form: transparency, visibility of tidal dynamics, aesthetic integration with the landscape (Van der Ham, 2018c). His description of the collaboration captures the spirit: “There was an idea, a main line: it must be so, but whether we can build it, we do not yet know. We are going on an adventure” (Van der Ham, 2018c, p. 386). In boundary-object terms (Star & Griesemer, 1989), the barrier under construction functioned as the ultimate materialisation of the re-orientation: a physical structure encoding ecological values in an engineering form.

The informal culture of decision-making within the Deltadienst deserves attention, because it is largely absent from the formal archival record. Vrijling described how project leader Frank Spaargaren managed meetings through a combination of persuasion, delay, and strategic deployment of complexity. When a meeting threatened to move toward a premature decision, Spaargaren would call a colleague to the whiteboard to fill it with equations, after which he could observe: “well, if it is that complicated, let us postpone the decision” (Vrijling, personal communication, 31 March 2026). On Friday afternoons at the drinks, the dynamics were different: colleagues could criticise Spaargaren openly, and he would receive the pushback without defensiveness. The vignette on the next page captures the formal counterpart of this informal dynamic: a structured protocol in which doubt was made explicitly safe before the moment of decision and explicitly consequential after it, sustained by an epistemic discipline in which even favourable results were investigated until they could be explained.

On 4 October 1986, Queen Beatrix operated the last sliding gate. Ferguson, reflecting on the programme’s achievement, identified the collaboration across domains, rather than any specific technical innovation, as the programme’s principal accomplishment (Van der Ham, 2018a, p. 70). This assessment is itself significant: the head of the programme located its achievement in the institutional capacity for working across domains rather than in the engineering feats that capacity had produced.

Vignette 7: “You may speak now or hold your peace”

Before a construction decision was finalised, engineers were explicitly told that they could voice doubts, raise concerns about calculations, or ask for more time. “You may now say that it does not add up, or that the calculation does not work out nicely. Then we will look at it together. But otherwise, we are going to build it tomorrow, and if it is not right, your head is on the line. So, you may choose now” (Vrijling, personal communication, 31 March 2026). This was the institutionalisation of doubt as a design resource: the design space was held open until a specific, formalised moment of closure.

The protocol carried a double function. It was simultaneously a safety mechanism and a commitment device. By creating a structured moment at which doubt was legitimate, it gave engineers explicit permission to halt a process that institutional momentum might otherwise have carried forward. And by declaring that the same doubt, if raised after the decision, would carry personal consequences, it converted the moment of closure into a genuine commitment.

What gave this protocol its substance was the epistemic culture that preceded it. The Deltadienst operated under the principle of “*begrepen ervaring*” (understood experience): only experience that is explained against a theoretical model advances knowledge (Vrijling, personal communication, 31 March 2026). Any engineer requesting funds for an experiment had to specify which coefficients would be calibrated, how many tests were required, and what the team would do if the result deviated from the prediction. An engineer who could not answer the third question did not receive funding. Within this culture, a result that could not be explained was inherently suspect, regardless of whether it was favourable or unfavourable. During one series of scale model tests on the stability of the stone mattresses protecting the barrier piers, results came back systematically too favourable. Investigation revealed that the model stones had been glued together during the preparation of the test bed, an artefact of the adhesive used to fix the stones in position. The discovery invalidated weeks of work and required a complete recalibration of the stability models (Vrijling, personal communication, 31 March 2026). An unexplained favourable result was treated with the same suspicion as an unfavourable one.

The “speak now” protocol and the “*begrepen ervaring*” discipline were two expressions of the same institutional logic. The first governed the moment of decision; the second governed the knowledge that informed it. Together they produced a culture in which doubt could circulate without undermining the programme’s capacity to act. The engineer who stayed silent at the moment of decision had endorsed the calculation knowing that the epistemic standard behind it was one that treated unexplained success as failure.



Figure 4.9: Picture of a model in Waterloopkundig Laboratorium Delft. Pebbles as seen in picture illustrative for those in the story of Vrijling.

4.6 The institutional turn: future-making by subtraction (1980s-1990s)

The institutional innovations that made the Oosterscheldekering possible did not survive the programme's completion. From the 1980s onward, under the influence of New Public Management doctrine, Rijkswaterstaat underwent a sustained shift toward outsourcing. This trajectory, introduced in chapter 2, would culminate in the formal markt-zij (market-unless) policy of 2004. This section reads it as a case of future-making by subtraction: the dismantling of the institutional conditions under which collective designing had been possible.

4.6.1 Future-making reading

Phase 6 shows future-making through subtraction. The institutional conditions that had carried the Oosterschelde reframing (in-house design capacity, the bouwteam model, the begrepen ervaring protocol, sustained Deltadienst autonomy) were progressively dismantled. In Wenzel et al.'s (2025) vocabulary, the *bedrijfsmatige wending* altered the situationality of all subsequent future-making: the practical conditions under which a future-claim could be enacted into institutional form were reshaped, and the practices that had carried the Oosterschelde transformation lost the architecture that had sustained them. In Andersson's (2018) terms, the dominant mode of future-making shifted from one technocratic configuration (centralised, in-house, learning-oriented) to another (decentralised, market-oriented, efficiency-driven). Both are technocratic. The difference lies in what each can perform. The first could carry a programme through frame destabilisation and double-loop learning; the second is structured for the predictable execution of pre-specified scopes.

4.6.2 Design-theoretic reading: path dependence, knowledge loss, and the erosion of design-ability

The trajectory towards the *bedrijfsmatige wending* progressively shifted activities to the private sector. Already in the 1980s and 1990s, the direction was set as activities the private sector could perform were transferred to contractors, and in-house technical staff was reduced accordingly. The *bouwteam model*, the collaborative governance structures, and the informal learning infrastructure of the Deltaschool were dismantled in favour of competitive contracting, client-contractor separation, and efficiency-driven procurement (Berkers, 2018, pp. 255–256).

The *Remkes-regeling*, which mandated early retirement for civil servants above 58, accelerated the loss. Vrijling described the practical consequence:

experienced engineers were pushed out to make room for a new generation of academics, many with backgrounds in IT, physical geography, public administration, or biology, who filled management positions without the engineering knowledge that had been the Deltadienst's institutional core (Vrijling, personal communication, 31 March 2026). The knowledge that left was tacit and experiential: the "understood experience" that had been the epistemological currency of the Deltaschool. It could not be replaced by hiring, because it had been produced through decades of collective practice.

Van der Ham described the process as "throwing away your own knowledge" and pointed to a revealing anecdote: Frank Spaargaren discovered, years after the shift, that monitoring protocols for the storm surge barriers had not been followed for twenty years (Van der Ham, personal communication, 7 April 2026). The monitoring regime that the Deltadienst had institutionalised as a condition of responsible engineering had simply lapsed. This is what Vrijling termed the *verbroken lus* (broken loop): the feedback cycle between measurement, theoretical model, and design revision that had been the Deltadienst's epistemological engine was severed.

In path-dependence terms (Camuffo et al., 2025), the *bedrijfsmatige wending* represents a new lock-in. Once on the path of outsourcing, the return to in-house capacity was institutionally and budgetarily difficult: as in-house expertise diminished, the organisation's ability to evaluate contractor work diminished with it, which in turn strengthened the argument for relying on contractors. In March's (1991) terms, the balance shifted decisively from exploration to exploitation, and the institutional infrastructure that had sustained exploration was dismantled rather than merely de-emphasised. Frank Spaargaren's testimony, given decades later, captures the cultural loss: "There was an atmosphere built between the parties [...] We had only one goal: the work must be done well. [...] Trust was needed [...] and that trust is now completely absent between contractors and clients" (Berkers, 2018, p. 258).

The Maeslantkering, completed in 1997, marked the institutional endpoint of this trajectory. Van Waveren drew the contrast directly: where the Oosterscheldekering's design had been produced through an integrated team of RWS engineers, contractors, and university researchers, the Maeslantkering's design was "already completely left to the market" (Van Waveren, personal communication, 23 March 2026). The design-

ability that the programme had cultivated was structurally impossible under the new procurement arrangements. RWS continued to design other projects in-house until the formal policy shift of 2004 (Berkers, 2018, pp. 255–256), but the direction was set.

A further dimension of the *bedrijfsmatige wending* deserves explicit attention. What the reorganisation produced was not only a loss of tacit knowledge in the conventional sense, but a structural mismatch between knowledge types. The Deltaschool had cultivated Beta-domain experiential knowledge: the kind of knowing that accumulates through sustained cycles of designing, building, observing, and revising. This knowledge was embodied in individuals and communities of practice, sustained through collective inquiry, and irreducible to codified procedure. The *bedrijfsmatige wending* systematically displaced this with Gamma-domain procedural knowledge: the formalised, contract-legible, auditable-by-specification forms of knowledge that procurement and New Public Management require and reward. These

are not gradations of the same capacity; they are structurally different epistemological modes. The consequence was not only that the organisation knew less after the shift, but that it came to know in a different way, one structurally incapable of supporting the kind of collective designing that programme-level future-making requires. Holding uncertainty productively, revising in light of accumulated observation, and navigating between what is known and what must still be designed are all capacities of experiential knowledge. Their systematic replacement with procedural knowledge of a different type produced a problem: the knowledge held by the organisation was no longer the kind of knowledge that design-ability demands. In this sense, the *bedrijfsmatige wending* did not just weaken the capacity for collective future-making, it removed the epistemological institutional conditions for that capacity.

Figure 4.10: The Maeslantkering, the construction of which marking the institutional endpoint of the collaborative design capacity the Deltaschool had cultivated



4.7 Summary of what the reading has shown

The chronological reading conducted across sections 4.1 through 4.6 traces a programme that built, used, and ultimately lost the institutional capacity for collective future-making. Several threads of insights run through the analysis and should be gathered before the chapter turns to the lessons they support.

The first concerns the relationship between

knowledge and institutional standing. At every consequential moment in the Deltawerken's history, the availability of knowledge proved insufficient to change the programme's direction. What mattered was whether the knowledge had a carrier with standing in the community whose premises it challenged. Van Veen's closure plans existed for decades without generating a programme. Ecological knowledge about the consequences of

closure accumulated for over a decade before it entered the decision-making orbit. In both cases, the knowledge was present. What was absent was the institutional channel through which it could become consequential.

The second concerns the nature of the designing capacity that the programme's most consequential moments required. The Oosterschelde redesign was not a correction within an existing design but a transformation of the brief itself. The shift from closed dam to storm surge barrier demanded a collective capacity to hold the design space open while multiple knowledge domains contributed to its formation. This capacity, design-ability, was sustained by specific institutional conditions: the Stafgroep Totaalontwerp's exploratory mandate, the bouwteam model's collaborative structure, the political mandate to explore rather than only execute. The Maeslantkering's full outsourcing demonstrated that these conditions were not self-sustaining.

