AGENDA KEY ENABLING METHODOLOGIES 2024-2027

CLICK NL

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Key Enabling Methodologies for Mission-Driven Innovation
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Authors
Frank Berkers, Mieke van der Bijl-Brouwer, Jacky Bourgeois, Miguel Bruns, Rik Crutzen, Michel van Dartel, Kees Dorst, Koen Frenken, Mathias Funk, Amber Geurts, Paul Hekkert, Sander Hermsen, Tom van der Horst, Caroline Hummels, Jos Kraal, Kees Krul, Derk Loorbach, Geke Ludden, Anja Overdiek, Deger Özkaramanlı, Linda Rindertsma, Nynke Tromp, Merel Willemsen.

Revised version edited by
Martijn Arnoldus - CLICKNL
Rik Braams - TNO
Kees Dorst - University of Technology Sydney
Paul Hekkert - Topsector Creatieve Industrie / TU Delft
Anne Fleur van Veenstra - TNO

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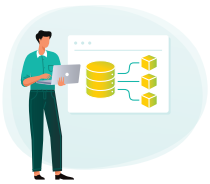


INTRODUCTION TO THE AGENDA

Global societal challenges, such as the sustainability of the economy, agriculture and society, as well as an inclusive, healthy and happy society, call for innovation and the transformation of existing systems. The urgency for this has been highlighted in countless publications in recent years[1]. The large-scale and complex issues require a multidisciplinary approach, in which technological innovation goes hand in hand with social innovation. In doing so, acquiring fundamentally new insights into, and the development and application of key technologies and methodologies are indispensable.

BACKGROUND: MISSION-DRIVEN INNOVATION POLICY

With the top sector policy, referred to as the mission-driven innovation policy since 2020, the government aims to utilise the innovative strength of the top sectors to address societal challenges. The top sectors are committed to cross-sectoral collaborations of science, applied research, businesses, and social organisations. The mission-driven innovation policy focuses on five societal themes during 2024-2027: energy transition, circular economy, agriculture, water and food, health and healthcare, and security[2].

To take targeted and collective steps in addressing societal challenges, concrete, measurable goals and ambitions have been formulated: the missions. Missions centre these challenges and act like a north star. Based on the missions, the top sectors developed Knowledge and Innovation Agendas (KIAs) that form the basis for programming groundbreaking research. Besides the five themes mentioned, cross-cutting agendas were developed for Key Enabling Technologies, Mission-Driven Innovation (KIA MV), and Digitalisation. The KIA MV aims to accelerate the scaling of innovation to achieve greater societal impact. This agenda Key Enabling Methodologies, or KEM agenda, is part of the KIA MV. Thereby, both the KIA Key Enabling Technologies and the KIA MV provide the means to address the issues in the other five mission-driven agendas.

MISSIONS REQUIRE SIGNIFICANT SOCIETAL TRANSFORMATION PROCESSES

The missions aim to realise societal and economic transformation processes or transitions. This involves achieving a complex set of closely intertwined interventions[3], systems, and institutions. Not only research and innovation are needed, but also supporting measures such as legislation and regulation and education aimed at behaviour change. There is no one-size-fits-all approach: missions vary, and each mission demands a specific policy mix and approach.

Achieving missions requires a multidisciplinary, cross-sectoral, and multistakeholder approach that not only utilises new technology but also pays attention to psychological, social, organisational, ethical, and cultural aspects. The knowledge to address these aspects is being developed in fields such as innovation sciences, administration and

1. For example, see the recent IPCC report on climate change, the ETES2050 report or the High-level EU expert group on AI.
2. Knowledge and Innovation Covenant 2024-2027.
3. Here we mean interventions in the most generic sense, as a collective term for all possible outcomes of a change or design process, such as products, services, infrastructure, facilities, measures, et cetera.

business management, psychology, law, philosophy, behavioural sciences, economics, and anthropology. There is an increasing need to employ knowledge from the social sciences and humanities in formulating and achieving societal missions. The SSH Council has recently mapped a list of 52 relevant expertise areas from the social sciences and humanities (such as mental health, meaning, entrepreneurship, and public administration).

These missions provide new contexts within which this social form of innovation must take place. Successful examples of previous major interventions, such as the Delta Works and the offshore wind farms, do not easily translate to the current desired changes in their specific contexts. Moreover, changes like these rarely occur as a linear process and are surrounded by uncertainties and ambiguous information. The missions call for a transition strategy where policy processes and innovation processes are deployed correctly and at the right time. Such strategies logically connect the steps needed to achieve a transition and thus guide the use of instruments. Without choosing or delving into the precise nature of such a coherent strategy, we can state that tools are needed within such a strategy to develop widely supported interventions, accelerate or scale new solutions, and realise systemic changes and breakthroughs.

KEY ENABLING METHODOLOGIES OR KEMS

For the development of applications, interventions, systems, or institutions that shape the process of societal change, we use **'tools' that provide direction and structure to our way of working.** This toolbox, consisting of methods, methodologies, models, strategies, processes, and tools, is referred to, by analogy with Key Enabling Technologies, as Key Enabling Methodologies (KEMs)[4]. It includes ways of working (together), tackling problems, and creating interventions; tools that enable 'changemakers', such as designers, policymakers, or managers, to structure their work, provide direction, and realise impact.

Two examples of KEMs that clarify the nature and application of KEMs are:

- **Behaviour Change Wheel** (Michie et al., 2014): a model that brings together multiple theories of behaviour change, with which you can discover fruitful strategies for developing interventions and policies for behaviour change by playing with the dimensions of the wheel (see Behaviour and Empowerment).
- **Digital Twins** (El Saddik, 2018): a method where a digital replica of a physical entity exists alongside and in close contact with the source object, enabling precise monitoring and testing of effects in the physical world (see Experimentation Environments).

KEMs are 'enabling' and thus provide a working principle for an integrative, change-oriented, and/or designing approach. They are instrumental and indispensable in determining the desired change – or at least the direction of the desired change – and in realising societal change at the level of interventions, systems, and institutions.

KEMs contribute to the integration of knowledge and insights from the social sciences and humanities (for example, about motivation, behaviour, ethics, or organisations) with the opportunities that technological developments offer us[5]. They support the development of meaningful applications and meaningful interventions. KEMs, therefore, answer questions such as: how can interventions respond to the relationships uncovered by social science theories? How can interventions intervene in that described reality to excite, involve, empower, or influence people's behaviour? How can an intervention in a system bring about a desired change?

4. In practice (and in this agenda), 'method' and 'methodology' are used interchangeably. In the narrow sense of the word, however, 'method' refers to a well-thought-out, pre-defined course of action to achieve a specific goal, and 'methodology' to the principles and thoughts behind the method. The Dutch language also has the word *'methodiek'* for a set of coherent methods. In English the term 'methodology' is also used for this. See, among others: Badke-Schaub, P.G., Daalhuizen, J.J., & Roozenburg, N.F.M. (2011). Towards a designer - Centred methodology - Descriptive considerations and prescriptive reflections. In H. Birkhofer (Ed), *The future of design methodology,* 181-197. Springer.
5. In line with the previously mentioned areas of expertise from the SSH (Social Sciences and Humanities) domain, we therefore prefer to speak of 'insights' or 'Key Enabling Insights' in this context.

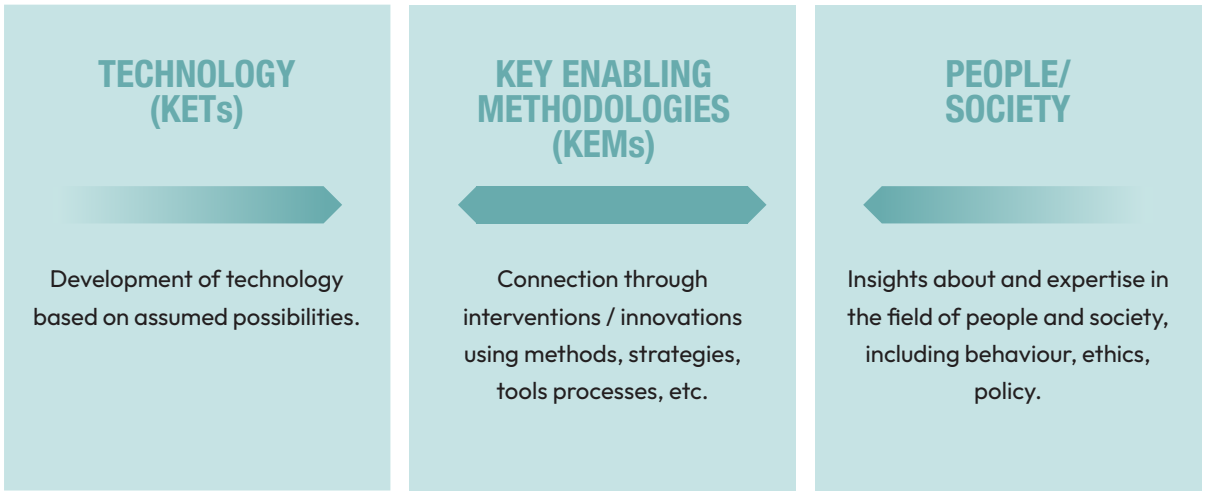


Figure 1: KEMs integrate knowledge of people and society with technological opportunities.

As illustrated above, KEMs are facilitating ('enabling') the connection between technology and society. KEMs can be used to make a technology successful in a societal context (referred to as technological innovation), but can also be directly applied to achieve that societal goal, with or without the use of (new) technology (social innovation). KEMs can thus help in the successful application of technology as well as guide its development.

Although KEMs are often developed at knowledge institutions, they find their application in practice, often in a way that deviates from the prescribed manner. Thus, in practice, variants of existing and validated KEMs are developed, sometimes leading to completely new tools.

The nature of KEMs can vary greatly. Some KEMs are generic in nature and lead – if applied correctly – directly to new concepts, interventions, or institutional changes. Others give direction and fill in a single and specific aspect of the intervention. Yet other KEMs are more conditional in nature, providing steps in the process (for example, techniques for vision development or methods to involve end-users). KEMs can therefore be used at different times and for different purposes in the innovation process.

Of course, both the user of the method and process play a significant role in the effective deployment of KEMs. In addition to knowledge about the procedure of a KEM and the ability to select the right KEM for an issue, competencies and skills are necessary to successfully apply the chosen KEM[6]. Proper use of a KEM requires the right skills and mindset, reflective and adaptive capacity, and confidence. This often involves tacit knowledge that a professional acquires through education and experience. Frequent experimentation and practice with various methods in equally diverse issues and contexts lead to the development of an intuitive feeling for when which method – or combination of methods – leads to successful results, and how to mould a method for the specific situation. Finally, the deployment of KEMs often requires collaboration between different parties, necessitating multidisciplinary thinking and acting, which comes with specific competencies.[7]

6. Also see the Power of Design Agenda which is also part of the KIA MV.
7. A recent study for the Public Design Practice (PONT) programme has listed four core competencies that are central to (designing for) social challenges: integrating, reframing, designing, and orchestrating. See: Van Arkel, T., & Tromp, N. (2023).

To illustrate the role of KEMs in transition projects, below is a brief description of four projects in which various KEMs are applied:

DELTA PROGRAMME

The Delta Programme is a national programme in which the Dutch government collaborates innovatively with provinces, municipalities, water boards, societal organisations, knowledge institutions, citizens, and the private sector. Its aim is to protect the Netherlands against high water, ensure sufficient fresh water supply, and organise the country to be climate-resilient and water-robust for future generations. Within the Delta Programme, an adaptive **monitoring and effect measurement method** (MWH, *'meten, weten, handelen'*, in English 'measure, know, act') has been developed. Additionally, methods for **co-creation with and participation of citizens** are utilised in **experimentation environments** such as living labs.

Image: Anne van Kooij

REDESIGNING PSYCHIATRY

Redesigning Psychiatry is a network of designers, philosophers, researchers, healthcare professionals, and people with lived experience collaborating to envision the future of mental health care. The Redesigning Psychiatry programme's activities are clustered around three tracks: innovation, movement (such as education, training, and workshops), and research. This includes exploring crossovers with other sectors and alternative forms of funding. A **vision-driven** design approach combined with methods for **systemic change** has been used to develop the design, aiming to drive the transition towards a reliable, accessible, and flexible mental healthcare network.

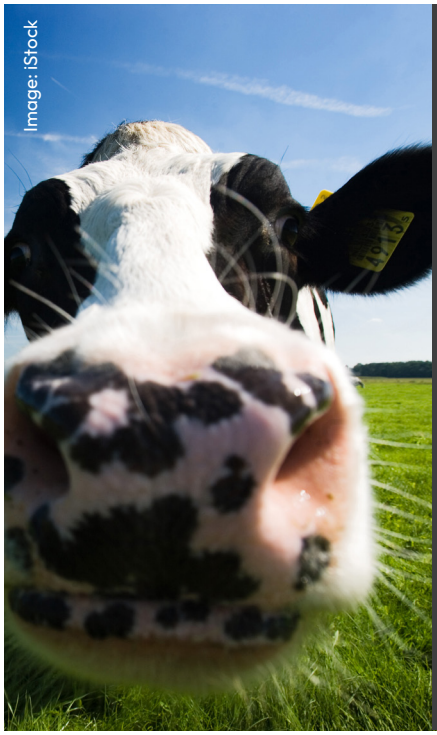


Image: iStock

NEW PERSPECTIVES ON AGRICULTURE AND NATURE

In the wake of the nitrogen crisis, a breakthrough is needed to address the recurring tension between nature and agriculture. A team of specialists in design and organisational science, together with agricultural entrepreneurs, nature conservators, and policymakers, are working on new **perspectives**. These perspectives aim to contribute to a **systemic change** where vital ecosystems, businesses, and regions coexist harmoniously. Crucially, the government, through new **policy**, is an integral part of both the problem and the solution. This is challenging: there is a lack of political and societal consensus, as well as agreement on the underlying scientific knowledge. **Experiments** will be conducted in **co-creation** to develop new **values** that move the entire problem field.

ELSA LABS FOR HUMAN-CENTRED AI INNOVATION

Within the Dutch AI Coalition, a community of Ethical Legal Societal Aspects (ELSA) labs focuses on developing human-centred Artificial Intelligence (AI). The ELSA labs target various societal challenges and domains where AI plays or will play a role, aiming to develop this technology responsibly. Central to this effort is the establishment of **experimentation environments** (labs) where technology is experimented with, in **co-creation** with various parties working on a societal challenge or in a specific domain. Research into **ethics** and **values** that the technology must meet is also conducted.

KEM CATEGORIES

In this agenda, we present eleven categories of Key Enabling Methodologies (KEMs) that are indispensable in the context of addressing societal challenges and shaping transitions. Each category represents a collection of methods, processes, and strategies that are connected through the purpose for which they are deployed. For instance, the **Behaviour and Empowerment** category encompasses all those methods and strategies that can be applied to develop an intervention with which (desired) behaviour can be influenced, adjusted, or made possible. Compared to the first version of the KEM agenda (2020-2023), three categories have been added: **Ethics and Responsibility**, **Meaning and Awareness**, and **Data for Inquiry and Evidence**.[8] Although not exhaustive, these eleven categories encompass the main domains of KEMs for achieving the missions. These are the eleven categories that will be further elaborated in the subsequent chapters:

Vision and Imagination

For every mission, it is necessary to know what the goal is. Sometimes the goal is obvious, but more often, it is necessary to design that goal, to make an inspiring vision of the future visible and tangible through the use of imagination, and thereby to give direction to change. KEMs in this category help to map the current world, imagine new worlds, and view phenomena and problems differently.

Participation and Co-creation

Missions involve many players with diverse interests, from citizens and businesses to governments and domain experts. It is crucial to involve them in the process, for the knowledge and experience they bring, to enable them to take initiative, and to create engagement and support. KEMs in this category help to involve stakeholders, to systematically go through the process, to analyse and understand the context of issues, and to develop new propositions.

Behaviour and Empowerment

For a transition to succeed, a change in behaviour is often desired. For example, to eat less meat or to fly less. In addition, people need to be enabled to make conscious choices and to be given the means to take control themselves. KEMs in this category assist in developing, testing, and validating an intervention to directly (via motivation) or indirectly (for example, through norms) change people's behaviour.

8. The other eight existing chapters have been updated for this revised agenda.

Experimentation Environments

Transitions are not easily steered, and related issues are often surrounded by uncertainties and ambiguous information. In the early stages of the innovation development process, space is needed for experimentation. Further in the process, there must be room to test and adjust the effects of developed interventions in simulated and/or real-life contexts. KEMs in this category assist in setting up these experimentation environments and offer methods of learning, working, and experimenting.

Value Creation and Upscaling

Current societal challenges call for effective interventions and the upscaling of innovations in the relatively short term. The speed at which transitions can be realised goes hand in hand with the ability and speed to create new value for society. This involves (changing) relationships in ownership and benefit, and issues of control and governance come into play. KEMs in this category help to structure this process and to validate and test in the early phase.

Institutional Change

In addition to the desires and possibilities of citizens and stakeholders, the organisation in and around the contexts of transition issues is crucially influential on the desired changes. Institutional change is a response to technical and social changes. At the same time, these changes can in turn bring about institutional change. KEMs in this category provide insight into the behaviour of institutions and help to develop appropriate structures and procedures for the changes.

Systemic Change

Transitions call for a transformation or pivot of an existing system. Systems are characterised by being difficult to define and unpredictable. Moreover, systems have a multitude of elements and (inter)relations, thereby forming a complexity that is difficult to manage or change. Developing for and with systems is thus a dynamic issue. KEMs in this category help to work in a system-oriented and future-oriented way and to elicit debate and feedback.

Monitoring and Effect Measurement

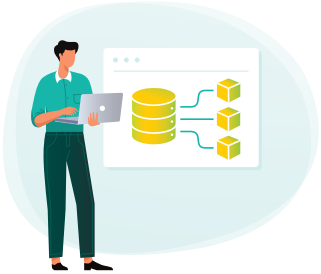
Because of the long horizon and unpredictable nature of (changes to) systems, it is particularly relevant for transition issues to monitor the effects of interventions and to evaluate (interim) outcomes. This generates knowledge about the potential effects of the interventions, which can be directly fed back into the process, thus supporting iterative development and adjustment. KEMs in this category help to measure the effects of interventions and monitor their impact on the system.

Ethics and Responsibility

Especially in societal missions and transitions, ethical and moral questions constantly arise. Therefore, under Ethics and Responsibility fall methods that promote ethical and responsible research and innovation practices, such as value-sensitive design, care ethics, techno-moral scenarios, and socio-technical experiments. Issues of reflection on digitalisation, the rise of AI technology, and other key technologies also have their place in this KEM category.

Meaning and Awareness

Transitions demand a re-evaluation of entrenched values and patterns. We must become aware of the consequences of our actions and realise that a new world calls for different values and meanings. Especially in the artistic domain, methods have been developed to come up with (artistic) interventions that broaden our view, challenge or mirror existing patterns and habits, encourage people to redefine conventional values, and/or criticise systemic discomforts.



Data for Inquiry and Evidence

Design challenges and societal transitions require constant questioning and substantiation. During transitions, new information becomes available that may lead to a change of direction. Likewise, the extent to which the choices made affect society and individuals demands ongoing substantiation and refinement. This KEM category presents an overview of approaches from data-inspired to data-driven that provide complex issues with inspiration and evidence.

The eleven categories are conceptually distinct. Yet, methods in one category sometimes have properties related to methods in another category and/or methods from different categories are often applied in combination. For example, some experimentation environments are particularly suited for user participation and/or co-creation, and a process of systemic change can seldom do without a previously established vision for the future. The nature of a chosen change process or transition strategy requires a specific sequence regarding the deployment of these KEMs.

In the concluding chapter, we delve into three integral approaches that guide the coherent use of methods from the different categories. In chapters 1 to 11 of this agenda, the eleven KEM categories are first described in detail. In addition to an overview of the current (scientific) state of affairs in the development and application of KEMs, each chapter addresses the main themes and questions that should be explored in future research. Thus, this agenda is explicitly a research agenda.

THIS AGENDA

In recent years, the concept of KEMs, as originally launched in the KIA Creative Industries 2018-2021, has been embraced by the (top) sectors as a valuable addition to the KETs (Key Enabling Technologies) and an indispensable link in the process of addressing missions.[9] For the mission-driven innovation policy, there is a need for strengthening the knowledge about and the development of new KEMs. The KEMs were therefore included in the KIA Key Enabling Technologies, from which they played a prominent role in the KIAs of the mission themes. In drafting the new KIC for the period 2024-2027, the KEM agenda was placed under the Knowledge and Innovation Agenda Mission-Driven Innovation (KIA MV). With this positioning, the KEMs retain a leading role in the research programming.

This revised agenda once again aims to indicate where the strengths (existing methods) and weaknesses (knowledge gaps) lie and which opportunities or needs are most pressing to address in the short term[10]. The further development of existing KEMs and the development of new strategies and methods will primarily take shape through application in concrete innovation processes (see also the concluding chapter). Although this agenda does not address the meta-question of what constitutes a 'good' methodology, KEM development will also involve addressing more fundamental, methodological issues.

The eleven categories elaborated in the document do not cover the entire methodological field but focus on those domains that are particularly relevant for mission-driven innovation policy. Thus, this agenda is not a catalogue of all methods, strategies, and processes for shaping change trajectories and innovations.[11] It provides an overview of the available KEMs for the eleven categories, the usability of specific methods in various transition issues, the scientific state of affairs within each category, and what further research is needed. Therefore, the agenda can also serve as an entry point into the world of KEMs; a diverse world where changemakers can find much to gain and contribute.

9. In the EU, the KEMs are now also on the innovation and knowledge agenda and are referred to and/or addressed in various calls and programmes.
10. These questions are also explicitly addressed in the KEM strategy, which will be introduced at approximately the same time as this revised agenda. Key points in that strategy are (1) further development of KEMs for acceleration of missions and transitions, (2) more coherence in the use of KEMs, (3) strengthening the preconditions for the use of KEMs, (4) more insight into the impact of KEMs and (5) utilisation of KEMs.
11. In recent years, the agenda has often been called upon to guide people through the field of methods and techniques. However, the agenda is not suited for this. To fill this gap, CLICKNL launched the KEM website in 2022, which aims to inspire and support the deployment of KEMs in practice.

1. VISION AND IMAGINATION

1.1 INTRODUCTION

Our relationship with the future is complex. We come to the future with what we know, extrapolating the way things have been, and are now, into the future. In doing so, we inadvertently extend the current situation. If we want to actively shape our world it is necessary to imagine what could be, and to design a vision of what should be. KEMs for vision and imagination help map the current world, imagine new worlds, and view phenomena and problems differently. They provide support answering questions such as: how do you design a vision of the future? How does the vision of the future help us to give direction to interventions now and in the medium term? How do you bring the interests of stakeholders together to collectively design and develop a desired direction?

Vision and imagination are valuable cognitive tools that foster creativity and aid in goal-setting. They empower individuals to conceive groundbreaking ideas and convert abstract concepts into achievable objectives. Nonetheless, these mental faculties bring forth challenges. Imagination may set the stage for idealistic expectations, leading to disappointment when reality diverges from envisioned outcomes. The difference between what we aspire to achieve and what we actually accomplish underscores the significance of involving diverse stakeholders and navigating the intricate relationship between creative vision and practical results. Ensuring that innovative ideas are aligned with the complexities of real-world implementation is critical to successfully shaping the future and achieving goals that benefit the good life.

The future is uncertain, but also holds untold, unimagined possibilities. Imagination, or imaginative power, is the ability to evoke mental images, ideas and/or feelings, without being perceived by the senses (Szczelkun, 2018). Imagination creates space to interpret reality and to look for new forms of looking and thinking. Imagination is the basis for inspiration and new ideas and plays an important role in the learning capacity of people (Hajer, 2017). Imagination can thus be seen as an important basis for innovation and development. Vision is the ability to envision the future with clarity, direction and flexibility. Visions provide a means by which current lifestyles and design interventions can be assessed, evaluated and critiqued in terms of how we are progressing towards a desired state (Irwin et al., 2015). Vision needs imagination to see beyond the obvious.

1.2 STATE OF THE ART

There is a tension in thinking about the future between specific goal-oriented, mission-driven thinking and the 'transitions school' that stresses the complexity and uncertainty of unfolding futures, and therefore tends to focus more on open innovation and iterative approaches. In the field of vision and imagination, we traditionally distinguish three clusters of methods, with a fourth one on the rise: 1. foresight and prediction, 2. shared vision development, 3. pathways, and 4. sensing the future. Each will be outlined in more detail below.

