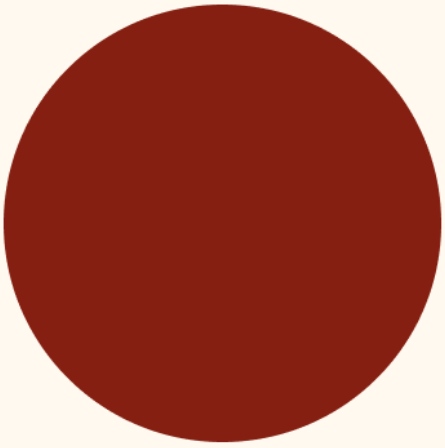
En rapport från Demos Helsinki på uppdrag av Formas

Towards Experimentalist R&I Funding

How research and innovation funders can drive societal transformation in the 21st century



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Förord

Samhället som vi känner det förändras snabbt. Omvälvande teknik som AI, liksom geopolitisk oro och intensifierade klimatförändringar är bara några exempel på vad som driver världen mot okänd mark. För Formas del innebär kombinationen av osäkerhet och brådska nya utmaningar. För att skapa förutsättningar för forskning och innovation som kan bidra till en hållbar samhällsomställning finns behov av att gå bortom utformningen av specifika instrument.

Hur vi som organisation kan arbeta med och genom utlysningar eller program kan därför behöva revideras.

Demos Helsinki har på Formas uppdrag tagit fram denna rapport. Utgångspunkt för rapporten är på vilket sätt forsknings- och innovationsfinansiärerna bättre kan bidra till omställning mot hållbara, rättvisa och resilienta samhällen. Rapportförfattarna föreslår experimentalism som ett möjligt tillvägagångssätt och presenterar vad detta kan innebära i praktiken.

Rapporten syftar till att vara ett kunskapsunderlag för lärande och är ett av Formas underlag inför den kommande forsknings- och innovations-propositionen. Analysen och rekommendationerna är dock rapport-författarnas egna. Jag vill rikta ett tack till dem för de insikter som rapporten ger.

Johan Kuylenstierna
Generaldirektör, Forma

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DEMOS HELSINKI

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By Demos Helsinki

Sammanfattning

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Finansiering av forskning och innovation, FoI, är avgörande för att skapa nya lösningar på komplexa samhällsutmaningar. Dagens FoI-finansiering står dock inför ett svårlöst problem. Å ena sidan måste finansiärerna agera snabbt för att hantera den snabba samhällsomställningen. Å andra sidan måste de hantera en omfattande politisk, organisatorisk och kunskapsbaserad osäkerhet kring hur detta ska utföras i praktiken. Om finansiärerna ska lyckas med sin uppgift måste de tänka om vad gäller beslutsfattande och övergripande styrning, det som på engelska kallas governance, av forskning och innovation.

Styrningen av FoI är idag påverkad av spänningar mellan två etablerade synsätt på hur samhällelig problemlösning bäst sker. Genom statliga initiativ eller genom marknadsstyrning? Denna rapport föreslår experimentalism som en alternativ ansats, en slags tredje väg som möjliggör nytänkande kring hur FoI-finansiering kan styras i riktning mot samhällsomställning. Experimentalism är en iterativ process som bygger på följande fyra funktioner:

1. **Konsensus** mellan huvudsakliga intressenter om processens övergripande mål.
2. **Experimentell** verksamhet som karaktäriseras av autonomi och tydligt ansvar.
3. **Kollegialt lärande** för att säkerställa kunskapsöverföring.
4. **Iteration** baserad på nya lärdomar

Rapporten presenterar ett ramverk för experimentell forskning- och innovations-finansiering. Ramverket illustrerar hur de fyra funktionerna kan användas inom finansieringsprocesser i praktiken. Detta görs på två sätt. Först identifierar vi åtta steg som tillsammans utgör finansieringsprocessen, från att sätta agendan och identifiera intressenter till att följa upp pågående projekt och ta till sig lärdomar. För att illustrera hur varje steg kan förverkligas på ett experimentellt sätt presenterar rapporten sedan exempel på konkreta verktyg.

Experimentalism är en iterativ process, inte en blåkopia. De verktyg som föreslås i denna rapport bör därför hanteras som hypoteser. De bör testas inom relevanta organisatoriska kontexter, vidareutvecklas om de visar sig vara framgångsrika och överges om de fungerar dåligt. Genom att omfamna iterativa processer och gemensamt lärande, kan FoI-finansiärer utveckla nya arbetssätt – och därigenom uppfylla sin potential som ledare av samhällsomställning.

Summary

Research and innovation (R&I) funding is key to ensure that our societies generate new solutions to complex societal challenges. However, today R&I funding is caught in a conundrum. On the one hand, R&I funders need to act fast in order to cope with urgent societal transformation. On the other hand, they must reckon with considerable political, organizational, and knowledge uncertainty for how to do so in practice. If R&I funders are to succeed in their task, they must rethink the governance of R&I.

The governance of R&I currently centers around an age-old tension between state-led and market-led approaches to collective problem-solving. In this report, we propose experimentalism as an alternative approach: that is, as a 'third way' for rethinking governance of R&I funding and steer it towards societal transformation.

Experimentalism is an iterative governance process realized through four functions:

1. **Consensus** among key stakeholders around a framework goal;
2. **Experimentation** through substantial autonomy and clear accountability;
3. **Peer-learning** to ensure knowledge transfer;
4. **Iteration** based on emerging learnings.

This report presents a framework for experimentalist R&I that illustrates how the four functions above can be brought into practice within R&I funding processes. This is done in two ways. First, we identify eight steps of R&I funding processes – such as agenda-setting, identifying recipients, and seizing learnings from ongoing projects. Second, we propose concrete tools to illustrate how each step can be realized in an experimentalist fashion.

Experimentalism is an iterative process, not a blueprint. Thus, the tools proposed in this report should be treated as hypotheses to be tested within each organizational context; further developed if proven successful; and abandoned if they fit uneasily within the given context. By embracing iteration and collective learning – we argue – R&I funders can design new working and organizational practices, and thus fulfil their potential as leaders of societal transformation.

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1. Introduction

Many research and innovation (R&I) funders aim to drive societal transformation by providing financial and managerial support to various activities. These are carried by a multitude of actors – such as public agencies, private companies, research institutes, universities, or civic stakeholders – that are intent on solving some of the most difficult challenges of our time. Doing so, however, is a challenging task.

On the one hand, these actors must answer to the pressing need for new solutions to tackle societal transformation. On the other, they must cope with the intrinsic uncertainty of both R&I operations and their potential contribution to societal transformation. Against this background, this report advances experimentalism as a new approach to govern R&I funding at a time of simultaneous urgency and uncertainty.

Experimentalism is rooted in the premise that the knowledge that policy decisions are based upon is inherently imperfect and constantly evolving. Policymakers cannot have definite knowledge of how to tackle complex societal challenges. For this reason, they should aim to structure their decision-making processes in order to enable and embed continuous learning at the core of policy design. By doing so, they can widen their knowledge-base; accommodate their deployment in shifting circumstances; and maximize their chances to find effective ways forward in the face of uncertainty.

This report has two goals. First, to articulate the need for and develop a new framework for experimentalist R&I. Second, to outline how policymakers can already start 'tilting' their decision-making processes to embed experimentalism within R&I funding. As a result, we aim to support R&I funders engaged in societal transformation by providing them with ideas on how to adapt their operations accordingly.

Chapter 2 depicts how today's societal challenges are putting R&I funders in front of a new conundrum: i.e., a mismatch between the ever-more increasing urgency of societal transformation and the persisting uncertainty that surrounds their potential resolution. Chapter 3 shows how experimentalism can help R&I funders overcome the conundrum by reconciling the need for urgent action while acknowledging uncertainty. Chapter 4 turns experimentalism into an 'experimentalist R&I' framework. The framework identifies eight organizational steps of R&I funding processes and a preliminary set of tools that funders can employ to tilt them towards experimentalist R&I. Chapter 5 outlines three recommendations for how R&I funders can make the most of the framework to lead societal transformation.

2. Background: R&I funders' operating environment

This chapter begins by depicting the context in which R&I funders are now operating and describes it as a state of 'polycrisis.' Second, we propose that the contemporary R&I policy debate revolves around two opposing views of how societal transformations should be advanced: state-led and market-driven approaches. Third, we explore what consequences this dichotomy has for R&I funders.

2.1 The Big Picture - The Polycrisis and New Demands for R&I

In the effort to advance societal transformation, governments are turning to R&I in the search for new solutions. In this report, we use the concept of 'R&I' to refer to all those activities in which research is developed or applied to create concrete solutions – i.e., 'innovations' – in order to address a given problem.[1] Historically, R&I funding has played an essential role in driving societal progress.[2] However, progress has often been more significant in some industries and sectors than others.[3] For this reason, the rise of new societal challenges has often called for a reappraisal of the role, mechanisms, and objectives of R&I funding. The literature identifies broadly three main rationales for promoting public R&I funding, which are all rooted in different challenges or 'failures.'[4]

- In the aftermath of World War II, the resolution of so-called **'market failures'** was seen as key to modernizing industrially developed economies. In this logic, public investment in R&I is justified in those areas where new scientific discoveries can seep into the applied R&I efforts of private companies, but

[1] In this report, we do not refer to *basic* research (advancing knowledge) but to *applied* research (applying knowledge to a problem). The line between research and innovation is blurry: research is key to developing workable innovation, whereas innovation is the ultimate output of (applied) research. For this reason, the two terms are often grouped. For more information, see W. Brian Arthur, *The Nature of Technology: What It Is and How It Evolves* (Simon and Schuster, 2009).

[2] Chris Freeman and Francisco Louçã, *As Time Goes By: From the Industrial Revolutions to the Information Revolution* (Oxford University Press, 2001).

[3] Richard Nelson, "The Moon and the Ghetto Revisited", *Science and Public Policy* 38, no. 9 (2011): 681–90.

[4] See K. Matthias Weber and Harald Rohracher, "Legitimizing Research, Technology and Innovation Policies for Transformative Change: Combining Insights from Innovation Systems and Multi-Level Perspective in a Comprehensive 'Failures' Framework", *Research Policy*, Special Section on Sustainability Transitions, 41, no. 6 (June 2012): 1037–47; see also Johan Schot and W. Edward Steinmueller, "Three Frames for Innovation Policy: R&D, Systems of Innovation and Transformative Change", *Research Policy* 47, no. 9 (November 2018): 1554–67.

private investment is limited – e.g., due to their short-term horizon of investment. As such, the logic of market failures privileges mono-disciplinary, sector-based R&I.

- In the 1980s, the market failures view was complemented by a growing demand to address **'system failures**'. In this logic, public investment is key to support the development and diffusion of R&I knowledge and solutions through the better coordination of R&I stakeholders. To do so, public investment can support the development of new infrastructures; support the formation of R&I capabilities; or establish institutional conditions (e.g., regulation) that favour such cooperation.
- Lastly, the 2010s have seen growing attention to **'transformation failures'**, i.e., misalignments between R&I efforts and the societal challenges. In this logic, public investment plays a crucial role in reorienting the distributed R&I efforts of public, private, and societal action towards the co-production of solutions that can help address such challenges. As such, the logic of transformation failures privileges trans-disciplinary, challenge-based R&I.

In the last decade, the attention to 'transformation failures' has been driven by at least five societal drivers:

1. The growing proximity to 2030 – that is, the time target of the United Nations' Sustainable Development Goals (SDGs);[5]
2. the growing acknowledgment of the urgency behind the climate crisis — as shown by the work of the Intergovernmental Panel for Climate Change;[6]
3. the rapid development of potentially disruptive technologies – e.g., AI;[7]
4. the outbreak of the Covid-19 pandemic; and,
5. the manifold implications of the military aggression of Russia toward Ukraine.

The compound effect of these drivers constitutes what has been defined as a polycrisis: i.e., a context 'where disparate crises interact such that the overall impact far exceeds the sum of each part.'[8]

The implications of the polycrisis are not merely geopolitical but also social, ecological, and economic. For example, the rise in energy prices spurred by the Russian aggression stimulated investments in the green transition across the EU and

[5] "Transforming Our World: The 2030 Agenda for Sustainable Development" (United Nations, 2015).
[6] "Climate Change 2022: Mitigation of Climate Change" (IPCC, 2022).
[7] Daron Acemoglu and Simon Johnson, "What's Wrong with ChatGPT?," *Project Syndicate*, February 6, 2023.
[8] Kate Whiting and HyoJin Park, "This Is Why 'polycrisis' Is a Useful Way of Looking at the World Right Now," *World Economic Forum*, March 7, 2023.

US. These investments, in turn, furthered pre-existing inflationary pressures that eroded the purchasing power of their households and businesses. After a long 'decade of missed opportunities', governments are now pressured to show they have learned from past mistakes. Yet, the lack of sufficient progress towards the SDGs and climate targets indicates that the road to the necessary transformations remains unclear.[9]

In this context, there is a growing consensus that R&I policy must tackle all of the three 'R&I failures' reviewed above. For example, greenhouse gas emissions can be seen as the compound outcome of market failures (e.g., lack of sufficient investment in 'green' R&I), system failures (e.g., lack of coordination in the development of regulatory standards for 'green' technology), and transformation failures (e.g., lack of shared direction among R&I stakeholders for the pursuit of a 'green' transition). Yet, while R&I policy has traditionally been focused on 'market' and 'system failures', there is still very little clarity on how to tackle 'transformation failures' successfully.[10] As a result, our societies seem stuck in a conundrum. On the one hand, we are pushed forward by the need for quick responses to the polycrisis. On the other hand, we are hindered by a persistent uncertainty on how to develop them.

As in the case of many other public agencies, also the role of public R&I funders should be reassessed to better cope with societal transformation.[11] Scholars have widely explored the characteristics of public R&I agencies across industrially developed economies – often stressing their critical role in managing public grants, developing new policy tools, or linking private companies and research institutes.[12] Depending on their operating context, R&I funders' role has been observed to vary based on the prominent driver of technological change in an economy (public or private); on the relative scope of public and private R&I initiative (strong or weak

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[9] Independent Group of Scientists appointed by the Secretary-General, "Global Sustainable Development Report 2023: Times of crisis, times of change: Science for accelerating transformations to sustainable development", (United Nations, New York, 2023).

[10] See, for example, Harald Rohracher, Lars Coenen, and Olga Kordas, "Mission Incomplete: Layered Practices of Monitoring and Evaluation in Swedish Transformative Innovation Policy", *Science and Public Policy* 50, no. 2 (April 2023): 336–49.

[11] Susana Borrás et al., "The Transformative Capacity of Public Sector Organizations in Sustainability Transitions: A Conceptualization", *Lund University*, Papers in Innovation Studies, (2023). The argument developed in this report can be applied to all forms of R&I funding. However, this report focuses on R&I agencies distributing public funding such as Formas.