The third concerns the role of doubt. The programme institutionalised doubt as a design resource through the scale models at De Voorst, through the Stafgroep Totaalontwerp's systematic exploration of alternatives, and through the formalised accountability structures that required knowledge to accumulate before commitments were made. This generative doubt was distinct from the decision-postponing doubt that characterises the contemporary deferral of consequential decisions. The difference lies in what the doubt does to the design space: generative doubt expands it, while postponing doubt contracts it.

The fourth concerns how futures acquire and lose institutional traction. The closure concept stabilised itself through multi-domain legitimacy bundling: Tinbergen's economic analysis, the Expo '58 narrative, the freshwater and road-connection benefits composed a justification architecture so resilient that challenge on any single dimension was absorbed by the others. The ecological future could only displace it when a coalition of actors supplied legitimacy across those same dimensions from their diverse positions. The instruments through which this was accomplished, POLANO for example, performed a dual function: translating knowledge across boundaries while simultaneously lending the translated position institutional credibility.

The fifth concerns what the programme made visible and what it left invisible. The Deltadienst's monitoring architecture measured hydraulic performance and did not measure ecological consequences. What was monitored became institutionally real; what was left unmonitored could not generate the signals that would trigger course correction. The performed future was

reproduced through the monitoring system as the only institutionally legible reality.

The sixth concerns the vulnerability of the conditions that sustained this capacity. The bedrijfsmatige wending demonstrated that the institutional achievements of the Deltaschool were not a given. The shift to outsourcing, competitive contracting, and efficiency-driven procurement dismantled the infrastructure of collective designing that the programme had built. The knowledge that left was tacit and experiential, and the institutional architecture that had produced it could not be rebuilt by simply reversing the policy.

And a seventh, quieter observation is that every performed future forecloses alternatives whose consequences are only visible retrospectively. The phenomenon of the progressive erosion of the tidal flats the Oosterscheldekering was designed to protect, is a reminder that the futuring process recognised risks it could only partly resolve. The thesis takes no normative position on this tension, it notes it as a structural feature of collective future-making. The inverse is equally true. Every performed future also opens possibilities that the designing process did not anticipate. The accompanying vignette on birding at the Oosterschelde traces one such unanticipated consequence: the nature-based tourism that the open estuary sustains is an economic and cultural future that the original closure concept would have foreclosed, and that the reframing of Phase 4 made possible.

These threads are not independent. The destabilisation of the old frame required boundary-spanning and coalition formation. The new frame demanded a collective designing capacity sustained by a culture of generative doubt. The future that was ultimately performed carried consequences the designing process could register but not fully resolve. And the institutional conditions that made all of this possible can erode. The next section distils these interacting threads into a set of lessons of collective future-making expressed at a level of generality that allows them to travel beyond the Deltawerken's specific history. Chapter 5 then takes these lessons forward, translating them into a management approach for practitioners working on complex, uncertain, long-horizon programmes.

Vignette 8: Birding at the Oosterschelde

The recreational future embedded in the original closure concept was one of freshwater leisure. Planners at the *Provinciale Planologische Dienst* projected watersport-oriented recreation around the newly created freshwater lakes as early as September 1953 (Buiter, 2018, p. 305). The Veerse Meer's development was planned around this paradigm: sailing boats, rowing, motorboats on calm, enclosed waters (Buiter, 2018, p. 309). The 1976 decision to keep the Oosterschelde open replaced that future with a fundamentally different one. By preserving the tidal dynamics of the estuary, the storm surge barrier sustained the ecological conditions for nature-based tourism rather than mass watersport.

“As a keen birdwatcher, I experience the Oosterscheldekering as a remarkable birding area as much as an impressive piece of hydraulic engineering. When Florian told me about his graduation project on the design process of the Deltawerken, I immediately suggested that we should go birdwatching there together. Precisely because the waters remained open, a dynamic tidal landscape was preserved, with salt water, currents, mudflats, and sandbanks. The preservation of tidal dynamics makes the delta ecologically more diverse. Waders forage on the nutrient-rich mudflats and sandbanks, where they can find food relatively easily at low tide. In this way, the design process considered the preservation of important habitats for species that depend on this tidal landscape alongside flood protection. At the same time, the new hydraulic structures have created space for species that benefit from hard, rocky coastal environments. The European shag is a particularly good example. This species is associated with open coastal waters, abundant fish, and rocky breeding or resting sites along the barrier. As a result, the Oosterscheldekering is one of the best places in the Netherlands to see this species. During our visit, the European shag was therefore our target species, and we managed to see it spectacularly well.” (Falko van Tilburg, personal communication)



Van Tilburg's short entry illustrates, at the scale of a single encounter, what the economic data show at programme scale. The Oosterschelde's tidal flats support over 800 species of macro-invertebrates (Van Heezik, 2018, p. 134). The estuary is a site of European significance for migratory birds, a status it holds precisely because the 1976 decision preserved the tidal dynamics that the original closure plan would have eliminated. The European shag that Van Tilburg and the author observed at the barrier depends on the rocky structures and open coastal waters that the storm surge barrier created (figure 4.12). A form of biodiversity that owes its presence to the specific engineering solution that the reframing of Phase 4 produced. The nature-based tourism that the open Oosterschelde sustains, from birdwatching to diving to shellfish culture, is a fundamentally different economic and cultural future from the mass watersport that the closed-delta planners of the 1950s envisioned, and it continues to generate value in ways that the programme's original justification architecture could not have anticipated.

Figure 4.11: European shag (“kuifaalscholver”) spotted at the Oosterscheldekering

4.8 Ten lessons in collective future-making

The summary above gathers what the Deltawerken case has shown. This section takes the next step by expressing the analytical material as ten lessons of collective future-making. The word lesson is used deliberately. These are not deterministic mechanisms that can be replicated, nor steps in a process that can be followed. They are recognisable aspects of future-making practice, identified through a careful reading of one richly documented case, offered as lenses for examining others. Two criteria guide the abstraction: each lesson can be stated independently of Deltawerken-specific vocabulary, and each names something analytically distinct from the others. The ten lessons are organised into three capacity domains that describe what collective future-making demands of a programme. Figure 4.12 presents this grouping visually.

The first domain concerns the perceptive capacity and asks what a programme can see. Every programme operates within a monitoring system

Figure 4.12: Lessons in collective future-making adapted from the design-theoretic reading of the Deltawerken

that constitutes what is institutionally visible and, by exclusion, what remains in the blind spot. When the governing frame can no longer accommodate what the programme encounters, the conditions for reframing emerge. And when a closed problem is converted into an open question, new possibilities become thinkable.

The second domain concerns the connective capacity and asks how a programme relates to difference and uncertainty. Knowledge that is relevant to a programme's future can exist well before it can enter the programme's decision-making architecture. Though, it can only land when institutional pathways are created, when actors with different interests align around a shared question, when a direction acquires legitimacy across multiple dimensions simultaneously, and when instruments make knowledge legible and credible to communities that could not previously receive it.

The third domain concerns generative capacity and asks how a programme organises for the unknown. Codification in law or binding policy can extend

commitment beyond the political moment that produced it. Over time, commitment can either remain productive, channelling resources toward a concept that remains viable, or tip into compulsive lock-in, where a direction persists because revision has become institutionally costly rather than because the direction still serves. Running underneath is a structural condition: the degree to which the programme protects the space for long-horizon learning from the pressures that would close questions prematurely.

The three domains build on each other. What a programme can perceive shapes what it is able to connect across boundaries. What it can connect shapes what it is able to generate. This ordering reflects an analytical logic, not a causal sequence. In the Deltawerken, these lessons interacted in overlapping and recursive ways; several were active simultaneously, and the boundaries between them are the product of interpretive choices rather than natural joints. A different analyst might draw them differently. The thesis retains ten because each names something that the case made visible, and the grouping into three domains prepares the translation into the practitioner-facing instrument that Chapter 5 develops.

4.8.1 Perceptive capacity: What can the programme see?

Lesson 1: What you measure is what you see

Monitoring systems shape what an institution can see and, by exclusion, what remains invisible. What is measured becomes institutionally real; what is left unmeasured has limited capacity to generate the signals that would trigger course correction. Monitoring regimes are performative in Wenzel et al.'s (2025) sense: they actively participate in constituting which features of the world are taken into future-making. This mechanism operates in both directions. A monitoring system that tracks the right dimensions enables adaptive response. One that excludes consequential dimensions reproduces the existing trajectory as the only legible reality. In the earlier phases of the Deltawerken, the monitoring architecture tracked hydraulic performance and excluded ecological consequences. This meant that ecological degradation could accumulate for years before entering the institutional field of vision.

Lesson 2: When the current approach stops working...

Large programmes orient their activity around a governing frame: a shared understanding of what the problem is and what counts as a viable response. Frame destabilisation occurs when evidence accumulates that the governing frame can no longer accommodate. Inquiry begins, in Dewey's (1938) pragmatist account, when a situation becomes indeterminate, when actors can no longer proceed within the assumptions they have been working from. The reading of the Deltawerken case supports that this mechanism can act suddenly as well as gradually. The emergency in 1953 shows how abrupt change can destabilise a frame by creating a "window of opportunity" (Meijerink, 2005). For the gradual working, evidence builds over time and is carried by actors who may lack the institutional standing to make it count. Destabilisation becomes actionable when carriers with sufficient institutional weight take up the accumulated signals. The pattern may be recognisable in other domains where governing assumptions come under pressure from accumulating evidence, though the case studied here can only demonstrate how it operated in one setting. In the Deltawerken, ecological signals accumulated for over a decade before the closure frame gave way. What the monitoring regime (lesson 1) makes visible or leaves invisible directly shapes whether and when destabilisation can occur.

TEN LESSONS FROM THE DELTAWERKEN

Lessons in collective future-making adapted from the Deltawerken, grouped by the capacity they address

What can the programme see?

What you measure is what you see

Monitoring systems shape what counts as real, and what stays invisible

When the current approach stops working

Evidence accumulates that the governing frame can no longer hold

Generative reframing

Turning a settled answer into an open design question

How does the programme relate to difference?

Knowledge that exists but cannot land

Relevant knowledge needs an institutional pathway to reach the decision table

aspects of the same process

Cross-boundary coalition formation

Different interests align around a shared question, each for their own reasons

An idea must be carried from multiple sides

A concept stabilises when it holds technical, political, and societal legitimacy simultaneously

Tools that translate and convince at once

Some instruments make knowledge legible to a new audience while lending it credibility

How does the programme organise for the unknown?