FORESIGHT AND PREDICTION

Roughly, while prediction seeks to nail down the most *likely future*, foresight seeks to identify a range of *plausible futures*. Foresight refers to methods that aim to map, analyse and understand ('read') the developing future and environment, the different ways to harness people's imaginative power. How are images of the future generated in the first place? Different forms of exploration address different types of social interests – pragmatic, progressive and civilisational (Riedy, 2020). Pragmatic explorations focus on performing current practices but potentially improving on these. Such explorations typically involve methods extrapolating past and present experiences and predicting a single future as accurately as possible. Progressive explorations go beyond today's practices to invent and encourage new ways of doing things. They engage with the future as plural and uncertain to inform present strategic and political decision-making. Finally, civilisational explorations look beyond what currently exists and consciously work to create the foundations of the next level of world civilisation and culture. These explorations benefit from methods that enable others to stretch their imagination beyond orthodox imaginaries (Dey & Mason, 2018).

Explorations of the future, also called futures studies or futurology, are those studies that seek to predict 'what is likely to continue and what is likely to change'. Part of this discipline strives for a systematic and pattern-based understanding of past and present and toward determining the likelihood of future events and trends. **Scenario Analysis** (e.g. Kahn, 1965; Wack, 1985), **Trend Analysis**, the **'Futures Wheel'** and **Delphi Method** can also be included in this group of analytical methods. Such explorations can focus on specific areas, such as technology (Jansen, 1994) market or economic explorations, or environmental change. Although these explorations are constantly becoming richer due to the greater availability of data, the key challenge - how to deal with uncertainties that the future holds – of course remains (Beckert & Bronk, 2019).

Well-known methods of mobilising the imagination are **Scenario Thinking, Visualisations** and **Storytelling**, but films (science fiction) and the arts more broadly also give shape and create content to feed our imagination (see also **Meaning and Awareness**). For example, very early in the 20th century, the writer H.G. Wells predicted the invention of the atomic bomb. Nature writer Rachel Carson sparked the environmental movement with *Silent Spring* (1962), envisioning a world without insects.

SHARED VISION DEVELOPMENT

Shared vision development aims to gather groups of actors around a shared sense of purpose to co-create forward (Sharma et al., 2022). Visions are articulated in a multi-vocal way that people can relate to and contribute to from diverse backgrounds (Ferraro et al., 2015). Shared visions can be developed on several levels ranging from groups to organisations to societies and from a single project to an ecosystem of initiatives.

These are methods that aim to develop a perspective of desirable futures ('utopia') or scary ones ('dystopia') and thereby arrive at visions. These are desirable visions for, for example, new products and services, technology or specific societal challenges. Developing desirable visions means making choices. Subjective, moral and also politically charged decisions are at stake. Resistance to a particular innovation strategy is often also related to the fact that innovations are in various cases also political interventions (weighing values and deciding which one has to prevail) that will influence people's living environments. A telling example of this is **Mission Thinking**, put on the agenda by Marianne Mazzucato (2013), among others.

On the one hand, methods in this category help shape desired visions. In the (product) design field, for instance, these are **Design Fiction, Technology Pyramid, Visual Thinking, Frame Innovation** (Dorst, 2015) and **Vision in Design** (Hekkert & Van Dijk, 2011). At the same time, inclusive vision development approaches help build support for visions, as is the intention in for example **Co-design, Design for Debate, Critical Design, Future Labs, Experience Labs** and **World Student Challenges**.

PATHWAYS (EX ANTE)

Impact pathways map out how and through which mechanisms and actors impact is achieved. In other words, they do not so much support the determination of the mission and vision, but the path to change. The concept of **Theory of Change** plays an important role in the ex ante way of mapping impact. KNAW (2018) describes Theory of Change as "a causal framework that provides insight into how and why a change process will take place and how the steps are related in a specific context". The starting point of Theory of Change is the intended (social) impact. Which activities are necessary to achieve this impact, and which conditions must be met to make it happen? Based on this, it can also be determined which stakeholders should be involved - an approach that is further elaborated in the **Participatory Impact Pathway Analysis** (Blokdyk, 2019).

Well-known methods for developing pathways are **Backcasting** (Robinson, 1982), **Roadmapping** and more specific methods that support sociotechnical system transitions (Geels, 2005) and **Technology Roadmapping** (Hasberg et al., 2012). Characteristic elements of the approach of **Mission-Driven Innovation Policy** (Goetheer et al., 2018) and **Transition Management** (Loorbach, 2007) can also be counted as part of the pathway group.

SENSING THE FUTURE

More recently, future-making practices or methods have been proposed that actively engage with systems dynamics to shape emergent properties from within. Methods like **Experiential Futures** (Candy & Dunagan, 2017), **Provotyping** (Boer et al., 2013), **Artefacts from the Future** (Hovorka & Peter, 2021) or **Future Probing** (Maessen & De Roos, 2021) use imagination as sites of inquiry. These methods seek to create future encounters that encourage the body to respond as if they were actually happening. The aim is to reduce the psychological gap between the present and imagined futures, and to counteract our tendency to underestimate the importance of future events. By triggering visceral response these methods approach possible futures in an intuitive rather than cognitive way and access practical sensory knowing. They raise awareness for previously inconceivable possibilities and chances to seize opportunities.

1.3 CHALLENGES AND RESEARCH QUESTIONS

As said, there is a tension between mission-driven thinking and the approaches that focus more on open innovation and iteration to drive change. Balancing these two different approaches in any concrete situation is a challenge for practitioners. For researchers, the challenge is to create a coherence across these paradigms and across a broad array of methods for vision and imagination. This should be a driver for new fundamental research into these methods, and for innovating them.

CHALLENGES FOR FORESIGHT AND PREDICTION

With regard to methods for foresight and prediction, the question is what exactly is a representation of a vision for the future. How is it designed? And can we say something about the quality, what is a 'good' representation? This includes internal measures, like coherence and consistency, and external measures like validity and usefulness. What does the media landscape offer that we have at our disposal (for example thanks to the internet and artificial intelligence) to conduct explorations? What if these representations become dynamic because they can be updated continuously?

Furthermore, how do we present the outcomes in a way that is both useful and appealing to the relevant audiences? For example, should it be a mix of fact-based analyses and appealing images? When does it appeal to the imagination? When does a representation mobilise a vision? To what extent do artistic aspects play a role? Why do certain visions of the future become dominant (such as a 'meme')?

Paradigm shifts get to the heart of what we need to achieve with vision and imagination: a challenging new view of the world and the future. This requires in-depth analysis and strong and consistent conceptual thinking, rather than just speculation on the future. The aforementioned H.G. Wells is a good example of a powerful conceptual thinker – his visions of the future are so compelling because they are grounded in deep conceptual insight. Deeper conceptual explorations are also in a way more stable, allowing a longer-term perspective and a better link between foresight and innovation systems.

CHALLENGES FOR SHARED VISION DEVELOPMENT

How do we create desirable visions, implying that subjective, ethical, moral and also political judgments are involved? This question really becomes critical when we are talking about system change: we create a new system not for society as it is now, but for a future society. What will a future society need? How does a desirable vision contribute to valuable social change processes? A related question is how vision and imagination become embedded in society. How can broad support in society be realised? How can methods based on vision and imagination authentically involve society in every step of their design, development?

CHALLENGES FOR PATHWAYS

How do we make different visions and pathways tangible (one of design's main strengths)? How do we involve broad constituencies in the process to improve the chances of implementation? And how do we understand the (past and present) conditions that will affect potential pathways? How can visions of the future be communicated experientially so as to evoke a real sense of change? How can they be linked to decision-making? Which organisational and institutional factors play a role in this? How to focus methodologies for vision and imagination on specific forms or moments of decision-making? Who has the power to create and embed visions? How can visions support strategic choices at the national, regional and European level being made faster and more effectively, given their interdependence?

CHALLENGES FOR SENSING THE FUTURE

As to sensing the future, the challenge is two-fold. First, adopting this intuition-based approach as valid future-making practice, and second, understanding that connecting possible alternative futures to present action requires attention to relationality next to relatable imaginative content. How do we maintain an inquisitive, experimental way of 'doing futures' rather than falling back too quickly on 'rational knowing' and conventional practices of analysis and planning? How do we contain the psychological discomfort that experiencing 'estranging' futures often brings about?

Urgent research challenges are not limited to just the four groups of methods, but extend to context-specific application, cross- and transdisciplinary research and to connections with other KEM categories.

CONTEXT-SPECIFIC RESEARCH INTO AND APPLICATION OF KEMS FOR VISION AND IMAGINATION

There are opportunities to conduct more context-specific interpretative research. Addressing visions for the energy transition requires a completely different approach than for the development and scaling up of the quantum internet. There can also be differences in the actor fields (their size, breadth, coherence) and their dynamics. Careful alignment with and anticipation of these contexts is therefore of primary importance. Context-specific research for (spatial) design issues, for example, can be carried out by co-designing research questions with citizens in combination with analyses of the processes by which visions spread through society. For example, by setting up an analytical framework to answer questions about 'techniques of futuring', the social practices that bring people together and orient them towards certain visions and actions.

CROSS- AND TRANSDISCIPLINARY RESEARCH INTO AND APPLICATION OF KEMS FOR VISION AND IMAGINATION

KEMs for vision and imagination are researched and applied from a wide variety of disciplines. There are opportunities to apply these discipline-specific methods to other disciplines and areas of innovation in a transdisciplinary fashion. For example, (product) design methods such as **Context Mapping** and **Systems Mapping** could be used more broadly for the complex societal challenges of mission-driven innovation policy.

There are also opportunities to intensify transdisciplinary research in collaboration from different disciplines. For example, by linking design methods with methods from intervention research (change management). Or by identifying interdisciplinary methods in which art, science and technology come together. In general, the idea is to develop a transdisciplinary language and methodology for vision and imagination that simultaneously bridges macro and micro perspectives and diverse application areas. This can result in a joint (transdisciplinary) body of thought and the bringing together of vision developers from different areas.

CONNECTIONS TO OTHER KEM CATEGORIES

The KEMs for vision and imagination have common ground with the other KEM categories described in the KEM-agenda. Achieving optimal synergy between the KEM categories is a challenge in itself, both in the development of KEMs and in their application in practical situations. For example, there is a clear relationship between the approaches described above for shared vision development and KEMs for **Participation and Co-creation**: the framing of a joint innovation assignment can be started with joint vision development and then further developed in co-creation processes. Similarly, vision and imagination can be the first impetus for **Behaviour and Empowerment** processes. Wherever possible, it is recommended to pursue these kinds of synergistic interactions between KEM categories in the development and implementation of KEMs for vision and imagination.

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2. PARTICIPATION AND CO-CREATION

2.1 INTRODUCTION

In societal missions, it's crucial that a diverse array of actors are involved. This includes citizens, societal organisations, governments, businesses, academics, and nowadays also plants, animals, and other elements such as landscapes and water systems, all of which have varying interests, knowledge, experiences, power, and forms of communication. Through such multi-actor ecosystems, a wide range of knowledge and experience can be brought together in mission-driven processes. Furthermore, encouraging involvement, representation, support, ownership, and initiative can enhance the likelihood of achieving and accelerating sustainable transitions and transformations. **Co-Creation** within these ecosystems is seen as any act of collective creativity (Sanders & Stappers, 2008), as a partnership between different actors to jointly create value (Osborne et al., 2016; Brandsen et al., 2018). **Co-Design** is a specific form of co-creation, namely when the collective creativity of all actors is applied as part of a design process. Co-design in missions requires the participation and co-ownership of all actors, where the types of actors may vary, as well as the form and timing of participation, which can differ per actor and per phase of the mission-anticipating innovation process. Increasingly, non-human actors such as plants, animals, landscapes, and the like are being included in the process, referred to as **More than Human Design** (Wakkary, 2021). Furthermore, the timing and duration of the design process change in prolonged missions, and the distinction between co-design and co-creation blurs due to the openness of the process. To emphasise the openness and continuity of the process, co-creation and co-design are sometimes given a new name, namely **Cohabitation**. Cohabitation is based on designing and living with other living beings, such as plants and animals, to question, explore, and develop the ecosystem (Tomico et al., 2023). In such an approach, designing, implementation, elaboration, appropriation, adaptation, and achieving impact converge in a continuous process of joint development.

Key Enabling Methodologies (KEMs) in this category help empower the various actors, spark imagination, and promote collaboration over a long period. They enable actors to collectively question, analyse, understand, and experience challenges to explore new opportunities and develop and sustain multiple value creation together. Co-creation can be initiated for various reasons, such as gaining a better understanding of the diverse needs, experiences, perspectives, conditions, and barriers. This is because complementary knowledge, resources, and power need to be brought together, or to create a rich environment for innovation and multiple value creation. The process can be aimed at addressing the current (problematic) situation and/or be more focused on a desired future situation.

KEMs focused on participation, co-creation, co-design, and cohabitation support (the actors within) multi-actor ecosystems around diverse questions. For example, which actors want and can participate in a transition trajectory, when, how, and why? How to deal with the different interests, knowledge, power, and insights of the diverse actors, ranging from a wide array of people and organisations, to plants, animals, landscapes, and water

systems? How to manage ownership and control within transition issues or the lack thereof? How can participants maintain their intrinsic motivation to participate? How can collaboration remain relevant and beneficial for the diverse actors? How can the joint output be made visible and measurable? How can bottom-up co-design initiatives be supported by a broader assembly? What does scaling and accelerating mean within a participative and pluralistic innovation trajectory? But also, when (in which sub-project, setting, or phase) is participation, co-design, and representation of plants, animals, and landscapes not a good idea?

2.2 STATE OF THE ART

Participation, co-creation, co-design, and more than human design (hereafter sometimes referred to as co-creation et al.) are characterised by the collaboration of a range of stakeholders and actors from various disciplines, sectors, and types. These actors play diverse roles, with factors such as geographical and socio-cultural backgrounds, societal vision, paradigms, and economic, institutional, and ecological perspectives also coming into play. The diverse actors benefit from a systemic approach, based on the values, needs, and motivations of the actors, thereby doing justice to the complexity of the whole. Co-creation et al. can help actors act strategically in developing interventions, understand the dynamics of the system, facilitate and stimulate reflexivity and reflection during the process, and much more.

The complexity and plurality of transition issues highlight the need for supportive Key Enabling Methodologies (KEMs) in the field of co-creation et al. There is a wide range of methodologies and methods available, which can be categorised in various ways. For example, along the axis of culture, structure, and practice (Loorbach, 2014) or concerning the types of actors involved (such as human and non-human). In the KEM agenda, a classification based on six different types of activities that impact the design process in various ways and at different times has been chosen. It should be noted that the activities sometimes overlap seamlessly and that various methods support multiple activities. The classification into six categories primarily serves to gain insight into the types of activities that take place within co-creation et al. and to provide a rough guide in finding methods.

The activities in the first two categories are based on exploring and bringing together the diverse actors in the multi-actor ecosystem. These are initially deployed at the beginning of missions, when the landscape of actors around a mission is not yet clear and/or the collaboration of all actors needs to be initiated. Due to the long-term and iterative nature of the design and innovation processes during missions, these activities are not concluded at the beginning of the process but regularly require attention to keep the multi-actor ecosystem accurate and engaged. The next two categories within co-creation et al. focus on connecting the different perspectives of actors and making sense of them, including decision-making. These activities directly follow the activities in the previous two categories and are sometimes seamlessly interwoven with them. During these activities, there is a deeper and longer engagement with the richness of perspectives, jointly finding relationships, and aligning and making decisions. In addition to the above activities, joint design of new value propositions through scenarios and prototypes can be utilised, which is presented as the fifth category. Finally, there are methods that specifically focus on jointly organising the process with a multitude of actors, which requires attention throughout the entire mission trajectory. Below, we briefly describe each of the six categories. There are many dozens of methods per category, of which we will briefly highlight a few.

EXPLORING AND MAPPING THE MULTI-ACTOR ECOSYSTEM

These methods focus on exploring and mapping actors, their interests, competencies, their power and influence, and how they relate to each other in an ecosystem. This includes all directly involved and beneficiaries of the transition trajectory, as well as indirectly involved, disadvantaged parties or potential stakeholders who cannot or do not want to participate or are not immediately considered. Examples of these methods include:

- **Actor Analysis and Multi-actor Perspective** enable exploration of the actor field, interests, roles, the field of forces, and the demands placed by actors on the process. For Actor Analysis, see Hermans and Thissen (2009); for Multi-Actor Perspective, Avelino and Wittmayer (2016).
- **Value Flow Model** supports identifying, linking, and balancing relevant stakeholders and the values important to each, in a total system (Den Ouden & Brankaert, 2013).
- **Strategic Navigation Methodology** supports strategic dialogue and decision-making for business and market development in connection with complex projects requiring collaboration between multiple stakeholders (Brand et al., 2020).

BRINGING TOGETHER AND STRENGTHENING THE ENGAGEMENT OF DIVERSE ACTORS

These methods focus on creating and strengthening cohesion, including by involving diverse actors, enhancing joint responsibility, allowing for the input of own values, and accommodating personal needs. It is important to experience together what motivates participation, what binds and separates actors, and how the sense of connection and engagement is truly experienced. Examples of such methods include:

- **Engaging Catalysers and Participatory Video** are specific tools that enable actors to share their own skills and perceptions with others, thereby increasing mutual connections, empathy, respect, and collaboration. The former utilises embodiment, and the latter uses filming and interviewing. For Engaging Catalysers, see Trotto and Hummels (2013); for Participatory Video, see Nemes et al. (2007).
- **Co-Design Canvas** allows stakeholders to jointly explore and discuss eight aspects of co-design, thereby improving their understanding of each other and increasing engagement and connection (Smeenk, 2023). The aspects include co-design context, change goal, stakeholders, outcomes, impact, focus, activities, and their settings.
- **Zoöp** is a new model of human and non-human collaboration in the form of a new type of cooperative legal entity, aiming to strengthen the position of non-human life forms within human societies (Kuitenbrouwer et al. 2022).

MAKING VISIBLE, EXCHANGING, AND CONNECTING DIFFERENT PERSPECTIVES

These methods focus on making visible, exchanging, and connecting a multitude of perspectives and relationships, to gain a rich understanding of the complex challenge, the aspirations, and the multi-actor ecosystem. This ranges from the micro-level of individual experiences to the macro-level regarding topics such as economic, societal, and ecological values. Examples of these methods include:

- **Contextmapping** and **Empathy Compass** facilitate a creative and collaborative way for people to gather insights about needs, desires, (im)possibilities, motivations, and experiences of people, with the latter particularly aimed at increasing empathy by better understanding one's own and others' perspectives. For Context Mapping, see Sleeswijk Visser et al. (2005); for Empathy Compass, see Smeenk et al. (2019).
- **Cohabitation** and P**articipatory/Embodied Sensemaking** are about jointly creating new, shared meanings in a situated ecosystem with other actors, with the former based on designing-with and living-with other living beings, such as plants and animals. For Cohabitation, see Tomico et al. (2023); for Participatory/Embodied Sensemaking, see Jaasma (2018), and Hummels and Van Dijk (2015).
- **Constructive Conflict Methodology** aims at clarifying and learning about the diversity of perspectives on unstructured (policy) issues, where there is disagreement or uncertainty about the facts and values (Cuppen, 2012).

JOINT MODELLING, ASSIGNING MEANING, AND DECISION-MAKING

These methods focus on collaboratively creating overview, insight, alignment, and decisions regarding complex issues through analysing, mapping, and modelling relationships. Examples include:

- **Group Model Building** helps stakeholders jointly unravel problems and cause relationships and build a picture of 'the system' (Vennix, 2001).
- **Multi-Criteria Decision Analysis** and **Participatory Value Evaluation** support decision makers in weighing various options based on a diverse set of values and criteria to arrive at a weighted decision, with the first method focusing on group decisions, and the second method focuses on citizens who can step into the shoes of administrators. Look at Salo and Hämäläinen (2010) for Multi-Criteria Decision Analysis; after Mouter et al. (2019) for Participatory Value Evaluation.
- **Participative Value Evaluation** supports decision-makers in weighing various options based on a diverse set of values and criteria to reach a balanced decision. The former method focuses on group decisions, and the latter allows citizens to step into the shoes of policymakers. See Salo and Hämäläinen (2010) for Multi-Criteria Decision Analysis; Mouter et al. (2019) for Participative Value Evaluation. Participative Multi-Modelling supports decision-making on complex issues with significant uncertainties, collecting input for the multi-model and unlocking system knowledge, followed by design, programming, and proof of concept simulation (Wurth et al. 2019).

DEVELOPING PROPOSITIONS THROUGH SCENARIOS AND PROTOTYPES

These methods focus on jointly exploring and designing new multiple value propositions through scenarios and prototypes, for developing alternative ways of interacting with the world. Examples include:

- **Participatory Design** en **Co-design** oParticipatory Design and Co-design Research have developed a range of frameworks and methods over several decades, focusing on the participation of a multitude of actors in design processes. See Schuler and Namioka (2017), Brandt et al. (2012), Sanders and Stappers (2008), and Smeenk et al. (2019).
- **Scenario-Based Design, Futuring**, and **Design Fiction** focus on questioning the world around us by developing alternative scenarios, stories, and objects, to propose how things could be done in the future. Scenario-Based Design is explained by Anggreeni and Van der Voort (2009); see Hajer (2017) for Futuring; Dunne and Raby (2013) for Design Fiction.
- **Value Sensitive Design** aims to systematically incorporate human values of all actors into the design process. In the conceptual phase, it explores which values are in play, for whom, and to what extent these values conflict (Friedman et al. 2019).

STRUCTURING AND ORGANISING THE COLLECTIVE PROCESS

This last set of methods focuses on the progress and organisation of the entire process towards multiple value creation. How is the whole process organised? Who are the driving forces? Who takes responsibility for what? What decision-making powers do, get, and take the various actors? Is transparency essential and how is this arranged? How are more people gradually involved in the process to systematically change regular policies and processes? Methods include:

- **Transition Arenas** are settings where initially a select group of participants and later coalitions of stakeholders develop alternative visions and solutions through a systems approach in the shelter of regular policy (Loorbach, 2014).
- **Multi Gains Approach** focuses on interest exchange and finding a win-win solution. It supports designing an appropriate process with associated rules from intended goals. Combined with process monitoring, interim process adjustments can be made (Susskind & Field, 1996).
- **Transdisciplinary Research** aims to transcend a discipline-specific approach by integrating a diversity of approaches to create new conceptual, theoretical, methodological, and translational innovations (Hirsch Hadorn et al. 2008).

2.3 CHALLENGES AND RESEARCH QUESTIONS

The design field generally agrees that many methods exist for participation and co-design, but the urgency and complexity of current societal challenges call for a long-term and systemic approach to participation, co-creation, and cohabitation. This calls for further development on four themes:

- Which actors?
- How do these actors collaborate?
- What do these methods contribute?
- How to connect the methods?

WHICH ACTORS ARE IMPORTANT TO INVOLVE IN MISSIONS AND HOW TO ACHIEVE A PLURALISTIC CO-CREATION PROCESS?

How can human and non-human actors participate, co-create, co-live, and co-design? How to ensure a pluralistic, inclusive process involving a wide range of actors? What new legal forms, forms of communication, and business models are needed to successfully collaborate in a more than human co-design process?

HOW DO THE VARIOUS ACTORS COLLABORATE OVER A LONG PERIOD IN MISSION-ORIENTED PROGRAMMES?

How can collaboration be strengthened and bridges built between diverse actors, disciplines, sectors, age groups, cultures, etc., to address the complexity of our transition issues together? How can connections be made between many small experiments and pilots to accelerate and scale? How do you ensure that experiments can scale up and be embedded in the participating actors' diverse organisations? How to create a safe space for experimentation, failure, and relinquishing control? How to maintain commitment, cohesion, collaboration, and (financial) support over decades of transition? How can alternative forms of governance and decision-making be developed in these multi-actor ecosystems that encourage openness and experimentation? And how to utilise emerging technology such as Artificial Intelligence and Virtual Reality without narrowing plurality, reducing participation, and stifling co-creation processes due to lack of support?

HOW DOES THIS PARTICIPATION, CO-CREATION, AND COHABITATION BENEFIT SOCIETY, AND CAN IT BE DEMONSTRATED?