[12] See 'Schumpeterian Developmental Agencies' in Dan Breznitz and Darius Ornston, "The Politics of Partial Success: Fostering Innovation in Innovation Policy in an Era of Heightened Public Scrutiny," *Socio-Economic Review* 16 (October 2018): 721–41; 'innovation bureaucracies' in Rainer Kattel, Wolfgang Drechsler, and Erkki Karo, *How to Make an Entrepreneurial State: Why Innovation Needs Bureaucracy* (Yale University Press, 2022); 'systemic innovation intermediaries' in Paula Kivimaa et al., "Towards a Typology of Intermediaries in Sustainability Transitions: A Systematic Review and a Research Agenda" *Research Policy* 48, no. 4 (May 2019): 1062–75.

public leadership); on the nature of the R&I target pursued (incremental or radical innovation); or on the domain and scope of R&I funding (technology-focused or portfolio-based). Such diversity has led to the acknowledgment that R&I funders can play different roles in this field – such as those of facilitators, upgraders, enablers, initiators, or even just observers of R&I ecosystems.[13] Among these possibilities, in the context of today's polycrisis, R&I funders need tools to lead change – rather than be led by it. However, the debate concerning their role in driving today's societal transformations is still open in many respects.

2.2 The Prevalent Responses - State-Led vs. Market-Driven

While there is a broad agreement that R&I is key to support societal transformation, opinions are divided on how R&I policy should be governed to do so. A way to characterize this disagreement is through a dichotomy between the 'state-led' and the 'market-driven' approaches to R&I policy.

The state-led approach holds that active governmental steering of R&I activities is key to ensuring the knowledge base and innovations necessary to address the polycrisis. In the last decade, this approach has been most prominently advocated for by Mariana Mazzucato in her book *The Entrepreneurial State*.[14] Mazzucato argues for rethinking the state's role in R&I through the adoption of ambitious 'missions': long-term targets that can catalyze collective investment towards a shared societal challenge. By doing so, Mazzucato challenges the view that the state should merely address market failures – namely, by arguing that the state has played, and should play, a central role in driving innovation through active funding and steering of R&I activities.

On the contrary, ***the market-driven approach*** proposes that the state should limit itself to addressing market failures. In this view, while the state can legitimately fund basic research, applied research to develop commercially viable solutions should be left to private actors. As the state does not face entrepreneurial risk – the argument goes – public engagement in R&I can lead to excess public spending and, simultaneously, 'crowd out' private investment. Recently, a defense of this approach has been outlined in *Questioning the Entrepreneurial State* – a book edited by Karl Wennberg and Christian Sandström. They argue that R&I policy should focus on securing operating conditions and removing barriers to innovation and suggest

[13] Darius Ornston, Dan Breznitz, and Steven Samford, "Mission Critical: The Ends, Means, and Design of Innovation Agencies," *Industrial and Corporate Change* 27 (October 2018): 883–96; Susana Borrás and Jakob Edler, "The Roles of the State in the Governance of Socio-Technical Systems' Transformation," *Research Policy* 49, no. 5 (June 2020).

[14] Mariana Mazzucato, "The Entrepreneurial State", *Soundings*, no. 49 (2011): 131–42.

caution against state-led 'grand schemes toward noble outcomes' but a patchy track record.[15]

The criticism of the state-led approach suggested by advocates of the market-driven approach lies in the **uncertainty** that surrounds the dynamics of the R&I process. The argument boils down to the 'knowledge problem' posed by Nobel laureate economist Friedrich von Hayek – according to which states cannot develop complete and nuanced knowledge on R&I processes in order for their top-down solutions to work as intended.[16] R&I processes are chaotic, non-linear, and fundamentally complex. For this reason, they cannot be coordinated in a centralized fashion. Markets, instead, are tied together by continuous variations in prices that respond to the decentralized action of all the actors that are engaging in them. For this reason, markets provide entrepreneurs with the best available information on how to navigate the risks and rewards of R&I processes.

Conversely, advocates of a state-led approach note the inability of a market-driven approach to ignite societal transformation with the **urgency** required by our times. In their view, markets are 'blind' in setting their direction for technological change and economic growth.[17] Individual entrepreneurial action does not accommodate concerns for collective welfare. As a result, without strong direction from the state, socially and environmentally unsustainable technologies may continue operating at the expense of the common good, and new ones may fail to be promptly developed. In this respect, the design of 'market-fixing' R&I policies – rather than 'market-creating' – fails to challenge existing technological paradigms in time, and therefore is prone to fail in solving the key challenges of our times quickly enough.[18]

Today, R&I funders are called on to reflect upon their role in societal transformation. In this respect, the relative strengths and weaknesses of each approach bear important implications for how funders run their operations. Among them, the three highlighted below play a paramount role in addressing 'transformation failures'.

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[15] Karl Wennberg and Christian Sandström, *Questioning the Entrepreneurial State : Status-Quo, Pitfalls, and the Need for Credible Innovation Policy* (International Studies in Entrepreneurship (ISEN, volume 53), 2022), 6.

[16] Johan P. Larsson, "Innovation Without Entrepreneurship: The Pipe Dream of Mission-Oriented Innovation Policy," in *Questioning the Entrepreneurial State: Status-Quo, Pitfalls, and the Need for Credible Innovation Policy*, (International Studies in Entrepreneurship (ISEN, volume 53), 2022).

[17] Giovanni Dosi, "Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants and Directions of Technical Change", *Research Policy* 11, no. 3 (1982): 147–62

[18] Mariana Mazzucato "From market fixing to market-creating: a new framework for innovation policy", *Industry and Innovation*, 23(2): 140–156 (2022).

- **Directionality vs. Creativity.** Depending on its purpose, R&I funding can range from selective (e.g., targeting distinctive technologies or sectors) to neutral (e.g., providing funding regardless of sector). The state-led approach suggests targeting ambitious challenges ('missions') to ensure that funding is assigned to projects with the greatest societal benefit. As such, it suggests 'directionality' in R&I funding and a more active role for R&I funders in managing its allocation.[19] On the other hand, the market-driven approach highlights how excessive 'top-down' steering of R&I projects may neglect companies' needs, interfere with natural market selection processes, and hamper companies' 'bottom-up' creativity.
- **Inclusivity vs. Expertise.** Depending on its degree of engagement with non-R&I stakeholders, R&I funding can vary from inclusive to exclusively expert-based. The state-led approach advocates for a greater inclusivity of R&I processes and highlights the need for an 'open science' approach where the experience and preferences of broader societal groups are taken into account.[20] As testified by the 'open innovation' movement, the market-driven approach is not against the engagement of 'users' in R&I processes.[21] However, it also highlights how publicly managed participatory processes may come with substantive costs in time and funding. As such, it privileges the role of expertise – specifically, those of private companies – as the key to effective R&I.
- **Accountability vs. Uncertainty.** Last, depending on the clarity of its objectives, R&I funding can either prioritize accountability or acknowledge uncertainty. The state-led approach aims to ensure that the public sector is accountable for the direction and ability of R&I to address societal challenges. Yet, the market-driven approach highlights that the intrinsic uncertainty of R&I entails many risks and requires the efforts and knowledge of multiple stakeholders. In turn, this can put at stake the transparency of the choices made for public investment and dilute the accountable use of public funds across decentralized networks.[22]

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[19] A trend that further contributes to this direction can be found in the surge of the Responsible Research and Innovation (RRI) approach. Mirjam Burget, Emanuele Bardone, and Margus Pedaste, "Definitions and Conceptual Dimensions of Responsible Research and Innovation: A Literature Review", *Science and Engineering Ethics* 23, no. 1 (February 2017): 1–19

[20] Andy Stirling, "'Opening Up' and 'Closing Down'", *Science Technology & Human Values* 33 (November 2007): 262–94.

[21] Henry William Chesbrough, *Open Innovation: The New Imperative for Creating and Profiting from Technology* (Harvard Business Press, 2003).

[22] Slavo Radosevic, Despina Kanellou, and George Tsekouras, "The Experimentation–Accountability Trade-off in Innovation and Industrial Policy: Are Learning Networks the Solution?", *Science and Public Policy* (May 2023).

These tensions provide visibility on why the state-led and market-driven approaches provide limited answers to the needs of today's R&I funders. The state-led approach asks them to show direction; include many stakeholders; and create accountability for societal transformation. The market-driven approach, instead, pushes them to seize on entrepreneurial creativity; rely primarily on actors with in-depth expertise; and embrace that the uncertainty of societal transformation defies individual accountability – be that individual, organizational, and sectoral. For all these reasons, we argue that the three dichotomies highlighted by the debate between the state-led and the market-driven approach must be transcended. If R&I funders are to advance societal transformation, they need to find a third way forward.

3. Experimentalism as a Third Way for R&I

In this chapter, we argue that experimentalism provides R&I funders with an approach to advance to contemporary societal transformation by reconciling the need to act swiftly with the need to be mindful of considerable uncertainty.[23] First, we introduce the theory underpinning experimentalism. Second, we illustrate how it can help transcend the stated dichotomy by addressing the urgency of today's polycrisis and the intrinsic uncertainty of R&I at the same time.

3.1. Towards Experimentalist Governance

Governance can be defined as the set of processes, structures, and institutions that guide (and restrain) the collective action of a set of stakeholders.[24] At an organizational level, governance is thus reflected in how members of an organization cooperate to define and pursue shared goals. At the societal level, it describes how public, private, and civic actors coordinate to identify and prioritize collective challenges and find and implement their solutions. Therefore, governance can be described as the 'invisible infrastructure' of organizations and societies that work together to reach goals.[25]

In the last 40 years, societal, economic, and technological changes have brought to the forefront of the governance debate a paramount challenge: i.e., *strategic ambiguity*.[26] Strategic ambiguity is the inability to specify what collective action to pursue and how to pursue it. This uncertainty is caused by the increased volatility of a rapidly changing environment. The lack of sufficient progress towards the SDGs 2030 agenda and the climate target of keeping the global temperature rise below 1.5 °C are paradigmatic examples of strategic ambiguity. In these cases, strategic ambiguity results from many factors. First, there is little knowledge on how to advance societal transformation in practice. Second, multi-stakeholder coordination is deemed essential to find out new solutions, and yet difficult to govern in practice. Third, such coordination is affected by political contestation both around the

[23] Charles Sabel, et al., "Individualized Service Provision in the New Welfare State: Lessons from Special Education in Finland", *Sitra Studies* 62 (2011).
[24] Robert Keohane, *Power and Governance in a Partially Globalized World* (London: Routledge, 2022).
[25] Christopher Ansell and Jacob Torfing, *Handbook on Theories of Governance* (Edward Elgar Publishing Ltd, 2016).
[26] Charles Sabel and Jonathan Zeitlin, "Learning from Difference: The New Architecture of Experimentalist Governance in the European Union," *European Governance Papers* C-07–02 (June 2007).

framing of the challenge and the feasibility or desirability of its potential solutions.[27] For this reason, strategic ambiguity constitutes a key challenge to R&I funders' ability to contribute to societal transformations.

The foundation of a promising approach to address strategic ambiguity can be found in the work of the American philosopher John Dewey.[28] Writing in the early 20th century, Dewey already saw change as the key problem of political life. As such, he held that the secret of effective democracy lies in the ability to continuously adapt governance to the evolving needs and problems that a changing society faces. For this reason, he pleaded for public organizations to be founded on the open acknowledgment of their *fallibility*: i.e., to continuously revise their ways of operating and long-held beliefs in the light of emerging knowledge and changing environment. For the same reason, he argued that public governance should therefore thrive on experimentation by adjusting the 'ends' and 'means' of public action in the face of new problems.

Far from being just a philosophical idea, this approach can be detected across several disciplines and practices concerning public administration, R&I funding, and their role in today's context. In the sustainability transitions scholarship, experimentalist principles underscore many popular analytical frameworks – such as 'Transition Management,' 'Strategic Niche Management,' and 'Transformative Outcomes.'[29] Similarly, the rise of design thinking in public administration highlights the growing openness of civil servants to test, iterate, and revise their services to ensure good performance.[30] Moreover, similar trends can also be found all across the industrial and innovation policy space.[31] Among these approaches, there is also

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[27] Iris Wanzenböck et al., "A Framework for Mission-Oriented Innovation Policy: Alternative Pathways through the Problem–Solution Space," *Science and Public Policy* 47, no. 4 (August 2020): 474–89.

[28] John Dewey, *The Public and Its Problems* (New York: H. Holt and Company, 1927).

[29] See René Kemp, Johan Schot, and Remco Hoogma, "Regime Shifts to Sustainability through Processes of Niche Formation: The Approach of Strategic Niche Management", *Technology Analysis & Strategic Management* 10, no. 2 (January 1998): 175–98; Derk Loorbach, "Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Governance Framework", *Governance* 23, no. 1 (2010): 161–83; Bipashyee Ghosh et al., "Transformative Outcomes: Assessing and Reorienting Experimentation with Transformative Innovation Policy", *Science and Public Policy* 48, no. 5 (October 2021): 739–56.

[30] See Emma Blomkamp, "The Promise of Co-Design for Public Policy", *Australian Journal of Public Administration* 77, no. 4 (December 2018): 729–43; Christian Bason and Robert D. Austin, "Design in the Public Sector: Toward a Human Centred Model of Public Governance", *Public Management Review* 24, no. 11 (November 2022): 1727–57.

[31] See Dani Rodrik, "Industrial Policy for the Twenty-First Century", SSRN Scholarly Paper (Rochester, NY, November 2004); Johan Schot and W. Edward Steinmueller, "Three Frames for Innovation Policy: R&D, Systems of Innovation and Transformative Change".

one which can be particularly helpful in supporting R&I funders' attempt to cope with strategic ambiguity: i.e., 'experimentalist governance'.

Experimentalist governance has been defined as "a recursive process of provisional goal-setting and revision based on learning from the comparison of alternative approaches".[32] As an ideal type, it is a process composed of four systemic functions that describe how collective action between a 'central' actor (e.g., an R&I funder) and its 'local' partners (e.g., a network of stakeholders receiving R&I funding) can be structured:

1. **Striking a thin *consensus* around a 'framework goal'.** A *framework goal* is an agreement on a problem formulation, decision-making procedures, and a set of initial metrics that leave the means for achieving the goal open for inquiry. This openness allows for exploring different approaches to address the issue at hand.
2. **Granting local partners broad discretion in pursuing the framework goal through *experimentation*.** This autonomy is key to spur and leverage actors' first-hand experience and expertise of the problem: i.e., it allows decentralized activities to develop innovative solutions for reaching the framework goal.
3. **Utilizing *peer-learning* to facilitate collective problem-solving.** In exchange for autonomy, local actors participate in peer-learning activities, where the outcomes of decentralized activities are compared to identify strengths and weaknesses. This ensures learning between local actors and knowledge accumulation for the central actor.
4. **Reviewing and adjusting the process *iteratively*.** The problem formulation, goal, decision-making procedures, and metrics are periodically revised in response to the problems and possibilities revealed through peer-learning. This iteration allows for opening up and/or deepening the consensus as knowledge of workable solutions is accumulated.

Together, these functions show how experimentalist governance coordinates 'central' and 'local' stakeholders facing strategic ambiguity. It establishes accountability that revolves around pursuing *dynamic* rather than static objectives. Further, it premises its success around the achievement of *learning* rather than the respect of prescribed rules.