Futures written into law

Legal codification binds future decision-makers to commitments that outlast the political moment

Path commitment & compulsive lock-in

Commitment that focuses effort vs. commitment that forecloses alternatives

Protecting the space to not-know

Long-horizon learning needs institutional shelter from the pressure to deliver certainty

Lesson 3: Generative reframing

Once a governing frame has been destabilised, the programme faces a gap: the old question has lost its hold, and a new one has yet to take its place. Generative reframing is the formulation of a new question that converts a closed problem into an open one. In C-K theory terms, this is the deliberate expansion of the concept space where a restrictive one had seemed inevitable (Hatchuel & Weil, 2003). In Argyris's (1977) terms, it is double-loop learning: the revision of governing premises rather than the correction of errors within them. In the Deltawerken, "how do we close the Oosterschelde?" became "can we keep water out and preserve the tidal ecosystem?" Ferguson's *leerschool* framing illustrates one way this can work in practice: by framing the ecological challenge as a harder exam rather than a cancellation of the exam, he kept the engineering identity intact while acknowledging that its terms had changed. Whether continuity-preserving reframing is a general feature of the mechanism or a feature of how one leader happened to handle it is a question the case alone leaves open.

4.8.2 Connective capacity: How does a programme relate to difference?

Lesson 4: Knowledge that exists but cannot land

Relevant knowledge can exist well before it becomes of influence. The barrier is typically one of access rather than of production: the knowledge sits in a community, a discipline, or a research institution that has limited standing in a programme's decision-making architecture. Institutional channelling is the creation of a pathway through which existing knowledge can enter the programme's concept space with sufficient credibility to be taken seriously. What counts as knowledge depends on who carries it and from what institutional position (Hatchuel & Weil, 2003). Transformation of knowledge across interests requires standing in the community whose premises are being challenged (Carlile, 2004). In the Deltawerken, ecological knowledge about the consequences of closure existed for over a decade before the appointment of Saeijs. His appointment created a channel through which it could reach the programme's engineers with credibility.

Lesson 5: Cross-boundary coalition formation

Complex programmes operate in landscapes where multiple actors hold different stakes in the programme's future. Cross-boundary coalition formation is the alignment of dissimilar interests around a shared question, where each actor attaches to the question through their own rationality rather than through a shared understanding (Carlile, 2002). Under conditions where the challenge requires

multiple types of legitimacy simultaneously, the coalition can derive force from its diversity. Each partner supplies a different type of legitimacy, and the combination is more resilient than any single actor's claim (Suchman, 1995; Meijerink, 2005). This requires a generative question broad enough for diverse actors to attach to, a political window through which the coalition can reach formal institutions, and legitimacy that the coalition composes from its varied parts. In the Deltawerken, the shellfish industry supplied pragmatic legitimacy, the environmental movement supplied moral legitimacy, and *Keerpunt '72* supplied the political vehicle.

Lesson 6: To become stable, an idea must be carried from multiple sides

A programme's governing concept stabilises itself by enrolling legitimacy across multiple dimensions simultaneously. Suchman (1995) distinguishes cognitive legitimacy (taken-for-grantedness), pragmatic legitimacy (serving stakeholder interests), and moral legitimacy (conforming to normative expectations). When a concept is bundled across all three, it becomes resilient: a challenge on any single dimension is absorbed by the others. The same logic governs displacement. A challenging future can only replace an established one when it, too, is supported across multiple legitimacy dimensions, often by different actors simultaneously. In the Deltawerken, the closure concept was bundled through Tinbergen's economic analysis, the Expo '58 narrative, and the freshwater and road-connection benefits. The ecological alternative could only displace it once it had assembled comparable extent.

Lesson 7: Adopt tools that translate and convince at the same time

Certain analytical instruments perform two functions through a single output: they translate knowledge across a domain boundary (making it legible to a new community) and they lend the translated position institutional credibility (making it legitimate in the receiving community). This dual-function character is what makes such instruments effective. They are the points at which knowledge from one domain becomes actionable in another, and at which a contested position acquires the standing to survive scrutiny (Carlile, 2004; Suchman, 1995). The lesson concerns the instrument rather than through individuals, which distinguishes it from institutional channelling (L4). In the Deltawerken, the POLANO study translated ecological values into engineering parameters while lending the ecological position the authority of an independent, scientifically validated analysis.

4.8.3 Generative capacity: How does the programme organise for the unknown?

Lesson 8: Futures written into law

Programmes can acquire institutional momentum through the codification of a specific future in law or binding policy. Legal-temporal codification operates through temporal extension of authority: it binds successive decision-makers to commitments that outlast the political moment of their creation. The institutional cost of revision grows with every year of execution, which means that codification simultaneously enables commitment and constrains adaptation. This lesson came up more as a contextual enabler than as an active process in the way that, for instance, generative reframing (L3) or coalition formation (L5) do. What the future-making lens adds to existing accounts of statutory lock-in in the policy studies literature is attention to how codification interacts with the other mechanisms. It amplifies the stability that legitimacy bundling (L6) provides and raises the threshold that frame destabilisation (L2) must clear. In the Deltawerken, the Deltawet of 1958 committed successive governments to the closure programme for decades, and the institutional cost of the Oosterschelde redesign was directly proportional to the codification that preceded it.

Lesson 9: Productive path commitment and compulsive lock-in

Concept-space closure is a necessary and productive feature of any large programme. At some point, exploration activity must give way to commitment so that resources can be channelled toward realisation (Camuffo et al., 2025). This mechanism is active as the distinction between productive commitment and compulsive lock-in. Productive commitment channels effort toward a concept that remains viable in light of accumulating knowledge. Compulsive lock-in maintains an inherited concept because revision has become institutionally costly, even when the concept can no longer accommodate what the programme knows. The tipping point between the two can be recognised, at least retrospectively, when knowledge accumulates that the governing concept can no longer accommodate. The case shows this as ecological evidence of irreversible damage existing for over a decade while the closure frame remained institutionally unchallenged. Whether practitioners can identify this tipping point in real time, rather than only in hindsight, is an open question. The case suggests that the signals were available but that the institutional conditions for acting on them were absent until activity covered by other lessons

(L2, L4, L5) created them. In the Deltawerken, the construction of the Oosterscheldekering after 1976 illustrates productive commitment, and the persistence of the closure frame into the late 1960s illustrates compulsive lock-in.

Lesson 10: Institutional protection for adaptive practice

Long-horizon learning benefits from institutional protection from the pressures that would close questions prematurely. When an organisation retains uncertain, exploratory work in-house rather than outsourcing it, and when it operates with a degree of autonomy from short-cycle political and procurement logic, it creates conditions that support experimentation, iteration, and the accumulation of tacit knowledge. The case shows one setting where such protection existed and was then removed, with visible consequences for the programme's learning capacity. Whether protection through isolation, as the Deltadienst operated, is a strict precondition or a strong enabler is a question the single case leaves open. What the case does show clearly is that the removal of protection corresponded with a measurable erosion of the collective designing capacity the programme had built. The lesson carries a tension: isolation enables learning, but only if boundary-spanning mechanisms (L4, L7) connect the learnings back to the broader programme.

A note on boundaries: the ten lessons are the product of interpretive choices. A different analyst might draw the boundaries differently. L5 (coalition formation) and L6 (legitimacy bundling) are closely related and could be read as two aspects of the same process. The legal-temporal codification covered by L8 functions more as a contextual enabler than as in the active sense as L3 or L4. Additionally, L9 (productive path commitment) describes a dynamic rather than a discrete pattern.

The thesis offers these lessons as recognisable aspects of the practice of future-making in programmes. The lessons are supported by a careful reading of one richly documented case. They can serve as analytical tools for examining other settings. Whether they apply, and how, is a question that the next chapter begins to explore through practitioner interviews at Rijkswaterstaat.



5 FROM THEORY TO PRACTICE

Chapter 4 concluded with ten lessons of collective future-making, traced through the Deltawerken programme. These lessons describe how actors perceived, connected, and generated under conditions that had yet to settle. This chapter translates those lessons into a practitioner-facing instrument for contemporary practice at Rijkswaterstaat.

The chapter proceeds in four steps. Section 5.1 recomposes the ten lessons into six reflection axes, each structured as a tension between two poles. Section 5.2 confronts these axes with the experience of four Rijkswaterstaat practitioners, asking whether the tensions are recognisable and consequential in their work. The section reports how these respondents experience the position of their organisation along the axes, using their

own words where possible. Section 5.3 translates the axes into the **Collective Design Compass**: a structured instrument through which programme teams can describe, diagnose, and give direction to the conditions for collective design within their own practice.

One question runs through this chapter, and it is aimed at the practitioner: *what does your programme's version of this story look like?* Every programme at Rijkswaterstaat faces its own encounter with uncertainty, institutional boundaries, and the pressure to choose between executing a settled plan and sustaining a collective design process. The Deltawerken is the exemplary case. The Compass is the instrument that helps practitioners read their own programme through its lens.

Figure 5.1: Aerial view of the Galgeplaat tidal flat, Oosterschelde. This sandflat is one of the areas losing volume to the sediment starvation that, as Chapter 4 showed, was foreseen and accepted as the price of keeping the Oosterschelde open. Sand nourishment ("zandsuppletie") is now required simply to maintain what the 1976 decision chose to preserve.

5.1 From lessons to reflection axes

The ten lessons concluding Chapter 4 describe how collective future-making operated at specific moments in the Deltawerken's history. They are analytical tools: they name patterns and trace their dynamics. The reflection axes proposed in this section take the analytical material and recompose it into six tensions along which any programme engaged in collective future-making can locate itself. Where the lessons try to describe how things work, the axes ask where you stand

5.1.1 The translation

The translation proceeds as follows. Several lessons cluster around a shared tension. Frame destabilisation (L2), generative reframing (L3), and productive path commitment (L9) all operate

along the tension between holding a design space open and closing it down. Institutional channelling (L4), cross-boundary coalition formation (L5), and dual-function instrumentation (L7) all concern the movement of knowledge and legitimacy across institutional boundaries. Performative monitoring (L1) and legal-temporal codification (L8) shape what an institution can see and what commitments it carries. The clustering is interpretive rather than deductive: it reflects the analyst's reading of which tensions are most consequential for practitioners. Different readings could produce different groupings. These six were chosen because each corresponds to a tension that every practitioner interviewed for this thesis recognised as present and consequential in their own work. The mechanisms are as presented below:

Axis 1: Engineerability or design-ability

Is the programme executing a specified design, or is it collectively designing the brief? This axis draws on lessons 3 (generative reframing), 4 (institutional channelling), and 10 (institutional isolation), and on the distinction between engineerability and design-ability developed in section 3.4.6.

Axis 2: Decision-postponing doubt or generative doubt

When the programme delays a decision, does the delay create space for new knowledge to enter, or does it foreclose options by default? This axis draws on lessons 2 (frame destabilisation), 3 (generative reframing), and 9 (productive path commitment), and on the pragmatist account of generative doubt in section 3.4.5.