How can the added value of this way of working be concretely shown, and can a connection be made between the approach followed and the desired impact regarding significant transition issues? What is considered successful participative co-creation, and what are the activities, motivations, mechanisms to get there? At which levels (micro, meso, macro) can the actors and the multi-actor ecosystem contribute, and how is this determined? And how do KEMs from this category work and co-create with KEMs from other categories?

HOW CAN A LANDSCAPE BE CREATED OF REINFORCING AND COMPLEMENTARY PARTICIPATORY CO-CREATION METHODS THAT ASSIST MULTI-ACTOR ECOSYSTEMS WITH THEIR MISSIONS?

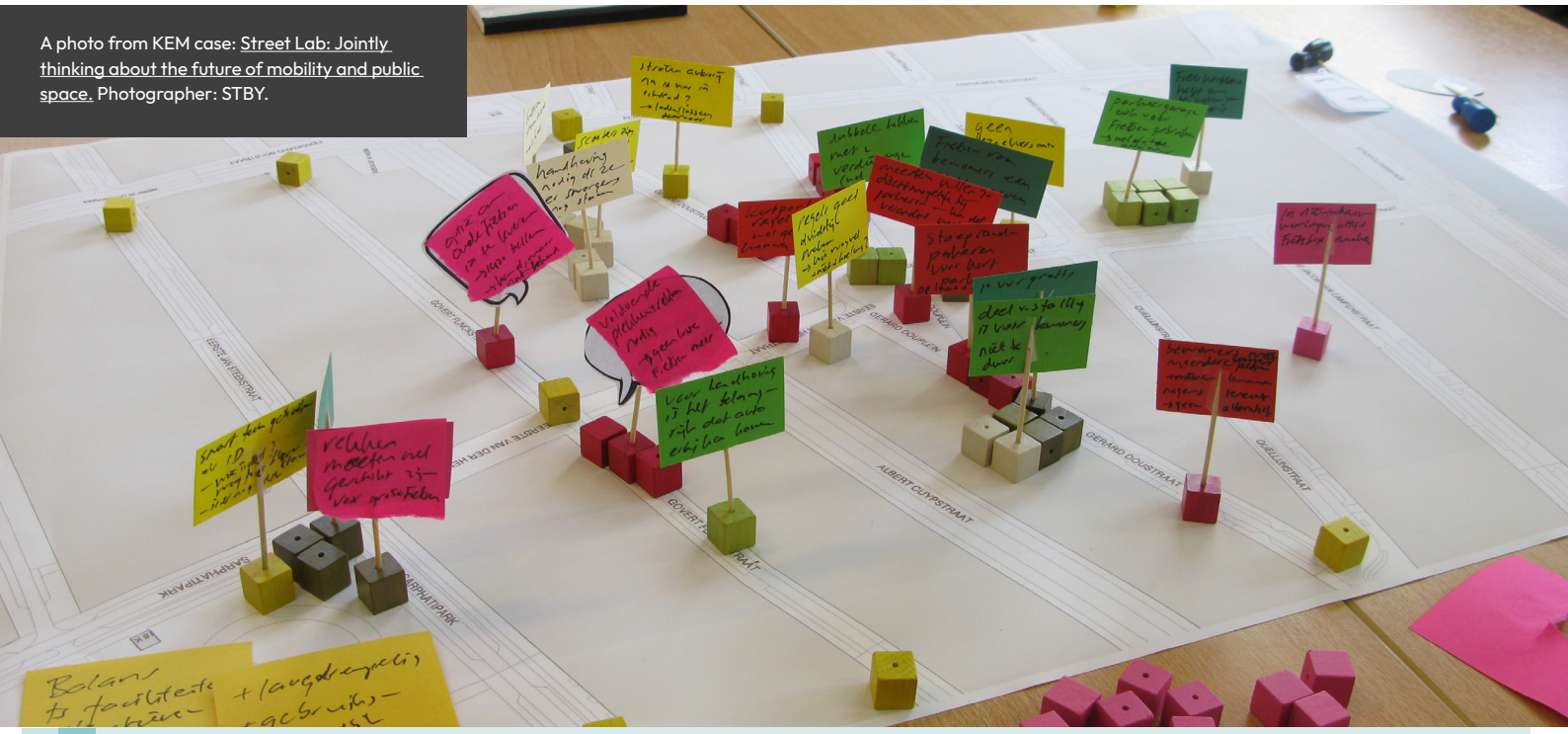
How can the various methods and insights from different interdisciplinary and transdisciplinary fields be connected, and how do we develop a common language for this?

It's crucial not only to conduct research on transitions and participation from an 'expert-design' perspective but to create safe environments to explore together, with an open attitude, what plurality, participation, and co-creation mean from the 'messiness' of everyone's everyday practices (Vink, 2023; Coops et al., forthcoming).

METHODOLOGICAL RESEARCH QUESTIONS

The challenges lead to various research questions focused on the actors, the method, the context, the organisation, the system, the content, and the effect of participation and co-creation, including:

- *Actors.* How do you determine who or what is involved in the various phases of the process? How do you engage the different actors, both in the short and the long term? What competencies, expertise, experience, status, and the like, must the actors have for certain transition issues? How do you create shared understanding, empathy, connection, responsibility? How do you achieve long-term commitment?
- *Impact and effectiveness.* How do you determine if the methods are effective in messy and diverse practices, and not just in simple situations? How do you generalise lessons regarding participation in multi-actor ecosystems, while doing justice to the complexity of systems? (More on this question can be found in the KEM category **Systemic Change**.) What are the stimulating and inhibiting factors that determine the value created in co-design and participation processes? Are there causal relationships to be found between approach and success or failure?
- *Perspectives and assumptions.* How do we make explicit whether and how the transition is viewed from various complementary perspectives: social, economic, technical, and institutional (for example, from an experiential and business perspective)? In what way can methods be linked so that integration takes place, since current methods often focus on a single dimension? What are the (normative) assumptions and objectives in processes of participation and co-creation, and how do they influence the design of the processes? Which contextual factors such as culture, the extent to which knowledge is implicit, or future-orientation, influence the co-creation process?
- *Various scales and structures.* What is the effect of interventions on a small and large scale, and in the short and long term? How do we deal with different time-space scales? The shift of societal challenges from national to local politics, for example, has drawbacks but also creates new opportunities. What is the role of politics and power? How can participation be anchored in institutional structures and other relevant structures?



A photo from KEM case: Street Lab: Jointly thinking about the future of mobility and public space. Photographer: STBY.

THE KNOWLEDGE DEMANDS OF THE FUTURE

As mentioned, many methods already exist for the various aspects of the co-creation process, but further development is needed regarding the participation of non-human actors. The complexity of the challenges, and designing and living in a multi-actor ecosystem, call for an expansion of the current methods developed for processes of a relatively shorter duration. The KEM category **Participation and Co-creation** calls for more methods that support longitudinal participation development processes. Additionally, there is a need for safe environments for experimentation, uncertainty, and openness, that allow for the risk of failure and thus for the chance of unexpected positive outcomes.

In conclusion, there is a need for connections between all the different approaches and 'meta-methods', to gain tools for, and insight into:

- When and in what form is co-creation or participation (not) a useful approach for which goals or values?
- Which combinations of methods should one choose for which context, for example, based on demonstrated impact of previous applications?
- How should various methods be adapted to the specific context in which they are used?
- How can all actors, including indirectly involved parties, disadvantaged groups, or potential stakeholders who cannot or do not want to participate, benefit from the outcomes of the design process?

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3. BEHAVIOUR AND EMPOWERMENT

3.1 INTRODUCTION

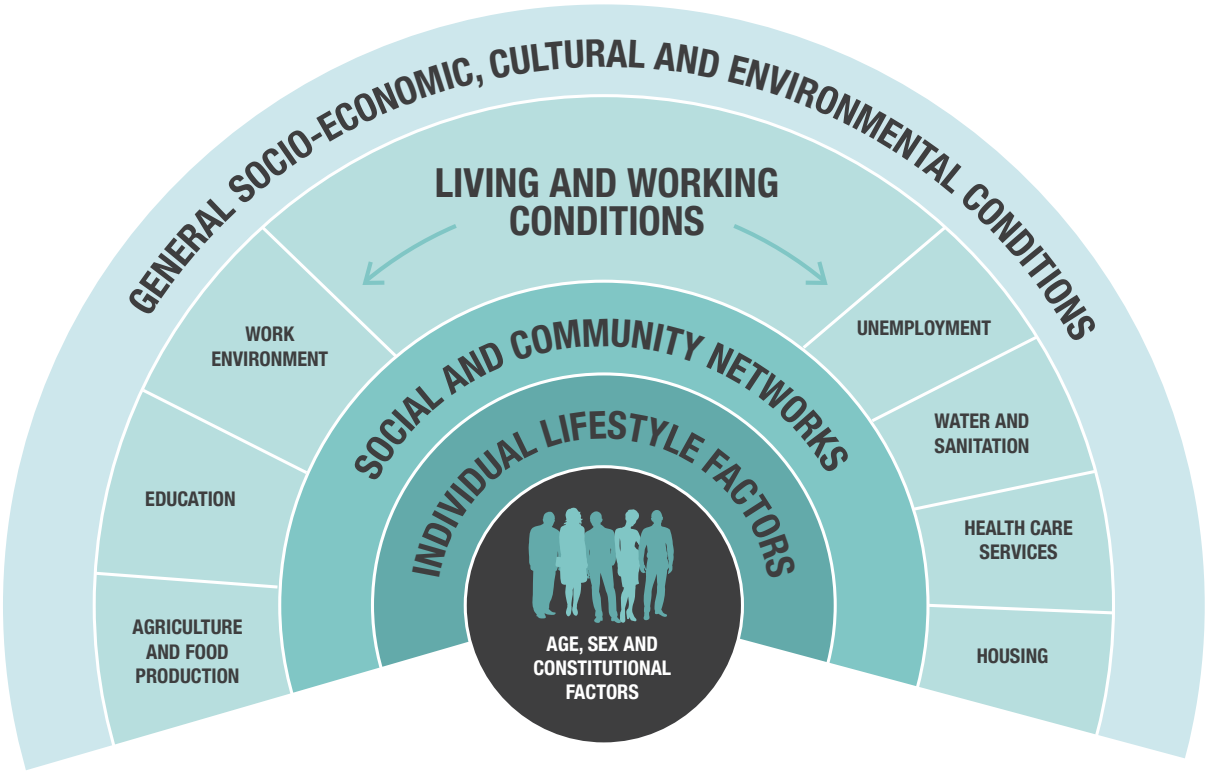
For a transition to succeed, alongside systemic changes and regulatory changes, behavioural change is often desired, such as opting for alternatives to meat or air travel. On the one hand, individuals must be capable of making conscious choices and taking control. But behavioural change may also be necessary among others besides the citizen or consumer to achieve transitions. For example, healthcare providers can discuss lifestyle changes instead of just prescribing medication. Retailers may need to shift their product offerings, or teachers might start providing sustainability education to children. The context in which behaviour occurs always prompts the preference for certain behavioural alternatives over others. This context is coloured by habits, individual beliefs, social norms, and practices, but also by the design of environments, information, and products. Consider, for example, how the design of information on packaging can influence students' food choices. Similarly, the presentation of healthy or unhealthy snacks in a school canteen, and even whether these choices are available at all, impacts our behaviour.

KEMs in this category can help in identifying the target group and other stakeholders involved in transitions, mapping current (undesirable) behaviour, and determining the behaviour that needs to change to more desired behaviour (the so-called 'target behaviour'). Additionally, KEMs in this category assist in developing, testing, and validating an intervention. In this context, an intervention is any (orchestration of) design of services, communication tools, or (digital) products aimed at changing behaviour. Interventions can be overt and explicit, aimed at strengthening knowledge or changing attitudes, but can also be less overt, employing more implicit influencing strategies such as **Framing** or **Nudging**. Transitions often involve breaking habitual behaviour - and ultimately creating new habits. Specific methods are aimed at changing habitual behaviour (Kok et al., 2016). On one hand, these methods are aimed at changing the environment, as in the case of **Cue Altering**. On the other hand, they enable individuals to better cope with the challenges of change, such as planning **Coping Responses**.

In both cases, there is often an explicit role for the individual in question, aligning with the other aspect this KEM category focuses on: mobilising and activating change processes by citizens themselves, or citizen empowerment. KEMs around empowerment address questions such as: what type and degree of influence are desirable and morally acceptable? How do you design mechanisms that enable individuals to take control of their actions and/or take collective action to affect societal change?

3.2 STATE OF THE ART

Methods focused on behaviour and empowerment are based on models and theories from various disciplines, including social, cognitive, and environmental psychology, organisational psychology, communication sciences, and sociology. Inspired by the rainbow model of Dahlgren & Whitehead (1991), theories from different disciplines can be placed on a continuum that ranges from the individual to the broader context (individual - social structure - environment, see also Niedderer et al., 2017).



Source: Dahigren and Whitehead, 1991

Where theories from cognitive psychology often aim to better understand the individual and how individual actions are determined, theories from sociology and organisational psychology are more focused on a better understanding of broad social structures and networks and how these influence our daily lives and actions. On the other end of the continuum, we find theories from environmental psychology, which focus on understanding how the environment influences our behaviour, and sociological theories about the impact of socio-economic and cultural aspects on our behaviour. The diversity of KEMs in this category reflects the thought processes of these different disciplines.

At an individual level, behaviour can be influenced by changing the knowledge and attitudes of individuals, by utilising the social structure in which individuals are embedded, or by changing the external context of these individuals, the environment. An example of the first is creating awareness of behaviour, as seen in most monitoring and coaching systems. The pedometer, a familiar example, makes us (individually) aware of how much we move. An example at the level of social structures is social proof, like how sales sites continuously show us what like-minded peers think about the product we're viewing or what else they have bought. An example of the last level, more environment-oriented behavioural change, is choice architecture, which relies on a default in

the environment that prescribes the desired behaviour. The printer set by default to double-sided and black-and-white printing (thus promoting more sustainable behaviour) is often cited. But also, a city designed for pedestrians rather than motorised traffic is an example of a design that follows this strategy. Further analysis of KEMs aimed at behaviour change shows that they don't always limit themselves to one level of influence. They can combine multiple levels, partly because the design of products, services, and systems - as a contextual factor - mediates the interaction between the individual and their environment. The following overview of methods makes this clear.

METHODS FOR BEHAVIOUR CHANGE

The previous section already mentioned examples of methods for behaviour change at three different levels of influence: individual, social structure, and environment. In a review, Kwasnicka and colleagues examined what, according to 117 different theories, contributes to lasting behaviour change (Kwasnica et al., 2016). They categorise their results into five categories that partly overlap with the mentioned levels of influence: 1. environmental change, 2. interventions on motivation, 3. support in self-regulation, 4. support of psychosocial resources (resilience, optimism), and 5. habit formation.

For an example in the first category, we can look at methods of **Nudging**, originating from the discipline of behavioural economics that combines theories from psychology and economics (Thaler & Sunstein, 2008). The design of our environment can influence our willingness to recycle, for example. A design of a waste bin can make recycling very clear and easy or provide information about how many other people in the neighbourhood choose to recycle. Also see Varotto and Spagnolli (2017), who discuss the effectiveness of various strategies in a meta-review. Examples in the second category, interventions on motivation, can be found in strategies that support behaviour change in a more conscious manner, based on **Self-Determination Theory** (Siering et al., 2019) and providing rewards. Support in self-regulation (the third mentioned level) can be through feedback on behaviour (Hermsen et al., 2016) and goal setting (Strecher et al., 1995). Examples of strategies in the fourth category, support of resilience, are pats on the back and emotional support from the environment. The **StopAdvisor** intervention (Brown et al., 2014) has implemented several strategies in this category. In the last category, habit formation, it's about behaviour change methods like context-dependent repetition, use of prompts and cues, and planning behaviour and how to deal with difficulties during change (Gardner & Rebar, 2019).

TOOLS FOR CHOOSING METHODS

Choosing a suitable method within the domain of behaviour change that is fundamental to a desired transition, is often complex. To aid in making a decision, considering the desired mechanism of change can provide guidance. How persuasive (strong) must, can, or may the influence be, and what level of influence is desired (see also Tromp, Hekkert & Verbeek, 2011)? Various tools offer overviews, such as the **Behaviour Change Technique Taxonomy**, primarily aimed at reporting interventions (Michie et al., 2013), and the **Taxonomy of Behaviour Change Methods** (Kok et al., 2016), which is mainly focused on developing interventions.

When choosing behaviour change methods, the most important thing is that they 1. connect with relevant determinants of the behaviour that needs to be changed and 2. are correctly translated into practical application. The Taxonomy of Behaviour Change Methods provides an overview of parameters that must be taken into account when applying them in a specific context. **Acyclic Behaviour Change Diagrams** (ABCDs; Metz et al., 2022) are an easy-to-use tool to visually represent the causal-structural chains from determinants of behaviour to final application in an intervention. This is helpful in communication within a design team and also towards other stakeholders or interested parties.

The **Behaviour Change Wheel (BCW)** (Michie, 2014) is another tool that consolidates multiple behaviour change theories, allowing the exploration of fruitful strategies for developing interventions and policies for behaviour change by playing with the wheel's dimensions. The BCW model is used to identify which behavioural intervention offers the best solution for a specific problem. It analyses the reasons behind a particular behaviour by examining capability, opportunity, and motivation. Based on this, it can determine which intervention functions and behaviour change techniques are necessary to influence behaviour. The BCW model is employed both to dissect the behavioural issue (exploring and orienting) and to systematically choose a strategy and develop a behavioural intervention based on it.

Lockton's **Design with Intent Cards** provide a comprehensive overview of different methods of influence and how they can be expressed in design (Lockton et al., 2010). The **Cards for Change** by Lucie Byrne-Davis also quickly reveal how various strategies can be deployed (Hart et al., 2023).

METHODS FOR EMPOWERMENT AND ENGAGEMENT

KEMs focused on citizen empowerment and engagement represent a distinct approach within this KEM category, shifting the focus from the individual being influenced to exhibit a certain desired behaviour or adopt it, to the individual or usually a collective of individuals seeking to effect change by acting together in new ways. In short, a more bottom-up approach to transition and change processes. Smith et al. (2016), for example, describe how grassroots initiatives can emerge and the role local governments and other stakeholders can play in facilitating these initiatives, enabling citizens to find the right conditions to initiate changes they deem important. Methods such as **Group Model Building**, where a diverse group of stakeholders jointly construct a model of the problem, gain insights into different processes and feedback loops, and can derive policy directions, are promising. **Participatory System Dynamics** is a method in which participants reflect, learn about the complexity of a problem, and search for potential solutions.

Empowerment and engagement are concepts long used in various application domains. We can talk about engagement with one's own health or care but also about engagement with sustainability and measures that promote sustainable behaviour. Empowerment within communities or communities can also lead to so-called citizen movements that initiate (the beginning of) a transition. For example, there are neighbourhood initiatives where people collectively and locally generate and share energy or purchase solar panels as a collective. There are also initiatives, like the Dutch *Herenboeren* (2023), where people collectively buy a piece of land, hire someone to grow food on that land together, and thus work on a change they desire towards a more sustainable model for the production and consumption of food.

POSSIBILITIES AND LIMITATIONS OF METHODS

How behavioural change is achieved and the choice of how behaviour is influenced in a specific context is complex and requires careful consideration. A top-down approach where people feel forced to make a particular choice can have a counterproductive effect. Interventions at the individual level are often embraced only by those who already see the utility and necessity of change and also have the right skills and mental space to initiate a change. Think of using an activity tracker that can motivate you to move more. However, this is not always the group that needs the change the most (Ludden, 2017). In the case of lifestyle changes, there is a large group of people who do not yet see the need for change themselves and/or find it difficult to initiate change but are at high risk of developing lifestyle-related diseases. Interventions placed in the societal context could effectuate a transition for this group. An example is the sugar tax, which has been successfully implemented in various countries.

However, one might question the desirability of such 'invisible' behavioural change strategies. Should designers and policymakers decide what desirable behaviour is in a particular situation? And, given that design always influences, how do we then make moral choices in how we influence? The solution to these issues is increasingly sought in actively involving the groups concerned. Participation and co-creation then come into sharp focus, thereby establishing a strong connection with KEMs from the corresponding category. If stakeholders can participate in determining what the desired behavioural change is, based on available knowledge and, for example, in conversation with experts, and then think along about how to effectuate this change, there may be more willingness and also the possibility to adopt interventions. Another relatively new way to approach this issue is to implement **Moral Goal Setting** in behaviour change tools. By doing this, we move away from merely thinking about individual goals (things that are 'good' for the individual) and encourage thinking about collective goals and societal goals (what is 'good' for myself and my environment). The work of Marleen Onwezen (2023) is an example of this approach.

3.3 CHALLENGES AND RESEARCH QUESTIONS

Despite the abundance of methods around behaviour and empowerment, significant challenges remain for the development and refinement of these KEMs. Five themes are highlighted in this KEM agenda.

1. FROM MISSION TO BEHAVIOUR CHANGE

To realise behaviour change in support of transitions, it's crucial to better determine which ingredients are necessary for public support regarding the missions. What is needed to motivate people to adopt interventions? This may include identifying the key psychological factors that prompt people to engage in societal actions or citizen engagement. Attention to the (in)visibility of problems as issues and the legitimacy of the status quo are critical conditions for change. However, more than just the right information and visibility is needed to actualize behaviour change. People sometimes lack skills and need help with setting goals and maintaining motivation. An environment that supports the desired change is highly beneficial.

2. EFFECTIVENESS OF METHODS

Despite having a plethora of theories, methods, and tools, behavioural change is often not easy. For example, Ludden and Hermsen (2020) provide an overview of types of interventions used for lifestyle change and discuss why these are often not effective enough. Besides the complexity of behavioural change, due to the vast variety of methods within this category, knowledge about when which method or which intervention works best and why is missing. Systematically conducted studies are needed to investigate this, evaluating the effect of interventions on actual behaviour. It's also important to understand the underlying process (mechanisms of action). Knowledge on how behavioural change can be sustained over the long term is also relatively scarce. The overview by Kwasnicka et al. (2016) provides a good initial indication, but more knowledge is welcome.

The challenge in determining the effectiveness of methods for designing interventions for behavioural change lies in the limited availability of outcome measures. Lifestyle change leads, if successful, to a longer life in relatively good health. However, this outcome is only measurable after some time. The same applies to sustainable behaviour. When determining the effectiveness of methods, we can look beyond just the desired outcome of the behavioural change. Research into feasibility can provide clarity about expected acceptance, practical usability, intended use, and perceived effectiveness of the design during and just after its development. Bowen et al. (2009) offer a handy overview for this purpose. In the slightly longer term, the **RE-AIM framework** (RE-AIM, 2023) provides points of reference for various outcome measures that together form the effectiveness of a design: reach, effectiveness in the context in which the behaviour is performed, adoption by the intended end-users, and implementation. The latter concerns the extent to which the design actually reaches the end-user in the intended manner, for example, in terms of costs and effort. The RE-AIM framework concludes with maintenance, the extent

to which the design becomes part of personal routines or organisational practices and policies. Even when the target behaviour and its consequences are well measurable, analysis of the aspects of RE-AIM can provide insight into the effectiveness of the used method, for example by stating whether the method leads to designs that are easy to adopt with wide reach and cost-effective implementation.

Ultimately, more knowledge about when which methods are effective, both in effecting behavioural change and in achieving easily implementable designs, could lead to a situation where we have standard solutions and tools for less complex situations around behavioural change. A challenge here is to develop and refine KEMs that many people can use well in developing interventions and that have a solid scientific basis. Current KEMs are often too complex and require solid expert knowledge. Moreover, they do not make the translation from theoretical mechanism of action to operationalised intervention clear (actionable) enough. More complex situations may thus require an approach and solutions led by specialists who can work on these issues within a network of stakeholders. This includes both designers of behaviour change and behaviour experts working with designers.