Experimentalist governance is tightly linked to Dewey's pragmatist approach. However, in contrast to Dewey's work, it has primarily been developed through

[32] Charles Sabel, Maurice Moore, and Jonathan Zeitlin, "Experimentalist Governance", in *The Oxford Handbook of Governance*, 2012, p.3.

empirical research, by studying governance regimes that have successfully solved societal challenges despite strategic ambiguity across and beyond geographical scales and policy domains. In the field of sustainability, major examples include the United Nations Environmental Programme's Montreal Protocol and the European Union's Water Framework Directive.[33] In the context of R&I agencies, key cases include the American Defense Advanced Research Project Agency (DARPA), the Finnish Innovation Fund (SITRA), and the European Institute of Innovation and Technology (EIT). These three case examples are further described in detail in section 4.3.

3.2. Transcending the 'States vs. Markets' Dichotomy

Earlier, we have sketched the relative merits and pitfalls of each side of the ongoing debate between the state-led and the market-driven approach to R&I. On the one hand, we identified the main weakness of the latter in its lack of solutions for *urgency*: markets left to themselves may not adapt as fast as needed to avert the worst outcomes of contemporary crises. On the other hand, we argued that the weakness of the state-led approach is its failure to address *uncertainty*: states cannot possess the knowledge for mere top-down solutions work. In both ways, experimentalism allows making the best of both to address the conundrum of urgency and uncertainty.

Against urgency, experimentalism proposes directionality and experimentation. By the former, it provides a clear direction to steer collective action by seizing on participation and deliberation (**Consensus**). By the latter, it prompts innovation through goal-driven 'learning by doing' (**Experimentation**). Against uncertainty, it proposes collaboration and iteration. By the former, it tackles the impossibility of engineering solutions from the top down by seizing on 'local' experience (**Learning**). By the latter, it embraces fallibility by ensuring the continuous reappraisal of collective action (**Iteration**). As a result, experimentalism provides an actionable third way for R&I funders to adopt in order to overcome the main tensions imposed by the 'states vs. markets' dichotomy on their organizational practices (cfr. Section 2.2).

1. **Experimentalism is neither fully top-down nor fully bottom-up.** Rather, it is both simultaneously in that it aims to integrate top-down direction (i.e., through collaboratively defined framework goals) and bottom-up creativity (i.e., through the autonomous initiative of multiple stakeholders).

[33] For an overview, see Charles Sabel and David Victor, *Fixing the Climate*: Strategies for an Uncertain World (Princeton University Press, 2022); and Bernardo Rangoni, 'Experimentalist Governance', in *Handbook on Theories of Governance*, ed. Christopher Ansell and Jacob Torfing (Edward Elgar Publishing Ltd., 2022), 592–603

2. **Experimentalism is neither fully democratic nor fully technocratic.** Rather, it builds on the premise that strategic ambiguity can only be successfully tackled as much as governance integrates the technical knowledge of in-depth expertise with the inclusion of citizens' experiences and values.
3. **Experimentalism is neither fully hierarchical nor fully network-based.** Rather, it aims to reconcile the accountability engendered by hierarchies with networks' ability to cope with uncertainty. On the one hand, it seizes on networks to encourage decentralized entrepreneurship. On the other, it uses hierarchies to organize forms of deliberation that can help align networks and public purpose.

Scholars have repeatedly called for experimentalism as a way to cope with the strategic ambiguity resulting from current socio-technical change.[34] Yet, despite such pleas and the positive results prompted by early case studies, its role as a 'third way' beyond the 'state-led' market-driven approaches has been seldom acknowledged. In this context, we propose to translate experimentalism into a framework that can help R&I funders reassess their roles and ways of working to lead today's societal transformation.

[34] See footnote 29.

4. The Framework for Experimentalist R&I

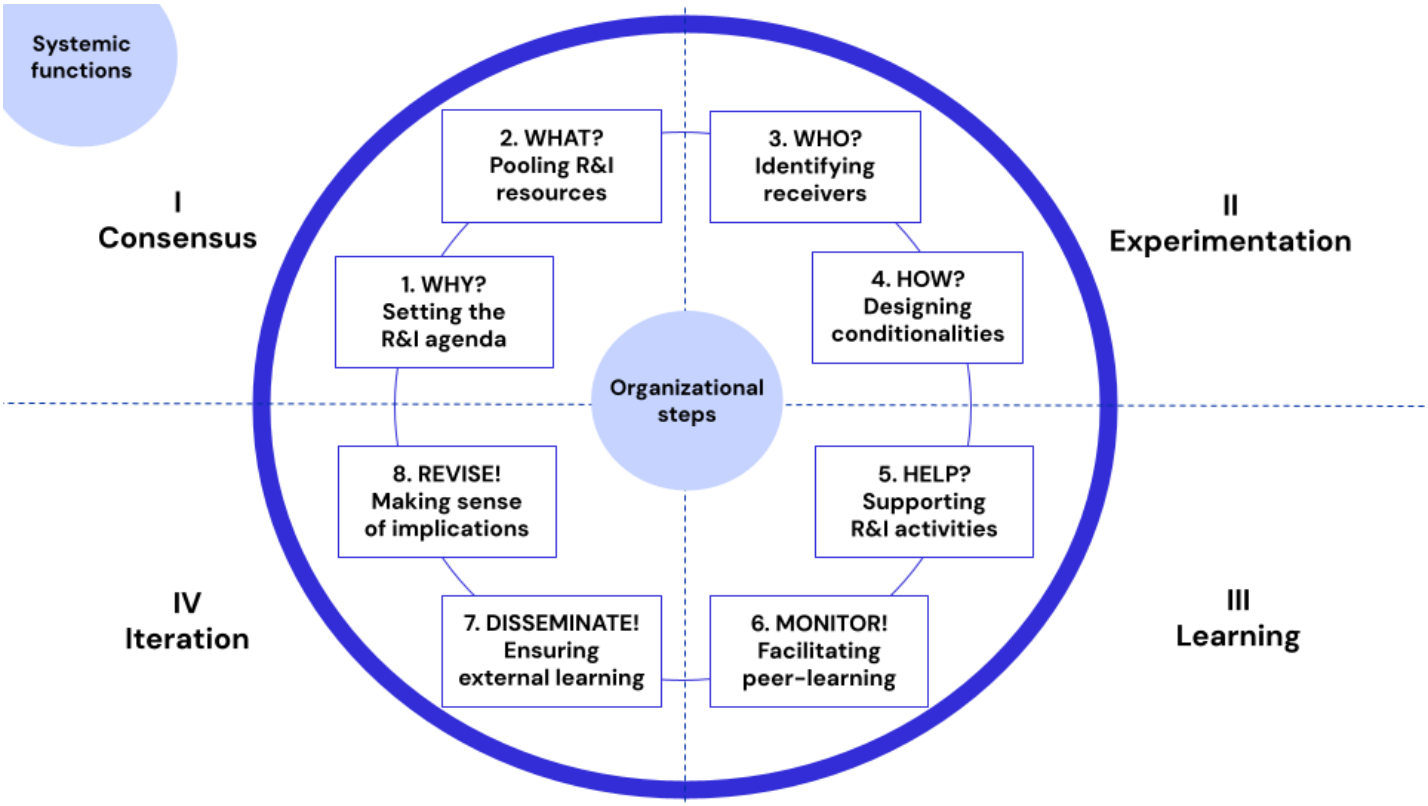
This chapter presents a framework for experimentalist R&I. The framework, outlined in Figure 1 below, shows how the four systemic functions outlined in the previous chapter can be combined with the daily operations of R&I funders.

The framework was developed by combining experimentalist governance with a model of decision-making. The outer layer shows the four *systemic functions* characterizing experimentalist governance. The inner layer points to eight *organizational steps* that, in broad terms, compose R&I funders' funding processes. These steps are interrelated: for example, the ways in which an R&I funder sets its agenda has implications for how this should be assessed in later steps.[35]

Combining these two layers, our framework illustrates how R&I funders can advance experimentalism in each step of their own funding processes. By doing so, the framework aims to help R&I funders lead societal transformations by 'tilting' their everyday processes and tools towards experimentalism. The following paragraphs highlight how the two layers are mutually linked, and how this effort of organizational and systemic change can be pursued in practice.

[35] This represents Harold Lasswell's model of decision-making as applied to R&I funding. See Harold D. Lasswell, *The Decision Process: Seven Categories of Functional Analysis, Studies in Government* (Lanham: Bureau of Governmental Research, College of Business and Public Administration, University of Maryland, 1956). In line with his ' undogmatic' approach grouping decisions under key functions, his model of seven functions has been contextualized here and renamed to make it 'serviceable' to the characteristics of R&I funders' processes (93). The lines connecting the organizational functions indicate that the organizational decision process is best seen as non-linear and interactive, rather than linear and sequential (97).

Figure 1. Experimentalist R&I framework



Source: Authors' elaboration based on Sabel and Zeitlin (2012) and Lasswell (1956).

I Consensus

Experimentalist R&I processes start with an agreement – or *thin consensus* – between multiple stakeholders around a broad 'framework goal'. *Framework goals* set an overarching goal but leave the means for achieving the goal open to stakeholders' inquiry and continuous revision. This can be contrasted with rigid goals that cannot be revised and that prescribe which approaches to use to achieve the goal. R&I funders are well positioned to strike a 'thin consensus' around a framework goal as they play a crucial role in identifying *why* and *what* kind of R&I should be pursued. The first step of the funding process is thus setting the R&I agenda. The second step entails pooling resources to fund activities to achieve the agenda. Both steps must be performed experimentally to ensure they lead to a thin consensus. In Step 1 (*Why?*), this means including both R&I funders and societal stakeholders in developing the R&I agenda. In Step 2 (*What?*), this means seeking a broad funding base by, e.g., facilitating cooperation between public and private funding. The overarching aim of these two steps is to develop a thin consensus among all actors involved in R&I funding about the direction to be pursued and start reflecting on its implications for different domains, sectors, and technologies.

II Experimentation

Experimentalism assumes that new solutions for achieving a framework goal are best discovered locally – i.e., by the people with experience of the problem and expertise in how to address it. Experimentalism grants these actors broad freedom in testing new ways toward workable solutions. R&I funders are tasked with identifying *who* should receive funding (Step 3) and *how* such funding should be used (Step 4). However, what makes experimentalist R&I different from standard practice is that it grants local actors' substantial autonomy, but balances this with clear impact-driven accountability structures. In Step 3 (*Who?*), experimentalist R&I funders employs iterative portfolio management to grant local actors the freedom to pursue the chosen broad framework goal as they see fit. In Step 4 (*How?*), the local actors' freedom is balanced by experimentalist 'conditionalities', i.e., specific conditions concerning the distribution of the knowledge developed during the process of experimentation. The overarching goal of these two steps is to ensure that every investment fulfills its intended strategic role in advancing the broad framework goal previously identified.

III Learning

Experimentalism balances decentralized autonomy by centralized processes for knowledge-transfer. It does so by engaging local actors in activities where different approaches to solve a common issue are compared in order to showcase and discover each solution's strengths and weaknesses. This process of peer-learning ensures knowledge accumulation and diffusion across the network of actors that are tackling a given issue. R&I funders are well-positioned to facilitate peer-learning activities. They often *help* stakeholders navigate the difficulties of the R&I process (Step 5) and *monitor and evaluate* the results emerging from the process (Step 6). In the experimentalist approach, however, these tasks are characterized by a distinctive focus on peer-learning. In Step 5 (*Help?*), this entails a hands-on management approach that aims to provide tailored assistance to the autonomous experimentation of local stakeholders involved in a given challenge. In Step 6 (*Monitor!*), this entails the creation of arenas where *horizontal* learning can be facilitated among actors engaging with similar issues in different ways. The overarching goal of these two steps is to ensure that all stakeholders, i.e., funders, grantees and actors benefitting from R&I, can make the most out of the knowledge produced and support one another in addressing a mutual challenge.

IV Iteration

Last, experimentalism is characterized by iterative review and adjustment at two levels: the societal understanding based on the new knowledge developed through the R&I process and the R&I funding practices themselves. Notably, such iteration is performed to strengthen the initial 'thin consensus' – be it by deepening the focus and granularity of the objectives to be pursued, or by challenging their current formulation if need be. R&I funders often *disseminate* the results from the activities they fund (Step 7) and *revise* (Step 8) their own practices in light of the learnings gained through the process. In this sense, experimentalism focuses on ensuring that new learnings have an impact both societally and in R&I funders' strategic decision-making. In Step 7 (*Disseminate!*), this entails building tighter connections with key stakeholders – be them public, private, or civic – in order to detect and address the bottlenecks preventing progress towards the goal. In Step 8 (*Revise!*), it means revising the funding process – by discontinuing unnecessary projects or launching new ones, if need be – and ensuring continuity among cycles of experimentation.

5. A Toolbox for Experimentalist R&I

Having briefly outlined the main elements of the experimentalist R&I framework, we now describe in greater detail how to execute the eight *organizational steps* accordingly. While doing so, we also describe selected tools that have already been utilized in different contexts to hint at how these can be brought into practice.[36] As a caveat, it is essential to note that the tools featured below are not prescriptive recommendations for R&I funders. Instead, they serve as illustrative examples of the means that R&I funders have at their disposal to advance experimentalist R&I. Each tool has distinctive advantages and challenges that we strive to address transparently. In this respect, a key takeaway of the report is that the experimentalist approach grants space for revision to R&I funders not only at the level of the entire R&I funding cycle, but also at the level of each step – thus encouraging and leaving ample room for managers and policymakers alike to explore alternative options for organizational or policy reform.

Step 1: WHY? Setting the R&I Agenda

An R&I funding process essentially begins with agenda setting, which can be seen to consist of two intertwined decisions: i) problem definition and ii) prioritization. R&I funders must define the problem(s) being addressed – often in the face of considerable uncertainty. Further, as funding is bound to be scarce, R&I funders must also prioritize between competing problems on the agenda.

In an experimentalist approach to agenda setting, i) the problem definition should be tentative, and ii) prioritization should be conducted in cooperation with various actors. Actors partaking in agenda-setting should accept that their collective understanding of the problem is bound to change as the context evolves and new knowledge emerges. This intellectual humility is essential to experimentalism, as it enables an agreement on the continuous re-evaluation of the problem statement during the funding process (see also Step 8).

What approaches can, therefore, be taken to agenda-setting to ensure it enables an experimentalist R&I process? In this section, we highlight two approaches.

[36] Each description outlines two tools chosen from a longlist compiled throughout the project. The longlist can be found in the Appendix 1 of this report.

First, R&I funders can use **citizen science** to incorporate non-experts' value-judgment into decision-making around problem-definition and prioritization. The case for citizen science stems from the argument of the value-ladenness of science. According to many philosophers of science, science cannot be a value-neutral exercise. Non-epistemic values are argued to play a role key in scientific reasoning – for example, when scientists choose what to study,[37] select factors in causal explanation,[38] and decide whether to confirm a hypothesis.[39] This does not imply that science cannot be objective.[40] However, it can be argued that citizens should play a role in defining and prioritizing the problems that receive public funding, as the resources handed out are publicly funded, and the R&I activities eventually impact ordinary citizens. In Box 1, we present a tool for enabling such participation.