Axis 3: Bounded rationality or bounded imagination

Is the barrier to action primarily informational (decision-makers lack the data to act) or imaginative (decision-makers lack the capacity to make the future feel real)? This axis draws on lessons 6 (multi-domain legitimacy bundling) and 1 (performative monitoring), and on the distinction between informational and imaginative barriers that the Veerse Meer episode illustrates.

Axis 4: Knowledge containment or boundary spanning

Does knowledge that matters for the programme's direction cross community boundaries in consequential ways, or does it remain within the community that produced it? This axis draws on lessons 4 (institutional channelling), 5 (cross-boundary coalition formation), and 7 (dual-function instrumentation), and on Carlile's (2002, 2004) boundary framework and the concept of K-relativity developed in section 3.3.

Axis 5: Crisis-dependency or non-crisis generativity

Can the generative functions that crisis performed in the Deltawerken (opening mandates, legitimating exploration, making futures visceral) be performed by institutional design? This axis draws on lessons 2 (frame destabilisation), 8 (legal-temporal codification), and 10 (institutional isolation).

Axis 6: Monitoring that confirms or monitoring that reveals

Does the monitoring regime confirm the programme's existing frame, or does it reveal dimensions that the frame currently excludes? This axis draws on lessons 1 (performative monitoring) and 8 (legal-temporal codification), and on Andersson's (2018) description of technologies of prediction.

5.1.2 A directional reading

The six axes could be treated as neutral: two poles, the practitioner somewhere between them. This thesis reads them directionally. The historical analysis consistently associates one pole with stronger conditions for collective future-making: ontwerpbaarheid over maakbaarheid, generative doubt over decision-postponing doubt, imaginative reach over informational depth, structural boundary spanning over reactive consultation, institutional generativity over crisis-dependence, and monitoring that reveals over monitoring that confirms. This pattern held across the phases of the Deltawerken and, as section 5.2 shows, resonated with the experience of contemporary practitioners.

This directional reading is a normative position: for programmes facing complex, uncertain, long-

horizon challenges, there is a more productive direction of travel along each axis. The instrument presented in section 5.3 builds on it.

The axes are analytical lenses, and they overlap. A programme can be simultaneously bounded by information and by imagination; crisis-dependence and weak boundary spanning can coexist in the same setting. This is consistent with the pragmatist stance adopted in section 3.1: the axes are instruments for inquiry, designed to foreground particular tensions that the analysis identified as consequential. They describe overlapping dimensions of the same complex of conditions rather than mutually exclusive categories. In practice, a practitioner who locates their programme on one axis will often find that their positioning resonates across others. The connections between axes are part of what the reflection can surface.

5.2 Interviewing practitioners at Rijkswaterstaat

The reflection axes were developed from a historical case that concluded decades ago. Before they can serve as the foundation for a practitioner-facing instrument, they need to meet the experience of people currently working in the domain. This section reports on four confrontational interviews with Rijkswaterstaat practitioners, each structured around the question: do these tensions show up in your work, and if so, where?

The practitioners were interviewed in March and April 2026. Each conversation oriented around the confrontation between the historical findings and the practitioner's own experience. Harold van Waveren, senior water safety specialist and adviser to the second Deltacommissie; Yvette Entius and Annelies Nagtegaal, both working on

institutional innovation and the renewal challenge at WVL; and Richard Jorissen, who directed the Hoogwaterbeschermingsprogramma for approximately six years.

The section is structured by axis rather than by interview. Within each axis, the respondents' observations are brought together to show where the tension surfaces in their experience of contemporary RWS practice, what they perceive as having shifted since the Deltawerken, and where their views converge. The claims that follow are grounded in these four conversations. They describe how these practitioners experience the tensions, and they should be read as such rather than as a comprehensive characterisation of the organisation.

5.2.1 Engineerability or design-ability

The contemporary organisation is, by the description of its own practitioners, optimised for production. Entius and Nagtegaal described a structure in which experts are often consulted reactively, brought in when something goes wrong, rather than structurally involved in the formation of projects and programmes. The knowledge integration that design-ability requires, the capacity to hold a brief open while multiple domains contribute to its formation, has limited structural presence in the current organisational architecture. Nagtegaal offered a counterintuitive observation that speaks directly to this axis. Infrastructure providers under pressure reflexively narrow the scope and simplify the process, in the expectation that this will accelerate delivery. In practice, she noted, this narrowing often causes delays, because the societal environment has grown more complex and resists simplification (Entius & Nagtegaal, 2026, April 1). The Klaasesz commission's decision in 1971 to open the scope rather than to restrict it, exploring a storm surge barrier alongside the dam option, was, in this reading, the more efficient response precisely because it acknowledged complexity rather than suppressing it. The implication for contemporary practice is that reframing (L3) may be a more effective response to pressure than the scope-narrowing reflex that institutions typically adopt.

Van Waveren confirmed that the contraction of in-house design capacity is being consciously addressed. *RWS Ontwerpt* ("RWS Designs"), a recently established internal design unit, is rebuilding the organisation's capacity to participate in the design process alongside contractors. The governing principle has shifted from "market unless" to "together with the market." Young Rijkswaterstaat staff are being placed at the design table alongside contractors from the earliest phases (Van Waveren, 2026, March 23). This is a deliberate attempt to reconstruct something that resembles the bouwteam model that the Deltawerken's construction phase depended on.

Jorissen articulated the same tension in management vocabulary. His distinction between project management and programme management maps directly onto the engineerability/design-ability axis. Projects, in his framing, are single-issue activities directed at output within a fixed scope. They require stability, and the institutional reflex is to "flatten" the environment to protect the scope. Programmes are directed at outcomes and require a "flexing phase" in addition to production: periodic evaluation of whether the course still holds and whether new knowledge warrants a change

of direction (Jorissen, 2026, April 10). The first Deltaplan was, as Jorissen observed, a "*programme cast in concrete*": a Deltawet plus a list of projects, a multi-project rather than a programme. The rigidity of the closure frame, the institutional inertia that the ecological challenge had to overcome, was a product of project-logic rather than programme-logic. Had the programme been managed with built-in flexing phases, the redesign would have required less force to accomplish.

In the second interview, Entius described SBIR (Small Business Innovation Research) as a procurement mechanism that inverts the usual relationship between client and market. Rather than specifying a product and buying it, RWS formulates the societal challenge and invites consortia to develop solutions. As instruments that formulates the challenge openly rather than prescribing the answer, it functions simultaneously as internal orientation device and external activation mechanism (Entius & Nagtegaal, 2026, April 22).

The convergence across the interviews is clear. The practitioners recognise the axis. They can name where their organisation sits (closer to engineerability) and where the challenge demands it to be (closer to design-ability). They can also point to specific initiatives (*RWS Ontwerpt*, SBIR, the shift to collaborative contracting) that represent conscious movement along the axis. What remains open is whether these initiatives are sufficient to shift the institutional default.

5.2.2 Generative doubt or decision-postponing doubt

Decision deferral is the fundamental institutional problem for water safety in the contemporary setting. The practitioners described a situation in which consequential decisions are being deferred, and in which the deferral progressively narrows the space for future action. Politicians defer large decisions until the solution space has collapsed, at which point only a crisis-mode response remains: expensive and without choice. Van Waveren's proposed response, "*de meloen in stukjes snijden*" (cutting the melon into pieces), is a strategy for making large interventions politically digestible by decomposing them into incremental steps that build financial, societal, and mental support over time. The Deltawerken itself, he noted, followed this logic: the programme began with small closures (Zandkreekdam, Veerse Gatdam) and built up gradually toward the Haringvliet and the Oosterschelde. The contemporary equivalent, Van Waveren suggested, would be to begin the eventual closure of the Nieuwe Waterweg with a lock alongside the Maeslantkering for the storm season, expanding gradually rather than committing to a single large intervention that political cycles would

defer indefinitely (Van Waveren, 2026, March 23).

Entius named the paradox that sits at the centre of this axis. The organisational demand for immediate results, the expectation that innovation must work the first time, is precisely the condition that prevents the iterative experimentation that innovation requires. "*It must have been finished yesterday, and it all has to work the first time. Well, innovating does not work the first time*" (Entius & Nagtegaal, 2026, April 1). This is a structural tension between the production logic that the organisation has been optimised for and the learning logic that complex challenges demand.

Jorissen's contribution concerned the programme architecture that could institutionalise generative doubt. His distinction between a "*flexing phase*" and a "*production phase*" within a programme's lifecycle is the programme manager's version of the distinction between generative and postponing doubt. The flexing phase is built into the programme architecture as a periodic moment of evaluation: does the course still hold, or does new knowledge warrant adjustment? In the Deltawerken, this function was performed informally through the Deltadienst's culture of experimentation and the *begrepen ervaring* protocol. Jorissen's formulation makes it an explicit design element of programme management (Jorissen, 2026, April 10).

System dynamics modelling (*stysteem-dynamisch modelleren*) is an instrument that can make doubt productive. In the second interview, Entius described how the method maps the interdependencies in a complex system and shows the consequences of different interventions across variables. It produces, as Entius described it, "a sort of relief": not because it resolves uncertainty, but because it makes the structure of uncertainty visible and thereby manageable (Entius & Nagtegaal, 2026, April 22). The limitation is scalability. The method is resource-intensive and appropriate for specific high-stakes decisions. It cannot serve as the default instrument for managing doubt across an entire programme. What it illustrates, however, is that instruments exist that can convert doubt from a source of paralysis into a source of insight. The question is whether the institutional architecture supports the use of such instruments, or whether the pressure for immediate results crowds them out.

The shared diagnosis across all three interviews is clear. Van Waveren, Entius, and Jorissen work at different levels of the system (strategic advisory, innovation management, programme direction) and frame the problem in different vocabularies. Yet they arrive at the same structural observation: the most consequential barrier to collective future-making in the contemporary setting is the deferral

of large decisions under conditions where deferral narrows the solution space. The question is whether doubt, in a programme, is being made generative (expanding the design space through knowledge development) or whether it is functioning as postponement (contracting the design space through inaction).

5.2.3 Bounded rationality or bounded imagination

Van Waveren's description of the awareness deficit provides the most direct evidence for this axis in the contemporary setting. Drawing on an assessment of Dutch water management by OECD (2014), he identified a paradox. The Netherlands is technically world-class in water management, and the greatest risk is a public and political lack of awareness that the system requires sustained investment and attention (Van Waveren, 2026, March 23). The technical knowledge about future flood risk exists. The Deltascenario's 2024 provide quantitative projections across four emission trajectories (Staf Deltacommissaris & Deltares, 2024). Decision-makers have sufficient information about what the future holds. What they lack is the felt reality of that information. The future fails to generate the urgency that would sustain investment and mandate large decisions. Van Waveren illustrated the asymmetry concretely: multi-billion-euro additions to the defence budget have passed parliament with minimal resistance in recent years, while comparable shortfalls in water safety investment attracted little sustained political attention (Van Waveren, 2026, March 23).