3. PERSONALISATION OF BEHAVIOUR CHANGE AND INTERVENTIONS

For behaviour change at the individual level, the possibilities offered by personal data to personalise an intervention are increasingly utilised. However, knowledge about when and whether the personalisation of interventions is effective, thus leading to sustainable behaviour change, is largely lacking. Moreover, little is known about effective ways to personalise, for example, how it can be linked to personal characteristics. These questions are also relevant for interventions not solely focused on an individual but on social structures, such as couples, families, or organisations. Another interesting development is the creation of automated adaptive interventions that personalise based on context: **Just in Time Adaptive Interventions (JITAIs)** (Nahum-Shani et al., 2015). JITAIs will enable the use of AI in behaviour change trajectories in the near future. For instance, we can expect, in time, to automatically send people signals based on sensor and context data that they are at risk of exhibiting undesirable behaviour, combined with suggestions for healthier or more sustainable alternatives. Another technological method to support personalised behaviour change is the use of chatbots and avatars for emotional and practical support. An example of a design employing such a chatbot is StopCoach, an intervention for quitting smoking specifically developed for people from lower socio-economic groups (Meijer et al., 2021).

4. WHERE IN THE SYSTEM?

As discussed in the introduction to this category, interventions can be implemented at various points within a system, such as with the citizen versus the healthcare provider or teacher. A key challenge is the lack of knowledge about where a change or intervention can best be implemented. How do we determine at what level a transition needs to be tackled to be effective, and how do the behaviours of different stakeholders interact? How do we prevent the behaviour of various groups from having an opposing effect?

Another important question is how combinations of interventions deployed at different levels can be combined and what effects we can then expect. Can we combine environmental interventions with individual-level interventions to make interventions more effective or transitions more likely? For example, an app also uses location-specific data and tells me where at the station I can find something healthy to eat. Knowledge and methods on how to design this type of combined interventions are lacking.

Regarding grassroots initiatives and citizen movements, we lack knowledge on how changes that are realised locally can grow. How do we form the step from local initiatives to actual system change? Do local initiatives grow from regional to national to global? Where do we encounter barriers?

5. MORAL QUESTIONS IN BEHAVIOUR CHANGE

Current KEMs offer little guidance on the moral aspects of behaviour change. Especially in a time when the role of big data in behaviour change interventions is growing, it is important to pay attention to this (see also **Ethics and Responsibility**). Should data about behaviour be collected? If so, what data and for whom should this data be available? The **Product Impact Tool** can be a starting point for ethical reflection and is an example of a method that supports research into the impact of technology on people, society, and the environment (see productimpacttool.org and Dorrestijn et al., 2014). In general, there is a need for further development of methods and tools that enable designers to determine the potential impact of an intervention on people and society before large-scale implementation.

A photo from KEM case: The Milk Salon.
Photographer: Noud van Tiem

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4. EXPERIMENTATION ENVIRONMENTS

4.1 INTRODUCTION

In addition to science and business, governments and citizens increasingly feel the need to experiment. This includes policies. In this context, the role of society becomes more relevant, and experiments are often conducted in so-called quadruple helix collaborations involving businesses, academic institutions, government, and citizens. Due to the wide variety of actors and interests, conducting these experiments on a large scale is complex, yet there is often ample reason to test and learn on a local and regional scale. Therefore, there is a need for environments where a diverse group of actors (citizens, governments, scientists and other researchers, companies, designers, artists, et cetera) have the opportunity to come together and collaborate on various societal challenges. Through participation and co-creation, as described in the KEM category of **Participation and Co-creation**, simple interventions and early prototypes can quickly be tested and experienced in the 'real' world in these experimentation environments, without having to wait for proof that something works on a large scale.

Experimentation environments offer the possibility to develop and test innovations that bring about change in a societal context. However, steering these societal changes is not straightforward, and related issues are often surrounded by uncertainties and ambiguous information. Therefore, there is a need for space in the early stages of the development process to try out and validate simple ideas. Additionally, further into the process, it must be possible to test the effects of developed interventions on changes in simulated and/or real-life contexts and, if necessary, make adjustments. See, for example, the methods in the KEM category of **Monitoring and Effect Measurement**. It is becoming increasingly clear that in addition to new technological solutions and their applications, new ways of collaborating are also needed. These ways, under the umbrella of 'social innovation', are also part of the experiment and take shape in the experimentation environment.

KEMs in this category assist in setting up and deploying experimentation environments, including in virtual environments, everyday life, workshops, and hybrid environments where both physical and virtual spaces serve a function. They address questions such as: how can you set up an experimentation environment? What conditions must an experimentation environment meet? Do you work with an everyday environment or a simulation of it? How is space given to technical ánd social innovation? What expertise, regulatory agreements, and financial resources are needed? How and when can you scale up?

4.2 STATE OF THE ART

The KEMs described here are categorised based on research related to large-scale and complex systems, down to the impact of specific interventions on the individual. Research is conducted through models of reality, field studies, observations, and design research in specific contexts. Thus, the KEMs provide insight into the effects of interventions and offer a perspective on how people deal with their (new) reality. Additionally, we describe methods that offer insights into how individuals themselves experience their daily lives and want to shape new situations. Traditionally, a lot of research still makes use of laboratories where people are observed while undergoing behavioural experiments. These are the so-called closed laboratories (Jones, 2018). However, in transitions, behaviour is more complex due to relationships between individuals and dependency on environmental factors. There is, therefore, a need for environments that are more open and thereby less controllable. Besides the categorisation of complex systems versus the individual, a distinction can be made on the time dimension. Models sometimes attempt to represent a new reality, for example, through a virtual world. Research is also conducted on the future in the present. Through exhibitions and the creation of experiential prototypes, visions are presented that give people a critical/different view of reality and of possible or desirable futures.

In the designing and constructing sciences, transitions are often addressed through research by design or design research. **Design Research** (Van Turnhout et al., 2023) focuses on devising technical prototypes that are tested with users in experimentation environments, but also extends to co-designing of, for example, new circular production chains together with multi-stakeholder groups. In this process, interventions are conceived, implemented, and analysed together, while also being reflected on. In their book on design research in practice, Koskinen et al. (2011) distinguish the closed lab, the open field (everyday life), and the showroom or exhibitions as research contexts with their variety of underlying theories and methods. The model of reality is not addressed here because the constructing sciences are pragmatic and focus on creating artefacts that are fitting and useful for possible or desirable futures. Given shifts in the design domain towards networked systems, data-centric methods, and social design, not only analysis but also synthesis and an inter- and transdisciplinary collaboration will become increasingly important for this approach. Here, the artefact is no longer seen as an isolated element but as a bridge between stakeholders in an environment.

VIRTUAL ENVIRONMENTS

When systems have a significant societal impact, they are not easily regulated. Additionally, interventions in these types of systems are often irresponsible or too costly. An example of this is safety-critical systems. Consider challenges such as maintaining large groups of people in city centres in safety-threatening situations. In these cases, one may decide to model the system. Based on broad knowledge and experience of the factors influencing a system, models can be created that mimic reality. Here, emerging technologies such as Artificial Intelligence (AI) come into play. These KEMs are mainly focused on simulation. An example is **Digital Twins**, which are digital replicas of living or non-living physical entities, where the digital twin adjusts based on data from the physical world (El Saddik, 2018). The digital replica can be used as a testing environment to monitor, for example, when maintenance is necessary in complex infrastructural or industrial installations, or to research processes. By adjusting certain variables in the models, one can try to predict the possible impact of interventions. How to properly include the needs of non-human entities such as animals, plants, and rivers (expanding to a 'quintuple helix') is an additional challenge that requires attention (Carayannis et al., 2012).

Another context in which models of reality are applied is the economy, where, for example, **Equilibrium Analysis** is used to study the impact of interventions. Furthermore, **Sandboxes** offer isolated digital environments where developers can create and test new concepts without interfering with other (critical) components in a project. There are also virtual environments that can actually be experienced by people, known as **Virtual Reality**. These virtual environments offer the control of laboratories but can also simulate complex processes such as an industrial production line or airport traffic control. In virtual environments, methods such as **Serious Gaming** (for example,

Mayer et al., 2014) can be used to study collaboration and provide training. However, the limitation of these virtual environments is that they have so far mainly served the visual and auditory channels, but the other senses to a very limited extent.

DAILY LIFE

Modern-day interconnected and data-centric systems, coupled with artificial intelligence, are making it increasingly easy to observe human behaviour in daily life (also see **Data for Inquiry and Evidence**). Methods like **Crowdsourcing**, which acquire sensor data and other user information via mobile phones, offer insights that minimally interfere with daily life. From software development, the **Perpetual Beta** method is relevant, in which system implementations are always in the testing phase, allowing developers to continuously make adjustments. This enables early design iterations to be implemented in the real world and online channels to be used to gather user feedback and improve designs. Perpetual Beta is applied, for example, in urban development (Fredericks et al., 2019).

Besides acquiring data through mobile phones, **Technology Probes** can also be used. These are specially designed artefacts with sensors and possibly actuators connected to the internet, allowing for data exchange with the environment. They can create experimentation environments in physical and/or virtual spaces that are part of society. These so-called **Experiential Design Landscapes** serve as playgrounds for in-situ design research by multi-stakeholder teams (Peeters & Megens, 2014; Alavi et al., 2020). Data can also be obtained from the environment by existing products and services in context. This is widely used in business for the development of new products and services. For example, Philips Design uses the **Data-Enabled Design** method, which combines sensor data from physical and digital products with qualitative user data. This provides designers with detailed and nuanced contextual, behavioural, and experiential insights from daily life (Van Kollenburg & Bogers, 2019). Naturally, these opportunities for experimenting in people's daily lives raise new questions about privacy protection, data ownership, and the ethics of applied technologies such as Artificial Intelligence systems.

In daily life, there are also various experimentation environments where large target groups come together: the so-called **Testbeds, Field Labs,** and **Living Labs**. These environments employ user-centred methods and often stimulate open innovation. They are used to observe and measure, build and validate prototypes, and address complex challenges in realistic living and working situations. Many labs are linked to Smart City or Smart Region initiatives in and around major cities. The environments are established permanently or temporarily around daily places and activities. By being supported by research and other monitoring and reflection, they offer a certain degree of control. Living Lab Scheveningen is an experimentation environment where digital innovations are tested along the extended boulevard of Scheveningen through a structured programme. In **Urban Living Labs** (Steen & Van Bueren, 2017; Brons et al., 2022), citizens, researchers, students, technologists, businesses, NGOs, entrepreneurs, teachers, and policymakers come together (for example, Scholl & Kemp, 2016). An example is NEMO Kennislink, where, in the context of the Science Museum, solutions for the future of the Amsterdam metropolitan region are worked on through co-creation. Living labs are prime environments for examining various aspects of complex societal challenges both separately and in relation to each other. Living LAB 040 in Eindhoven, for instance, is developing 119 'discovery homes' addressing spatial planning issues, material selection and development, sustainability, and various related themes and questions. The Green Village in Delft offers a similar space for experimentation, providing a low-regulation zone.

Living labs can also be linked to specific target groups, such as athletes, by turning a sports complex into an experimentation environment, or to doctors, nurses, and patients in a hospital. They can also be temporary, like festivals. During festivals, prototypes can be tested and experienced, and a lot of data can be generated or fed back in a short time. A festival is considered a temporary mini-society with challenges in areas like energy, waste, logistics, water, and food. **Innofest**, for example, is an organisation that offers entrepreneurs the opportunity to

conduct research at various festivals. However, there is limited coherence between the methods used in different labs. The labs vary greatly in quality regarding the safeguarding of co-creation principles and transparency in collaboration, as well as the reliability and scalability of results (Overdiek & Geerts, 2023).

The effectiveness of experimentation environments in daily life is not yet sufficiently proven. This is due to the often temporary nature of these labs (and the insufficient embedding of knowledge and learning effects), but also because transitions involve long-term changes in societal systems that do not have a simple cause-effect relationship. Like biological systems, social systems often have a tipping point. Changes are less visible leading up to this point. The advantage is that in a short time and in a flexible manner, the feasibility and scalability of initiatives can be tested and experienced by people. Provided the labs guarantee basic principles of responsible collaboration, experimentation environments in daily life are a safe space for co-design and participation.

LEARNING ENVIRONMENTS

Joint learning is commonplace in experimentation environments. However, there's considerable variation in how this learning is structured, such as targeting specific learning outcomes, documenting learning experiences, or making them transferable. Environments where learning is prioritised can be classified as learning environments. These involve public-private partnerships that act as a nexus between innovation (experiment), learning, and work.

In recent years, the concept of Learning Communities has soared in popularity in the Netherlands, both in research and practice, especially in addressing societal missions and transitions (NWO, Regieorgaan SIA, Human Capital Topsectoren, 2023). Learning Communities encompass concepts, tools, strategies, and methods aimed at strengthening the connections between innovating, learning, and working. In such environments, learning isn't just about knowledge sharing but primarily involves the joint development and application of (new) knowledge.

A photo from KEM case: The Innofest Method. Photographer: Dian Kors

WORKSHOPS AND MAKER ENVIRONMENTS

In these environments, making is central. In **Fablabs**, knowledge is shared on, for example, production processes, models, and software code, and technology is made accessible to everyone. Influenced by the **Maker Movement** (Dougherty, 2012), these 'maker environments', or workshops, promote bottom-up initiatives and encourage self-determination by merging cultural and economic practices. This can also give rise to research initiatives based on **Citizen Science** (Irwin, 1995). By enabling a large group of people to develop specific products for conducting measurements, such as an air quality metre, public data can be generated on a large scale. By linking different measurements, the action perspective of the research community and thereby knowledge production is enhanced through public involvement.

Making can also be used in the arts, design, and science for critical reflection on technology in society. This so-called **Critical Making** is based on **Critical Design** (Dunne, 1999). Through **Speculative Making** or **Art-science**, a hybrid form of art and science is created, both of which have a unique ability to shape our understanding of the world. The collaboration brings new insights to both fields and leads to new hybrid forms of knowledge and presentation. Artistic research provides space for subjectivity that can lead to universally applicable principles through the use of performative and speculative research methods (see **Meaning and Awareness**). This type of research is often linked to the previously mentioned **Showroom Approach** (Koskinen et al., 2011). The experimentation environments associated with this are exhibitions and museums or **Future Labs**. A relatively new development in this area is the World Design Embassies and What-If Labs of the Dutch Design Foundation. Over the years, they have safeguarded the showroom initiatives connected to the annual Dutch Design Week (DDW) by linking them with networks and labs concerning major societal questions. Thus, the showroom becomes part of a broader and more extended experiment that continues between editions of DDW.

4.3 CHALLENGES AND RESEARCH QUESTIONS

Experimentation environments have emerged in the context of **Open Innovation** and **User-Centred Design**. Currently, they are mostly linked to transitions (that is, long-term societal change processes). This has two consequences: models and methods based on an innovation model and market mechanism need to be revisited. Questions of implementation thus become more design-oriented, such as: how can we translate this solution towards frameworks and stakeholders who can use it to change the system? There is also a need for greater connection with transition thinking, such as the **Multi-Level Perspective** (Geels 2002; 2011), **Transition Design** (Irwin et al., 2022), **Design for Sustainability Transformations** (Ceschin & Gaziulusoy, 2016), and thinking about **Complex Adaptive Systems** (for example Nobles et al., 2022) to understand how and when collective experimentation and its outcomes can promote and accelerate changes. Deploying experimentation environments in transitions requires systemic knowledge from the participants and specific new roles for designers (Zifkovic, 2018; Design Council, 2021a; 2021b). Secondly, experimentation environments could be seen more as programmes and containers for experimenting with multiple innovations aimed at the same transition goal.

Innovations that can contribute to transitions often arise at the intersection of different disciplines. Experimentation environments, where these disciplines can meet, are an ideal place to tackle them. However, collaboration must be facilitated, and the creative industry plays a significant role in bringing together and encouraging transformative collaboration and creation among stakeholders through participation and co-creation methods (see also **Participation and Co-creation**). The effectiveness of experiments in the described environments on changes, for example in the collaboration of economic sectors, the use of resources and CO2 emissions (sustainability), or policy, is, however, not yet sufficiently proven. There is also little consensus on the process by which multi-stakeholder groups go through and possibly implement an experimental project. Moreover, knowledge about making the experimentation environments themselves sustainable is still lacking. Public-private collaboration is a model to make funding and governance of these environments sustainable. What other models are there?

Furthermore, the interdisciplinary approach to experimentation also leads to paradoxes, resulting in a number of challenges and research questions that could be scheduled for this KEM category. We have distilled several challenges, with related research questions. First, some practical questions regarding the setup and interaction between participants in experimentation environments, and ultimately some questions aimed at validity. This also connects to other KEMs in this agenda, such as **Monitoring and Effect Measurement**.

SETUP

There's a wide variety of contexts and methods for setting up experimentation environments. There are also multiple organisations and networks involved in both designing and participating in experiments and knowledge is required about the systems that need to be set up to gather relevant data. Since many of the described environments take place in daily life, it's important to carefully consider the role of participants in the research. Ethical basic principles for collaboration and systematic reflection play a significant role in the development of the environments and can be addressed at different levels. Participating in experiments in daily life will likely impact the behaviour of actors in or using the environment, as they need to learn to deal with new situations. This is related to the attitude of a reflective practitioner (Schön, 1984) who reflects on actions and continually adjusts the environment. The following questions can help define common frameworks for the different experimentation environments.

- What organisational embedding, processes, and human qualities (skills) are necessary for an experimentation environment to generate new routes and solution directions (technological and social innovation)?
- How are actors encouraged to contribute to and provide feedback on the large-scale development and implementation of prototypes? What ownership do they have of the results?
- How is information obtained from experiments safeguarded, clustered, and made accessible?
- How do involved actors experience continuous experimental form and change in their daily lives?
- When and how can lessons from an experimentation environment be scaled beyond the local environment (for example, changed perspectives, work processes, power relations, policy initiatives, et cetera)?
- What systemic knowledge and skills are needed to set up and guide processes in experimentation environments that can have a systemic effect?

ETHICS

Many of the above questions regarding the role of actors in an environment also lead to discussions about ethics and values (see also **Ethics and Responsibility**). These form a second challenge. When interventions are made in daily life, a very diverse group of actors must be sufficiently involved and heard in developing a vision and potential new practice for the future.

- When are experiments legitimised?
- How do we ensure that (different) public values are safeguarded?
- How do we deal with knowledge production and innovation within planetary boundaries and how directive are these limitations?
- Should experimentation environments only experiment with new solutions and ways of working (building), or also design and test how to dismantle old ways of working?
- To what extent are researchers not neutral observers, but stakeholders in the multi-stakeholder process of experimentation environments? What are the implications?

TIME DIMENSION

A third challenge pertains to the time dimension. Firstly, it's crucial to consider when experiments truly add value. There's also a conflict between current environments and future environments. For Urban Living Labs, for example, it's known that they can enhance citizen engagement in two ways: 1. as a contribution from everyday life where citizens are the experts, aimed at uncovering the choices of a very diverse population in the process of co-creating new systems, and 2. as a break from everyday life aimed at facilitating reflective choice freedom in (re)shaping the future (Brons et al., 2022). However, it's nearly impossible to evaluate new propositions in a future context, further complicated by the complexity and constant dynamism of society. To what extent are people able to envision how the proposition will affect their future actions? Especially since in the future, both the individual's situation and the environment can completely change. A significant scientific challenge, therefore, is evaluating technology and interventions in development in a developing world, especially when propositions have been designed to achieve long-term impact.

Simultaneously, the development and widespread accessibility of Virtual Reality and Artificial Intelligence technologies offer new opportunities for people to experience futures. Thus, experimentation environments can enable temporary experiences in virtual futures for exploration. See, for example, the ambitions and plans of the Creative Industries Immersive Content Coalition (CIIIC). These challenges and contradictions lead to the following research questions:

- How are constants and variables determined in a developing experimentation environment?
- How do we investigate the suitability and meaning of emerging technology with a focus on future, complex societal challenges? And who do we involve in this process?
- How do we gain insights about experiences aimed at an unknown future context?
- How can an experimentation environment test a new route and direction for eventual feasibility and desirability?

VALIDITY, RELIABILITY AND IMPACT

The final challenge concerns the validity of the described experimentation environments. This is a discussion point raised from different values and reference frames. While certain groups of scientists need control, there is a contrasting view from the creative industries that values engagement and application in society. This leads to a paradox, as a society cannot be modelled and thus does not provide the control required for what is understood as scientific research. Therefore, there's a need for different experimentation environments, with varying levels of control.

- How can we extend the boundaries of ecological validity while maintaining experimental control in daily life?
- What is the setup, organisation, and validation of interdisciplinary and trans-disciplinary methodologies and practices when so many stakeholders are involved in the research process?
- What happens when society is involved as a researcher, and how do we validate citizen-driven knowledge production and innovation in contexts such as Citizen Science?
- How do we address and investigate complexity, ambiguity, and constant change, where even the research methods and results are not stable because their meaning changes over time?
- Can we link our understanding of validity to an understanding of impact? How can we describe this impact for experimentation environments, and under what circumstances does this impact cease?

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5. VALUE CREATION AND UPSCALING

5.1 INTRODUCTION

KEMs for Value Creation and Upscaling primarily focus on how organisations can create value, including through services, goods, or in broader societal applications. Not only in a financial-economic sense, but also in a societal, cultural, or ecological respect and aimed at society as a whole or a significant part of it.

The evolution of the concept of 'value' can be illustrated by three main phases that science, technology, and innovation policy have undergone (Schot & Steinmueller, 2018). In the first phase, the starting point was that new knowledge development, especially in the field of technology, should serve the development and growth of the (competitive) strength of companies. The second phase followed the oil crisis, where the emphasis was on the promotion of national innovation systems as clusters of activity, based on an excellent knowledge infrastructure. The current, third, phase is primarily about bringing about societal transitions, and thus also about other forms of value. The nature of this is found in the United Nations Sustainable Development Goals, but also within mission-driven innovation policy and dealing with material scarcity (Wieclawska & Gavrilova, 2021; Bastein et al., 2022). The urgency of societal challenges is great and necessitates rapid scaling of innovations and collaboration.[1] However, the value images from the first phases are still active, as can be seen, for example, in the focus of the National Growth Fund on earning capacity.

For this KEM category, a broad approach to business modelling is taken as a starting point. Business models succinctly describe how value is created, delivered, and then monetised, how an organisation has organised its activities, and which target groups it serves (Osterwalder & Pigneur, 2010). Chesbrough (2007) already showed that innovations also need a business model to be successful. Innovations are then not only of a technical nature but can also involve interventions and social innovations.[2] At the same time, it must be acknowledged that the usual image of business models is about companies that are profitable in the long run with their products or services.

KEMs for Value Creation and Upscaling help structure the design and realisation process of value creation, and preferably validate and test these at an early stage. Indeed, on the way to societal impact, there are still numerous challenges, such as adoption, to overcome. These KEMs answer questions like: how can economic, cultural, societal (such as sustainability), and social values be combined and integrated? How can decision-making be supported? How can transaction- and product-thinking be expanded with thinking in sharing, services, access, and collectivism? How can value be protected and monetised? How do you ensure scaling and acceleration of value creation and how is new knowledge optimally used in this? How do you contribute to the ecosystem in which value is created and can also continue to exist sustainably?

1. For this, missions have been formulated in the areas of energy transition, circular economy, agriculture, water and food, health and care, and safety.
2. It may be noted here that (parts of) governments can also have a business model, after all, they also create (public) value, have activities and balance costs and revenues.

Parallel to the above described evolution of the value concept within policy, the focus within KEMs for value creation has also shifted (see Table 1).

From	To
Firm-centric	Collaborative and collective, including government and societal actors
Consumption	Scarcity/sufficiency
Value	Impact (and missions)
Technology	Services, interventions, organisation (governance)
Financial growth (monetary value)	Broad well-being (inclusive value)
Method	Impact, community, learning effects

Table 1: Shift in emphasis around KEMs for value creation

Where previously the focus was centrally on the individual and singular enterprise, emphasis has now shifted towards cooperation and joint change, within a broad societal system of sometimes changing actors, depending on the mission objectives and the more or less intertwined domains that are central. In this, the role of the government also changes. It assumes an important, coordinating and also directing role in defining missions and strategically allocating resources for knowledge development to enable societal transitions. In this process, **Citizen Engagement** plays a crucial role in defining missions (compare Mazzucato, 2019).

Where previously humans were framed as consumers, emphasis is now placed on what humans need. Where previously the focus was on value creation, it has shifted towards effecting coherent societal change on the topics we deem important as a society. Societal change implies a substantial scale. Scaling and reproduction are thus critical themes. This ties into the adjacent concept of diffusion, which can take various forms and has made a mark in the extension of the work of Everett Rogers (1962).