Second, while R&I funding can be argued to require input from citizens, it should also be based on a sound knowledge base, i.e., the best available knowledge of the problem at hand. However, views of what constitutes 'best available knowledge' are bound to vary across different communities. In this respect, R&I funders are uniquely positioned to act as **knowledge brokers** in gathering and synthesizing streams of knowledge from different communities – particularly when involved in multi-disciplinary and cross-sectoral efforts. Because of their central positioning, R&I funders can strive to strike compromises and identify points of consensus to ensure that the R&I agenda has broad legitimacy among the multiple stakeholders involved. Again, this requires that R&I agendas are deemed provisional - i.e., up to revision whenever new information arises. In Box 2, we present a tool for enabling such knowledge brokering.

Box 1. Citizen Science - The Value Judgment Principle

Approach: Citizen Science
Tool: The Value Judgment Principle

To enable citizen science, R&I funders can require funding receivers to comply with the so-called 'Value Judgment Principle' (VJP). The VJP establishes that all actors that receive R&I funding (e.g., research teams or companies) should identify and explain the central value judgments made in their activities. Further, these

[37] Helen E. Longino, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry,* Princeton University Press, 1990.
[38] Robin Zheng, "A Job for Philosophers: Causality, Responsibility, and Explaining Social Inequality", *Dialogue: Canadian Philosophical Review / Revue Canadienne de Philosophie* 57, no. 2 (June 2018): 323–51.
[39] Heather Douglas, "Rejecting the Ideal of Value-Free Science", in *Value-Free Science? Ideals and Illusions* (Oxford University Press, 2007), 120–41.
[40] Helen E. Longino, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*.

value judgments should be documented in a format that can be presented to non-experts. R&I funders can attach the VJP as a conditionality to their funding (see Step 4) – e.g., whenever funding applicants commit to identifying the choices made in their research that are not settled by the available scientific evidence. These may entail decisions on which topics to study, which research questions are examined, the methodology used to answer such questions, how data is interpreted, how much evidence is demanded, and how results are framed and communicated.

The VJP is often deployed as a key principle of good science journalism. For example, it has been used to highlight the value judgments involved in the research on radiofrequency radiation and its effect on the health of humans and other organisms. In this case, the VJP enabled explaining impacts to the public, and science journalists provided information about the health risks that incur from radiofrequency radiation in a manner that promoted decision-making in conformity with public values.

Further reading: Science journalism on radiofrequency radiation and human health[41]

Box 2. Knowledge brokering - Joint Fact-Finding

Approach: Knowledge brokering
Tool: Joint Fact-Finding

Joint fact-finding (JFF) is a method that helps non-scientist actors grasp technically intensive policy and planning challenges. This method aims to bridge the gap between science, policy, and other stakeholders to reach a shared view – even when facts are uncertain. As a result, JFF aims to help stakeholders engage in research collaboration by developing a shared set of facts upon which to inform decision-making.

For example, JFF has been used in Rotterdam in the context of infrastructure policy to assess and increase its resilience to climate change in cooperation with multiple stakeholders. In this case, the JFF process was conducted through six stages:

1. Evaluating the need for process and identifying critical technical issues and actors
2. Bringing stakeholders to the table and framing the process

[41] Kevin C. Elliott, "Science Journalism, Value Judgments, and the Open Science Movement", *Frontiers in Communication* 4 (2019).

3. Translating key issues into researchable questions
4. Stakeholders working with technical experts to conduct research transparently
5. Receiving data and iterating previous steps to address information gaps
6. Jointly considering research findings, implications, and possible ways forward

Further reading: Joint Fact-Finding to Climate-Ready Infrastructure in Rotterdam[42]

Step 2: WHAT? Pooling R&I Resources

R&I demands considerable funding. Traditionally, R&I funders' role has been to distribute public funding earmarked for a particular (set of) topic(s). In doing so, R&I funders often encourage stakeholders to make the most of the public funding granted through their organization. However, R&I funders can often play a broader role in pooling R&I resources and funding from other public, private, or civic stakeholders.

Experimentalist R&I aims to establish incentives for collaboration across the traditional public-private divide. Across the world, there is an increasing political will to employ an ever more cross-sectoral effort to pool R&I funding. For example, the European Union has increased its R&I investment by allocating a budget of close to 100B€ to the Horizon Europe Programme 2020-2027.[43] However, a key goal of Horizon Europe is to create new partnerships between the public and private sectors to incentivize more private financing of R&I activities. While there is a political will to mobilize private resources for R&I activities, the public sector now deploys a narrow toolkit to drive such mobilization. Here, R&I funders can play a pivotal role in identifying new mechanisms.

How, then, can R&I funders work to pool a broader funding base for R&I activities? Here, we highlight two approaches.

One approach is **orchestrating coalitions of funders** in which private equity actors operating in one or multiple sectors are brought under common R&I activities and have the collaboration facilitated by a third party. R&I funders are uniquely positioned to do so, thanks to their first-hand insight into ongoing research, contact points to the actors setting the R&I agenda, and access to national and international R&I ecosystems. In Box 3, we outline how engaging with private equity can enable

[42] Todd Schenk et al., "Joint Fact-Finding in Practice: Review of a Collaborative Approach to Climate-Ready Infrastructure in Rotterdam", *European Journal of Transport and Infrastructure Research* 16 (January 4, 2016): 273–93.
[43] European Commission, "*Horizon Europe: Investing to shape our future*", DG RTD, Bruxelles: Publications Office of the EU (2021).

new R&I funding.

A second approach is to **cooperate with individual private organizations** by providing them with tailored support to channel their resources into R&I activities. Public innovation agencies frequently use 'self-funding' conditionalities to RDI-funding (see also Step 4). This can be applied to research funding as well to incentivize third-party funding for R&I activities that can be of interest to private actors. In doing so, R&I funders can act as 'matchmakers' between researchers and private actors. This introduces a consultative role less frequently deployed by R&I funders but that can significantly enhance their capacity to proactively advance societal transformations. This approach has further implications for the dissemination of R&I activities' results (see Step 7). In Box 4, we describe how such cooperation can be advanced.

Box 3. Orchestrating coalitions of funders - Coalition building

Approach: Orchestrating coalitions of funders
Tool: Coalition building

R&I funders can seek coalitions of funders by coordinating with private equity actors – such as venture capital firms and family offices. These stakeholders have a history of collaborating in R&I funding in areas that are of interest to them. Private equity can offer a more flexible alternative to finance R&I with shorter timeframes than the ones traditionally provided by R&I funding.

One example where private funding has been harnessed to the use of research and innovation funding is Repro Grants. Inspired by similar projects tackling the COVID-19 pandemic (Fast Grants) and longevity (Impetus Grants), Repro Grants grants between $25K-$100K to ambitious research projects focusing on female reproductive biology. The initiative was launched to speed up research in a neglected yet critical sector of science. Repro Grant is managed by the venture capital fund Fifty Years, with the family office Illusian as a founding donor.

Further reading: Repro Grants, Impetus Grants, Fast Grants[44]

[44] "Repro Grants," https://www.reprogrants.org;
"Longevity Impetus Grants," https://impetusgrants.org;
"Fast Grants," https://fastgrants.org/.

Box 4. Individual cooperations - Matchmaking

Approach: Individual cooperations
Tool: Matchmaking

Research organizations can engage in individual cooperation projects requested by private actors. In these privately funded proposals, research discoveries are owned by the entity funding the project(s). These can take various forms, for example:

- Collaborative research agreements, where companies provide funding for specific research projects in exchange for exclusive rights to the resulting intellectual property.
- Patent licensing – where R&I institutions or inventors may license their patents to companies for a fee or royalties. Companies can acquire these licenses to gain exclusive or non-exclusive rights to use the patented technology. One notable example is when Google acquired a license from Stanford University for the PageRank algorithm, which has become a fundamental part of Google's search engine technology.
- Technology Transfer Offices (TTOs) employed in many universities and research institutions to facilitate the transfer of research and inventions to the commercial sector. These actively seek partnerships with companies interested in licensing or acquiring the intellectual property generated by their researchers.
- Joint development agreements developed with R&I actors and companies to work collaboratively on specific projects. As a corollary, these agreements may involve sharing resources, knowledge, and expertise while often including provisions for intellectual property rights.

Further reading: Systematic analysis of 50 years of Stanford University technology transfer and commercialization[45]

Step 3: WHO? Identifying Receivers

As argued previously, a significant issue in the scholarly literature and the broader political debate on R&I funding concerns the grounds for deciding on funding allocation. On the one hand, some scholars see a concern with the state 'picking winners' when channeling public R&I funding towards some activities rather than others in a top-down fashion.[46] In this argument, the state should strive for 'funding (or technology) neutrality' – as civil servants often lack the knowledge needed to

[45] Weixin Liang et al., "Systematic Analysis of 50 Years of Stanford University Technology Transfer and Commercialization", *Patterns* 3, no. 9 (2022).
[46] Karl Wennberg and Christian Sandström, *Questioning the Entrepreneurial State*.

evaluate which R&I projects may have the highest potential for addressing prioritized challenges. On the other hand, others argue that the state needs to act entrepreneurially to find solutions to today's societal challenges.[47] According to this argument, markets are 'blind', and the R&I trajectories that emerge spontaneously from them may end up being too slow in solving such challenges and thus represent suboptimal outcomes for societal welfare.[48]

If experimentalism can overcome this dichotomy, which approaches and tools can be deployed by R&I funders to decide who gets the funding?

Advanced by scholars who have criticized centrally planned R&I funding decisions, one approach is to opt for **innovation and research competitions**.[49] R&I calls are typically designed to be merit-based – meaning that projects and ideas submitted are evaluated based on quality, novelty, feasibility, and potential impact. Relative to this approach, innovation and research competitions focus on the challenge to be addressed, rather than on the delivery of a preconceived solution. This shifts the focus of project selection from the identification of the 'best provider' of a given R&I product to the identification of the most transformative ideas. On the one hand, such an approach helps R&I funders attract new, unlikely innovators in order to change the status quo of a field. On the other hand, it helps R&I funders 'prompt' incumbent stakeholders to reassess their efforts and find new ways to think about the problem. As a result, Competitions can foster greater participation and openness to the R&I effort – thus enhancing the diversity of the ideas and solutions presented. However, whereas the flexibility and adaptability of this approach may enable quick responses to new challenges and changing priorities, the core issue of ensuring a solid evaluation and long-term planning for the selected ideas and solutions must be navigated: a bias toward short-term, measurable outcomes may sideline research with lengthier and more profound societal impacts. Doing so may require both well-defined evaluation criteria and a qualified panel of reviewers. In Box 5, a vital example of this approach and its related issues is further illustrated.

A different solution, instead, is to opt for an **autonomy-based portfolio approach**, which grants individual project managers working in the R&I funder's organization substantial autonomy in deciding who gets the funding. Their choice can be underpinned by looser criteria – such as, for example, vision-driven selection, where managers are encouraged to take higher levels of risk in R&I funding to compose a

[47] Mariana Mazzucato, "The Entrepreneurial State".

[48] Giovanni Dosi, "Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants and Directions of Technical Change"; Richard Nelson, "The Moon and the Ghetto revisited".

[49] See e.g. Nina Kahma, Mikko Rask, and Veronica Ahonen, "Research-Based Innovations through Challenge Competitions?" (ISPIM Innovation Symposium, Manchester, 2018).

portfolio of projects that reflect a potential long-term development of a given R&I trajectory. On the one hand, the autonomy to award small short-term grants for new ideas helps managers 'test' them before further developing the most promising ones while building greater expertise in the R&I domain. Conversely, the portfolio approach helps them diversify their 'bets' and avoid the pitfalls of top-down decision-making. In Box 6, an example of such an approach is provided.

Box 5. R&I Competitions - Challenge Prizes

Approach: R&I Competitions
Tool: Challenge Prizes

Challenge prizes are public competitions that offer a monetary award to whoever can first or most effectively solve a pre-defined problem. The problem a challenge prize seeks to solve can be chosen in varying ways: some organizers engage the public in problem selection, while others offer a pre-defined challenge. All challenge prizes are agnostic regarding the methods as long as the solution is the best. In addition to their targeted problem statement, challenge prizes differ from other R&I competitions because they focus less on scientific credentials and do not have attached conditionalities like innovation loans.

The Big Green Challenge is an example of a challenge prize organized in 2009-2010 to reduce CO2 emissions in the UK through new community-led solutions. Organized by the UK innovation agency Nesta, the competition saw three winners and one runner-up awarded a share of the £1 million prize fund. The competition initially gathered 355 entrants that were then, through multiple application rounds and the evaluation of a panel of judges, narrowed down to 10 finalists – each of which was given £20,000 and additional support to deliver on their concept. Finalists were given one year to complete the challenge in the method they saw fit.

Further reading: The Big Green Challenge, Challenge Prizes: A Practice Guide (Nesta)[50]

[50] "Big Green Challenge Final Evaluation Report," https://www.nesta.org.uk/report/big-green-challenge-final-evaluation-report/ ; Challenge Prizes: A Practice Guide," https://www.nesta.org.uk/toolkit/challenge-prizes-a-practice-guide/.

Box 6. Autonomy-based portfolio approach - Vision-driven selection

Approach: Autonomy-based portfolio approach
Tool: Vision-driven selection

In vision-driven selection, peer reviewers solicit and rate proposals based on several criteria. However, program managers are autonomous and do not simply defer to the traditional review process adopted in public procurement. Instead, they decide what to fund in terms of how the suggested proposals fit into the holistic vision of the R&I portfolio they have been assigned to.

For instance, in the United States, the operations of the energy innovation agency ARPA-E are led by autonomous program managers. While peer review matters in their evaluation, managers are first and foremost seeking to fund R&I projects that contribute to solving specific technological challenges that they have identified as critical to progress. To do so, they may fund diverse projects geared towards a similar objective to ensure success – i.e., adopting a portfolio approach.

Another example is the Small Grants for Exploratory Research (SGER) program run by the National Science Foundation (NSF) from 1990 to 2006. This program allowed NSF's program managers to bypass peer review and award small, short-term grants of their choosing. About two-thirds of the recipients then leveraged their initial outcomes to apply for larger grant funding programs. Remarkably, 80% of those who pursued larger grants were considered successful. In this approach, small short-term grants serve as experiments before more extensive development, ensuring that only the most promising ideas receive larger funding. At the same time, granting managers a higher level of autonomy allows greater risk-taking and can thus open up the way to more radical innovations.

Further reading: Advanced Research Projects Agency - Energy (ARPA-E)

Step 4: HOW? Designing Conditionalities

R&I funding comes with conditionalities. At its simplest, projects must meet specific criteria and standards and produce results by a given deadline and in an agreed format. However, the design and implementation of conditionalities can significantly impact the outcome of funded projects by inducing or hampering innovative solutions.