Drought emerged as a contemporary instance of bounded imagination in the domain of climate adaptation. In the second interview, Entius and Nagtegaal extended this observation by describing how RWS had historically focused the challenge of moving water away. The conceptual frame, built over centuries of Dutch water management, was oriented around the problem of too much water. The emergence of drought as a structurally significant challenge, with consequences for freshwater availability, saltwater intrusion, and soil subsidence, required a conceptual reorientation for which the organisation had limited repertoire. As Nagtegaal observed, the organisation tends to look at the problems of today rather than the problems of tomorrow, partly because the problems of today are immediate and politically relevant, and partly because the problems of tomorrow are difficult to imagine when the available frames are built around different challenges (Entius & Nagtegaal, 2026, April 22).

Entius's response to bounded imagination was practical. In the development of the Kennis- en

Innovatiestrategie (Knowledge and Innovation Strategy), she constructed what she called a “*stip op de horizon*” (a dot on the horizon). These scenarios describe what the Netherlands would look like in ten years if all currently active innovations succeeded. The scenario was deliberately speculative and optimistic. Its function was to make an alternative future tangible enough to generate engagement, both internally and among market parties. “*I took all our current innovations as a starting point and sketched: this is what the Netherlands looks like in ten years. I do not know whether that always leads to imagination, but for me it works very well. If you have a dot on the horizon, it gives something to hold on to*” (Entius & Nagtegaal, 2026, April 22). This is a contemporary, deliberately designed attempt to bridge the gap between knowing and imagining.

The axis distinguishes between two different diagnoses and, correspondingly, two different responses. If the barrier is informational, more data and better models are the appropriate intervention. If the barrier is imaginative, the intervention must make futures tangible and felt. The practitioners’ stories suggest that, in their experience of the contemporary RWS setting, the imaginative barrier is at least as important as the informational one.

5.2.4 Knowledge containment or boundary spanning

The contemporary RWS setting faces a boundary problem that differs from the Deltawerken’s reliance on exceptional individuals. Saeijs could translate ecological knowledge into terms the Deltadienst’s engineering culture could receive, and Ferguson’s institutional entrepreneurship connected the programme’s learning culture to the political and societal context. The contemporary challenge concerns the channels through which knowledge enters discussion. Van Waveren identified an entry-point asymmetry: the relevant knowledge for water safety decisions exists across multiple domains (spatial planning, ecology, engineering, economics), but it enters the deliberation process through the water domain. “A dike is never built unless the area underneath benefits. You must think from the area, from the spatial domain, and then find your water safety solution to fit” (Van Waveren, 2026, March 23). The consequence is that the solution space is narrower than it would be if the entry point were reversed. The knowledge is available but the channel through which it reaches the decision is misaligned.

Nagtegaal described a related pattern in how expertise is mobilised within the organisation. Experts are consulted reactively: “pulled in by the hair” when something goes wrong, rather than structurally embedded in the formation of projects

from the outset (Entius & Nagtegaal, 2026, April 1). The knowledge exists within the organisation, but the institutional architecture does not provide a channel through which it can enter the design process at the moment where it would be most consequential: the moment of problem formation.

The boundary-spanning function at RWS has been distributed across structures rather than concentrated in individuals. In the second interview, Entius and Nagtegaal addressed the question of whether a contemporary equivalent of Saeijs exists, and their conclusion pointed to this distribution. As can be seen in figure 5.2, RWS currently organises its knowledge around 16 hoofdkennisvelden (main knowledge fields) supported by communities of practice, with kennisveldtrekkers (knowledge field leads) and topadviseurs (senior advisory specialists) performing the integrative function at different levels (Entius & Nagtegaal, 2026, April 22). The boundary-spanning function is still present, but it is carried by structures rather than by individuals. Whether this distribution produces the same depth of boundary work that Saeijs achieved at the pragmatic level, in Carlile’s (2004) terminology, is an open question. The advantage of the distributed model is resilience: it is less dependent on exceptional individuals. The risk is that distributed structures may operate at Carlile’s syntactic and semantic levels (sharing vocabulary, translating between communities) without reaching the pragmatic level (transforming the knowledge bases on both sides of the boundary).

Jorissen added a further dimension from his experience at the HWBP. The programme’s challenge was to get autonomous water boards to adopt innovations that had been developed elsewhere. The technology was available, so the institutional and behavioural challenge was to make adoption happen. The programme used indirect steering mechanisms (“comply or explain”, peer pressure within the funding collective) rather than hierarchical authority (Jorissen, 2026, April 10). Jorissen’s summary captured the asymmetry: “*the technology is easier to bend than behaviour and governance*” (Jorissen, 2026, April 10). The boundary problem, in this case, was less about translation between knowledge domains and more about the movement of proven knowledge across institutional boundaries where autonomous actors hold their own interests.

Figure 5.2: The “knowledge tree” of Rijkswaterstaat, illustrating the organisation’s approach to knowledge management, including core objectives, main knowledge domains, and their interrelations (2026)



5.2.5 Crisis-dependency or non-crisis generativity

The practitioners confirmed, without exception, that crisis functions as the most reliable generator of institutional change at RWS. Entius was direct: “often those extremely difficult circumstances are necessary to force yourself to work in a completely different way” (Entius & Nagtegaal, 2026, April 1). She illustrated this with the Julianakanaal case, where a construction failure led to a fundamentally different working method: small teams, trust-based coordination, iterative problem-solving, delivered on time. The parallel with 1953 is that crisis creates room for working methods that are institutionally blocked under normal conditions.

The prevailing culture at RWS constrains generative doubt through institutional fear of failure. In the second interview, Entius and Nagtegaal described the tension in cultural terms, characterising the culture as one of “te weinig ruimte voor lef” (too little room for courage) and a “brandweer-mentaliteit” (firefighter mentality): the expectation that when something goes wrong, the response must be immediate, comprehensive, and correct the first time (Entius & Nagtegaal, 2026, April 22). This is in tension with the conditions that sustained generative doubt during the Deltawerken. The begrepen ervaring protocol, the 25 scale models at De Voorst, the Stafgroeps Totaalontwerp’s systematic exploration of alternatives: these all depended on an institutional tolerance for uncertainty and iteration that the current culture, as described by the practitioners, constrains.

At the same time, both interviews surfaced evidence of non-crisis generativity operating informally. Entius described a group of innovators within the organisation who “do not pay much attention to the absence of a formal decision” and who are driven by a genuine conviction that their innovation serves the organisation’s goals (Entius & Nagtegaal, 2026, April 22). This innovators’ subculture functions as an autonomous space for experimentation, analogous to the Deltadienst’s semi-autonomy. The fragility is similar in the sense that this subculture depends on a degree of informal tolerance from the production organisation. This tolerance is vulnerable to budget pressure and organisational restructuring.

The pattern across the interviews is consistent. The practitioners all confirmed that crisis remains the most reliable trigger for institutional change, and that the prevailing culture constrains the conditions under which generative work can happen outside of crisis. At the same time, the innovators’ subculture that Entius described shows that non-crisis generativity does exist within RWS, though it operates informally and without institutional protection. The generative function

that crisis performed in the Deltawerken, opening a political mandate, creating room for exploration, legitimating the holding-open of design space, is precisely the function that the contemporary institutional architecture lacks under normal conditions. The axis asks how that function can be built into the programme architecture rather than left to the contingency of events.

5.2.6 Monitoring that confirms or monitoring that reveals

Water safety is formally designated as “priority number one” at Rijkswaterstaat. Yet in practice, as Van Waveren illustrates, that designation is shared at the strategic level with sufficiently many other priorities that its operational weight is limited. Van Waveren and Jorissen spent years to convince the organisation’s leadership that the categorical distinctiveness of water safety risk (discontinuous, potentially thousands of casualties, hundreds of billions in potential damage) required budgetary treatment different from the continuous risks of road infrastructure (Jorissen, 2026, April 10; Van Waveren, 2026, March 23). A comparison Van Waveren drew as illustration is that an unsafe tunnel can be closed with a sign, converting a safety problem into an availability problem; a storm surge barrier cannot be closed with a sign. An institution that treats both as infrastructure risks makes the categorical difference invisible.

Jorissen identified a contemporary form of the same mechanism at the level of individual projects. Within the HWBP, a relatively large number of dikes are being reinforced as “special constructions” (concrete and steel) to preserve a tree or a building, rather than as adaptive earth structures. The special construction solves the immediate problem and satisfies the metrics by which the project is evaluated. It does so, however, at the cost of transferring rigidity to the next reinforcement cycle. The structure is harder to adapt than the earth dike it replaced. The monitoring system measures whether the dike meets today’s standard. It does not measure whether the solution preserves adaptability for the future (Jorissen, 2026, April 10). This is the same mechanism the thesis identified in the Deltawerken: what is measured becomes institutionally real, and what is left unmeasured shapes the future by its absence.

The organisation’s monitoring and accountability systems structurally favour today’s problems over tomorrow’s. In the second interview, Nagtegaal articulated this temporal dimension. The organisation tends to focus on the problems of today because those are the problems that are politically salient and administratively measurable. The problems of tomorrow, particularly long-term climate risks and the narrowing of solution spaces,

are structurally less visible in the monitoring and accountability systems that govern the organisation’s daily work (Entius & Nagtegaal, 2026, April 22). The Deltadienst’s monitoring architecture reproduced the performed future as the only institutionally legible reality by measuring hydraulic performance and excluding ecological consequences. The contemporary monitoring architecture may perform a structurally similar function by measuring production output and project delivery. It makes the dimensions that matter most for long-term future-making (institutional readiness, solution-space width, knowledge capacity, adaptive potential) constitutively invisible.

5.2.7 What the RWS practitioner interviews reveal together

Three convergent findings emerge from the interviews taken as a whole.

First, the respondents recognised the axes. Across four interviews conducted independently, the six tensions surfaced as present and substantial features of their own working experience. This is the most basic claim the thesis can make: the axes are understandable and recognisable to practitioners working in the contemporary setting. The lessons, abstracted from a programme that concluded decades ago, describe tensions that these respondents experience as active and felt.

Second, the respondents converged on the same core problem. The deferral of decisions under conditions where the solution space narrows emerged across

all four conversations as what these practitioners perceive as the most fundamental barrier to collective future-making. Van Waveren described it as political procrastination. Entius described the paradox of immediate-result expectations blocking the iterative learning that complex challenges require. Jorissen identified the project-logic reflex that flattens the environment rather than learning from it. The convergence is worth noting because the three practitioners work at different levels of the system and frame the problem in different vocabularies, yet arrive at the same observation.