Where previously the focus was strongly on technology (and its development), emphasis is now placed on thinking in terms of services, interventions, and how we organise ourselves. Where previously the emphasis was on financial growth or an increased gross national product, the focus now shifts to multiple values and well-being. CBS defines this as “the quality of life in the here and now and the extent to which it does or does not come at the expense of that of future generations and/or of people elsewhere in the world.” (Van Bree & De Jonge, 2022).

Finally, where the emphasis was previously on knowledge development and dissemination in the form of methods, focus has shifted towards developing the capacity to actually employ those methods for change and to learn from it.

5.2 STATE OF THE ART

The broader concept of value is not yet crystallised. This category is therefore still very much in development. This is richly illustrated in the publication 'Societal Earning Capacity: This is How You Do It!'. This report presents no fewer than 95 forms of work, models, methods, and toolboxes (with an application area wider than this KEM category).

BUSINESS MODEL TOOLBOX

The **Business Model Canvas** introduced by Osterwalder and Pigneur (2010) remains an important tool for companies. It enables them to develop their value proposition, align their business activities with customer needs, and gain renewed insight into the core values that drive the organisation itself (purpose). In cases of business model innovation and portfolio innovation, this often leads to business model re-development: adjusting the value proposition, the business model, and realising the created value due to a new customer base. This also includes **Brand Driven Innovation** by Roscam Abbing (2010), which connects brand, innovation, and design to help companies build human-centred brands that match their vision and values. Within these approaches, methods often derived from the design discipline or science are used. An example is the **Customer Journey** or **User Journey**, where the steps of a (potential) user, from considering purchase to actual use, are traced to discover how a (broader) group of users can be served (Følstad & Kvale, 2018).

With **Business Process Mapping** (Tseng, 1999), a new or existing business process can be visualised and insight gained into the steps a process must go through from start to finish. This method provides a clear picture of what happens and who should take the lead. It is closely related to a **Service Blueprint** and a **Customer Journey Map**. A Business Process Map also describes who is involved in the process and what their roles are. It can be linked to tasks that still need to be done, or to **Empathy Maps** or **Personas** to gain deeper insights into the process. An Empathy Map (Ferreira et al., 2015) is a way to better understand the motivations of people involved within the ecosystem, by 'putting oneself in their shoes'. This tool can help both in gaining insight for developing change management initiatives and in testing and developing new concepts. In addition, work has been underway for some time on various extensions for dealing with business models, such as **Business Model Portfolio** (Globocnik et al., 2020), **Roadmapping** (De Reuver et al., 2013), and **Experimentation** (Sosna, 2010). Various related **Business Modelling Tools** are collected in the Business Model Lab and Strategyzer.

BUSINESS MODEL INNOVATION PROCESS

Although there are various perspectives on the process of **Business Model Innovation**, the model from the literature study by Wirtz and Daiser (2018) can serve as a reference model for the innovation process. They identify the following phases: analysis, ideation, feasibility, prototyping, decision-making, implementation, and sustainability. This is relevant to illustrate because the typical design activities can be preceded and followed by analysing, evaluating, and detailing activities.

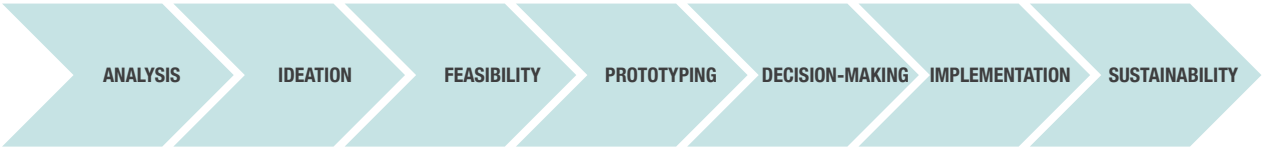

Figure 1: Business Model Innovation (process) (adapted from Wirtz and Daiser (2018))

Another approach to business model innovation is (**Service) Design Thinking**, which, through an iterative process, gains more insight and understanding of end-users' problems and situations. This can provide insights into how design outcomes can have an impact within their specific contexts (Cross, 2013). The **Lean Startup** method (Ries, 2012) is often associated with Design Thinking, but it is different. It advocates for developing business models based on an iterative cycle of building, experimenting, measuring, and learning. Here, the focus is on testing assumptions and quickly adjusting strategies based on customer feedback. While Design Thinking centres on the user and the problem, Lean Startup focuses on the idea and the customer (Müller & Thoring, 2012). Lean Startup also follows a more linear and structured process, whereas Design Thinking employs a more non-linear and flexible process. Furthermore, Lean Startup adopts an analytical and data-driven (evidence-based) mindset, while Design Thinking is characterised by an empathetic and intuitive mindset. Both methods can reinforce each other, with Design Thinking used for generating ideas and the Lean Startup method applied to test these ideas.

VALUE NETWORKS AND MULTI-ACTOR THINKING

Our society is becoming highly networked, and dependencies between organisations are becoming more significant. Research and development of methods to innovate within the context of networks are well advanced. There are multiple conceptual frameworks, methods, and tools available. Within these, the ecosystem concept plays a significant role (see, for instance, Adner, 2012). Methods are primarily used to understand the complexity of multi-stakeholder settings and to establish a foundation for shared values, goals, and actions. **Stakeholder Analysis** provides insights into actors who may exert a significant facilitating or obstructive force on innovation and scaling. Actors can also be analysed in the form of a **Value Network**, mapping out the value flows between organisations (Allee, 2008). A similar method is **Ecosystem Mapping** (West et al., 2018), which visualises and analyses the interconnected relationships between different entities within a specific ecosystem. This tool aids in understanding the dynamics, dependencies, and interactions between various players, organisations, technologies, and stakeholders within a particular sector or market.

This means that an ecosystem-wide business model must be supported by an ecosystem-wide strategy (Wieringa & Gordijn, 2023). Another methodology for situations with many actors is **Agent-Based Modelling**. Here, modelling and simulation are used to identify and eliminate weaknesses in the business model.

In the context of value creation, the emerging **Commoning** and **Collective Action Models** must also be mentioned (consider the significant increase in energy cooperatives, or the knowledge platform Collective Strength). Here, various independent actors (individuals and organisations) jointly manage and develop a resource, aiming to create optimal joint benefit (Ostrom, 1990). This involves the convergence of value creation and governance of collaborations and ecosystems (Reeves & Pidun, 2022).

MULTI-VALUE, BROAD WELL-BEING AND PLURAL ECONOMY

One of the central issues in collective action (multi-actor challenges) is that the costs and benefits lie with different parties. The **Value Case Methodology** (Dittrich et al., 2015) is a method to map out the value network within a consortium to ensure alignment. This method focuses mainly on the distribution of costs and benefits, but power dynamics are not really recognised. **Frame Analysis** is used to gain a better understanding of underlying values among different actors. In line with these approaches (multi-actor, multi-value) is the **Business Model Radar**. This multi-stakeholder business model approach is based on the so-called **Service Dominant Logic**[3]. Central to the development of a shared idea of and for value creation is the concept of value-in-use, which emphasises that products only deliver value when they are actually used, and that this involves an interplay of actors. This aligns with the focus on so-called 'as-a-service' business models (see below, Tukker, 2004).

3. "S-D logic is essentially a value co-creation model that sees all actors as resource integrators, tied together in shared systems of exchange – service ecosystems or markets. In this way markets are characterised by mutual value propositions and service provision, governed by socially constructed institutions." (Vargo, 2011, p220).

The focus on business for post-growth is emerging (Raith, 2021), with various experiments underway (see, for example, the Doughnut Economics Action Lab). At a more systemic level, the field of **Regenerative Business Models** is unfolding (Konietzko et al., 2023). On the social side of value creation, various movements are arising under the banner of a social and solidarity economy (Yi, 2023). In our country, various researchers and professionals are actively developing services and products that build on this, such as bread funds and green energy cooperatives. Often, there is a combination of value creation and upscaling, which, due to the need to adapt to the context, can also take the form of replication[4]. This fits well within the **Sustainable Market Transformation** model (Ter Haar & Simons, 2019), where the third phase calls for non-competitive collaboration as a precursor to institutionalisation.

TRANSFORMATIVE INNOVATION

Approaches and methods of Value Creation and Upscaling that fit within the frame of transformative innovation often touch on themes like social values, sustainability, and circularity. A foundational contribution is that of Tukker (2004), which assessed eight **Product-Service Systems** (PSS) for their environmental value. In an extensive literature review, Geissdoerfer et al. (2018) provide an overview of **Sustainable Business Model Innovation**. In this movement, various tools have also been developed, such as the **Sustainable Business Model Canvas, Societal Impact Canvas, Triple Layered Business Model Canvas**, and **Indicator Framework.** Later, Bocken et al. (2019) provided an overview of **Circular Business Innovation Tools** (see also Lüdeke-Freund et al., 2019). Wieringa & Gordijn (2023) describe how a circular production process can be designed from a joint business model of a value network for production and recycling.

Other developments relevant to value development through transformative innovation are the so-called **Collaborative Business Models**, which can be developed and realised within the scope of a transition (CBM4T). Derks et al. (2022) link the level of a single company, the collaborative business model, and the ecosystem, describing various scaling paths. However, guidelines on whether business models are introduced in new or highly competitive markets are not provided. Westley et al. (2014), and more recently Bohan et al. (2024), refine the different scopes and directions of scaling as: scaling up, out, deep, in, long, across, down and back, and beyond. However, how value creation needs to change and collaboration can be scaled is still underexplored. This conclusion is also drawn by Derks et al. (2022) when providing concrete research directions.

ORGANISATION AND GOVERNANCE

More specifically aimed at innovation for societal impact, an approach referred to as **Orchestrating Innovation** (Berkers, et al., 2023), heavily relies on **Value-Driven Alliances** (Boonstra, 2023) and **Multi-Stakeholder Cooperatives** (Berkowitz et al., 2020). This approach aids in designing, setting up, and leading an innovation hub (or network), often representing a strategic public-private partnership. The approach includes a reference business model for all variants of an innovation centre (including **Experimentation Environments**) and training for the leader of the initiative. The intention is for the innovation hub to unite all capacities necessary to bring various innovations to fruition and societal impact, thereby bridging the clusters mentioned above from the second phase, and focusing on broad value.

The shift towards a broader understanding of value has massive implications for entrepreneurship, leadership, and boundary workers, especially when looking at the shift from traditional customer-supplier relationships to positioning within an ecosystem. Professionals in value creation are expected to understand multiple values, ecosystems, transitions, and planetary boundaries. Moreover, despite the multitude of methods described above, the development of successful business models is far from guaranteed. For example, in the reproduction, scaling, and diffusion of innovation, we must consider unintended consequences, such as rebound effects and the Jevons paradox.

4. Both projects were presented during a session at CLICKNL Design Drive 2020, with the theme Creating Industries: Enabling Societal Transitions.

5.3 CHALLENGES AND RESEARCH QUESTIONS

Various challenges play a role in the field of value creation. Firstly, the concept of 'value' in the diverse contexts of innovation for various societal transformations needs further elaboration and refinement, moving beyond the previously dominant financial-economic definition. Additionally, negative externalities, such as environmental damage or growing inequality resulting from economic and market operations, should no longer be treated as mere inconvenient residues. They must be fully incorporated into the valuation of new services, applications, and systems, and seen as part of societal challenges and transitions. In the context of value creation, the development of the concept of value and economic principles is likely more context-specific than the general approach chosen for national-level well-being indicators. An example of such a well-being indicator is 'Median disposable income', as an approach to assessing purchasing power development. In this case, specific business models for a particular target group, such as non-households, could focus on measures leading to favourable changes in income or expenses, for instance, through cooperative energy generation. However, these business models may not directly account for inflation, differentiating the operationalization of broad well-being in the context of value creation from a regional or national monitor.

In the context of innovation in networks and value chains lies another significant challenge that has already been partially addressed: the further development and validation of collaborative models for value creation. This is important in light of societal transitions where coalitions necessarily extend beyond the economic domain and involve societal stakeholders more than ever before (Ter Haar & Simons, 2019). Here, it is clear that developing and evolving the governance of collaboration, and dealing with the inherent paradoxes of collaboration (Boonstra, 2023), remains an open question in specific domains and contexts. This also applies to the upscaling of collaboration (as already mentioned above).

Methods to explore the underlying value systems of stakeholders and ensure alignment are crucial for innovation aimed at societal transitions. Including and organising users is essential for diffusion and upscaling, as is involving civil society at large. Mazzucato (2019) frames this challenge through questions on how to engage citizens in processes of futuring, agenda-setting, co-design, co-creation, co-implementation, and co-assessing for societal missions. She also wonders about the capacities and tools needed by the public and collective sectors to foster a dynamic and innovative ecosystem, including the ability of officials to enable experiments and help governments and other organisations work beyond their traditional silos. This calls for leadership qualities focused more on solidarity and equal cross-boundary cooperation (Boonstra, 2023).

There's still relatively little known about the organisational capabilities required to create value in an ecosystem with multiple stakeholders. Value creation in such a complex context raises specific dilemmas that require special skills. Little is known about the dynamics of sensemaking: how stakeholders jointly determine what value is, what is valuable, and how value should be created. How to ensure that individual contributions in collaborations all lead to a joint goal? How to ensure that each individual contribution is properly valued (compare Oskam et al., 2020; Boonstra, 2023)? The same applies, by analogy, to the conceptualization of what markets in this context are, how market formation occurs, and ultimately what upscaling entails and whether it is desirable and possible apart from the specific contexts, and whether there are different forms of failure (Frenken & Hekkert, 2017). Achieving this necessitates collaboration between different knowledge disciplines, which must maintain a close relationship with the broader societal practice. It's also important to understand resistance to innovations and develop ways and methods to deal with it. Especially in the field of societal transitions, this is current and essential: setting goals for these transitions is a political process and prompts discussions. Generally, both theoretical and practical innovation exhibit a pro-innovation bias. This was already noted by Rogers (1962) decades ago. There's too little attention to resistance against innovations, which is often presumed merely to be the absence of adoption. However, there's usually more at play. According to transition studies, it's necessary to also consider active dismantling to make room (X-curve, DRIFT).

RESEARCH QUESTIONS

The preceding sections have already introduced numerous relevant questions for further research.

BROADENING OF THE VALUE CONCEPT FOR SOCIETAL TRANSITIONS

- To what extent are the archetypes, methods, and tools (including those still under development) aimed at creating economic value through innovation, suitable for realising societal transitions through innovation, where cultural, societal, and ecological values are also important? What extensions are needed?
- What contributions can diverse economic schools of thought make in this context?
- How can the underlying, potentially conflicting, value systems of stakeholders relevant to societal transitions be mapped and aligned?
- How should language use and framing (Dorst, 2015) be utilised to contribute to value creation?

DEVELOPMENT OF COLLABORATIVE BUSINESS MODELS, PARTNERSHIPS, AND ALLIANCES

- What are the (basic) elements of collaborative models for value creation aimed at societal transitions? How can these serve for the diffusion and scaling of necessary innovations?
- Which actors are necessary for a minimum viable ecosystem sufficient as a basis for societal transitions, to which parties can be added in a later upscaling and diffusion phase?
- How do you organise governance and decision-making for collaborative business models? How do you specifically adapt these to the context of transition, and how do you allow them to evolve?
- How should startups and scale-ups contributing to impact and value chain transformation be more adequately supported? The same for governments?
- How can we effectively use simulation, prototyping, and experimentation in the development of business models?
- Which methods are suitable to better understand and operationalize the process of diffusion and the different forms of reproduction, scaling, and diffusion? What variables should be considered?

FINANCEABILITY AND VALUE CAPTURE IN SOCIETAL TRANSITIONS

- How can the costs, benefits, and risks of a transition, located at different places within a value network, be balanced in such a way that support for the transition grows?
- How can financiers organise their offerings more seamlessly to facilitate upscaling to the maximum extent?

ENTREPRENEURSHIP AND LEADERSHIP CAPABILITIES

- What organisational capabilities are required, with a view to societal transitions, to create value in an ecosystem with multiple stakeholders?
- What entrepreneurship and leadership capabilities are necessary for value creation in the context of societal transitions?
- How can these be adequately developed? What is the impact on individuals who operate on the boundary of their own organisation and must deal with the complex tensions that arise from this?

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6. INSTITUTIONAL CHANGE

6.1 INTRODUCTION

Institutions play a crucial role in initiating and effectuating transitions. Highly institutionalised systems can obstruct transitions, while other institutions - or the lack thereof - can significantly propel innovations. Although there is no unanimous definition of the term 'institutions', they are often seen as the rules of the game. These rules, formally as laws and regulations and informally as norms and values, facilitate and coordinate interaction between individuals and organisations. They bring various possibilities, limitations, and conditions, ultimately affecting the effectiveness and lifespan of transitions. The games are mostly played across various political, economic, and societal arenas, but often also between them.

The central question in this category is how institutional change can contribute to the realisation of transitions towards more sustainable and equitable societies ('just transitions'). On one hand, institutional change can be a response to socio-technical and socio-ecological transitions, but at the same time, institutional changes can greatly influence the direction and speed of socio-technical transitions. Examples of new institutions include tradable emission rights for companies, citizen cooperatives where people share land, cars, energy, or other resources, online platforms for the circular economy, new forms of democratic decision-making, new financing models for social value creation, and new regulations for increased producer responsibility. This dynamic is accompanied by methods that provide insight into which institutional arrangements can best align with societal issues.

KEMs from this category, therefore, assist with questions like: how can policy and regulatory means be deployed to guide transitions? How do you design and facilitate the corresponding organisation and network rules, and encourage different behaviour? What kind of leadership is desired in transitions? But also, which institutional arrangements can spontaneously propel transitions? Which institutional arrangements obstruct change processes, and to what extent and how can such institutions be dismantled, phased out, and replaced? How to deal with new forms of governance such as network and self-management? And what ultimately ensures societal acceptance of transitions?

6.2 STATE OF THE ART

THE KNOWLEDGE BASE AND IMPACT

The subject of institutional change has been extensively discussed across various fields including public administration, sociology, business studies, political science, and management and organisational sciences. The influx of literature accelerated following the so-called 'institutional turn' in the early 1990s. Since then, different schools of thought have emerged within these disciplines, each shedding light on the role of institutions from their perspective. These efforts have resulted in significant advances in developing methods to encompass institutional change over the past three decades.

The traditional approach is primarily based on an exogenous perspective. It focuses on how institutions should be designed, with the underlying assumption that there exists a central and benevolent actor along with a (generally rational) society that will both follow the imposed rules. Therefore, the emphasis is on designing institutions that ensure the most favourable outcomes. 'Getting the institutions right' is a commonly heard motto here.

Recently, much attention has also been given to other forms of institutional change. This literature originates from the structure-agency debate, centering on the question: if the behaviour of actors is strongly influenced by existing institutions, how can those same actors change the institutions? This question can be answered by not viewing institutions as a single entity, but as arrangements specific to sectors. For example, the mobility system, with a car system and a public transport system, is institutionalised very differently than the food system, where a dominant (market) system exists. Transitions can then be driven, for example, by social movements or disruptive start-ups that emerge as institutional entrepreneurs, by criticising existing institutions, experimenting with alternatives, and lobbying for new institutions. This also means that existing governance methods are subject to change. In addition to traditional forms of hierarchy and markets, there is increasing attention for networks as an alternative governance method. Network governance relies on mutual relationships and trust among actors, which is often also found in the governance mechanisms of transitions and innovations.

These developments, often technical and societal in nature, have led to increasing complexity in the institutional environment. This has not gone unnoticed in institutional literature. On the one hand, it has led to conventional institutional methodology falling short in explanatory power and applicability. On the other hand, it has accelerated the development of new KEMs. Therefore, below is a selection of recent state of the art methods that attempt to encompass and explain current institutional changes. A distinction is made between methods of emergence and design, which respectively approach the endogenous and exogenous processes of institutional change.

EMERGENCE METHODOLOGY OF INSTITUTIONAL CHANGE

Most institutional scholars today agree that institutional blueprints or transplantation, the one-to-one copying of institutional arrangements, is an unsuitable method of institutional change. The terms polycentric governance or institutional bricolage are increasingly used to indicate the time- and space-dependent diversity of institutional arrangements, which often autonomously manifest at the micro-level. This is referred to as 'emergence methodology' in the following.

Some of these methods and approaches are inspired by and built upon the work of Nobel Prize laureate Elinor Ostrom. Ostrom conducted groundbreaking research into the governance of socio-ecological systems, showing that local actors are capable of regulating the use of natural resources (the commons) without leading to depletion. This has sparked interest in alternative (not private or public) forms of governance, such as informal, hybrid, and self-governing governance forms. To encompass this diversity, Ostrom developed the **Institutional Analysis and Development Framework (IAD)**, which can be applied at different interaction levels (Ostrom, 2005). Within the action arena, the relevant rules, biophysical attributes, and characteristics of the users are then examined. There is also increasing interest in the extent to which Ostrom's (2009) **Social-Ecological Systems** (SES) framework can be applied to socio-technical systems.

In addition to diversity, institutional dynamics are important aspects of emergence methodology. 'Institutions are the products of the past,' is a well-known statement by the founder of institutional economics, Thorstein Veblen. He meant that institutions always hopelessly lag behind their (technology-fed) changing environment. By now, we know that successful institutional change rarely occurs via exogenous shocks or metamorphoses but is evolutionary and incremental. This has been extensively addressed by proponents of historical institutionalism. For instance, Mahoney and Thelen (2009) have developed a new framework for the incremental processes of institutional change. With a focus on the origin and history of institutions, this framework contributes to fundamental questions

about how and why institutions often change only gradually. It can also help explain discrepancies between the intentions and outcomes of institutional change, by looking at endogenous processes, such as information asymmetry and power relations.

Another significant method for approaching institutional dynamics is **Process Tracing** (Collier, 2011). This in-depth method can be applied to trace causal mechanisms and how they unfold within a specific case. It involves gaining detailed knowledge by collecting mechanistic evidence within the case, which then provides insight into how causal processes occur in reality. While Process Tracing is applied to a single case, comparative research can uncover similar mechanisms. This is closely related to **Comparative Institutional Analysis** (Morgan et al., 2010), a framework that can be used to learn from institutions and practices in other domains, regions, or countries.

Finally, within the emergence methodology, there is also increasing attention to the role of underlying cognitive and psychological processes. Here, **Institutional Logics** is a popular theory (Thornton et al., 2015). An institutional logic is the set of symbolic systems, such as assumptions, values, and beliefs, through which individuals and organisations give meaning to their daily activities. Typically, seven logics are distinguished: community, family, religion, state, market, profession, and corporation. This classification, which goes far beyond 'public-private', allows large-scale institutional changes to be described and understood as changes in the configuration of the dominant logics within a domain. Transitions in sectors like energy, mobility, food, and health can then be understood as the merging of technological changes and changes in institutional logics. For instance, community logic plays a significant role in the energy transition as citizens in cooperatives exploit solar and wind energy. Additionally, logics can hinder transitions if they become dominant. For example, a unilateral state logic can slow down transitions if officials are not given the space to experiment and form specific alliances (Braams et al., 2022), while a unilateral market logic can lead to technological lock-ins and monopolistic market forms (Mazzucato, 2013).

DESIGN METHODOLOGY OF INSTITUTIONAL CHANGE

The increasing degree of institutional diversity and dynamics has made the design of institutions more complex. Functional approaches that only look at organisational forms and formal rules often seem to fall short. In the need to broaden our perspective, design methodology plays a key role in supporting policymakers in designing and evaluating institutional change.

Institutional Design specifically focuses on the design and redesign of formal institutions that should lead to desired effects (Alexander, 2005). This includes strategies for institutional design, where knowledge about the nature and variety of institutional rules that guide the behaviour of actors within policy networks is used to influence network rules. **The Design Approach** as applied by Waardenburg et al. (2020) offers a design approach specifically for collaborative governance forms, including small-scale experiments and co-creation of innovative solutions, fitting the dynamics and uncertainty of contemporary societal challenges.

Evaluation tools can further improve institutional design. The **Framework for Analysing Leadership Functions, Tasks and Strategies**, developed by Meijerink and Steller (2013), can be used to assess different forms of leadership in interorganizational networks. This tool distinguishes five key leadership functions that need to be fulfilled to achieve transitions. Closely related is the **Adaptive Capacity Wheel** (Gupta et al., 2010), an assessment tool developed in the Knowledge for Climate research program, to evaluate the adaptive capacity of institutions. It can show the strengths of existing institutions and where adjustments are needed. Besides the use of independent assessments by researchers, the tool can also be used to allow practitioners themselves to reflect on the institutional context within which they operate. This coincides with **Process Management** (De Bruijn et al., 2010), as part of which diverse strategies can be employed to motivate actors and bring about change in institutions. For technological change, the **Technology Assessment** offers an interactive and communicative method to form a public opinion regarding the desirability and the way of institutionalising new technologies (Van Est & Brom, 2012).