Conditionalities can be divided into four key categories: money-based, eligibility-based, knowledge-based, and penalty-based conditionalities. Money-based conditionalities establish strict requirements to govern the financial aspects of the projects supported by the R&I funder. These may include, e.g., adhering to

budgetary guidelines and cost-sharing conditions. As a result, they promote grantees' accountability in achieving project milestones and managing funds responsibly. Eligibility-based conditionalities establish requirements that grantees are asked to meet to participate in the program designed by the R&I funder. These may include, e.g., collaboration with different actors, location of activities in a specific area, target, or the provision of periodic reports about project-related elements of interest. Knowledge-based conditionalities establish requirements to govern funded projects' legal and knowledge-related aspects. These may include, e.g., open access to the project results via full disclosure or negotiation of service agreements. Fourth and last, penalty-based conditionalities establish sanctions designed to break the grip of the status quo within a specific R&I domain and encourage participation in the collective problem-solving process. These include, e.g., exclusion from a market by denial of a license or certificate of conformity with standards or by regulation. As such, they make it risky for actors to fail to make good-faith efforts to achieve results.

How, then, can conditionalities be deployed to advance experimentalist R&I?

First, it is vital to acknowledge that some types of conditionalities are 'tougher' than others. Experimentalism adopts 'penalty-based' (or default) conditionalities, combining broad autonomy with measures that cut off non-cooperative or -compliant grantees from the support infrastructure provided by a public agency. R&I funders already recur to money-, eligibility-, and knowledge-based conditionalities in their grant processes. if R&I funders are to make and learn the most from the activities they fund, they must continuously review them to engender grantees' accountability and ensure that their activities effectively contribute to advancing solutions to the challenge they mean to address. In this perspective, the design of conditionalities can be adjusted to impose stricter or looser conditions depending on the nature of the problem at hand. Box 7 below outlines how knowledge-based conditionalities can be applied to do so.

Further, it is vital to acknowledge that **penalty-based (or default) conditionalities** are available not only to R&I funders but also to other public agencies. Most notably, they're usually championed by regulatory authorities, which dispose of complementary tools for steering stakeholders' behavior. This has implications for R&I funders. R&I funders can enhance the effectiveness of their experimentalist approach by exploring coordination strategies with agencies governing the regulation of sectors critical to their activities (e.g., environmental protection authorities). By doing so, they can co-design persuasive penalty-based conditionalities. Box 8 outlines such a case example.

Box 7. Design of conditionalities - Accountability via knowledge-based conditionalities

Approach: Design of conditionalities
Tool: Accountability through knowledge-based conditionalities

The effectiveness of well-designed funding conditionalities in achieving specific goals becomes evident through varying degrees of stringency. In the context of experimentalism, the need for autonomy is counterbalanced by the necessity of well-defined conditionalities.

Illustrating this concept is the case of the Oxford/AstraZeneca partnership during the COVID-19 pandemic. This instance showcases the harmonization of autonomy and knowledge-sharing requirements within funding conditions, effectively ensuring the optimal utilization of substantial resources. Amid the pandemic, the University of Oxford and AstraZeneca collaborated, securing funding at a predetermined cost under non-reversible terms. In return, they committed to supplying the UK Government with 30 million vaccine doses developed within six months of fund reception, ultimately totaling 100 million doses. Notably, these manufacturers refrained from profiting off the vaccine during the pandemic, and the patent rights, initially held by Oxford's spin-off entity, Vaccitech, were made accessible to any pharmaceutical producer.

This example serves as a testament to the capacity of knowledge-driven conditionalities to leverage publicly financed R&I. Their effectiveness lies in their capability to steer efforts toward the overarching objective of widening access to products and services at reasonable price points. Simultaneously, they facilitate the accessibility of patent rights, contributing to the achievement of strategic goals.

Further reading: Oxford University/AstraZeneca partnership case[51]

[51] Mariana Mazzucato, "Rethinking the Social Contract between the State and Business: A New Approach to Industrial Strategy with Conditionalities", *UCL Institute for Innovation and Public Purpose*, Working Paper Series (2022).

Box 8. Inducing penalty-based conditionalities - Cooperation with regulatory actors

Approach: Inducing penalty-based conditionalities
Tool: Cooperation with regulatory actors

While R&I funders often lack the mandate to develop regulatory penalty-based conditionalities, they can leverage their networks and expertise on subject matter to collaborate with regulatory agencies.

A prime illustration is the symbiotic partnership between the California Air Resources Board (CARB) and automotive manufacturers, as well as pollution-control technology providers, to curtail vehicular emissions. The Zero-Emission Vehicle regulation exemplifies a strategic alignment with the state's emission reduction objectives. This is achieved by intensifying the prerequisites for zero-emission vehicles through more stringent targets for their sales. Concurrently, the framework introduces incentives to stimulate their adoption and utilization. Such an approach has enabled CARB and analogous regulatory bodies in California to jointly expedite the progress of electric vehicles and other inventive remedies. Notably, these policies embody critical facets of an ecologically conscious industrial policy.

This instance underscores the potential of collaborative engagement with regulatory entities to invigorate grassroots participation, established through imposing penalty-based conditionalities. The strategies are carefully tailored to local circumstances, emphasizing transparency and accountability. This ensures their pertinence to regional requisites while generating locally conceived solutions that evolve into overarching benchmarks.

Further reading: CARB-E Low- and Zero-Emission Vehicle Program[52]

Step 5: HELP? Supporting R&I Activities

R&I funders do not merely hand out money. They often engage with the funded projects during the project cycle through management and support functions. Experimentalism assumes that, when addressing complex societal challenges, the actors closest to the challenge at hand are best positioned to find workable solutions. For this reason, experimentalist R&I requires funders to grant broad autonomy to those actors who have received funding. The best preconditions for success are deemed best when R&I actors can freely innovate in their local circumstances. However, this does not mean that R&I funders need not interact with

[52] Charles Sabel and David Victor, "How to Fix the Climate".

funding receivers during their activities. Quite the contrary, central to experimentalism is that bottom-up innovation is combined with horizontal coordination and support, as these are critical for learning.

How, then, can R&I funders support R&I activities without adverse consequences?

R&I funders hold a unique position within the R&I ecosystem that grants them an overview of various ongoing activities, funding streams, and emerging research, which can be of substantial use for actors involved in R&I activities. Thus, funders can establish **hands-on relationships** with the actors who are granted funding. This can mean that R&I funders offer assistance in R&I activities but with information and methodological assistance rather than financial contributions. Box 9 illustrates how R&I funders can deploy capacity building to develop hands-on support systems for their projects.

Further, it is vital to consider the role of **informal support**. Societal transformation asks for structural changes. However, the role of peer-to-peer interactions, mentoring, and networking at the micro-level should not be underestimated. Funders can establish formal structures that support R&I activities at large. However, a staff with the right skills and expertise can support grantees by identifying key initiatives to network them with solutions to emerging bottlenecks and connections within the broader project portfolio managed by the funder. This type of support does not require institutionalization. Instead, it is a matter of capacity building and work culture within R&I funders' organizations. Box 10 illustrates an example of such an approach.

Box 9. Hands-on relationships - Capacity building

Approach: Hands-on relationships
Tool: Capacity building

R&I funders can play an essential role in enhancing researchers' capacity to conduct impact-driven research. Funders facilitate a dynamic exchange of knowledge and expertise between the research community, the policy sphere, and private actors. Thus, they can conduct capacity building to enhance researchers' ability to develop the usefulness of their outputs. Regarding public policy, R&I funders can provide briefs about ongoing political developments, equipping researchers with up-to-date insights into the evolving policy landscape and hands-on support with outlining and effectively communicating policy recommendations. This not only enriches the policy discourse with well-informed perspectives but also nurtures a culture of effective science-policy communication, helping bridge the gap between academic expertise and policy impact. In terms of the private sector, R&I funders

can, for example, facilitate dialogues and clarify the intended end-use of technical innovations.

The International Development Research Centre (IDRC) has, for example, used Centres of Excellence to support policy capacity building for researchers through various thematic and regional programs, such as the Think Tank Initiative (TTI), which aims to strengthen the capacity of independent policy research organizations to produce and communicate high-quality research that informs public policy.

Further reading: Centers of Excellence and Capacity Building: from Strategy to Impact[53]

Box 10. Informal support - Service platforms

Approach: Informal support
Tool: Service platforms

R&I funders can establish support networks to offer funding receivers help during the R&I process. Here, we can draw inspiration from the private sector. One of the most central assets a venture capital firm can offer to its portfolio companies beyond providing capital is its networks. These have been proven to be essential in providing new funding opportunities for the startups they have funded.[54]

Venture Capitals (VCs) also increasingly have service platforms to offer assistance beyond investment to their portfolio companies and have developed dedicated functions for this. In practice, this translates into VCs' in-house teams advising portfolio companies on different functions like communications, talent acquisition, and product development. The VC fund Speedinvest has a dedicated Platform+ team to support their portfolio companies. The platform consists of in-house experts and a global network of experts that can help portfolio founders with aspects like product launches, go-to-market strategies, customer retention, or measuring product-market fit.

Further reading: Speedinvest[55]

[53] Tomas Hellström, "Centres of Excellence and Capacity Building: From Strategy to Impact", *Science and Public Policy* 45, no. 4 (August 1, 2018): 543–52.
[54] Cristiano Bellavitis, Igor Filatotchev, and Dzidziso Samuel Kamuriwo, "The Effects of Intra-Industry and Extra-Industry Networks on Performance: A Case of Venture Capital Portfolio Firms", *Managerial and Decision Economics* 35, no. 2 (2014): 129–44.
[55] "VC Platform | Startup Resources for Early-Stage Tech Founders," https://www.speedinvest.com/platform.

Step 6: MONITOR! Facilitating Peer-Learning

Supporting R&I actors should be held analytically distinct from monitoring and evaluating their activities, albeit the fora and tools for doing so may overlap. Monitoring is an ongoing process that involves systematically tracking and observing the progress, activities, and outputs of a project. Evaluation concerns a project or program's effectiveness, impact, and outcomes. Evaluation can be summative or formative. The summative evaluation focuses on assessing the overall outcome or results of a learning program or project. Formative evaluation, on the other hand, is focused on gathering feedback and information during the learning process or project development.[56]

Monitoring and evaluation of R&I projects is often conducted through written or oral reporting.[57] Experimentalism expands this toolkit through peer-learning: monitoring and evaluation based on dialogue, sense-making, and deliberation.

As a problem is addressed autonomously in a decentralized R&I ecosystem, actors gather knowledge about workable solutions. Importantly, actors also gather knowledge about bottlenecks that prohibit their solutions from being applied in practice. R&I funders can take a leading role in accumulating this information to ensure vertical learning among the actors involved. By overseeing vertical learning, R&I funders also gather information that enables the monitoring and evaluation of ongoing activities. Actors must report on their advances and are then invited to collectively reflect upon their successes and potential challenges to identify ways forward.

One approach to facilitate peer-learning is **research and innovation summits**. Research seminars are a conventional fora for bringing scholars together to share knowledge and challenge each other. Research and innovation summits go beyond knowledge-sharing, engaging in deliberations that target cross-project peer-to-peer evaluation. Further, summits can be used to identify shared bottlenecks.

Another approach is for R&I funders to promote continuous **peer-learning networks** between or within funded projects. These combine regular reporting on progress and problems concerning the goal they are advancing, and sharing new developments and challenges with the other participants.

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[56] Matthijs J. Janssen, Anna Bergek, and Joeri H. Wesseling, "Evaluating Systemic Innovation and Transition Programmes: Towards a Culture of Learning", *PLOS Sustainability and Transformation* 1, no. 3 (March 2022).

[57] Jordi Molas-Gallart et al., "A Formative Approach to the Evaluation of Transformative Innovation Policies", *Research Evaluation* 30, no. 4 (October 2021): 431–42.

Peer-learning may be deemed insufficient for monitoring and evaluation. Indeed, R&I funders can make the most of peer-learning only when paired with broader sense-making activities (see Step 8) and with effective conditionalities (see Step 4). When combined with conditionality and sense-making, peer-learning can help assess whether the grantee's activities live up to the purpose of the R&I funding program – thus balancing out its function as a 'carrot' (support) and as a 'stick' (conditionality). On the one hand, it is in every R&I actor's interest to partake in collective peer-learning activities, as this grants them access to new information and a chance to communicate and address emerging bottlenecks in their R&I activities. On the other hand, the exchange of knowledge among R&I stakeholders and with the funder also enables light monitoring. As a result, when multiple sources of information are triangulated, R&I funders can build a richer source of information to understand the progress of ongoing R&I activities and make better-informed assessments around their (dis)continuation.

Box 11. Research & innovation summits - Sensemaking workshops

Approach: Research & innovation summits
Tool: Sensemaking workshops

The goal of sensemaking is to enable a team or network of teams to reflect on their current portfolio of activities to maximize their impact and effectiveness. As such, it aims to ask questions investigating the reason for running a particular (set of) project(s) at a given point in time, the relevance and coherence of a given (set of) project(s) to the current or emergent needs of a shared R&I agenda, the key bottlenecks emerging from project implementation, and the best use of the available resources for R&I funding, support, and network management. As such, adopting sensemaking methodologies – for example, through workshops – within the context of research & innovation summits can be critical to support monitoring, evaluation, and learning.

Based on their experience from running Sensemaking workshops for UNDP offices and government partners, the UNDP Asia-Pacific Regional Innovation Centre has developed a Sensemaking Preparation Guide and Facilitator Guide that provide a relevant starting point for reflecting on how sensemaking can be used to monitor complex R&I project portfolios for the purpose of peer- and collective learning. In broad terms, this is done by structuring multi-day sessions covering three key steps: i) observing and making sense of an existing portfolio of projects; ii) extracting insights and intelligence from the presented projects; iii) creating an action plan based on such insights to accelerate the impact potential of the portfolio.
Further reading: UNDP Sensemaking Workshop Methodology[58]

[58] "Sensemaking Workshop Preparation Guide and Facilitator Guide and Sensemaking Training | United Nations Development Programme," UNDP,

Box 12. Promoting peer-learning networks - Customized round tables

Approach: Promoting peer-learning networks
Tool: Customized round tables

Customized roundtables organized at various locations regularly by the R&I funder can be used to gather key stakeholders to reflect on progress, challenges, and solutions to individual projects and cases within a given portfolio. By customizing the meetings to the challenges emerging throughout project execution, different viewpoints can be cross-fertilized to gather knowledge from different viewpoints and promote collective learning on how to advance beyond similar issues. As such, customized round tables can ensure the efficient monitoring of decentralized R&I activities while at the same time embedding dynamics of peer-learning across the network of local stakeholders.

In the Netherlands, Utrecht has developed an approach to delivering customized youth and family care provision based on customized round tables. These helped mixed teams of generalist and specialist care providers working in the urban ecosystem to perform joint reviews of individual cases, thus triggering peer-learning and continuous adaptation in the face of different circumstances. Similarly, the United States Digital Services team leveraged an analogous approach in teams working on similar problem statements convene on a regular basis (e.g., bi-weekly) for brief scrum meetings (e.g., 15-30 minutes) during which advances and bottlenecks are identified, and follow-up meetings are booked in case an issue requires quick responses.

Further reading: Utrecht Social Care Model[59]; US Digital Services Playbook[60].

Step 7: DISSEMINATE! Ensuring External Learning

While Step 6 focuses on internal learning during the R&I activities, R&I funders also play a crucial role in disseminating the learnings of their activities to external stakeholders. This is necessary to ensure a shared knowledge base for iterating R&I activities (Step 8) and ensuring they contribute to the desired societal transformation.

https://www.undp.org/publications/sensemaking-workshop-preparation-guide-and-facilitator-guide-and-sensemaking-training.