Third, the respondents described a gap between where they experience the organisation to be and where they believe the challenge requires it to be. In their collective account, the organisation sits closer to engineerability than to design-ability, closer to decision-postponing doubt than to generative doubt, closer to bounded imagination than to bounded rationality in its awareness challenge, and closer to reactive expertise deployment than to structural boundary spanning. The initiatives they named (RWS Ontwerpt, SBIR, the knowledge-field architecture, the innovators’ subculture) represent conscious movement toward the other pole. Whether these initiatives are sufficient to shift the institutional default is the open question the interviews leave behind.

The respondents’ descriptions point toward a shared need: orientation rather than further analysis. What would it look like to take the productive side of each axis as a starting point for practice? The next section addresses that question.

5.3 The Collective Design Compass

The reflection axes validated in sections 5.1 and 5.2 identify six dimensions along which the conditions for collective design vary. Each axis captures a tension that practitioners recognised in their own experience. What remains is a way for these axes to enter practice: a form that programme teams can work through together, that helps them see where they stand, and that gives direction to where they could be heading.

This section presents the Collective Design Compass: a structured instrument built around six diagnostic questions, organised across three capacity domains. The essence of the Compass lies in the questions and in what a team produces when they answer them together. Each question asks a programme team to describe, in their own words, how a specific dimension of collective design manifests in their practice. The collectively formulated answers constitute the diagnostic act: they make visible what is usually distributed across individual perspectives,

and they surface agreements and disagreements that would otherwise remain implicit. A compass provides orientation: it tells its user where they stand relative to a set of directions, while leaving the specific route to their judgement. This resonates with the epistemological stance that runs through this thesis (section 3.1): the findings are defensible rather than proven, and the instrument invites situated reflection in place of universal prescription.

The Compass, inserted as figure 5.3, is organised along a reading direction that reflects how the conditions for collective design build on each other: **PERCEIVE → CONNECT → GENERATE**. What a programme can perceive shapes what it is able to connect across boundaries. What it can connect shapes what it is able to generate. Each domain contains two diagnostic questions, derived from the reflection axes in section 5.1 and grounded in the lessons identified in Chapter 4.

COLLECTIVE DESIGN COMPASS

An orientation instrument for programmes facing complex, uncertain, long-horizon challenges

PROGRAMME _____

DATE _____

THE PERFORMED FUTURE

What future is this programme currently enacting?

PERCEPTIVE CAPACITY

What does the programme see?

VISIBILITY



"Does your monitoring system make certain futures invisible?"

- Who determines what is measured?
- Do results feed back into design, or only execution control?
- What new measurements would reveal a different picture?

CONNECTIVE CAPACITY

How does the programme relate to uncertainty and difference?

PRODUCTIVE DOUBT



"Is not-knowing treated as a problem to be resolved, or as a starting point for design?"

- When facing the unknown: contract out, or investigate in-house?
- Is there protected time/budget for exploration without fixed outcomes?
- Which decisions expand options by waiting, which contract them?

GENERATIVE CAPACITY

How does the programme organise for the unknown?

DESIGNABILITY



"Can the programme's brief be fundamentally revised, or is it structured only to deliver what was decided?"

- Could new knowledge challenging the core premise be absorbed?
- What is settled (contractable) vs. still being designed (in-house)?
- Does governance allow reframing, or only scope changes?

IMAGINATION



"Is your programme limited by what it knows, or by what it can imagine?"

- When was a fundamentally different alternative last explored?
- Does the programme generate new concepts, or only evaluate existing ones?
- Are there people whose role is to imagine, not only to analyse?

BOUNDARY SPANNING



"Who carries knowledge across community boundaries, and do they have standing in more than one community?"

- Can you name individuals bridging knowledge domains?
- Does a new perspective have a carrier with institutional standing?
- Are there forums where communities confront each other's assumptions?

GENERATIVITY



"If no crisis occurs in the next decade, can this programme still open fundamentally new directions?"

- What mechanisms exist for challenging the trajectory from within?
- Is there a structural role for dissent or alternative scenarios?
- Has the programme ever changed course without external shock?

Figure 5.3: Six diagnostic questions across three capacity domains. Teams articulate the performed future, formulate collective answers, and read them against the spectra derived from the Deltawerken analysis.

At the top sits a field for the *programme's performed future*: the future that the programme is currently enacting. Articulating this is the opening move, and it is often the hardest, because it asks for explicitness about what usually remains implicit. The performed future anchors everything that follows: each question asks about the conditions under which *this particular future is being made*.

5.3.1 The six questions

I. Perceptive Capacity asks: *what does the programme see?*

The first question addresses the programme's monitoring regime: does your monitoring regime confirm the programme's existing frame, or does it reveal dimensions that the frame currently excludes? Monitoring regimes are performative: they constitute what counts as relevant for a programme rather than merely recording what already exists. Each monitoring choice makes certain dynamics visible while rendering others invisible. The collectively formulated answer to this question should describe what the monitoring system foregrounds, what it leaves outside its field of vision, and whether the programme's capacity to imagine alternative futures is shaped by what the monitoring regime makes available.

The second question addresses the nature of the constraint on the programme's capacity to generate alternatives: is your programme limited by what it knows, or by what it can envision? Programmes frequently assume that more data, more analysis, or more expert input will resolve their impasse. Yet in many situations the impasse is imaginative: the programme holds sufficient knowledge yet lacks the capacity to envision fundamentally different alternatives. The collectively formulated answer should identify where the team experiences the boundary of their programme's capacity to think differently, and whether that boundary is informational or imaginative.

II. Connective Capacity asks: *how does the programme relate to uncertainty and difference?*

The third question addresses the programme's epistemic stance toward uncertainty: is uncertainty treated as a problem to be resolved before action, or as a starting point for design? Uncertainty can take two fundamentally different forms within a programme. In one form, doubt postpones decisions and narrows the solution space. In the other, doubt generates: it holds the problem frame open so that new knowledge can enter and the solution space expands. The Rijkswaterstaat respondents converged on this as the most fundamental tension in their experience. The collectively formulated answer should describe what happens in the programme when knowledge is incomplete and a

decision is due.

The fourth question addresses boundary crossing: does knowledge that matters for the programme's direction cross community boundaries, or does each community's perspective remain within its own domain? Programmes involve multiple communities of practice: engineers, ecologists, policymakers, programme managers. Each community holds knowledge that is relevant to the programme's trajectory. The question is whether that knowledge reaches across boundaries in ways that are consequential, or whether it remains contained within the community that produced it. The collectively formulated answer should describe how knowledge travels between the communities involved in the programme, and whether those who carry it hold the standing to make it land.

III. Generative Capacity asks: *how does the programme organise for the unknown?*

The fifth question addresses institutional architecture: can the programme's brief be fundamentally revised, or is the organisation structured exclusively to deliver what has already been decided? This distinction, between *maakbaarheid* and *ontwerpbaarheid*, is the central tension that emerged from the analysis. The collectively formulated answer should assess whether the programme's organisational form allows the brief itself to be reopened when conditions change, and what institutional arrangements protect or constrain that capacity.

The sixth question addresses the programme's capacity for self-renewal: does your programme depend on external crisis to open new directions, or does it hold institutional space for reframing from within? Some programmes can only change course under external shock; others sustain the conditions for reframing as part of their ongoing institutional architecture. The contemporary challenges at Rijkswaterstaat are slow-burn phenomena that will rarely announce themselves through acute crisis. The collectively formulated answer should assess where the impulse for fundamental change would come from in the programme, and whether that can emerge from within.

5.3.2 From description to direction

The six questions, together with the collectively formulated answers, produce a description of the programme in the team's own words: anchored in a performed future and structured by three capacity domains. This description is the Compass's primary output. It captures how a team collectively understands the conditions under which their programme operates, and it surfaces the points where individual perceptions converge or diverge.

The analytical contribution of this thesis enters when these descriptions meet the theoretical vocabulary developed in Chapters 3 and 4. Each question corresponds to a dimension with two poles, derived from the Deltawerken analysis: Visibility spans from monitoring that confirms to monitoring that reveals; Imagination from bounded by information to bounded by imagination; Productive Doubt from doubt that postpones to doubt that generates; Boundary Spanning from boundaries that contain to boundaries that are spanned; Designability from organised for execution to organised for collective design; and Generativity from crisis-dependent to generative independent of crisis.

These spectra carry a directional reading: the right pole of each represents the condition that the historical analysis and practitioner experience associate with stronger collective design capacity. When a team reads their collectively formulated answers against the spectra, they can locate where their programme sits on each dimension and, crucially, identify what their descriptions left out. The confrontation between the team's own language and the analytical vocabulary is where the Compass moves from descriptive to directional: it reveals gaps, tensions, and patterns that the collective formulation may have obscured.

5.3.3 Applications

The Compass can be used in several settings, each building on the same core: a team works through the six questions, formulates collective answers, and reads the result against the analytical vocabulary this thesis provides.

A programme team can use the Compass as a **self-assessment tool**, working through the questions to produce a diagnostic snapshot of the programme's current conditions for collective design. The collectively formulated answers reveal where perceptions converge, where they diverge, and what the team's own language foregrounds or leaves out. The same instrument serves as the basis for a **periodic review**, revisited at phase transitions or regular intervals to detect drift. The *bedrijfsmatige wending* demonstrated how rapidly conditions for collective design can erode; successive snapshots make this erosion visible before it hardens into lock-in. In **design mode**, the Compass becomes a design brief: for each dimension where the team identifies a gap, they ask what would have to change structurally for the programme to move along the spectrum. The guiding question shifts from "where are we?" to "what would have to change for us to get where we should be?"

Beyond the programme team, the Compass can function as a **structured conversation piece** ("*praatplaat*") across communities. The questions

ask for each community's own language before introducing a shared analytical frame, which makes the instrument legible across disciplinary boundaries. In this capacity, the Compass functions as the boundary object it seeks to diagnose: a shared artefact through which communities that discuss future-making in divergent vocabularies can structure a conversation in shared terms.

The Compass also lends itself to **facilitated workshops**. This application was recognised with particular enthusiasm during supervision: the question-based format invites the kind of open, situated group reflection that workshop settings are designed to support. The Compass was designed as a diagnostic instrument; that it could work as workshop facilitation material follows from its core design choice to place questions, and the collectively formulated answers to them, at the centre.

Having said that, it should be mentioned that the Compass is an orientation instrument rather than a scorecard. A programme in a stable execution phase may sit closer to the left pole on several dimensions. The diagnostic power resides in a situational question: *is this where the programme should be, given what it faces?* The Compass offers a vocabulary and a structure for that judgement; the judgement itself remains with the practitioner.