Finally, within governments, new principles and ways of design methodology are emerging. Contemporary policy, for example, relies less on cost-benefit analyses and leans more on ethical, environmental, and societal interests. Emblematic is **Vision Zero**, an established Swedish policy approach based on the ethical principle that every traffic fatality is socially unacceptable (Johansson, 2009). As a result of this program, a series of technological, institutional, and behavioural measures have been taken that significantly reduced the number of traffic fatalities in Sweden. The Vision Zero principle is now applied in other countries and in various domains, such as healthcare and environmental policy. More recently, many countries have embraced mission-driven innovation policy, seeking a more integral policy that starts from a societal challenge and translates it into a mission with concrete policy goals.

At the same time, new policy instruments are being designed that can adapt to societal changes. An example is the **Right to Challenge**, which has its roots in the United Kingdom but is now also implemented in the Netherlands (Ministry of Economic Affairs, 2016). With a view towards a participative society, the Right to Challenge grants social groups the legal possibility to achieve or even take over the objectives of a statutory regulation in an alternative way. This example demonstrates that governments are willing to weigh the opportunities for innovation against the burden of additional oversight and uncertainty. Recent developments in transition management (Loorbach et al., 2021; Hebinck et al., 2022), aimed at designing new institutions and practices, as well as phasing out existing institutional arrangements, build on the design methodology of institutional change.

6.3 CHALLENGES AND RESEARCH QUESTIONS

CHALLENGES

Van Bueren and Klievink (2017) identify five institutional challenges: 1. a fragmenting decision-making structure (as a result of decentralisation and deregulation), 2. increasing dynamics within decision-making (where institutions are transforming and breaking down), 3. the emergence of a participatory society, 4. the diminishing role of knowledge in policy processes (accompanied by a shift towards data-driven methodology), and finally 5. expanding policy discussions.

While these challenges, often fueled by societal transitions and technical innovations, rapidly succeed one another, institutional change is inherently slow. There lies a constant danger that existing institutions no longer align with the new reality or provide insufficient space for transitions and innovation. Concurrently, institutional voids may arise, where there is no fitting institutional framework to address and solve the issue at hand (Pelzer et al., 2019). Innovative companies like Uber and Airbnb often exploit such gaps to launch new technology and business models, thereby disrupting institutions on one hand, but also triggering a reflective process that can lead to new institutions. In other cases, there may be institutional congestion, where an issue can be addressed from multiple regulatory frameworks. The question then is which framework is applied and under what circumstances a new framework can emerge.

As a result of constant challenges, we must look towards new ways and methods of institutional change. This can be intentional through deliberate interventions, but also often occurs through processes of emergence, evolution, and serendipity. In reality, it's mainly a combination of conscious and unconscious action. The challenge for policymakers is how to steer institutional change under dynamic, complex, and uncertain conditions. Although various solutions present themselves, each harbours an apparent dilemma. For example, how to deal with institutional inertia versus highly dynamic change? Softening institutions and allowing them to adapt may offer a solution, but at the same time, this can also undermine mechanisms of institutional stability, such as the constitution. Transformative and rapid change can be an effective means to close institutional voids but often leads inevitably to frictions with existing institutional structures.

These dilemmas are also rooted in the methodology of institutions. Emergence methodology is often better able to appreciate time-bound and context-dependent variables - which there seems to be a need for right now - but often struggles with generalising and extrapolating. The design approach offers concrete solutions, but because institutional change is comprehensive, it can only contribute partially. Therefore, there is no one-size-fits-all institutional recipe. The greatest challenge might ultimately be finding balance and integration. How can emergence and design methodologies of institutional change be brought together to support transitions and, most importantly, not obstruct them? To this end, disciplinary approaches from public administration and political science may fall short, as they start from market and state as the two logics. However, institutional theory is equally used in public administration and political science as well as in more interdisciplinary fields such as organisational, innovation, and transition studies, and can thus be employed as an integral framework for interdisciplinary studies into socio-technical and socio-ecological transitions.

RESEARCH QUESTIONS

The challenges described above raise new research questions, including at least:

- What is the role of new organisational forms in mobilising resources, commitment, and knowledge regarding social problems and possible innovative solutions?
- What is the role of leadership in bringing about institutional change, and what new forms of leadership are needed for this?
- How can successful practices and institutions be transferred from one context (domain, sector, region, time) to another context?
- How can institutions adapt to technological dynamics on the one hand and maintain their desired steering effect on the other?
- How can a radically new solution to a social problem gain support among those involved?
- How can institutional arrangements to promote transitions be designed in collaboration with citizens and stakeholders?
- How can we shape mission-driven innovation policy, including its governance and evaluation, so that it is both effective and legitimate for those involved?
- How can new legislation and regulations accelerate transitions and at the same time strengthen bottom-up initiatives?
- Which research methods (Process Tracing, comparative research, experimental research, discourse analysis, Constructive Technology Assessment) are appropriate to study institutional change?
- Which transdisciplinary approaches are effective in studying and driving institutional change processes?

NEED FOR NEW METHODS

The institutional environment within which transitions occur has become increasingly diverse and dynamic. Here, new and experimental methods can aid in learning from institutional change, such as Living Labs that gain new insights into the micro-processes of change. New methods can build on previously mentioned methods, such as Incremental Change, Institutional Logics, and Comparative Methodology. This can lead to new insights into the institutional mechanisms that determine the effectiveness and lifespan of transitions. For instance, regarding matters such as what can contribute to breaking through existing power structures, which have an interest in maintaining the status quo, or in a better understanding of why many attempts at desired societal change fail while only a few are successful. This means we must also distinguish between aspects of institutions that are changeable and negotiable, with a view to under which conditions, how, and by whom. An important aspect therein is the time factor, which calls for methods that go beyond a snapshot and offer the possibility to observe and monitor over a longer period. At the same time, historical insights can help understand how current societal issues have been resolved in the past. After all, innovation is something that exists throughout all times.

Additionally, within the design methodology of institutional change, many steps can be taken to better align with transitions. One of the possibilities for this is Technology Assessment and Participatory Monitoring, where citizens or other stakeholders are involved in monitoring the effects of interventions. This also includes new methods specifically aimed at network governance and promoting collaboration between different actors and sectors. It can lead to an increase in trust between parties and ultimately more support for innovations. Recently, various initiatives have emerged from the government, such as the new Environmental Law or the discussed Right to Challenge, which provides a rich breeding ground for developing new insights and methodologies. Furthermore, there is renewed interest in more top-down policies, such as mission-driven innovation policy, transformative policy, and stronger regulation, which can go hand in hand with initiatives that have more of a bottom-up character. When new, clear frameworks are set by governments, it can further strengthen the development, funding, and legitimisation of alternatives. All this, however, places new demands on the design and evaluation of government policy (Ter Weel et al., 2022).

Finally, there is a great need for methods that can integrate insights from emergence and design methodology. Although promising steps have been made for both over the past three decades, they often stand apart from each other. Moreover, institutional methodology is spread across different disciplines such as economics, political science, law, and sociology, as well as in interdisciplinary fields like organisational, innovation, and transition studies. Here too, integration is desired. Transitions in areas such as climate, mobility, and agriculture are a good example that many solutions can no longer be approached from a single discipline. For the time being, there are a multitude of analysis methods, but the field of systematically developing a framework is sparse.

These described challenges also raise new research questions, including:

- How can we design mission-driven innovation policies, including their governance and evaluation, so that they are both effective and legitimate for stakeholders?
- How can new legislation and regulations accelerate transitions while simultaneously strengthening bottom-up initiatives?
- Which research methods (Process Tracing, comparative research, experimental research, discourse analysis, Constructive Technology Assessment) are suitable for studying institutional change?
- What transdisciplinary approaches are effective in studying and driving institutional change processes?

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7. SYSTEMIC CHANGE

7.1 INTRODUCTION

To understand and influence current societal crises and turbulence, a systemic perspective is essential. The (complex adaptive) systemic perspective complements traditional natural science reductionism. While reductionism seeks explanation and improvement by analysing the elements of an issue and looking for linear cause-effect relationships, a systemic perspective shifts our focus to the relationships between those elements and their impact on the stability or change of the whole. In the context of KEMs we're talking about a transition or tipping point of societal subsystems such as healthcare, education, mobility, or energy, but also a ministry or city. Complex societal systems are characterised by their subjective delineation and unpredictability in their (emergent) behaviour. Systems contain a multitude of elements and (inter)relationships, forming a complexity characterised by non-linearity, co-evolution, emergence, and self-organisation. As a result, systems cannot be controlled or managed through central direction. However, systemic change is the outcome of various types of behaviour (agency) and is therefore influenceable. Donella Meadows (2001) refers to this as 'dancing with systems'. It is important to develop knowledge on how we can influence systems to move in a desired direction; on how our values and the characteristics of a system can work together. In this strategic learning process, the connection between the systemic perspective, the dynamics within that system, and the intervention is central. Given the systemic lens and the dynamics we observe, how and where do we want to intervene? And what dynamics result from our intervention?

To illustrate: A transition to CO2-neutral mobility requires changes at micro, meso, and macro levels. For example, in their daily lives, people may make choices about modes of transport, time planning and other weekend outings (micro level), organisations like Shell make choices regarding business models, production lines and markets (meso level), and governments make choices at national and international level about the infrastructure of charging stations and CO2 legislation (macro level). This can mean that the systemic conditions for an intervention to be considered effective depend on the level at which it is implemented and the anticipated systemic effects. For example, a charging station infrastructure is a precondition for the adoption of electric vehicles, and the increase in electric vehicle sales will affect Shell's profit figures, which, in its turn, will intensify political lobbying, while at the same time multiple services related to electric driving utilise these networks.

The KEMs within this category are therefore aimed at understanding the interactions between these levels, including their temporal and geographical dimension, investigating the patterns and dynamics of systemic change, influencing it, and learning from these interventions, thereby improving strategy. Logically, more specific KEMs play a role within this, such as methods for **Participation and Co-creation**, **Monitoring and Effect Measurement**, and **Vision and Imagination**.

To understand a complex societal system, knowledge from different disciplines and stakeholders is needed; a transdisciplinary approach. This will always require a choice to be made in determining systemic boundaries and the types of knowledge we wish to consider in exploring a system. This is done based on our values, our worldview, and assumptions. In addition, to intervene, different interventions must be viewed in conjunction. A network approach is proposed, complementary to existing approaches such as top-down policy, in which different organisations and stakeholders learn and experiment together. Besides knowledge production, these processes are inherently social learning processes: new and shared insights emerge, leading to a change in the actions of the involved parties. Systemic change methods therefore also include methods such as reflexivity and dialogue, which address differences in values and perspectives and promote transdisciplinary work (Popa et al., 2015).

Based on a wide range of system theories, such as complex system theory and cybernetics, methods are developed from various disciplines and fields to understand and guide systemic change (such as transition management, organisational design, systemic design). KEMs in this category help to embrace complexity and navigate a long-term course. They address questions like: what drives systemic change? How do we design systemic change processes? How and where can we best intervene in the system to accelerate the desired transition? And, how can conditions be created that enable societal systems to continuously change themselves?

7.2 STATE OF THE ART

The Netherlands is home to leading academics who study the dynamics of complex societal systems and strive to better understand how we can intervene within these systems to shape transitions. An article in the journal Research Policy that outlines the development of the field of 'sustainability transitions' (Markard et al., 2012) highlights how the Netherlands is a front-runner in developing knowledge in the area of **Transition Management** (see also Kemp et al., 1998; Rotmans et al., 2001), **Transition Pathways** (see also Geels & Schot, 2007), and **Technological Innovation Systems** (Hekkert et al., 2007). Much of this work has been brought together to lay the foundation for a theory of transitions for sustainable development (Grin et al., 2010). A review paper from 2017 shows how the field has then developed globally and how the social and ecological dimensions of transitions have come to the forefront (Loorbach et al., 2017). Within the area of systemic design, there is a growing group of Dutch academics contributing to the development of this relatively new field of knowledge (Sevaldson & Jones, 2019; Van der Bijl-Brouwer & Malcolm, 2020) and who convene in various networks such as the Expert Network on Systemic Co-design and the international Systemic Design Association.

Societal systems are complex dynamic systems, meaning they are constantly undergoing changes: new services are developed, new technologies enter the market, decisions are made to do things differently, task agreements are changed, or new players enter the market. In this sense, complex systems are always in motion. Research into systemic change and influence is also continually evolving, with various trends identifiable in studies on transitions and systemic design. The literature on transitions is rapidly growing, but a meta-study shows that research into transitions in practice is still limited (Köhler et al., 2019). Recent research into transitions has focused much on destabilisation and phasing out (breakdown), alongside research into niches, transformative social innovation, and emergence (build-up). In this context, the actors within the 'regime' and their position are also receiving increasing attention: how do they deal with 'transition pain' or 'transition space', and what is the role of 'activist public servants'? There is also a shift in research into the role of governance in transitions and active influence (transition

management). The 'transformative government' and 'transformative innovation policy' align with thinking about a new and more robust role for central governance. In the field of systemic design, traditionally focused on system visualisations, there is growing attention to the integration of system theories with design methods and practices such as meaning-making, framing, and co-design. Moreover, research into designing for a system is increasingly supplemented with 'designing from within'. Here, designs and infrastructures are developed to facilitate design by system actors, for example, from the perspective of **Service Ecosystem Design** (Vink et al., 2021).

Methods that support the realisation of systemic change can be divided into four subcategories: methods that 1. explore and model a system according to a chosen system perspective and conceptual framework to understand its dynamics, 2. are focused on developing innovative experiments and interventions, 3. help organise the process of intervention development as systemic change itself, and 4. facilitate and stimulate dialogue and reflexivity in the process. These methods are closely intertwined. To understand a complex system, intervening is crucial (Snowden & Boone, 2007). And since an objective perspective on complex, societal systems does not exist, dialogue and reflexivity are essential elements in choosing a systemic perspective (Checkland, 1999).

METHODS FOR MODELLING THE SYSTEM (UNDERSTANDING DYNAMICS)

To determine the strategy for influencing a desired systemic change, it's necessary to understand the current landscape. Based on a chosen system lens or conceptual framework questions are asked, such as: who are the key players (in terms of power or interest)? What are the dominant frames? How is value exchanged and which innovations are being pursued? The connections and relationships between these system elements are especially important, as well as their effect on the dynamics of the system under consideration. Various disciplines offer methods for this, for example:

- **X-Curve Analysis.** This method is based on the insight that systemic change arises from the interaction between a destabilising regime and emerging niches. The X-Curve allows for the analytical and/or participatory mapping of patterns and mechanisms in a specific context. It lays the groundwork for positioning and a shared perspective on a transition and thereby for later interventions. It can be applied both qualitatively and quantitatively (Hebinck et al., 2022).
- **Process Method TIS Analysis.** This method is positioned within the perspective of Technology-Innovation Systems (TIS): the network of interacting agents in the economic field that operate within a certain institutional infrastructure and are involved in the generation, diffusion and use of technology. The Process Method studies the mechanisms underlying technology change over time, through data analyses of events at the micro level (such as meeting reports and organisational reports) or system level (newspaper archives and trade journals) (Hekkert et al., 2007).
- **Gigamapping.** This method falls within the pluralistic systemic design approach, where a conceptual lens is pragmatically chosen based on the characteristics of a complex issue. This can involve ecological, technological, societal, personal, cultural, political and legal, economic, and/or demographic lenses, as well as both micro and macro perspectives. A mixed-method approach, for example, stakeholder interviews, user observations, and dialogue sessions, is used in a gigamap to bring together different perspectives and the resulting elements and relationships (Sevaldson, 2011).
- **Social Structure Analysis.** This method highlights the invisible social structures of systems and institutions: norms, rules, roles, and beliefs that play a significant role in systemic change. The social structures are identified by participatory analysis of the visible effects of these structures on behaviour, relationships, symbols, and artefacts (Vink & Koskela-Huotari, 2021).

METHODS FOR DEVELOPING AND EVALUATING INTERVENTIONS (HOW TO INTERVENE)

Guiding systemic change is complex. Methods are required that help develop interventions and provide a reference for making strategic choices. What is our shared vision of how change will come about? Which interventions do we see as most effective? Which initiatives exist that we need to scale up?

- **Leverage Points.** The concept of leverage points identifies places within a complex system where a small change can lead to significant system-wide impacts (Meadows, 1999). Meadows identified twelve leverage points in order of effectiveness, with the least effective level being the manipulation of constants, parameters, and numbers (such as subsidies or standards). The most effective levels involve the mindset or paradigm out of which the system arises and the power to transcend paradigms. These levels can be used to design and evaluate interventions (Murphy, 2022).
- **Transition Governance.** Transition governance distinguishes four types of governance (build-up, adapt, break-down, and guide). '*Sturing in transities*' (Bode et al., 2020) translates this into a method to identify interventions in these four quadrants based on the transition analysis. Combined with insights into the different roles of governments, this framework provides a basis for a transition strategy that intervenes in various dimensions of a societal transition.
- **Transition Design.** Transition design promotes a design-driven societal transition towards a sustainable future. It is based on a concept for a completely new lifestyle that is developed locally and on a human scale, while being globally networked in the exchange of information and technology. The framework encompasses four key areas (vision for the transition, theory of change, attitude and mindset, and new ways of designing) for which narratives, knowledge, skills, and actions can be developed (Irwin, 2015).
- **Multicriteria Mapping.** This method helps map different perspectives on various policy options for systemic changes. Through a structured interview technique and computer analysis, all options are examined symmetrically by different actors, considering both social and technological aspects (Stirling et al., 2007).

METHODS FOR ORGANISING TRANSITIONS

It's impossible to achieve systemic change from the outside without engaging with the system. This means that actors or companies aiming to steer systemic change must strategically consider how to engage with and shape their relationship with the existing system. How do you form a network with a shared mission? How do you structure the process? How do you distribute roles and build new cooperation structures? And how can a network of stakeholders 'pilot' accomplish systemic change by experimenting together with new means and processes?

- **Transition Arena.** In this method, a selective group (an innovation network) with diverse perspectives and roles works on a future vision and transition path for a specific transition (Loorbach, 2014).
- **Sociotechnology.** Sociotechnology demonstrates how (networks of) organisations can be integrally changed to contribute to society. This starts with the structure (how tasks are divided and linked). What a 'better structure' entails varies with every concrete context. Sociotechnics offers a tool to design and redesign structures per context (De Sitter, 1994).
- **Transformative Practice.** This design-driven approach helps multi-stakeholder teams explore, design for, and innovate in response to complex systemic societal challenges. By playfully experimenting with different configurations of people and mediations (through products, systems, environments, services, policy instruments), the personal and social ethics and related behaviours of (groups of) people are transformed.

METHODS FOR COLLABORATIVELY LEARNING FROM CHANGE

As mentioned earlier, complex dynamic systems cannot be controlled. We must learn to 'dance' with systems. Drawing on, for example, Eastern philosophies, we must apply our Western knowledge, often acquired from reductionist paradigms, in our practices to guide transitions. This requires reflexivity. How can we learn as effectively as possible from our actions while acting?

- **Pragmatic Reflexivity.** Traditional reflexive approaches aim to generate consensus. In contrast, Pragmatic Reflexivity is an open, transformative, and action-oriented collective process of reframing the issue and underlying values, ideologies, and power structures. The methodology consists of joint experiments and social learning with both scientific and non-scientific expertise (Popa et al., 2015).
- **Dialogic Design.** This method, as part of co-design, allows different stakeholders to contribute their specific ideas, skills, and culture and take action. The problems and tensions that may arise are discussed using a dialogue technique, where actors apply listening skills, may change their minds, and converge towards a shared perspective (Jones, 2014; Manzini, 2016).
- **Reflexive Monitoring.** This method, emerging from social learning and transition research, can be used to promote transformative learning among parties working on a transition in a specific area or policy practice (Beers & Van Mierlo, 2017). The Reflexive Monitoring handbook outlines the steps and principles, but the method has significantly developed in practice and is now widely used as a modern form of monitoring and evaluation in policy processes (Van Mierlo et al., 2010).

7.3 CHALLENGES AND RESEARCH QUESTIONS

As early as the 1970s, the Club of Rome explored the limits of our world systems and their constraints on human numbers and activity. This resulted in the report Limits to Growth which, using computer simulations, showed that there is a limit to economic and population growth (Meadows et al., 2004). Rather than economic growth, governments should focus on resilience and adaptation. The COVID-19 crisis could not make it clearer how crucial it is for our society to develop systems that are resilient: capable of adapting or transforming when the environment demands it. This requires innovative capacities from organisations, as well as system properties of society itself, such as diversity and flexibility. Therefore, we need methods that answer questions like: how can we increase a system's adaptability? How can we develop better transdisciplinary action research in this context? How can we better monitor and understand systemic change in the long term? How can we organise government, the private sector, science, and society as a learning system?

ADAPTIVE SYSTEMS

This cluster concerns the conditional properties of complex societal systems that promote adaptive and regenerative system behaviour, and guiding desired changes:

- What are the general and sector-specific conditions under which societal systems can adapt to changing circumstances and innovate responsibly?
- How do we deal with issues in 'chaos' where there are various competing interests about where a system should go? What is a suitable participation model? Which actors should be involved in which phase?
- How can we guide the dismantling and phasing out of existing structures? How can we link existing initiatives and systems?
- How can we develop open structures and interventions that increase a system's adaptability?

INTER- AND TRANSDISCIPLINARY (ACTION) RESEARCH ON SYSTEMIC CHANGE

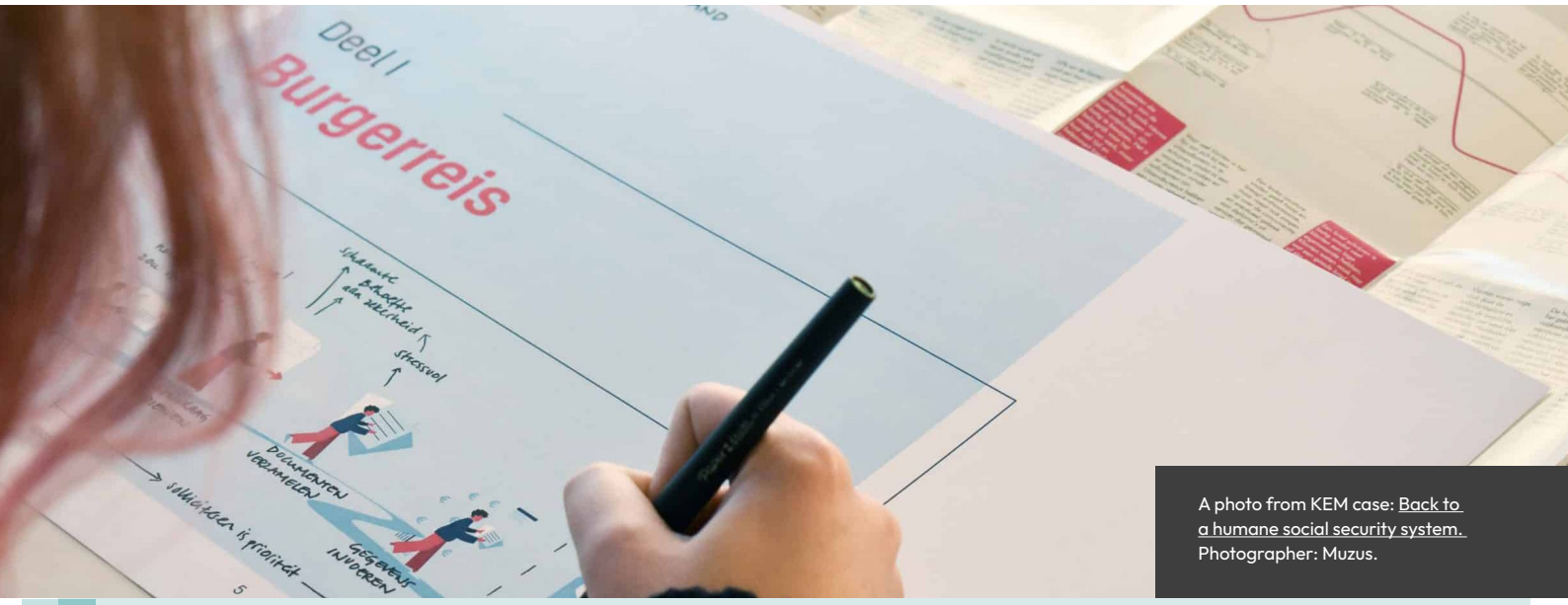
A common critique of the field of systems thinking is the emphasis on understanding systemic changes that have already taken place and sharing this knowledge among academics, instead of exploring what a systemic approach could mean for the future and sharing that with societal actors (Ackoff, 2004). Hence, the rise of transdisciplinary action research in recent decades. Through active experiments and the development and implementation of initiatives, this research contributes to knowledge about how systems behave and how we can influence or guide them. A transdisciplinary lens ensures the integration of knowledge from both the academic and societal domains. Questions include:

- What are effective leverage points for conducting innovation experiments?
- What are methods for designing systems interventions that focus on the social and emotional dimensions of change, for example influencing mental models, paradigm shifts and human relationships?
- How do we stimulate transdisciplinary action research and make academic research more entrepreneurial?
- How can bottom-up and top-down changes be better balanced? Bottom-up often initiates from niches, but such situations will only work if the regimes adapt. How do the niches within regimes work?
- How can public administration play a greater role in systemic change? How can complexities of public administration and transition studies be combined to enable them to play their role so much better?