[59] Charles Sabel, Jonathan Zeitlin, and Jan-Kees Helderman, 'Transforming the Welfare State, One Case at a Time: How Utrecht Makes Customized Social Care Work', *Politics & Society*, 17 January 2023.

[60] "The Digital Services Playbook — from the U.S. Digital Service," https://playbook.cio.gov/.

If this is the case, which approaches are at the disposal of R&I funders who wish to find new tools for disseminating the results of funded projects?

First, while funding receivers often are well-positioned to evaluate the policy implications of their work, R&I funders benefit from a unique position in the **science-policy interface**. First, disseminating knowledge of bottlenecks to the political level is pivotal to ensuring impact. R&I funders who oversee peer-learning are well-positioned to take up the role of synthesizing challenges and proposing solutions. Second, while researchers are often required to propose policy recommendations, R&I funders provide capacity building to support in the process. Third, R&I funders with multidisciplinary and communicative capabilities can support synthesizing R&I findings into impactful materials.

While R&I funders can play a key role in the science-policy interface, they can also use the dissemination of results to drive substantial structural change in the availability and processes of science. Some scholars have argued that the science community should advance radical transparency by **abandoning pre-publication peer-review**. The role of prepublication peer-review has been questioned after the recent replication crisis, bringing into play not just the accessibility of science, but also the thresholds for its publication. For example, it has been argued that peer-review doesn't suffice as quality assurance, creates inequalities in research communities, and gate-keeps potentially valuable information from publishing. Some have thus argued for abandoning pre-publication peer-review and moving towards radical open science.[61] Promoting such transparency rather than mere open access could be an innovative approach to allow R&I funders to drive substantial shifts in the societal impact of R&I.

To showcase a novel approach, R&I funders could also consider engaging with more commercialized science – in which findings are only available to those actors who have pooled resources to fund R&I activities. As said, more private sector funding is needed to fill the R&I funding gap. Yet, private actors may be disincentivized to enter funding coalitions where some actors who have not contributed towards funding can benefit from outputs that are open access. Therefore, a case can be made for R&I funders facilitating the processes but leaving the choices of knowledge dissemination up to the actors who have contributed to R&I funding.

[61] Remco Heesen and Liam Kofi Bright, "Is Peer Review a Good Idea?", *The British Journal for the Philosophy of Science* 72, no. 3 (September 2021): 635–63.

Box 13. Science-policy interaction - Gamified dissemination

Approach: Science-policy interaction
Tool: Gamified dissemination

Gamified dissemination can be used as an alternative to the traditional dissemination format consisting of publishing a synthetic report and policy recommendations followed by a seminar. Gamification creates a risk-free and interactive environment where researchers can verify their assumptions by testing their proposals with decision-makers.

This method has been employed in Poland in the context of the Polish rural bus transport market and decreasing accessibility of rural areas. A new policy regulation was tested through a 'rural transportation game' to answer questions concerning impacts on key stakeholders, what mechanisms the regulation might trigger amongst key stakeholders, and the overall effectiveness of the policy. The same method could be adjusted to R&I funders' context to address identified bottlenecks as well as to discuss policy recommendations derived from research.

Further reading: Regulation cash-test [62]

Box 14. Radical transparency - Abandoning pre-publication peer-review

Approach: Radical transparency
Tool: Abandoning pre-publication peer-review

Many R&I actors already demand open access to research publications funded by them. However, many still require peer-review of outputs to secure quality and scientific credibility. However, R&I funders could consider abandoning the pre-publication peer-review of their work and instead support transparent post-publication peer-review. This would ensure maximal access to outputs but would leave judging the credibility of outputs to the public engaging with the product.

In practice, this would mean that scientists would publish their work online when they see fit, for example, in a preprint archive. After that, other scientists could comment on the work, and these comments are updated on the article with replies from the original authors. The role of scientific journals would be to create curated collections of previously published articles. In the traditional journal curation process, pre-publication peer-review would be replaced by post-publication peer-review.

Further reading: Is peer-review a good idea?[63]

[62] Karol Olejniczak, Michał Wolański, and Igor Widawski, "Regulation Crash-Test: Applying Serious Games to Policy Design", *Policy Design and Practice* 1, no. 3 (2018): 194–214.
[63] Remco Heesen and Liam Kofi Bright, "Is Peer Review a Good Idea?".

Step 8: REVISE! Making Sense of Implications

At its core, experimentalism is an iterative process. It begins with a provisional problem definition and moves on to decentralized problem-solving, during which learnings are gathered to facilitate an iteration of both problem definition and projects involved. Thus, a key step for R&I funders is to consider how they can bridge the gap between Step 1 (Setting the agenda) and the learnings gathered throughout the experimentalist cycle.

Thus, Step 8 links back to the agenda-setting process by focusing on reassessing i) the R&I projects that have been funded and ii) the tools deployed by the R&I funder in the funding cycle. The end goal is to synthesize the learnings from previous steps by summoning relevant actors to deliberate whether and how to revise the R&I agenda (e.g., by deepening or challenging the objectives previously identified) and its related project portfolio (i.e., the pool of activities supported by the R&I funder). For example, actors may learn that the problem statement is focused on a flawed understanding of the issue at stake and that funding consequently should be redirected towards other activities than those initially identified. Further, they may learn that peer-learning activities have been too time-consuming and directing resources away from pivotal activities and that, hence, the funder must opt for fewer peer-learning meetings or more rigorous reporting.

In evaluating the overall process, R&I funders can facilitate revision by synthesizing the learnings gathered and disseminated in Steps 6 and 7 and convening R&I stakeholders to deliberate around a reviewed problem statement for the next round of R&I funding. To do so, they can use the same tools employed in Step 1 (Setting the agenda).

Moreover, in evaluating the overall project portfolio (and individual projects' aptness for continuing or discontinuing funding based on the emerging outcomes), R&I funders can deploy a stage-gate process, i.e., a formative approach to the implementation of an R&I project included in the portfolio. An example of this approach is outlined in Box 15.

Box 15. Revision - Stage gate processes

Approach: Revision
Tool: Stage gate processes

In stage-gate processes, R&I funders incentivize grantees to meet set goals while still retaining dynamic accountability in their use of public money by evaluating aptness for continued funding. The approach draws inspiration from classic product development processes in manufacturing, where five stages are used: i) idea generation, ii) scoping, iii) building a business case, iv) development, testing, and validation, and v) launch. At each development stage, projects are evaluated based on key variables of interest – ranging from their potential for commercial success to their alignment with public goals – which helps filter out projects. 'Gates' are thus applied at each stage to promote learning, validation, and progress in the desired direction.

In procedural terms, stage-gate processes operationalize this accountability through revision strategies. This has been, for example, applied in the Defense Advanced Research Projects Agency (DARPA). DARPA works via project-based assignments organized around a challenge model, where a significant portion of the agency's projects are organized around specific technology challenges. First, DARPA identifies the challenges it aims to address and envisions new innovation-based capabilities to solve them (the right end of the pipeline). Then, DARPA works back to the breakthroughs needed to build up these capabilities (the left end of the pipeline).

Through this model, DARPA can continuously reevaluate whether its research activities are relevant from the perspective of the chosen challenges. Although DARPA's typical projects last three to five years, the selected challenges can be addressed over more extended time periods, ensuring patient long-term investment.

Further reading: Applying the DARPA Model to Energy Innovation[64]

[64] William B. Bonvillian and Richard Van Atta, "ARPA-E and DARPA: Applying the DARPA Model to Energy Innovation", *The Journal of Technology Transfer* 36, no. 5 (October 2011): 469–513.

6. Varieties of Experimentalism

One of the most critical aspects of the framework for experimentalist R&I is that it does not establish a blueprint. It does not command pre-formulated answers to how experimentalism can be successfully embedded in the operations of an R&I funder. Instead, it should be understood as a *compass*. It provides a heuristic to diagnose gaps in organizational roles, capacities, and capabilities; compare different solutions to perform the eight Steps; and guide the exploration of potential organizational reform strategies. The reason is that the framework is *functional* rather than *structural*. In other words, it represents a set of necessary functional steps that can be performed through a variety of possible institutional arrangements and tools.[65]

In this section, the implications of the framework and proposed toolbox are examined through three case studies that portray different ways to utilize the compass to land at varieties of experimentalism. By doing so, we aim to provide a comparative analysis that illustrates both the lack of 'one-size-fits-all' solutions, as well as the opportunity this provides for designing solutions whose nature and ambitions can be as transformative as context-specific.

6.1 The DARPA Model

The American Defense Advanced Research Project Agency (DARPA) was established in 1958 because innovation in space activities was found important to avoid technological defeats in the Cold War. DARPA's organizational structure balanced the ability to carry out basic research through university partnerships with a strong commitment to enabling technology transfer from laboratories to major producers in relevant industries.

Over time, this model fed into the rapid commercialization of key 'dual-use' technologies (military and civilian) that not only contributed to the moon landing but also to our societies at large – including the likes of the Global Positioning System (GPS) graphical user interfaces (GUIs), and vocal assistants. The transformative outcomes of the DARPA model were largely built through an experimentalist approach to R&I. This distinctive governance approach has been extensively studied and copied – with new agencies such as ARPA-E (energy), ARPA-H (health), and recently ARPA-I (infrastructure and transportation) taking hold across the US R&I ecosystem.

DARPA's experimentalist governance model places expert project managers at its core. DARPA's project managers have a scientific and/or industrial background which

[65] Charles Sabel and Jonathan Zeitlin, "Learning from Difference: The New Architecture of Experimentalist Governance in the European Union".

enables them to successfully manage broad portfolios of projects to induce the formation of new R&I networks. The managers perform a pivotal role in striking a balance between the top-down and bottom-up elements that form experimentalist R&I.

The table below depicts the combination of tools utilized by DARPA to realize its experimentalist R&I processes.

Table 1. DARPA model of experimentalist R&I

Function	Step	Tools
Consensus	WHY	"**Consensus building meetings**": facilitated discussions to formulate sets of high-level programmatic themes that can galvanize sub-research programs.
	WHAT	"**Challenge-based procurement**": challenge-based research model that seeks advances meeting significant technology challenges via high-risk, high-reward projects.
Experimentation	WHO	"**Two-stage selection process**": applicants respond to project managers' application review, thus creating positive feedback loops in the selection.
	HOW	"**Money-based stage gate process**": candidate projects are evaluated at each R&D stage and weeded out based on their own evolving commercial potential.
Learning	INTERACTION	"**Hands-on relationships**": project managers talk and meet at frequent intervals with grantees to support their progress – e.g., by linking them with venture capital funds.
	INTERNAL LEARNING	"**Innovation summits**": major technology showcase events in Washington are held that engage grantees in showcasing results to public and private leaders.
Revision	EXTERNAL LEARNING	"**Science-policy interface**": experimentation is protected and learning diffused due to the autonomy of DARPA ("island") relative to federal agencies ("bridge").
	REVISION	"**"Right-left" research model**": project managers assess emerging technology from the right end of the pipeline (I) to the left side of the pipeline (R) in order to look for proposals that may be conducive to the breakthroughs sought after.

Source: Authors' elaboration based on Fuchs (2010), Bonvillian and van Atta (2011).

6.2 The SITRA Model

Proposed by the Bank of Finland and approved by Parliament as a gift to mark the 50th anniversary of national independence, SITRA, the Finnish Innovation Fund, was established in 1968 with a broad mandate to promote the competitiveness of Finland's economy. This mandate has been enacted through cooperation with firms and actors standing at the periphery of the post-WWII economic system, hence allowing SITRA the liberty to be first in Finland to experiment with R&D grants first and then venture capital funding in the electronics sector. In this way, SITRA played a key role in nurturing the instruments and connections that, also thanks to other

agencies in the Finnish innovation landscape, eventually led in the '90s to the rise of the telecommunications ecosystem around Nokia. During the last decade, SITRA largely focused on spearheading social innovation across the country.

A key example of such intent was the 'Ratkaisu 100' challenge prize: a programme that aimed to solve Finland's future challenges by spurring the formation and incubating the development of groundbreaking ideas emerging from Finnish society. Running during 2016 and 2017, the 'Ratkaisu 100' challenge prize has revolved around the proposition of nurturing the shared development, learning, and creativity of unconventional teams as a key to the emergence of new solutions that could address complex societal problems. As such, its experimentalist R&I approach was characterized by a strong dominance of the bottom-up element, which eventually fed into the seeding of 15 business ideas and the funding of two social innovations focused on applying AI to skills and education.

Table 2. SITRA model of experimentalist R&I

Function	Step	Tools
Consensus	WHY	"**Direct involvement**": The general public is asked what they see as the key social challenges that will affect the future of the Finnish population.
	WHAT	"**Matchmaking":** Challenge prizes attract new experts to the field defined by a given challenge and determine relevant criteria for new innovations. These are then translated into an open call for teams with diverse backgrounds.
Experimentation	WHO	"**Challenge prize**": Idea teams are selected by the general public to develop their ideas into a business model and pitched in several competitive rounds.
	HOW	"**Eligibility-based conditionality**": Teams must fit criteria of diversity and stay in line with the goal of the challenge in order to move to the incubation period.
Learning	INTERACTION	"**Support networks**": Integrated incubation/development period can support the progress of the participating teams' idea journeys. Interactions are linked specifically to the elaboration and championing phases of the idea journey.
	INTERNAL LEARNING	"**Mentoring concepts**": Various interactions and conversations within the network of innovators play a key role in developing the new ideas.
Revision	EXTERNAL LEARNING	"**Prizes and honors**": Developed solutions are evaluated by judges based on their innovativeness, expected social impact, as well as practical feasibility.
	REVISION	"**Prizes and honors**": Winners are chosen by an independent jury of seven experts and granted a total of 1M€ to be used to implement their ideas.

Source: Authors' elaboration based on Toivonen, Nordbäck and Takala (2018, 2021).

6.3 The EIT KIC Model

Set up in 2008 by the European Union as an independent body, the European Institute of Innovation and Technology (EIT) aims to bring together leading public, private, education and research organizations from across Europe to deliver thematically-driven innovation. A key component of its operating model is its reliance on so-called Knowledge and Innovation Communities (KICs): i.e., partnerships that bring together businesses, research centers and universities to develop innovative products and services; help kickstart new companies championing them; and training new generations of entrepreneurs to scale and diffuse them across the continent.

So far, the EIT established nine KICs in the fields of climate, digital, food, health, raw materials, urban mobility, and more. Among them, the Climate-KIC has been one of the most successful both in terms of its setting the agenda on the urban governance of the green transition, and in terms of accelerating the growth of climate-positive start-ups (more than 2000 in the span of 5 years). One of the most distinctive aspects of the EIT KIC model consists of the composite multi-level architecture that results from its implementation: on one hand, stemming from the EIT's attempt to catalyze community formation with the establishment of KICs; on the other, emerging from the broad autonomy left to each KIC in designing, managing, and ensuring the long-term feasibility and sustainability of their project portfolios.