Appendix A provides practical guidance for applying the Collective Design Compass in a group setting, including a walkthrough of the instrument's three steps and a discussion of how to work with the collectively formulated future that the Compass produces.

5.3.4 Positioning

The Compass responds to Wenzel, Cabantous and Koch's (2025) observation that practice-based futuring research benefits from tools that bridge analytical frameworks and practical application. Its design addresses this challenge through sequence: practitioners first produce situated descriptions in their own vocabulary, then encounter an analytical frame grounded in historical evidence. Each diagnostic question is traceable to specific lessons from analysis of the Deltawerken case, and each spectrum connects to a lesson that the Rijkswaterstaat respondents recognised in their own experience.

6 CONCLUSION

This thesis set out to understand how collective future-making works in practice. It did so by re-reading the Deltawerken through a lens assembled from pragmatist epistemology, practice-based

futuring theory, and design and innovation theory, and by translating the findings into an instrument for contemporary practitioners at Rijkswaterstaat. This chapter gathers what the thesis has shown.

Figure 6.1: Bird's eye view of the Oosterscheldekering



6.1 Answering the research questions

RQ1: How did actors working on the Deltawerken build and sustain the capacity for collective future-making?

The capacity for collective future-making in the Deltawerken rested on a configuration of institutional, epistemic, and relational conditions that reinforced each other. Institutionally, the Deltadienst functioned as a learning organisation with protected space for experimentation: the scale model landscape at De Voorst, the structured accountability of the begrepen ervaring protocol, and the bouwteam model that kept designing and realising inside the same organisational boundary. Epistemically, the programme sustained generative doubt as a design resource. At its strongest, during the Stafgroep Totaalontwerp's exploration of approximately 360 design variants, doubt was institutionalised: the programme held open its concept space while knowledge from multiple domains accumulated. Relationally, the programme depended on actors who could carry knowledge across community boundaries with sufficient standing to make it consequential. Saeijs translated ecological knowledge into terms that an engineering culture could receive. Ferguson connected the programme's internal learning culture to political and societal audiences. The instruments they used,

POLANO among them, performed a dual function: translating knowledge and lending the translated position institutional credibility.

The analysis also showed how this capacity was lost. The bedrijfsmatige wending of the 1980s and 1990s dismantled the conditions that had sustained collective designing. Outsourcing transferred tacit knowledge to contractors. Competitive procurement replaced collaborative structures. The monitoring architecture continued to reproduce the performed future as the only institutionally legible reality. The Maeslantkering, designed and built entirely by an external consortium, demonstrated that the institutional achievements of the Deltaschool were contingent rather than permanent.

The ten lessons presented in section 4.8v gather these findings into recognisable aspects of collective future-making practice, organised across three capacity domains: perceptive capacity (what the programme can see), connective capacity (how the programme relates to difference), and generative capacity (how the programme organises for the unknown).

RQ2: How can the findings of this thesis' analysis guide practitioners that are engaged in contemporary collective future-making?

The translation from historical lessons to practitioner guidance proceeded in three steps. First, the ten lessons were recomposed into six reflection axes, each structured as a tension between two poles: engineerability or design-ability, generative doubt or decision-postponing doubt, bounded rationality or bounded imagination, knowledge containment or boundary spanning, crisis-dependency or non-crisis generativity, and monitoring that confirms or monitoring that reveals. Second, these axes were confronted with the experience of four Rijkswaterstaat practitioners, who recognised all six tensions as present and consequential in their own work. Their accounts converged on a shared core problem: the deferral of decisions under conditions where deferral progressively narrows the space for future action.

programme teams to describe, in their own words, how each dimension of collective design manifests in their practice. The collectively formulated answers constitute the diagnostic act: they surface what is usually distributed across individual perspectives and make visible the points where perceptions converge or diverge. These descriptions then meet the analytical vocabulary developed in Chapters 3 and 4, producing a confrontation between the team's own language and the theoretical frame. The Compass orients rather than prescribes. It tells its users where they stand relative to a set of directions grounded in historical evidence, while leaving the specific route to their situated judgement.

Third, the axes were translated into the Collective Design Compass: a structured instrument built around six diagnostic questions, organised across the three capacity domains. The Compass asks

6.2 Contribution

This thesis makes three contributions. The first is analytical: it offers a design-theoretic reading of a historical case that is predominantly told as an engineering story. By assembling a lens from C-K theory, IDER, path dependence, learning theory, design-ability, and boundary work, the thesis reveals conditions for collective future-making that remain invisible from the engineering narrative alone. The distinction between engineerability and design-ability, developed in section 3.4.6 and traced across the case, is the thesis's central reframing.

The second contribution is empirical. The practitioner confrontation in section 5.2 demonstrates that tensions identified through a historical case concluded decades ago remain active and felt in

the experience of contemporary professionals. The convergence of four independently conducted interviews on the same core problem (decision deferral as structural barrier to collective future-making) lends credibility to the analytical frame.

The third contribution is practical. The Collective Design Compass translates the analytical findings into a form that practitioners can work with. It responds to Wenzel, Cabantous, and Koch's (2025) observation that practice-based futuring research benefits from tools that bridge analytical frameworks and practical application. Its design addresses this by placing questions and collectively formulated answers at the centre, inviting situated reflection in place of universal prescription.

6.3 Scope and limitations

This thesis is a twenty-week graduation project that mobilises a single historical case to develop a theoretical lens and a practical instrument. The contribution is recognised by practitioners in early conversations, and it is also bounded.

The analytical reading of the Deltawerken in Chapter 4 is selective and goal-directed. It represents one plausible reading through a design-theoretic lens; alternative vocabularies would foreground different lessons. The claim is that this reading is defensible and productive for the research questions posed. The historical account relies on a limited number of secondary sources. A reading conducted from the perspective of actors outside the Deltadienst would yield a different emphasis and likely surface additional lessons.

The practitioner confrontation rests on four interviews with Rijkswaterstaat professionals. The respondents recognised all six axes, converging most notably on decision deferral as a perceived barrier to collective future-making. Their accounts are grounded in their own words and should be read as situated perceptions rather than as an organisational diagnosis. A complementary approach, in which practitioners describe their experience before encountering the axes, could strengthen the empirical basis. Testing the axes outside Rijkswaterstaat and outside Dutch infrastructure practice remains a productive direction for future research.

The Collective Design Compass is a conceptual prototype. It has been designed from the historical analysis and tested in conversation with practitioners, yet it awaits deployment in a live programme context. Several design questions remain open: whether the sequence from open description to analytical confrontation works as intended when a team encounters the instrument for the first time, the degree to which facilitation is required to make that transition productive, and the way the Compass interacts with existing programme governance instruments.

The theoretical lens is centred around design theory and pragmatist epistemology. This foregrounds knowledge production, boundary crossing, and institutional architecture while backgrounding power dynamics, distributional justice, and the affective dimensions of sustained uncertainty. Integrating these perspectives would enrich the Compass and open the instrument to questions it currently leaves aside.

6.4 Future research and closing reflection

The Compass opens several avenues for inquiry beyond this thesis. Empirical deployment with programme teams would test its diagnostic power and drive iteration on the instrument's design. Longitudinal tracking across multiple cycles would generate data on how conditions for collective design evolve and erode over time. Comparative application across programmes within the same organisation could reveal structural patterns at the organisational level that remain invisible at the level of individual programmes. Testing the axes outside Rijkswaterstaat remains a productive direction for future research. An exploratory conversation conducted in the course of this research with the programme director of the national ERTMS rollout (see vignette 9) suggests preliminary grounds for this direction. The tensions identified in the Deltawerken analysis surfaced in a programme operating under distributed governance, in a different technology domain, and in a context where legitimacy must be continuously constructed rather than inherited from a single founding event. A dedicated comparative study, conducted with the methodological depth such a case deserves, would test whether the Compass illuminates dynamics in sectors and governance contexts beyond those from

which it was derived, and whether practitioners navigating those dynamics can use its vocabulary to see what practice alone leaves implicit.

The facilitation format presented in Appendix A is, at the time of writing, untested. It translates the Compass's diagnostic logic into a walkthrough that a programme team can work through together, but it has not yet been facilitated with practitioners. A first session is planned with a Rijkswaterstaat programme team in the period following this thesis's submission. That session will test whether the sequence from collectively articulating a performed future to reading the six dimensions against the analytical vocabulary produces the kind of situated orientation the instrument is designed to offer, and it will inform the iteration that the Compass, as a conceptual prototype, requires.

The question that opened Chapter 5 remains: *what does your programme's version of this story look like?* The Compass is one way to engage with it. The Deltawerken's story has been told. The stories it can illuminate have yet to be written.

Figure 6.2: View of the Oosterscheldekering



Vignette 9: “We take not-knowing as the central premise”

The Dutch European Rail Traffic Management System (ERTMS) programme coordinates the nationwide replacement of the rail sector's signalling infrastructure. It involves dozens of autonomous organisations (ProRail, NS, DB Cargo, regional carriers, contractors) that must move in synchrony across a thirty-year horizon, under a governance structure in which formal authority is distributed among parties that are simultaneously interdependent and commercially autonomous. Authority is distributed across the ecosystem; the programme director describes his role as that of a conductor in an orchestra where each musician is responsible for their own part (G. Scheffrahn, personal communication, May 15, 2026).

In a conversation about how the programme navigates this complexity, the programme director articulated a management philosophy that resonates with the core of this thesis's analysis: “*We take not-knowing as the central premise, instead of the classical mentality in which you make plans based on the assumption that you do know*” (G. Scheffrahn, personal communication, May 15, 2026). He described a deliberate shift from a waterfall approach to a tranche-based learning model, in which the programme freezes a defined scope for execution while simultaneously keeping the next scope open for exploration. He had split his organisation into two teams to protect this boundary: one focused on delivering what has been designed, the other on designing what comes next. Alongside the formal half-yearly parliamentary progress reports, which he characterised as backward-looking and factual, he writes a separate management letter: a qualitative, reflective, forward-looking document through which he gives meaning to what the programme is learning. His observation about the tension between these two instruments was precise: “*We are actually projecting the instruments of the old way of thinking onto the new way of thinking*” (G. Scheffrahn, personal communication, May 15, 2026).

What makes the ERTMS programme a compelling candidate for future research is the relationship between this practitioner's experience and the vocabulary this thesis has developed. Scheffrahn navigates tensions that the six axes describe: the pull between execution and design, the performativity of monitoring regimes, the structural production of bounded imagination in a sector organised around operational continuity. He has built institutional mechanisms to manage these tensions. Yet his language for them remains personal and situational. A practitioner working from within can describe the terrain and respond to it; what a historical analysis provides is the longer pattern: how such institutional conditions are assembled over decades, and how the Deltawerken record shows they can be dismantled in years. The question a comparative study could pursue is whether the Compass's vocabulary, grounded in that historical pattern, helps practitioners like Scheffrahn articulate, diagnose, and protect the conditions and capacities they are building.