MONITORING SYSTEMIC CHANGE AND MAKING LONG-TERM ESTIMATES

A point of concern is that changes within society and the economy are happening faster than science can keep up. In addition, we would like to understand long-term systemic change. This leads to questions like:

- How can we better monitor systemic change?
- How can we understand long-term changes and develop indicators of change?
- How can we develop better cost-benefit studies for transitions?
- How can we better understand the coordination between systemic changes in different domains?
- How can we use different qualitative and quantitative methods to monitor and understand systemic change in the long term?



A photo from KEM case: Back to a humane social security system. Photographer: Muzus.

SYSTEMIC AWARENESS, REFLEXIVITY & COLLABORATIVE LEARNING

At the heart of effective systemic change and societal transitions is a structured form of collaborative learning about our perspective on the system, what we learn about that system, and our role in intervening in the system. Relevant questions include:

- How do we involve different system actors in the system perspective? How can we guide actors in understanding different worldviews and perspectives? How do we make them aware of qualities of resilient systems such as flexibility and diversity?
- How can we ensure that values and beliefs underlying systems change along with desired transitions? (deep transitions)
- How can we make tensions within a societal system productive? How do we prevent polarisation from limiting learning?
- How can we help system actors develop skills that encourage dialogue and adaptive leadership?
- How do we assist system actors to be reflexive about how they are engaging with systemic changes?
- How do we stimulate knowledge transfer between system actors? How do we create a learning system?
- What are new forms of public, private, civil cooperation?

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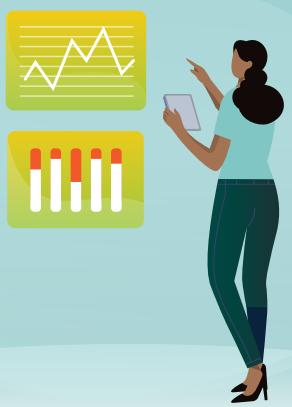
8. MONITORING AND EFFECT MEASUREMENT



8.1 INTRODUCTION

Given the long horizon and unpredictable nature of (changes to) systems, monitoring and (interim) evaluation of the effects of interventions are particularly relevant for transition issues. This process gains knowledge about the possible effects of the intervention methods. This knowledge can be directly implemented into the process to support iterative development and adjustments. Interventions often take place in an uncertain, complex, and dynamic environment, where the ultimate effects are also dependent on other factors and systems, such as breakthroughs and innovations abroad. Therefore, it's important to gain insight into the changes during the intervention, in terms of direction, speed, and impact. Although these measurements mainly occur during and after an intervention, it's very important to think about monitoring and effect measurement especially before the start of the project.

For proper monitoring and effect measurement, it's crucial to have an unambiguous understanding of the end goals, to select and develop the right indicators for these, and to align the methods accordingly. Key Enabling Methodologies (KEMs) in this category thus help monitor the process, measure the effects and contributions of interventions, and monitor the impact on the system. This develops insight into the course of the project or program and the uncertainties associated with it. The methods provide important information to adjust the intervention during its trajectory. Due to the complex and dynamic nature of transition issues, it should be possible based on progress to adopt an adaptive approach, including a policy mix and methods, which can be adjusted during the process. Monitoring and evaluation are thus not only used to inform and provide political and administrative accountability but also to enable politics and policy to maintain a better course and, where necessary, shift it by learning and providing space for improvement and adjustment. In addition, it's important that the monitoring and effect measurement are transparent, thereby contributing to maintaining and increasing support and involvement.

Below, an overview is provided of different KEMs that can be employed within mission-driven transitions to measure progress and effects. We discuss various goal-oriented and learning KEMs and identify the main challenges for these methods. The KEMs in this category answer questions such as: how can we measure and analyse the effects of an intervention on the entire system, in the short and long term? How do we also capture the unpredictable and unintended effects and dynamics? How can we analyse the value created by the interventions and changes? Which interventions and instruments work under which conditions and when do they not? How can we learn from the results of monitoring and evaluation, and how can the learned lessons be scaled up? What does this mean for the continuation of your monitoring and evaluation? How can transitions be steered through monitoring and evaluation, from a perspective of broad well-being?

8.2 STATE OF THE ART

Measuring progress, effect, and impact in transition issues is essential to demonstrate whether the predetermined goals have been achieved and whether this can be attributed to the interventions carried out. This involves not only the direct effects (output) but also the expected and unexpected changes that occur (outcome), the reasons for these changes, and the impact of these changes on systems. During the monitoring of progress, information and data can be systematically and/or continuously collected and analysed. Since monitoring takes place during the project or program, it is possible to make timely adjustments if things are not going according to plan. Impact measurements complement monitoring activities, providing in-depth and objective insights into the relevance, efficiency, effectiveness, impact, and sustainability of the intervention at certain times.

The use of appropriate KEMs depends on the intended goal and the context in which the transition takes place. Interventions with a clearly specified end goal require a different method of monitoring and effect measurement than interventions aimed at structural change where the desired end goal is (still) unknown. This also applies to the environment in which the change takes place. Changes in complex and dynamic systems cannot be monitored with methods based solely on, and/or dependent on, protocolled data, structure, and certainty. This requires new methods and new data sources.

The methods in the overview below are explained using a conceptual framework that describes the dynamics of monitoring and adjustment. This framework distinguishes methods focused on 1. **goal-oriented** monitoring and effect measurement, methods focused on 2. **learning** monitoring and effect measurement, and methods focused on 3. **systemic** monitoring and effect measurement. Methods of goal-oriented monitoring and effect measurement often start with predefined goals, where progress is monitored through measurable indicators selected at the beginning. The strength of these methods lies mainly in accounting for project goals and demonstrating the relationship between activities within the intervention and the outcomes. Learning methods are better equipped to deal with uncertainty about the approach beforehand and with unexpected effects during the process, where the strategy can be adjusted based on changes during the intervention. Systemic methods are primarily intended to view transitions from a system perspective. A characteristic of systems is that they consist of interacting elements, so the functioning of systems cannot be inferred from information about individual elements. The strength of these methods lies mainly in accounting for the effects of transition-driven policy on different individual elements and at various levels (such as a project, program, or policy mix as a whole). Systemic monitoring and effect measurement are thus particularly useful for better maintaining and, if necessary, adjusting the course.

GOAL-ORIENTED METHODS

Methods based on goal-oriented monitoring and effect measurement are mainly applied to account for projects and interventions. By establishing the project's goal before starting the project, indicators are chosen that can demonstrate whether or not the goals have been achieved. It is therefore important to have a clear and unambiguous picture of the expected effects of the intervention beforehand. These methods are highly regarded within academia. However, they are often unsuitable for interim testing of assumptions and for adjustments during the process. The **Randomised Controlled Trial (RCT)** is an example of a project evaluation method that provides insights into the direct relationship between activity and result because the effects of the intervention are compared with the effects on a comparable population (the control group) without the intervention (Donaldson et al., 2015). However, experiments with a randomised and controlled design are often time-consuming, cumbersome, and static. Small-scale experiments with randomisation – such as those used in **Rapid Cycle Experiments** – can quickly gain insights into which parts of an intervention work, to further develop and optimise the intervention based on that (Johnson et al., 2015).

Using a **Cost-Benefit Analysis** (CBA), an accurate estimate of the expected effects of the intervention can be made in advance. This method maps out the positive and negative effects and is therefore used to account for policy measures. The method focuses on the welfare effects of the measures and can also estimate so-called soft effects, such as the impact on culture, happiness, and well-being. CBAs demand high-quality information and research methods used as input, making this method limitedly useful for unstructured and incomplete datasets and projects with uncertain outcomes. Especially within transition issues with a complex nature, these are aspects that often arise (Koopmans et al., 2016). After the intervention, variants of the CBA can be used as evaluation measurements, such as cost-effectiveness analysis. With the help of surveys and the registration of indicators, a clear picture is painted of improvements and changes after the intervention. An example of this is the Healthcare Monitor, which provides insight into the performance of the healthcare system using a broad set of predefined indicators (Van den Berg 2011).

LEARNING METHODS

Transition issues often involve complex changes in systems where both the required approach and the expected effects of this approach are difficult to estimate in advance. Therefore, transition issues typically require a method of monitoring and effect measurement that is dynamic and adaptive, ensuring the desired outcome is achieved. To facilitate transitions, it's about the direction of change and adjusting it where necessary (Janssen, 2023). From various disciplines, methods have been developed that match the uncertain nature of transition issues and move along with the changes of the transition. For instance, in data science, recent developments in AI and big data have introduced new methods for monitoring and effect measurement (Geurts et al., 2022). **Data-Driven Predictive Analysis** can generate real-time insights into the effects of interventions. More on the opportunities and challenges of these methods is discussed in the section on challenges and research questions.

In behavioural sciences, we see the emergence of methods trying to combine dynamic monitoring with scientific accountability known from randomised trials. For example, **N-of-1 Studies** (or **Single Case Design**) can monitor the direct effects of interventions on behaviour, based on repeated quantitative measurements of an individual over time (McDonald et al., 2017). A significant advantage is that the intervention can be developed and adapted during the measurements. Another advantage is that the baseline can be different for each participant, providing insights into individual differences, the effect of context, and minimising statistical disadvantages of variance in the target group. However, N-of-1 Studies are mainly suitable for digital behavioural interventions and highly depend on the participants' adherence to the intervention. Yet, this is a promising method for transition issues with a component of behavioural change. Other promising methods that identify working mechanisms in design propositions and interventions are **MOST - Multiphase Optimisation Strategy** (Collins et al., 2007), and **CIRO-logic** (Denyer et al., 2008).

Reflexive Monitoring in Action (RMA) is a participatory method for monitoring and effect measurement developed to monitor the progress of system innovations (Van Mierlo et al., 2010). It facilitates the development of learning processes during transitions, thereby stimulating the determination of the direction of the transition. The goal setting, approach, and indicators evolve with the progress of the process. Although the specific monitoring tools vary by topic or ambition, these activities must be an integral part of the transition. Examples of methods applicable in RMA include **Theory of Change, Learning History,** and **Most Significant Change Method** (see, for example, Wittmann et al., 2022; Janssen et al., 2022; Kroll, 2019). The monitoring process cycle consists of the steps 'observing', 'analysing', 'reflecting', and 'adjusting activities'. Because reflexive monitoring is an adaptive method, directions can change during the project, and unexpected effects can be mapped. The participatory nature of reflexive monitoring is very important. To achieve institutional change, it's essential that all stakeholders are involved, looking for synergies in policy and policy processes and to what extent these match the prioritised directions.

Related to reflexive monitoring is the **Measure Know Act Methodology**, developed for the Delta Programme (Loeber & Laws, 2016). Structured reflection moments stimulate 'learning during the intervention', making it possible to respond to new developments, slow down or speed up activities, and adjust the strategy based on changes in systems. Steering is based on four main questions: 1. is the project on schedule (budget and time)? 2. Is the project on course (are goals being achieved)? 3. Is an integrated approach being applied? 4. Is there broad participation of stakeholders?

SYSTEMIC METHODS

Transition challenges often involve complex changes in systems. It is difficult to measure the outcomes of transitions because they lie far in the future, since outcomes often arise not linearly but from interacting elements, and because causality is a challenging concept in the context of transitions and system changes (Janssen, 2023; Baarslag et al., 2024). Therefore, it becomes increasingly important to also monitor and evaluate from a systemic perspective, paying attention, possibly through sub-analyses, to underlying processes and interacting elements.

In the literature on mission-driven innovation policy, the emergence of a new type of evaluation frameworks focusing on 'system lenses' is noticeable (Janssen, 2023). Such evaluation frameworks use 'metatheories' to better understand missions and transitions. Examples of such frameworks include the **Mission-Driven Innovation Framework** (Elzinga et al., 2023), frameworks based on socio-technical systems and transitions (Haddad & Bergek, 2023), or frameworks based on the multi-level perspective (Ghosh et al., 2021). The advice often is not necessarily to investigate the (effects on) the whole system but to use a system perspective to look at specific parts of that system. A system lens thus offers a framework to examine processes important for realising transitions and transformations.

The system lens is also characterised by an awareness that focusing on economic growth (often expressed in gross domestic product) has become too limited a measure of prosperity, and that sustainability and social aspects must also be included in monitoring and evaluation. Economists, policymakers and administrators are increasingly speaking about 'broad prosperity' and the need to manage this. In the Broad Prosperity Monitor, CBS (2023) defines broad prosperity as "the quality of life in the here and now and the extent to which this is or is not at the expense of that of later generations and/or that of people elsewhere in the world." Applied to transition issues, it therefore concerns the considerations of how scarce resources are used to achieve social goals by trading off between the three main elements of broad prosperity (economy, sustainability and social aspects) and their interaction in time and space ('here and now', 'later' and 'elsewhere') (De Groot, 2023; Van Bree & De Jonge, 2022). However, how concretely broad prosperity can be managed has not yet been fully crystallised, as is also evident from the podcast series by economists' journal ESB on this subject ('Prosperity. The broad podcast', autumn 2023).

8.3 CHALLENGES AND RESEARCH QUESTIONS

Existing methods for monitoring and effect measurement are continually being developed, and new methods are being worked on, as described above. Within this KEM category, there are significant challenges across various areas with accompanying research questions that require attention in the coming period.

LEARNING, ADJUSTING, AND ACCOUNTABILITY

Goal-oriented methods of monitoring and effect measurement provide scientifically based insights into the relationship between project activities and visible results for accountability purposes. However, adjustments during the process based on monitoring and effect measurement are often minimally facilitated. Learning and systemic methods allow for adjustments given the uncertainty in transitions. Part of learning about transitions is that certain innovations or policy measures may not prove effective, necessitating adjustments to try a different approach (Maas & Suurs, 2023).

But how do we know if these adjustments are improvements, or which interventions work? How reliable are the initial insights that serve as input for iteration, enabling the approach to be adjusted? It is important in such transition monitoring to strike a balance between methods of monitoring and effect measurement with sufficient scientific 'rigour' on one hand, and useful and applicable methods for monitoring changes in complex systems on the other. Is the development of new methods required, or is the adaptation of existing methods sufficient? And how important is it to 'statistically' substantiate all decisions?

Additionally, the current practice of monitoring and effect measurement is strongly based on existing administrative principles, such as the gold standard focused on the efficiency, effectiveness, and legality of policy (Van der Steen et al., 2018). This makes it difficult to experiment with new, transition-driven methods of monitoring and effect measurement (Baarslag et al., 2024). How can experimenting and learning be encouraged in a policy world focused on accountability?

Possible research questions include:

- How can we test assumptions in the design process in an insightful but non-burdensome way, such that it provides us with an evidence-based foundation for further developing the intervention?
- How can we test the designed intervention in a way that provides us with useful information about changes at the system level and context level, and about the generalizability of the intervention (effectiveness of underlying mechanisms), without hindering or freezing the design process and development of the intervention for a long time?
- How can monitoring be used to support learning processes on which policy can be adjusted to better steer (the preconditions of) transitions?
- How can the practice of monitoring and effect measurement be renewed in light of transitions, and which experiments can support this development?
- How can accountability be provided for a long-term transition?

QUANTIFYING SYSTEMIC AND SOCIETAL IMPACT AND THE ROLE OF SELECTED INDICATORS

Change within systems is difficult to objectively and completely map. It is often challenging to analytically formulate an optimal plan to achieve such changes beforehand. Additionally, a change within systems often involves more than just direct and expected effects. How can the system be understood and captured? How can a change in the system be made visible? How do we map indirect and external effects? Indirect effects often become apparent late and are difficult to quantify or, for example, monetise.

Furthermore, the choice of indicators or certain methods or tools can also determine the form and direction of the interventions. We see that the development strategy is determined by measurable indicators or KPIs. But is this the right strategy, and how important are data or indicators that cannot (yet) be measured? What opportunities can developments in the field of AI and big data analytics offer for issues around monitoring and effect measurement? How can new data sources (such as citizen science data, open source data, or data from non-protocolled studies), which are by definition diverse, unstructured, and incomplete, be used? New developments in this area can also determine the nature of interventions.

Finally, there is growing awareness that a strong focus on economic growth has often led to undesirable side effects in practice. As a result, there is increasing attention on broad prosperity (Van Bree & De Jonge, 2022). In line with the debate on broad prosperity, it is also expected that new impact indicators will be formulated for monitoring and effect measurement to support the policy-making process. Moreover, it is anticipated that thinking and practice around monitoring and effect measurement will pay more attention to potential trade-offs between the economic, social, and sustainable dimensions of broad prosperity - here and now, later, and elsewhere.

Possible research questions include:

- How can the system be captured and understood? How can a change in the system be made transparent, and how do we map indirect and external effects?
- How can we formulate output, outcome and impact indicators that are relevant to the transition goal and intermediate goals, and that are tailored to the transition as much as possible?
- What is the effect of the measurable and available indicators on the form and direction of our interventions?
- Which methods should we apply and/or develop to make the correct estimates (prognosis) and classifications (diagnosis, screening, monitoring) from new types (diverse, new, unstructured, incomplete) data?
- How do we identify the relevant data sources and data types for monitoring and evaluating transitions, including validating data and information?
- How can we test the effectiveness and efficiency of our design process?
- How can indicators of broad prosperity be formulated to support the policy-making process? And how can trade-offs between the dimensions of broad prosperity be operationalized?

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9. ETHICS AND RESPONSIBILITY

9.1 INTRODUCTION

People interact with numerous technologies every day, ranging from physical and digital products to services, systems, and spaces. These technologies serve utilitarian functions, and they also redefine or reinforce societal values and social practices. The idea that technological innovations influence moral norms and values—both positively and negatively—is not new. This is mainly the terrain of the philosophy and ethics of technology. Against this backdrop, it is essential to think critically about how to better align the creation (that is, design, development, and deployment) of technologies with societal needs and values. This requires embedding engagement with ethics as a core activity in design and innovation processes. The main goal of the ethics- and responsibility-focused KEMs is to stimulate such engagement in mission-driven innovation projects.

This chapter is informed by literature research and conversations with eight experts (six academics and two practitioners) working at the intersection of technology, design, innovation, and ethics.[1] This collaborative effort resulted in a preliminary mapping of ethics-focused methods and approaches based on two main dimensions, (see Figure 1): 1. assessment to accompaniment and 2. theory-grounded approaches to theoretically-flexible techniques. This emerging typology is intended to trigger discussion in design and innovation teams, and to help navigate various ways of engaging with ethics through critical questions and healthy disagreements. As a result, the KEMs in this category address questions such as: how to create space for responsibility and accountability in multidisciplinary, multistakeholder (that is, networked) innovation processes? How to deal with moral dilemmas and paradoxes? How to identify and address value conflicts among stakeholders, such as citizens, government, industry, experts, et cetera? How to engage with ethics in a positive and experientable manner? How to navigate some of the key ethics-focused methods and approaches at the intersection of philosophy of technology and design?

1. To explicate positionality, the lead author is a design researcher with expertise at the intersection of design ethics and design methods.

9.2 STATE OF THE ART

In this chapter, we focus on methods and approaches from two main knowledge fields, namely 'philosophy and the ethics of technology' and 'design theory and methodology'. Philosophy approaches help conceptualise and interpret the role of science and technology in society beyond everyday interpretations or dominant discourses. Approaches and methods from design help add an experiential dimension to abstract discussions around **values** and ethics, and with that, pinpoint concrete opportunities for influencing technology development and deployment. In addition, many design methods have implicit moral intentions (for example, **participation**, provocation, **behaviour-change**) and they involve value judgments as part of procedural decisions. In comparing these methods to those in philosophy, practitioners can also become aware of the (often hidden) ethical qualities of design methods.

We propose a typology along two main dimensions: 1. From assessment to accompaniment; and 2. From theory-grounded approaches to theoretically-flexible techniques (see Figure 1). The spectrum from assessment to accompaniment represents the form of engagement with ethics and ranges from reactive analysis focused on predicting impact to proactive analysis focused on guiding action.

The spectrum from theory-grounded approaches to theoretically-flexible techniques evaluates how actionable a specific approach is: can the proposed approach be coupled with supporting techniques and tools that can be directly applied in design and innovation processes? Alternatively, this spectrum invites explicit engagement with specific philosophical lenses so that new techniques and tools can be developed that are inspired and informed by these theories (for example, Intersectionality Studies, Capability Approach). Such theoretical commitments can offer purpose and clarity to activities and decisions of a project team (for example, avoiding implicit biases and stereotypes, promoting justice and wellbeing).

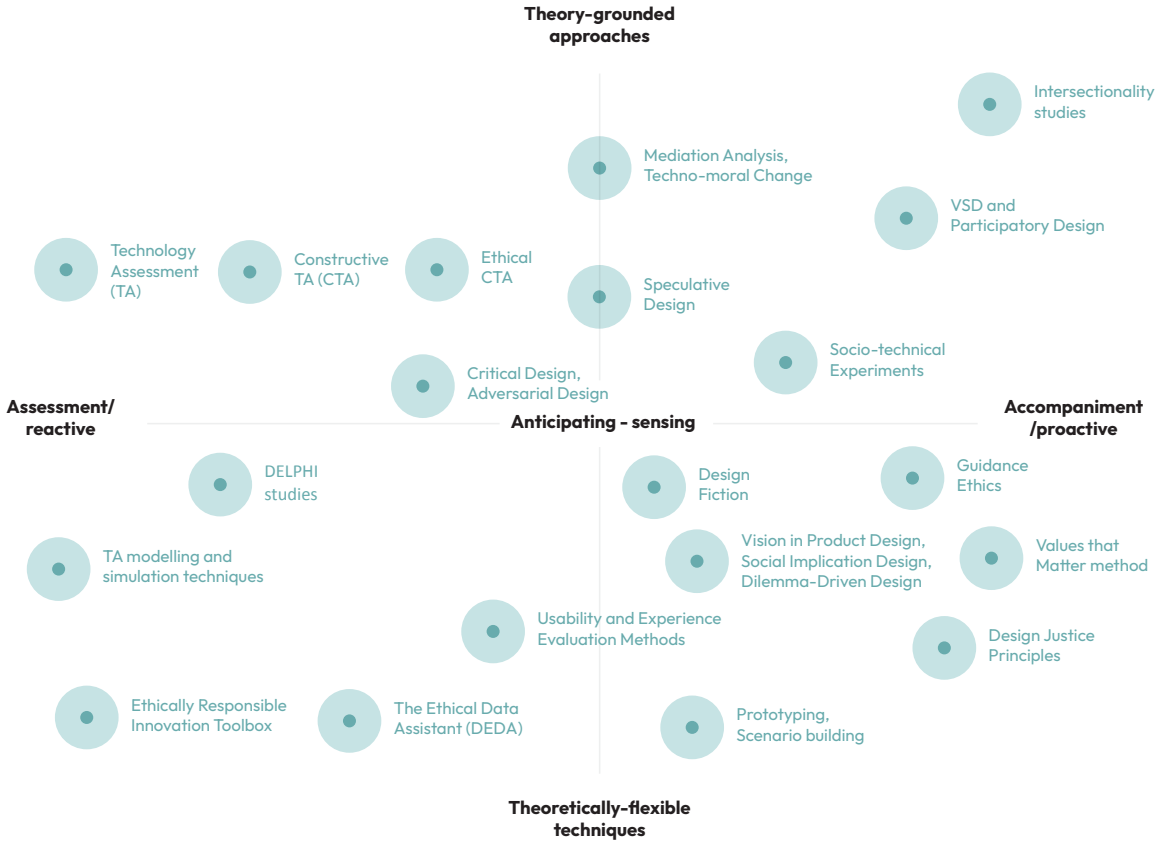

Figure 1: Mapping of ethics-focused methods and approaches based on two main dimensions.