Table 3. EIT KIC model of experimentalist R&I

Function	Step	Tools
Consensus	WHY	"**Active advocacy**": EIT prompts the formation of KICs that engage 'challenge owners' – e.g., mayors, regional leaders, ministers and companies' CEOs – to grasp their needs, identify constraints and build consensus for transformation.
	WHAT	"**Public-private partnerships**": KICs identify where and how innovation can play a role towards catalyzing change; and elaborate the design of portfolios around key leverage points. EIT provides 'seed funding' for up to 25%.
Experimentation	WHO	"**Autonomous portfolio management**": KICs build a portfolio of 30 to 100 pilot innovation projects that are designed to address the targeted leverage points.
	HOW	"**Money-based conditionality**": EIT monitors KICs' adherence to a 'business logic' (long-term strategic approach aiming at KICs' own self-sustainability) and an 'investment logic' (KICs' business plan with measurable targets).
Learning	INTERACTION	"**Support networks**": EIT provides guidance to KICs on implementation of the financial, legal, administrative or operational management of the Community.
	INTERNAL LEARNING	"**Co-design and co-creation events**": KICs use learnings from the portfolio to inform the dynamic management of emerging innovation options.

Revision	EXTERNAL LEARNING	"**Science-policy-interface**": EIT develops a knowledge-pool starting from KIC-focused studies and conferences; organizes an EIT Stakeholders' Forum to spread knowledge, exchange, exploitation of results in EU Member States.
	REVISION	"**Reassessing the cycle**": EIT implements results-oriented monitoring (both in terms of direct outputs and behavioral change) along strategic KPIs and KIC-specific indicators to determine each KIC's annual funding allocation.

Source: Authors' elaboration based on EIT Climate-KIC (2022), Leceta and Könnöla (2021).

6.4 Comparative Analysis

The key differences that distinguish the three varieties of experimentalism reviewed in this section can be summarized in three respects: focus, R&D priority, and role.

In terms of focus, DARPA primarily funds technical innovation for the military which often spills over into dual-use purposes. However, its model has been replicated also for other sectors that have a stronger societal dimension (e.g., ARPA-E). SITRA's Ratkaisu 100 has instead focused on societal challenges defined by and of interest for many stakeholders: in such a perspective, technology can be part of the solution (and usually has been), but is not necessary. Last, EIT-KICs has engaged actors from higher education, research, and business to identify bottlenecks hindering the societal adoption of new technologies – thus spanning the boundaries of the societal and the technical domain.

In terms of R&D priority, DARPA's project management practices proved to be able to cover the entire innovation pipeline – i.e., from the idea to the market commercialisation. SITRA's innovation challenge prizes, instead, have focused on nurturing new solutions and providing initial funding to them; thus, with lesser attention for their potential towards commercialisation. EIT-KIC's model, finally, has developed project portfolios that are mostly focused on understanding how to unlock socio-technical transitions at scale – thus, at the level of diffusion inducement, rather than idea development.

As anticipated, these differences are ultimately reflected in different interpretations of the experimentalist R&I model suggested in the previous section. DARPA's role resembles that of an 'orchestrator': its role, indeed, is critical in forging new technology visions and steering emerging technological trajectories. SITRA's role can be associated with that of a 'midwife' in that it is key in nudging the initial rise of new ideas, but does not cater for their ensuing development. Last, EIT's role in the KIC model can be defined as that of a 'facilitator' convening multiple stakeholders and supporting their effort to understand, analyze, and address key bottlenecks towards transformation.

Table 4. Three varieties of experimentalism

Variable	DARPA model	SITRA model	EIT KIC model
Focus	Technical	Social	Socio-technical
R&D	Holistic	Idea-oriented	Diffusion-oriented
Role	Orchestrator	Midwife	Facilitator

Source: Authors' elaboration

Overall, these three roles can also be compared in how they position themselves at a spectrum between more top-down and more bottom-up approaches to experimentalist R&I. While DARPA is relatively top-down, SITRA focuses on bottom-up initiatives, and EIT KIC combines both approaches. Together, they illustrate two points. First, that experimentalism can be translated in very different ways depending on context-specific needs and preferences. Second, that experimentalism can help R&I funders equip themselves with the tools needed to address strategic ambiguity.

7. Conclusions and Recommendations

While there is an urgent demand for R&I to drive societal transformation forward, R&I actors are still looking for new approaches to redesign their operations accordingly. To address this, we have proposed experimentalism as an approach that both enables rapid action in the face of urgency, and promotes collaborative learning in the face of uncertainty.

In practice, experimentalist R&I can be realized by tilting each key step of R&I funding towards the logic of recursive and collaborative learning. The experimentalist R&I framework gives R&I funders and policymakers a direction forward and toolkit to steer their organizations towards ways of working fit for today's challenges. At the same time, however, we wish to underline that any process of organizational and systems change is extremely complex. As such, it is beyond the scope of this report to provide a fully-articulated solution to this challenge (if there ever could be one). For this reason, we outline three main recommendations for R&I funders to keep in mind when attempting to reform their operations towards experimentalism.

7.1. Treat Experimentalism as a Compass Rather Than as a Blueprint

To begin with, there is no 'one-size-fits-all' solution to implement experimentalism. Previously, we showed how experimentalism has been interpreted in different varieties depending on the organization it was used by and the goals for which it was deployed (see section 4.3). Indeed, the best way that any R&I funder has to 'tilt' their operations towards experientialism is to do so by adapting its principles to their own operative context. Successful organizational change can only emerge from a successful interplay of the initiatives of the management and their co-workers; contingent windows of opportunity; and unique institutional conditions. As the definition of organizational success itself mirrors plural aspirations, concerns and needs, the only reasonable approach to adopting experimentalism is by making sense of such diversity, and crafting a shared direction forward out of them.

As such, managing organizational change resembles pathfinding. Experimentalism does not and should not constitute a *blueprint* for 21st century R&I funding. Rather, it should be seen and used as a *compass* to reform its governance. Experimentalism offers to R&I funders a 'direction' to pursue. However, only the members of such organizations can discover their own path towards it. In this sense, our framework is intended to assist them during this journey by articulating what such a 'direction' consists of and by detailing its implications for each step in the R&I funding process.

At its best, these can be summarised as follows:

1. WHY? Involve stakeholders in setting the R&I agendas.
2. WHAT? Ensure public-private synergies in R&I spending.
3. WHO? Adopt a dynamic portfolio management approach.
4. HOW? Ensure accountability through strategic design of conditionalities.
5. HELP? Empower hands-on relationships for customized project support.
6. MONITOR & EVALUATE! Set out arenas for promoting systemic peer-learning.
7. DISSEMINATE! Think beyond conventional approaches for external learning.
8. REVISE! Embed sensemaking in the stage-gate review process.

7.2. Lead People By and Through Experimentalism

Reforming an organization is essentially a group effort. Thus, the process of change management that underpins the effort should be centered around the people in the organization. If need be, organizational and policy reform can be supported by external stakeholders – such as trustworthy consultants. Yet, in order for external support to be effective, the intent for reform must be cultivated within the organization as well as by a management that is committed to pursuing a desired change in the first place.[66] In this effort, change makers must act like 'pathfinders' exploring an uncharted territory: they do not know the path in advance, but they are ready to try out different approaches and revise their journey in order to bring their team forward. Likewise, the management level of R&I funders committed to pursue experimentalism need to do so by means of experimentalism itself: by discovering how to 'walk' the organization in the shared 'direction' by means of incremental, but cumulatively decisive steps towards a new way of working. In this sense, the role of management is critical in at least three respects:[67]

- **Leading:** Engaging each employee – from management to front-line – in the process of organizational change. This can be pursued by engaging the whole organization in such a process – e.g., by structuring a collective process to crowdsource new ideas and test new practices from the bottom-up.
- **Learning:** Monitoring emerging practices as they accumulate in the process of organizational change. This can be pursued by engaging the organization in the iterative review of the challenges faced by each employee during the process, and comparison of their approaches to advance peer-learning.

[66] Philip Selznick, *Leadership in Administration: A Sociological Interpretation* (Berkeley: University of California Press, 1957); Paul S. Adler and Charles Heckscher, "Collaboration as an Organization Design for Shared Purpose", in *Toward Permeable Boundaries of Organizations?*, vol. 57, Research in the Sociology of Organizations (Emerald Publishing Limited, 2018), 81–111.

[67] See Arjen Boin and Tom Christensen, "The Development of Public Institutions: Reconsidering the Role of Leadership", *Administration & Society* 40, no. 3 (May 2008): 271–97.

- **Embedding:** Codifying and formalizing the best practices emerging in the process of organizational change. Once that collective 'experimentation' has resulted into new, well-accepted routines, locking them into the mandate and legal rules of the organization is key to ensure their long-term viability.

7.3 Think Beyond Your Organization

As shown by our framework, experimentalism can be applied at the organizational level – for example, whenever R&I funders set their agenda; pick recipients of funding; facilitate peer-learning; and seize the findings in decision-making. Yet, experimentalism is first and foremost a mode of governance. It identifies a logic of collective action that can be applied at other governance levels too – including the national, or even international one. Research has identified many successful case examples of experimentalism that transcend the organizational boundaries, like the UNEP's Montreal Protocol.[68] Today's societal challenges cut across policy silos and thus demand coordinated action from different public stakeholders – including, e.g., regulators, funders and ministries.

R&I funders play a key role in advancing societal transformations on their own. Yet, as they progress towards the successful development of new solutions, their large-scale deployment will necessarily require collaborating with other public agencies. In this pursuit, experimentalism can provide them with a model they can use to prompt further coordination at higher levels of policy-making while maintaining organizational autonomy. If R&I funders are to prioritize their capacity to lead societal transformations, the role of 'thought leader' or 'change maker' within the landscape of their public administrative environment is not a 'nice-to-have': rather, it is an integral part of staying true to such organizational ethos.

To conclude, R&I funders' call to lead societal transformations has no easy answer. Yet, the stakes could not be higher. It is from this perspective that we invite all policymakers committed to address the most wicked challenges of our times to reflect on what they can do to help their organizations become able to succeed in such an operating context. Experimentalism constitutes a promising compass to find a path forward. Still, even the most committed change makers will meet setbacks – and at times, even dead ends – in the pursuit of meaningful organizational change. However, action is our biggest source of hope and we believe the times are ripe to make it count.[69]

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[68] See Charles Sabel and David Victor, *Fixing the Climate: Strategies for an Uncertain World*.

[69] See Rainer Kattel, Wolfgang Drechsler, and Erkki Karo, *How to Make an Entrepreneurial State: Why Innovation Needs Bureaucracy* (Yale University Press, 2022).

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Appendix 1: Longlist of Tools

The table below lists the approaches and tools identified during this project. The list is not a prescriptive account of tools ought to be deployed, but a source for inspiration and case studies elucidating tools that can be adopted in pursuit of experimentalist R&I.

Table 5. All approaches and tools identified

Approach	Tool
Step 1: WHY?	
Knowledge-brokering	**Informal consensus-building meetings** can inform the first stages of agenda-setting, by bringing decision-makers and researchers together to exchange viewpoints around a problem. Instead of producing tangible outputs (decisions, summaries) the facilitated discussions aim only to prepare a common ground between key stakeholders to enable future cooperation. Case: Timeout dialogues[70]
	Standing panels of experts from one epistemic community work continuously to synthesize divergent viewpoints within a discipline or to identify key premises of disagreement so these can be communicated transparently externally. R&I funders can be the fora that gathers such panels in matters related to agenda-setting. Case: IGM Economic experts panel[71]
	Large-scale phenomenon identification is an effective way to map various groups' understanding of the phenomena related to the prioritized challenge by gathering e.g. parliamentary and civic bodies to define a problem and to identify and potentially reconcile underlying epistemic and value-based assumptions. Case: The Finnish social security reform-deliberations[72]

[70] "Tools", Timeout, https://www.timeoutdialogue.fi/tools/.

[71] "European IGM Economic Experts Panel", Clark Center Forum, https://www.kentclarkcenter.org/european-economic-experts-panel/.

[72] "Perusturvan ja toimeliaisuuden uudistushanke", Valtioneuvoston kanslia, https://vnk.fi/toimi.

	Joint fact finding is a method that helps non-scientist stakeholders grasp technically intensive policy and planning challenges to collaboratively engage in research and arrive at shared sets of facts to inform their decision-making. This allows stakeholders to collaboratively engage in research and to arrive at a shared set of facts to inform decision-making. Case: Joint Fact-Finding to Climate-Ready Infrastructure in Rotterdam[73]
Citizen science	**Civic panels** consist of random selection combined with structured deliberations to land at tangible policy-recommendations. They help ensure the democratic legitimacy of value-choices made for research purposes. R&I funders can endorse citizen science as an approach for incorporating the value-judgment of non-experts into decision making around problem-definition and prioritization. Case: The Scottish Approach to Service Design (SAtSD)[74]
	Direct involvement of citizens through online platforms has been used by various public entities to gather input on citizen preferences and to prioritize between competing viewpoints. In addition to enabling more comprehensive problem-solving, this fosters democratic engagement, and enhances the legitimacy and effectiveness of decision-making processes. Case: 365 Online Gwanak-gu Office – Online Platform for Direct Democracy[75]
	Futures ecosystem forums are collaborative spaces for stakeholders from diverse sectors to collectively envision and shape potential future scenarios. They utilize foresight-methods to anticipate emerging trends, challenges, and opportunities and build a shared strategic goal. Backcasting-methods then help inform strategic decision-making and

[73] Todd Schenk et al., "Joint Fact-Finding in Practice: Review of a Collaborative Approach to Climate-Ready Infrastructure in Rotterdam".
[74] "The Scottish Approach to Service Design (SAtSD)", http://www.gov.scot/publications/the-scottish-approach-to-service-design/pages/about-this-resource/.
[75] "365 Online Gwanak-Gu Office - Online Platform for Direct Democracy", Observatory of Public Sector Innovation, https://oecd-opsi.org/innovations/gwanak-gu-office/.

	policy formulation and identify the steps needed to reach the shared goal. Case: Future cities dialogues[76]
	In line with the **Value Judgment Principle (VJP)**, knowledge brokers can contribute to open science by identifying and explaining major value judgments in scientific research and the factors that could be influencing those judgments on behalf of non-specialists. To enable citizen science, R&I funders can require funding receivers to comply with the VJP. Case: Science journalism on radiofrequency radiation and human health[77]
Step 2: WHAT?	
Building coalitions of funders	In **co-funding arrangements** multiple organizations or entities contribute financial resources to support a project or program. This type of funding often involves partnerships between government agencies, research institutions, industry players, and philanthropic foundations. Case: Marie Skłodowska-Curie COFUND Actions[78]
	Forums provide valuable opportunities to establish coalitions of funders. They allow not only for debates on the most recent advancements in research and innovation policies and practices, but also serves as a hub for networking opportunities between leading organizations from various sectors, including industry, research, innovation, and policymaking. Case: The Science|Business Network[79]
	R&I funders can seek coalitions of funders with **private equity** actors such as venture capital firms and family offices. These actors have a history of collaborating in funding research in areas of interest to them. Private equity

[76] "Case Study: Future Cities Dialogue", sciencewise, https://sciencewise.org.uk/wp-content/uploads/2018/08/Future-Cities-Case-Study.-FINAL.pdf.
[77] Kevin C. Elliott, "Science Journalism, Value Judgments, and the Open Science Movement", *Frontiers in Communication* 4 (2019).
[78] "COFUND | Marie Skłodowska-Curie Actions," https://marie-sklodowska-curie-actions.ec.europa.eu/actions/cofund.
[79] "The Network," Science|Business, https://sciencebusiness.net/network.

	can offer a more flexible alternative for financing research targeting specific problems or problem areas, which need quick funding. Case: Repro Grants, Impetus Grants, Fast Grants[80]
	R&I funders frequently seek to be a part of **public-private partnerships** geared towards solving specific problems. These can consist of public partners (e.g. the European Commission) mixed with private ones like communities, networks, and membership organizations. These kinds of partnerships can offer R&I funders the potential to leverage diverse expertise, resources, and perspectives to address complex challenges and drive innovation. Case: Built4People & Science Coalition "Built4People," https://www.ectp.org/built4people/; "About The Coalition - The Science Coalition,", https://www.sciencecoalition.org/about-the-coalition/.
	Commercialization support refers to the assistance and resources provided to help bring a product or innovation to market successfully. It can be done through for example co-innovation, co-creation, or co-research funding between research institutions and companies to support bridging the gap between research, development, and the commercialization of a product or technology. R&I agencies can deploy such approaches to increase the demand for their services. Case: Business Finland[81]
Supporting individual private organizations	R&I funders can support individual private organizations in channeling their resources into R&I activities. Innovation agencies frequently deploy the approach of attaching self-funding conditionalities to RDI-funding. This can be applied to research funding as well, to incentivise third-party funding for research that is of interest to private actors. In doing so, R&I funders can act as "**matchmakers**" between researchers and private actors. This introduces a consultative role less frequently deployed by R&I funders.