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Figure 4.7-1: Berrevoets, J. D. C. (1972, August 26). [Oosterschelde] [Photograph]. Fotoarchief J.D.C. Berrevoets, Zeeuws Archief / ZB Bibliotheek van Zeeland.

Figure 4.7-2: Berrevoets, J. D. C. (1972, August 26). [Oosterschelde] [Photograph]. Fotoarchief J.D.C. Berrevoets, Zeeuws Archief / ZB Bibliotheek van Zeeland.

Figure 4.8.1: roelmeijer. (n.d.). Dutch salt marsh in autumn colors: Nature reserve “Koudekerkse Inlage”, Oosterschelde NP, Schouwen–Duiveland, Zeeland, Netherlands [Photograph]. Adobe Stock.

Figure 4.8.2: Ramon. (n.d.). Group of seals enjoying the sun on a sandbank in nature reserve the Oosterschelde in the Netherlands [Photograph]. Adobe Stock.

Figure 4.9: Rijksvoorlichtingsdienst [RVD]. (n.d.). Waterloopkundig Laboratorium te Delft. Rivierbocht afsnijding van de rivier de Flent bij Nottingham in Engeland [Photograph]. Fotocollectie Rijksvoorlichtingsdienst, Nationaal Archief.

Figure 4.10: GAPS Photography. (n.d.). Maeslant Storm Surge Barrier in The Netherlands [Photograph]. Adobe Stock.

Figure 4.11: Van Tilburg, F. (2026, February 20). European shag at the Oosterscheldekering [Photograph].

Figure 4.12: Author’s own work. Ten lessons from the Deltawerken [Diagram].

Figure 5.1: [Photographer unknown]. (n.d.). Bird’s eye view of Galgeplaat [Aerial photograph]. Zuidwestelijke Delta. Retrieved from <https://www.zwdelta.nl/nieuws/planuitwerkingsfase-zandsuppletie-galgeplaat-in-de-oosterschelde-gestart/#thema-s>

Figure 5.2: Rijkswaterstaat. (2026, 3 maart). De kennisboom. <https://rijksportaal.overheid-i.nl/organisaties/rws/artikelen/dit-doen-we/kennis-bij-rws/de-kennisboom.html>

Figure 5.3: Author’s own work. Collective Design Compass [Diagram].

Figure 6.1: Bird’s eye view of the Oosterscheldekering [Photograph]. Adobe Stock.

Figure 6.2: Eastern Scheldt Storm Barrier in The Netherlands [Photograph]. Adobe Stock.

Appendix A: The Collective Design Compass — Instrument and workshop format

This appendix accompanies the thesis “Designing Futures That Could Not Be Foreseen: Collective Future-Making in the Deltawerken, 1953–1997” by Florian Cascino (TU Delft, Faculty of Industrial Design Engineering, 2026). It provides the Collective Design Compass as a standalone instrument and a facilitation format for its use in workshop settings. The analytical foundations (the historical analysis of the Deltawerken, the theoretical lens, and the practitioner interviews from which the Compass is derived) are documented in Chapters 3, 4, and 5 of the thesis.

A.1 What the Compass does

The Compass is an orientation instrument. It helps a programme team articulate, in their own words, how they collectively understand the conditions under which they operate, and then read those descriptions against an analytical vocabulary grounded in the Deltawerken case. Like a compass in the geographical sense, it tells its users where they stand relative to a set of directions, while leaving the specific route to their judgement. The diagnostic power resides in the confrontation between the team’s situated language and the analytical vocabulary: what surfaces when practitioners describe their programme and then read that description against the spectra (see attached Compass on next spread).

A.2 Walking through the Compass

The Compass follows a reading direction: **PERCEIVE** → **CONNECT** → **GENERATE**. What a programme can see shapes what it can connect; what it can connect shapes what it can generate. Work through the instrument in this order.

Step 1: Articulate the performed future

Before addressing the six questions, the team must make explicit the future the programme is currently enacting. This is the hardest step, because it asks for explicitness about what usually remains implicit: the commitments already made, the contracts signed, the assumptions no longer questioned. Pose the prompt from §5.3: *What future is this programme currently enacting? What has been settled, and what remains open?* Record the answer visibly. It anchors everything that follows.

Step 2: Work through the six questions

For each question, the team describes what they observe in their programme. Brief contextual notes per question:

Visibility. Monitoring regimes are performative: they constitute what counts as relevant. The question asks whether the programme’s monitoring makes certain futures invisible (§4.5, §4.8.3).

Imagination. Programmes often assume more data will resolve their impasse. In many situations the constraint is imaginative, not informational (§4.2, §4.8.1).

Productive Doubt. Uncertainty can narrow the solution space (deferral as delay) or expand it (deferral as exploration). The question asks which form doubt takes in the programme (§4.6).

Boundary Spanning. Knowledge exists across communities. The question is whether it reaches across boundaries in ways that are consequential, or stays contained within the community that produced it (§4.4, §4.7).

Designability. The distinction between engineerability and design-ability. Is the programme organised to execute a settled brief, or to hold a design process open (§4.6, §3.4.6)?

Generativity. Crisis is a reliable generator of institutional change, but contemporary challenges are often slow-burn. Can the programme open new directions without external shock (§5.2.5)?

After describing each dimension, the team reads their description against the corresponding spectrum (figure 5.3) and locates where the programme sits. The confrontation between the team’s own language and the analytical vocabulary is where the Compass becomes diagnostic.

Step 3: Read the pattern

Once all six dimensions are positioned, look at the pattern as a whole. The right pole of each spectrum represents the condition associated with stronger collective design capacity, but a programme in a stable execution phase may sit closer to the

left on several dimensions without that being a problem. The situational question is: *is this where the programme should be, given what it faces?*

A.3 Working with the collectively formulated future

The diagnostic snapshot (six positions on six spectra) serves a larger purpose. The most important output of a Compass session is the collectively formulated future from Step 1, read through the lens of the six dimensions.

The performed future is usually implicit. It lives in contracts, governance arrangements, political mandates, and the accumulated weight of past decisions. Making it explicit, collectively, already changes what the programme can see. But articulation alone is not enough. The question that follows is: given what the six dimensions reveal about the programme’s collective design capacity, what can this team actually do with the future they have just described?

Three directions could be worth pursuing after a Compass session.

First, identify where the performed future has been settled by design and where it has been settled by default. It could well be that the team discovers aspects of the programme’s future they are enacting were never deliberately chosen; they accumulated through incremental commitments, contractual lock-in, or institutional habit. The Compass can make visible which of those default settlements are significant (they sit on dimensions where the programme is closer to the left pole) and which are not.

Second, test the performed future against the dimensions where the team identified the largest gaps. If the programme is positioned toward “monitoring that confirms” on the Visibility spectrum, what aspects of the performed future remain unchallenged because the monitoring architecture does not make alternatives legible? If Boundary Spanning is weak, whose knowledge about the programme’s trajectory is not reaching the people who set its direction? The Compass provides a structured way to ask these questions rather than leaving them to individual intuition.

Third, revisit the performed future periodically. The Deltawerken analysis showed how rapidly the conditions for collective design can shift: the *bedrijfsmatige wending* of the late 1900s transformed

Rijkswaterstaat’s institutional architecture within a few years, with consequences for the programme’s capacity that only became visible in retrospect (§4.7). A performed future that was adequate under one set of conditions may become inadequate under another. Repeating the Compass at regular intervals (at phase transitions, after major decisions, or on a fixed cadence) allows the team to detect drift before it hardens into lock-in.

A.4 Facilitation notes

The Compass can be used as a self-assessment, a conversation piece (“*praatplaat*”), or the centrepiece of a facilitated session. For a facilitated session with a programme team (6–15 participants, 2–3 hours):

Print the Collective Design Compass (attached on next page) at A2 or A1 for central display. The facilitator introduces the instrument briefly (its origin, the reading direction, the fact that all answers are situated in the team’s own experience), then works through Steps 1–3 as described above. Individual reflection (silent writing) before group discussion helps surface perspectives that would otherwise stay quiet. Mixing participants from different communities of practice within small groups is important: the divergences between how different communities experience the same programme are themselves diagnostic.

The facilitator’s main task is to hold description before evaluation. Parts of the session that ask “*what happens in your programme?*” should stay descriptive; the evaluative move (“*is this where we should be?*”) comes after the team has produced its own account. When perspectives diverge, the divergence should be recorded, not resolved. It is a finding.

The instrument is designed to be legible on its own; participants can engage with the six questions from their situated experience, without the analytical background.

COLLECTIVE DESIGN COMPASS

An orientation instrument for programmes facing complex, uncertain, long-horizon challenges

PROGRAMME _____

DATE _____

THE PERFORMED FUTURE

What future is this programme currently enacting?

PERCEPTIVE CAPACITY

What does the programme see?

VISIBILITY



"Does your monitoring system make certain futures invisible?"

- Who determines what is measured?
- Do results feed back into design, or only execution control?
- What new measurements would reveal a different picture?

CONNECTIVE CAPACITY

How does the programme relate to uncertainty and difference?

PRODUCTIVE DOUBT



"Is not-knowing treated as a problem to be resolved, or as a starting point for design?"

- When facing the unknown: contract out, or investigate in-house?
- Is there protected time/budget for exploration without fixed outcomes?
- Which decisions expand options by waiting, which contract them?

GENERATIVE CAPACITY

How does the programme organise for the unknown?

DESIGNABILITY



"Can the programme's brief be fundamentally revised, or is it structured only to deliver what was decided?"

- Could new knowledge challenging the core premise be absorbed?
- What is settled (contractable) vs. still being designed (in-house)?
- Does governance allow reframing, or only scope changes?

IMAGINATION



"Is your programme limited by what it knows, or by what it can imagine?"

- When was a fundamentally different alternative last explored?
- Does the programme generate new concepts, or only evaluate existing ones?
- Are there people whose role is to imagine, not only to analyse?

BOUNDARY SPANNING



"Who carries knowledge across community boundaries, and do they have standing in more than one community?"

- Can you name individuals bridging knowledge domains?
- Does a new perspective have a carrier with institutional standing?
- Are there forums where communities confront each other's assumptions?

GENERATIVITY



"If no crisis occurs in the next decade, can this programme still open fundamentally new directions?"

- What mechanisms exist for challenging the trajectory from within?
- Is there a structural role for dissent or alternative scenarios?
- Has the programme ever changed course without external shock?

Full analytical foundations: Cascino, F. (2026). *Designing Futures That Could Not Be Foreseen: Collective Future-Making in the Deltawerken, 1953–1997*. MSc thesis, Faculty of Industrial Design Engineering, TU Delft.