[80] "Repro Grants", https://www.reprogrants.org;
"Longevity Impetus Grants", https://impetusgrants.org;
"Fast Grants", https://fastgrants.org/.
[81] "Cooperation between Companies and Research Organizations", https://www.businessfinland.fi/en/for-finnish-customers/services/funding/cooperation-between-companies-and-research-organizations.

	Case: Technology transfer offices (TTOs), Systematic analysis of 50 years of Stanford University technology transfer and commercialization[82]
	R&I funders can encourage private investment in R&I by developing **co-funded research grants** for private-research-consortia that are required to obtain self-funding when applying for a public grant. Case: Vinnova[83]
Step 3: WHO?	
Innovation and research competitions	**Challenge prizes** are public competitions that offer a monetary award to whoever can first or most effectively solve a pre-defined problem. All challenge prizes are agnostic in terms of the methods, as long as the solution is the best one. In addition to their targeted problem statement, challenge prizes differ from other R&I competitions in that they are less focused on scientific credentials and do not have attached conditionalities like innovation loans. Case: The Big Green Challenge, Challenge Prizes: A Practice Guide (Nesta)[84]
	Challenge competitions are different from more traditional research funding in that they don't only measure research performance through consortium credentials, but also things like teamwork, the public's assessment, branding, and presentation skills. They facilitate the process of science-making into either process or product innovations through science-society interaction. Case: Helsinki Challenge[85]
	Innovation competitions engage a wide array of actors

[82] Marcus Holgersson and Lise Aaboen, "A Literature Review of Intellectual Property Management in Technology Transfer Offices: From Appropriation to Utilization", *Technology in Society* 59 (November, 2019); Weixin Liang et al., "Systematic Analysis of 50 Years of Stanford University Technology Transfer and Commercialization", *Patterns* 3, no. 9 (September 2022).

[83] "Vinnova är Sveriges innovationsmyndighet | Vinnova", https://www.vinnova.se/.

[84] "Big Green Challenge Final Evaluation Report", https://www.nesta.org.uk/report/big-green-challenge-final-evaluation-report/; Challenge Prizes: A Practice Guide" https://www.nesta.org.uk/toolkit/challenge-prizes-a-practice-guide/.

[85] "Helsinki Challenge – Science Based Competition and Idea Accelerator", https://challenge.helsinki.fi.

	ranging from private sector entities like businesses and startups to academic institutions, and third sector organizations. Innovation competitions usually have a broader range of submissions, and don't have as targeted a problem statement as challenge prizes for example. Case: European Social Innovation Competition[86]
	Governments and banks offer **innovation loans** for developing innovative products, processes, or services. They may vary in terms of the stage of R&D activities (early/middle/late), and can have attached conditionalities that dictate needs for roadmaps, development of particular products, and age of a company. Case: Innovate UK[87]
Autonomy-based portfolio	The autonomy-based portfolio-approach grants individual project managers substantial autonomy in deciding who receives funding. This can be realized through, e.g., **vision-driven selection**, where managers of R&I portfolios are encouraged to take higher levels of risk in R&I funding than they currently do. They have the autonomy to award small short-term grants for innovative ideas to be tested before broader implementation of the most promising ones. Case: Advanced Research Projects Agency - Energy (ARPA-E)[88]
Step 4: HOW?	
Money-based	**Money-based conditionalities** establish strict requirements to govern the financial aspects of the projects supported by the R&I funder. These may include, e.g., adhering to budgetary guidelines and cost sharing conditions. As a result, they promote grantees' accountability in achieving project milestones and managing funds responsibly.

[86] "The European Social Innovation Competition", https://eic.ec.europa.eu/eic-prizes/european-social-innovation-competition_en.
[87] "Innovation Loans Future Economy Competition: Round 9 - Innovation Funding Service", https://apply-for-innovation-funding.service.gov.uk/competition/1574/overview/927ec67e-225e-47f5-ae92-bc1a79a0ccc9.
[88] William B. Bonvillian and Richard Van Atta, "ARPA-E and DARPA: Applying the DARPA Model to Energy Innovation".

	Case: Germany's KfW loans and grants[89]
Eligibility-based	**Eligibility-based conditionalities** establish requirements that grantees are asked to meet in order to participate in the programme designed by the R&I funder. These may include, e.g., collaboration with different actors, location of activities in a certain area, target or the provision of periodic reports about project-related elements of interest. Case: Israel Innovation Authority's R&D funding instrument[90]
Knowledge-based	**Knowledge-based conditionalities** establish requirements to govern the legal and knowledge related aspects of funded projects. These may include, e.g., open access to the project results either via full disclosure or negotiation of service agreements. Case: Oxford/AstraZeneca Partnership[91]
Penalty-based	Penalty-based conditionalities are applied horizontally – i.e., regardless of whether an R&I actor takes part in the experimentation. While R&I funders often lack the mandate to develop regulatory penalty-based conditionalities, they can leverage their networks and expertise on subject-matter to **collaborate with regulatory agencies**. Case: CARB-E Low- and Zero-Emission Vehicle programme[92]
Step 5: HELP?	
Hands-on relationships	**Service platforms** are employed by Venture Capitals (VC) to offer assistance beyond investment to their portfolio companies to help them succeed. In practice this for example translates into VCs' in-house teams that advise portfolio companies on different functions like communications, talent acquisition, and product development. Case: Speedinvest[93]

[89] Mariana Mazzucato, "Rethinking the Social Contract between the State and Business: A New Approach to Industrial Strategy with Conditionalities".
[90] Ibid
[91] Ibid
[92] Charles Sabel and David Victor, "How to Fix the Climate".
[93] "VC Platform | Startup Resources for Early-Stage Tech Founders", https://www.speedinvest.com/platform.

	R&I funders can offer **advisory services** for R&I activities beyond financial contributions, for example in information assistance. In practice this means funders consult recipients and provide them technical and/or business referrals, and other innovation services as needed, or match firms with organizations that have necessary expertise. These services cover every aspect of the innovation process from concept to commercialization and include technology and business assistance, expertise searches, and linkages to appropriate resources. Case: Canada's Industrial Research Assistance Program[94]
	R&I funders can play an important role in enhancing researchers' capacity to conduct impact-driver research. Funders facilitate a dynamic exchange of knowledge and expertise between the research community, the policy sphere and private actors. Thus, they can conduct **capacity building** to enhance researchers' ability to develop the usefulness of their outputs. Case: Centers of Excellence and Capacity Building: from Strategy to Impact[95]
Support networks	**Research support networks** focus on strengthening cooperation and peer learning between different actors. Some methods they can employ include peer collaboration (e.g. workshops and conferences), mentorship and advisory services, access to facilities and expertise, and knowledge transfer and commercialization support (e.g. strategy help, technology transfer, training). Case: EIT Knowledge and Innovation Communities[96]
Informal support	R&I funders can play an informal role as actors who identify and promote **change-state advocates**, and offer peer-to-peer interactions, mentoring and networking to individuals with drive and potential to achieve substantial impact when given the support they need.

[94] National Research Council Canada, "About the NRC Industrial Research Assistance Program", https://nrc.canada.ca/en/support-technology-innovation/about-nrc-industrial-research-assistance-program.

[95] Tomas Hellström, "Centres of Excellence and Capacity Building: From Strategy to Impact".

[96] "Knowledge and Innovation Communities | EIT", https://eit.europa.eu/global-challenges/knowledge-and-innovation-communities.

	Case: ASPN mentorship program & Accountability Incubator[97]
Step 6: MONITOR!	
R&I Summits	**Co-design and co-creation events** bring together experts, stakeholders, policymakers and interested citizens in the co-design and co-creation of products and/or services. These events foster open dialogue and shared decision-making, allowing diverse perspectives to contribute to the research and innovation process.es By involving stakeholders throughout, co-design and co-creation events result in user-centric and inclusive solutions that meet the needs and preferences of those involved. Case: UNDP Sensemaking workshop methodology[98]
Peer-learning networks	**Agile ecosystems** is an approach utilized in innovation ecosystems inspired by private sector agile development processes. Here, teams working on similar problem statements convene on a regular basis (e.g. bi-weekly) for brief scrum-meetings (e.g. 15-30 minutes), where advances and bottlenecks are identified, and follow-up meetings are booked in case an issue requires quick responses. This can provide quick and efficient monitoring of R&I activities with substantial funding and tight timelines. Case: U.S. Digital Services (USDS) team & Canadian Digital Services team[99]
	Customized Round Tables organized at various locations regularly by the R&I funder can be used to ensure the efficient monitoring of decentralized R&I activities while at the same time embedding dynamics of peer-learning across the network of local stakeholders. By customizing the meetings to the challenges emerging throughout project execution, different viewpoints can be cross-fertilised to

[97] Tetyana L. Vasylyeva et al., "Developing a Research Mentorship Program: The American Society of Pediatric Nephrology's Experience", *Frontiers in Pediatrics* 7 (2019); "Accountability Incubator," Observatory of Public Sector Innovation, https://oecd-opsi.org/innovations/accountability-incubator/.

[98] "Sensemaking Workshop Preparation Guide and Facilitator Guide and Sensemaking Training | United Nations Development Programme," UNDP, https://www.undp.org/publications/sensemaking-workshop-preparation-guide-and-facilitator-guide-and-sensemaking-training.

[99] "Canadian Digital Service", https://digital.canada.ca/; "The Digital Services Playbook — from the U.S. Digital Service", https://playbook.cio.gov/.

	gather knowledge from different viewpoints and promote collective learning on how to advance beyond similar issues. Case: Utrecht model of elderly care[100]
	Collective quality review meetings are peer-learning processes with the objective of evaluating quality rather than progress. Such meetings can serve three functions; 1) capacity building, 2) experience exchange and 3) foster new collaborations to heighten the quality. Case: Child welfare reform in Utah and Alabama[101]
Step 7: DISSEMINATE!	
Science-policy interface	**Gamified dissemination** can be used as an alternative for the traditional dissemination format consisting of publishing a synthetic report and policy recommendations followed by a seminar. Gamification creates a risk-free and interactive environment where researchers can verify their assumptions by testing their proposals together with decision-makers. This approach can be deployed to address identified bottlenecks as well as to discuss policy recommendations derived from research. Case: Regulation cash-test[102]
	R&I funders are uniquely positioned to synthesize knowledge derived from research. This is vital for both the agenda-setting and dissemination steps of an R&I cycle. One approach for doing so is to produce (or co-produce with researchers) **systematic reviews** of funded research. Case: The UK What Works Network[103]
	While systemic reviews produce an overview of outputs across research projects, **specialized review production** focuses on sensemaking of a single R&I project. This

[100] Charles Sabel, Jonathan Zeitlin, and Jan-Kees Helderman, "Transforming the Welfare State, One Case at a Time: How Utrecht Makes Customized Social Care Work".
[101] Kathleen G. Noonan, Charles F. Sabel, and William H. Simon, "Legal Accountability in the Service-Based Welfare State: Lessons from Child Welfare Reform", *Law & Social Inquiry* 34, no. 3 (July 2009): 523–68.
[102] Karol Olejniczak, Michał Wolański, and Igor Widawski, "Regulation Crash-Test: Applying Serious Games to Policy Design".
[103] "The What Works Network: Five Years On," GOV.UK, https://www.gov.uk/government/publications/the-what-works-network-five-years-on.

	provides in-depth understanding, context, and insights into the nuances, successes, challenges, and potential impacts of the project, enhancing decision-making, refinement, and future planning. Case: Solutions from science Finland[104]
Radical transparency	R&I funders could consider **abandoning prepublication peer-review of their work**, and instead support transparent post-publication peer-review. This would secure maximal access to outputs, but would leave judging the credibility of outputs to the public engaging with the product. Case: Is Peer Review a Good Idea?[105]
Commercialized research	In **commercialized science**, researchers employed by universities work directly for private companies or coalitions, to address their challenges, with the findings remaining the intellectual property of the funder. While such an approach can come with adverse effects on e.g. the trust in science, R&I funders could support such efforts by for example conducting matchmaking to increase private R&I funding. Case: UKRI on commercialization of science[106]
Prizes and honors	**Prizes and honors**, as tools for incentivizing collaboration, recognition, and idea generation in science and innovation, enable R&I funders to effectively disseminate learnings, inspire stakeholders, showcase best practices, and facilitate networking, ultimately promoting broader awareness, engagement, and adoption of their impactful activities and outcomes. Case: Howard Hughes Medical Institute Investigators[107]
Step 8: REVISE!	
Stage-gate process	**Contribution Analysis-method** is a theory-driven approach that assesses the impact of an intervention by analyzing

[104] "Ratkaisuja tieteestä – väyläsi strategisen tutkimuksen tuloksiin," https://ratkaisujatieteesta.fi/.
[105] Remco Heesen and Liam Kofi Bright, "Is Peer Review a Good Idea?".
[106] "Why Commercialisation Is Important" https://www.ukri.org/councils/esrc/impact-toolkit-for-economic-and-social-sciences/how-to-commercialise-your-research/why-commercialisation-is-important/.
[107] Matt Clancy, "Steering Science with Prizes", *New Things Under the Sun*, March 25, 2022, https://www.newthingsunderthesun.com/pub/zjh5ozx1/release/3.

	how it led to specific outcomes, identifying key elements and contextual factors that played a crucial role. This process generates a "contribution story" that highlights the intervention's influence on observed outcomes, distinguishing its contribution from other factors. Case: Applying the DARPA model to energy innovation[108]

[108] William B. Bonvillian and Richard Van Atta, "ARPA-E and DARPA: Applying the DARPA Model to Energy Innovation".

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