THEORY-GROUNDED, ASSESSMENT APPROACHES

Traditional Technology Assessment (TA) methods focus on predicting technological impact. TA originated in the 1960s in the United States of America, and they help monitor the social, legal, economic, and ethical impact of technological developments on society to inform policymakers on alternative policies (Banta, 2009). TA is an extremely broad field of practice, with sub-fields such as **Health Care Technology Assessment** (Banta, 2023) that provides input for decision-makers on health technology options. Traditional TA approaches rely on expert knowledge, quantifiable risks, and are conducted by institutions outside of technology development (such as, TNO, Rathenau Institute, and *Centrum voor Ethiek en Gezondheid*). Traditional TA also includes the legal aspects of technological development, for which legal scholars are involved to ensure compliance with pre-determined rules and regulations (for example, product safety, GDPR for privacy concerns) and to ensure accountability.

Constructive Technology Assessment (CTA) (Schot & Rip, 1997) aims to include a larger variety of actors (such as, social, technological actors) in predicting impact and emphasises the importance of assessing and addressing the social implications of technologies during their development. Building on CTA, **Ethical CTA (eCTA)** (Kiran et al., 2015) adds an explicit ethical dimension to CTA and argues for a more co-creative form of assessment that is mindful of individual and cultural differences and in line with a co-evolutionary approach to technological impact (that is, the idea that society co-evolves with technology (Geels, 2005)).

We place critique-oriented design approaches, such as **Critical Design** (Dunne, 1999; Dunne & Raby, 2013) and **Adversarial Design** (DiSalvo, 2012) in this space as well. Critical Design produces provocative artefacts that challenge consumerist desires and societal norms. Critical Design is not concerned with immediate utility but acts as 'food for thought', highlighting possible implications of present-day technologies, often merging insights from ethics, philosophy, political science, and more. Adversarial Design – as its name suggests – is a more radical way to design 'against' expectations to challenge the status quo and is grounded in agonistic democracy. Although these are not typical 'assessment' approaches, they may have a 'monitoring' function as they critically reflect on ongoing scientific and technological developments to inform and inspire new and radically different ways of designing.

At the border of this space are the anticipating-sensing approaches: **Technological Mediation** (Verbeek, 2011) and **Techno-Moral Change Scenarios** (Swierstra et al., 2009). These approaches employ anticipation exercises to identify or 'sense' key concerns and values around emerging technologies or technological ideas so that they can be inserted into design and innovation processes (for example, see the case of Google Glass in Kudina & Verbeek, 2019; or AI ethics in Steen et al., 2021). For instance, Theory of Technological Mediation deems technologies as mediators of human-world relations, recognizing that everyday experiences are fundamentally shaped by technologies that we use (for example, an ultrasound examination of a foetus shapes perceptions and expectations from parenthood) (Verbeek, 2011). This helps technology developers to analyse, anticipate, and experiment with the relations between humans and products. **Product-Impact Tool** implements and builds on mediation analysis to facilitate moral reflection and discussion in a practical and engaging manner (Dorrestijn, 2020). In addition, Techno-Moral Change Scenarios explore the emotions and controversies that new and emerging scientific and technological developments provoke through stimulating moral imagination using narratives (see the case of the obesity pill, Swierstra et al., 2009).

THEORY-GROUNDED ACCOMPANIMENT APPROACHES

Socio-Technical Experimentation views anticipation critically, and instead, focuses on regulating the innovation process (versus speculating about its outcomes) (Van de Poel, 2011; 2013). It acknowledges the radical uncertainties and potential hazards of new technologies (for example, nanotechnology, biotechnology) and aims to deal with them through an adaptive learning process similar to scientific and medical experiments. Thus, Socio-Technical Experimentation does not assume a specific ethical theory, but it builds on principles from research ethics and biomedical ethics and is based on certain theoretical assumptions about the relation between technology and

society. It also implies a view of design in which the design process does not end once a technology has entered society, but in which technologies can be redesigned based on new insights on moral implications that become clear after a technology has been introduced into society.

Value Sensitive Design (VSD) (Friedman & Hendry, 2019), and **Participatory Design** (for example, Bjögvinsson et al., 2012) emphasise distributed responsibility of stakeholders involved in design and innovation projects, and the outcomes are open-ended and informed largely by the positions and views of the involved stakeholders. VSD is grounded in conceptual, empirical, and technical explorations. It has inspired a range of approaches in engineering and design ethics, such as **Design for Values** (Van Den Hoven et al., 2015). Participatory Design is loosely grounded in particular visions for democracy (for example, Bannon et al., 2018). We place **Speculative Design** (Dunne & Raby, 2013) on the border between accompaniment and assessment because it involves asking provocative 'what if' questions that potentially serves both assessment and accompaniment. Although Speculative Design is closely related to Critical Design due to a shared critical ethos, Speculative Design focuses on futures whereas Critical Design focuses on parallel, alternative realities.

At the extreme end of this quadrant is an illustrative example of a theory-grounded approach, namely **Intersectionality Studies**. Other examples may include **Capability Approach** (Nussbaum, 2011) and **Feminist Care Ethics** (Toombs et al., 2016). The main idea here is that committing to a specific theoretical lens guides decisions throughout the design and innovation process, giving purpose and clarity to these decisions.

THEORETICALLY-FLEXIBLE ACCOMPANIMENT TECHNIQUES

We populate this quadrant mostly with design methods and approaches that offer actionable guidance for designers, engineers and other technology developers. This is because the task of interpreting a specific theory and transforming it to actionable design guidelines often rests with designer-researchers, unless previous research and/or case studies offer guidance that can be appropriated. For instance, **Design Fiction** (Sterling, 2005; Bleecker et al., 2022) focuses on visualising possible worlds where specific artefacts exist, allowing designers to showcase and evaluate their ethical desirability. Although it shares origins with Speculative and Critical Design, it does not rely on a specific theory, and thus, we place it in the theoretically-flexible quadrant

Vision in Product Design (Hekkert & Van Dijk, 2011), **Social Implication Design** (Tromp & Hekkert, 2018), and **Dilemma-Driven Design** (Ozkaramanli et al., 2020) are designer-driven methods that offer opportunities for moral reflection and guidance on how to deal with emerging value conflicts in design projects. Vision in Product Design (ViP) (Hekkert & van Dijk, 2011) emphasises the freedom, authenticity, and responsibility of the designer as a societal actor. ViP invites engaging in design projects through forming a statement or a vision that balances people's needs with the designer's interpretation of larger factors that influence society (for example, technological progress, economic factors, psychological factors, socio-cultural developments). The Social Implication Design (SID) method (Tromp & Hekkert, 2018) builds on ViP to support designers in reasoning from a social issue to a design proposal through focusing on social dilemmas. In this way, it exploits the implicit yet inevitable role of design in changing human behaviour in socially desired directions (for example, social cohesion, healthy living). Similarly, Dilemma-Driven Design (Ozkaramanli et al., 2020) considers personal dilemmas as valuable starting points for understanding people and conceiving innovative design ideas. This brings a human-centred focus to technological discussions by explicating the mixed emotions and conflicting concerns that people may experience in response to new technologies.

Finally, accompaniment approaches include **Guidance Ethics** (Verbeek & Tijink, 2020) which advocates for a bottom-up and positive approach that provides concrete actions for those involved in technology development. Guidance Ethics involves a workshop in which various stakeholders (ranging from citizens to technology developers and managers) interact with each other and brainstorm about the positive and negative outcomes of technology.

This workshop can be done in the conceptualization phase of a technology, but also during development or implementation. Its outcomes relate to concrete action opportunities for technology (hardware and software), technology-users (behaviour), and context (for example, education, management, policy). Similarly, the **Values that Matter** method focuses on analysing and integrating the dynamic nature of values into technology design and development by studying the lived experiences of stakeholders in their daily context through action research and living labs (Smits et al., 2022).

The **Design Justice framework** (Costanza-Chock, 2020) critically examines how design can disproportionately distribute burdens, rewards, and risks among different societal groups. Grounded in the idea of intersectionality, Design Justice advocates for the evaluation of multiple socio-economic and historical factors when determining the allocation of benefits and harms. This ensures that justice remains at the core of design decisions. The essence of such ethical-principle-driven approaches is not merely to infuse designs with ethical considerations but to anchor them as the very foundation upon which designs are conceived and realised.

Theoretically-flexible techniques often include scenario creation, which has been implemented in various forms such as **Techno-Moral Scenarios** (Swierstra et al., 2009), **Value Scenarios** (Friedman & Hendry, 2019), **Socio-Technical Scenarios** (Rip & Kulve, 2008), and **Design Fiction** (Sterling, 2005; Bleecker et al., 2022). Another popular technique is designing prototypes that add an experiential dimension to discussions around values and ethical principles, rendering the topic accessible to a wider audience. **Prototypes** are sometimes built in an intentionally provocative manner (in other words, 'provotypes', also see Boer & Donovan, 2012) to stimulate debate and elicit deeper emotions and value discussions among stakeholders.

THEORETICALLY-FLEXIBLE ASSESSMENT TECHNIQUES

Mirroring TA approaches, this quadrant includes concrete protocols and formats of assessment widely used across philosophy of technology and design. For instance, Delphi is a scientific method that helps to organise an expert discussion to generate insights on controversial topics that result from rapid technological and social change (for example Beiderbeck et al., 2021). In addition, a variety of computational modelling and simulation techniques are used to execute TA. Moreover, specific 'toolboxes' are developed in governance contexts, such as the **Responsible Research and Innovation (RRI) Toolkit**, **Ethically Responsible Innovation Toolbox**[2], the **Data Ethics Decision Aid (DEDA)**, and the **Impact Assessment Mensenrechten en Algoritmes** (IAMA) to facilitate responsible practices. Finally, in design research, various usability and experience evaluation methods exist to test and redesign existing technologies in line with design requirements (for example, accessibility, durability, et cetera).

9.3 CHALLENGES AND RESEARCH QUESTIONS

Although ethics has made a comeback in design and technology research, its uptake still encounters some resistance both in academic and non-academic settings that do not directly deal with ethics. This resistance can be due to three main misconceptions about ethical engagement, each of which comes with associated risks. First, engaging with ethics is often perceived as an activity to avoid negative outcomes instead of bringing about positive ones (for example, Lloyd & Busby, 2003). We see the risk of this negative framing as disregarding the contribution of ethics to discussions on moral values such as happiness, care, and justice. Second, ethics is often perceived as an abstract, theoretical activity that only philosophers can engage with. This pushes ethics to be an afterthought (for example, a work package in a consortium project or a work-group in a design agency). This common practice prevents other actors from engaging with ethics and for it becoming embedded in daily practices (Van Wynsberghe & Robbins, 2014). Finally, and perhaps due to the first two misconceptions, practitioners often voice the need for a universal framework or a checklist-approach to ethics (Ozkaramanli et al., 2022). However, the large variety of ethical issues and moral dilemmas that practitioners and organisations encounter does not lend

2. Developed for the Impact Assessment Human Rights and AI Algorithms *(Impact Assessment Mensenrechten en Algoritmes* (IAMA), in Dutch).

itself easily to a single theory, framework, or checklist. Narrowing down ethical engagement to a single method or a checklist would not do justice to the complexity of reality, as ethics is context- and situation-dependent (Ozkaramanli et al., 2022). These practice-based challenges raise the following research questions:

- What are the opportunities and challenges of engaging with ethics in research and innovation practices?
- What are organisational and inter-organisational structures that can support responsible and value-driven innovation?
- What are the ethical questions and moral dilemmas that practitioners face when choosing and using methods? How do these questions and dilemmas differ across disciplines, methods and use cases?
- What are institutional and sectoral strategies that can facilitate harvesting insights from practice-based research on how abstract ethical theories and principles are operationalized in day-to-day practices (for example, in living labs or learning communities)?

Doorn et al. (2013) explain that ethical engagement may take different formats, namely cooperative, temporary, parallel, and embedded engagement. For instance, VSD (Friedman & Hendry, 2019) requires cooperative engagement where technology developers (for example, researchers, engineers, designers) take on the responsibility of value discussions and involving stakeholders. In addition, CTA (Schot & Rip, 1997) involves structured discussions between social actors and technological actors (such as, engineers, designers), which are temporarily inserted into research and innovation processes. Apart from the methods that Doorn et al. (2013) examined, we do not yet know what the best format might be for the methods in Figure 1. In line with this, we may ask:

- How to organise transdisciplinary settings in a way that conceptual, technical, and empirical considerations are pursued collaboratively (that is, not just by one discipline or group of people), so that transdisciplinary tensions are revealed and negotiated?

Designing and engineering technologies are inherently moral activities charged with ethical questions and moral dilemmas. Whitbeck (1996) famously drew an analogy between design problems and moral problems, arguing that philosophers can learn from design reasoning to respond to moral problems. This analogy highlights that design reasoning can aid ethical reasoning through dealing with uncertainty and being open to the dynamic character of problem situations and pursuing viable solutions instead of the 'best' solution. This analogy suggests that design methods possess implicit ethical qualities that, if explicated, may help moral reflection. Since these ethical qualities arise in response to specific historical events and technological developments, we may ask:

- What are the implicit ethical qualities and historical trajectories of methods that may support moral reflection in design and innovation processes?

3. For a more in-depth discussion on these four different forms of engagement, refer to Doorn et al. (2013).

In connection to this, we observe that many stakeholder-driven methods, such as VSD and Co-Design, focus on consensus building and problem solving, with little attention to conflicts and disagreements that are the true doorways to capturing and negotiating moral values. In line with this, we may ask:

- What are the main reasons to consider 'consensus' a desirable quality of multi-stakeholder settings? How can conflict-driven approaches, such as Speculative Design and Critical Design, lead to constructive outcomes?

As there is no one-to-one relationship between certain techniques and theoretical approaches (hence they are theoretically flexible), we may ask which technique may work best for a specific theoretical approach and why. Here, we see a role for designers in integrating different perspectives in a meaningful way that are necessary to achieve a responsible application of technologies (for example Harbers & Overdiek, 2022). To create new techniques and tools based on theoretical approaches from philosophy of technology requires interdisciplinary collaboration with empirically-oriented disciplines, such as design, engineering, and psychology. Therefore, we may ask:

- What are viable empirical methods (phenomenological analysis, digital ethnography) to support interdisciplinary collaboration between philosophy of technology and other empirically-oriented disciplines?

In addition to direct interaction with specific philosophical theories and approaches, we encourage method-developers to better communicate and justify the ethical qualities that underpin their methods. For instance, 'design for behaviour change' approaches might be problematised through the question of paternalism (Gertz & Ozkaramanli, 2023). In fact, the question of paternalism applies not only to design methods that explicitly aim to change behaviour, but also to hidden forms of paternalism in, for example, user-centred design. As a result, this emerging typology may invite method researchers to be explicit and precise about the ethical qualities of their methods when thinking about where to place them on the diagram:

- How to negotiate conflicting perspectives when what designers or stakeholders want to achieve through technology interferes with human freedom?

Finally, in implementing popular value-driven approaches, such as Value Sensitive Design, future research should address:

- What are different conceptions of values across disciplines (moral, non-moral, procedural, contextual, universal, et cetera)? What are the opportunities and challenges of using value-driven methods, such as VSD, across different cultures and across time?

Since the notions of ethics and responsibility cut across all KEM categories, KEM-users are encouraged to reflect upon the similarities, differences and interconnections between the approaches presented here and other KEM categories. This chapter mainly relates to the KEM categories **Vision and Imagination**, **Participation and Co-creation**, and **Behaviour and Empowerment**, which tackle ethics mainly from the perspective of individuals and teams working collaboratively in research and innovation projects. With this, the governance dimension of innovation and technology has not been addressed (for example, **Political Technology Assessment** (PTA), Van Est, 2013). This is not to say that considering ethics is limited to the agency of individuals and teams. In fact, a strict focus on individual and team responsibility runs the risk of being co-opted by a system that one ends up serving even when trying to fight it (for example, ethics washing in organisations). As a result, we remind the reader that this emerging typology of 'ethics-focused' approaches is not exhaustive due to the vast variety of disciplines and considerations that need to be considered (for example, social, cultural, legal, political).

As a final word of caution, method-usage, on its own, will not guarantee ethical practices or outcomes. The interaction between these approaches and the mindset of those who implement them will likely yield responsible processes and outcomes. Thus, this KEM category intends to be a starting point for discussion among researchers and practitioners.

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10. MEANING AND AWARENESS

10.1 INTRODUCTION

Within the KEMs, artistic methods are regarded as a diverse collection of approaches, actions, and processes rooted in art practice. These methods are applied in various contexts and stimulate the development of meaning and awareness. In doing so, they promote innovative and inclusive solutions to societal challenges that are central to the mission-driven innovation policy.

They make complex social transitions manageable and make us aware of the invisible, intangible and abstract. They inspire behavioural change and increase societal engagement in urgent challenges, for instance by evoking emotions and encouraging involvement. Additionally, they promote inclusivity by involving a variety of stakeholders. For example, through collaborative processes, co-creation and community art. Outside the art domain, artistic methods can drive an art-driven approach in policy frameworks, where artists can act as essential bridge builders between complex issues and the general public, between meaning and awareness, with the artistic as a diverse palette of methods or as an attitude in thinking and creating.

AWARENESS

Art is a powerful means of raising awareness. This is particularly evident in the use of artistic methods. For example, they can raise awareness by evoking emotional responses, or provide insight into complex topics through narrative expression. Artistic methods employ these powers to highlight specific aspects of societal challenges, to reimagine them, or to promote awareness about them.

Reflection and contemplation are also facilitated using artistic methods. They create space for contemplation, reflection, and debate on societal challenges, and direct our attention to matters worthy of our thoughts, reflections and conversations. In short, artistic methods effectively address societal challenges, emphasising emotional engagement, adopting different perspectives, and stimulating reflection for a more comprehensive or alternative understanding of the societal transition challenges at hand (Simonsen et al., 2014).

MEANING

Art goes beyond merely creating aesthetically pleasing objects. It also has the power to forge profound connections between people, things and their environment. These connections extend beyond mere cognitive processes and ‘caregiving’. They also concern feelings and our place in the world. Through artistic methods such as improvisation, metaphors, storytelling and composition, we can shape ourselves, our experiences, and the world around us in tangible and empathetic ways. When we view art as a form of caring thought, we acknowledge the inherently fragile nature of human relationships and interactions with our environment.

Artistic methods serve as essential tools here, as they not only underline the fragility of these connections, but also help to strengthen and deepen them. For example, through improvisation we learn to be flexible in our relationships and to deal with uncertainty. Metaphors allow us to articulate complex ideas and feelings, while composition and storytelling help us give structure and meaning to our experiences. In this way, these artistic methods are not only a creative outlet, but also a crucial means for shaping meaning in our lives and valuable connections with the world around us (Brouwer et al., 2019).

ARTISTIC METHODS, RESEARCH AND ATTITUDE

Artistic methods lead to a range of creative expressions, including paintings and sculptures, but also photographs or installations. In less traditional art forms, even software or social encounters can serve as the medium of expression. A hallmark of artistic methods is their inspiration from a multitude of methods and strategies from various domains, thereby fostering collaboration across domains. Borgdorff (2012) describes this as the 'methodological pluralism' of artistic methods, while Hübner and Vanmaele (2020) highlight their transdisciplinary network character, resulting in "a dynamic atmosphere within which the interaction between method, artistic practice, and research can develop in a creative and future-oriented manner" (p.5).

In this light, it's important to distinguish artistic methods from artistic research. Artistic methods involve the use of creative approaches in various contexts, including societal issues. On the other hand, artistic research is about exploring and developing new artistic ideas and practices. Sometimes they overlap, for example, when artistic methods are applied in research projects or when artistic research approaches traditional questions in unconventional ways. This synergy between artistic methods and artistic research promotes diversity and innovation within both the art world and the academic community.

Finally, Coumans (2023) emphasises the importance of the artistic attitude, which transcends art practice. This attitude shifts the focus to broader societal dynamics, encourages engagement with the environment and fosters origin-oriented thinking with room for uncertainty. This contrasts with result-oriented thinking, which focuses on concrete outcomes and confirmation of existing knowledge. Origin-oriented thinking goes beyond known ideas, embraces uncertainty and prioritises curiosity over the pursuit of certainty, laying the foundation for the development and application of artistic methods in artistic research and socio-artistic practices.

Misiconi: The performance Shifting Faces, 2021. Under the artistic direction of Joop Oonk. Photographer: Mihai Gui.

10.2 STATE OF THE ART

In policy documents within the art domain, such as The Vienna Declaration on Artistic Research (2020), the term 'artistic methods' refers to a broad range of approaches that are inherent to artistic practice in the broadest sense, including applied arts, design, and architecture. These approaches encompass not only research methods, design methods, and techniques deployed during the creative production process but also serve as a response to external questions and challenges.

Policies concerning artistic methods outside the art domain often use the term 'art-driven'. This term implies that art is the driving force behind intended changes in other policy domains, though the (societal) effects of artistic methods are often indirect and always also relate to the art itself. On the other hand, within the art domain, such external changes (like innovations) are typically seen as an inherent part of the art practice or the artwork itself. Art inherently drives society; artistic methods are always connected to society.

This intertwining of artistic methods with the context in which they are applied leads to a dynamic playing field where methodology, practice, and research merge. As a result, artistic methods exhibit two important characteristics:

- They do not emerge beforehand or according to strict prescriptions but gradually manifest during the artistic research process, thus allowing for the development of new methods and practices (Hübner & Vanmaele, 2020, p.5).
- Artistic methods have the potential to also redefine the nature of the issues themselves, by establishing a different, more profound relationship with these issues or shedding new light on the context in which they occur (Simonsen et al., 2014).

In these unique features of artistic methods, combined with the power of these methods to stimulate and develop meaning and awareness, lies their capacity to contribute valuable insights to societal challenges. Thus, societal transformation benefits from the active use and development of artistic methods.

The following list of activities and practices that can be deployed and combined as artistic methods (based on Vanmaele, 2017, and Badura et al., 2015) is merely a non-exhaustive selection upon which to build. Similarly, the subsequent typological classification into five characteristics distinguishing artistic methods from one another (temporal, situated, embodied, documentary, and experimental) is intended solely as a means to illustrate the diversity of approaches within artistic methods and identify blind spots. Further research will be necessary to determine which typology is best for effectively integrating artistic methods in diverse contexts, and for optimising their potential for societal impact.

It's important to note that Vanmaele (2017) and Badura et al. (2015) describe the activities and practices more as approaches of artists than as standalone methods. They are not developed to solve a specific problem or challenge but arise from the practices of artists and are often closely connected to their art. Therefore, a widely applied artistic method such as 'composing' can take very different forms in different practices and in relation to different art forms. This often makes artistic methods difficult to define concretely outside the context of a specific practice.

In the typology of artistic methods that follow, each method is therefore provided with a course that can lead to a better understanding of that method and some good practices from artistic practice, related to meaning, awareness and the potential for innovation and social transition.

TEMPORAL

This subclass includes methods in which artists and researchers primarily use the dimension of time to shape and explore processes over time. This involves but is not limited to, researching changing patterns, evolutions, and narrative structures as they unfold. Mapping the multitude and versatility of temporal artistic methods and their value for societal transformation requires more research. Activities and practices include: composing, rehearsing, serial working, and notation.

- Dance company Misiconi in Rotterdam
- Performing arts network Women Connected
- Art project Jusititieel Complex Zaanstad

SITUATED

The second subclass refers to practices where artists and researchers anchor their creative processes in specific physical or social locations. This approach focuses on exploring and understanding the unique dynamics and meanings that arise from the interaction between art and the environment in which it is created. This situated knowledge and experience can be transposed to other environments to generate new insights and perspectives. More research into and casuistry of how art professionals work situatedly is needed for the more effective use of situated methods for societal transformation. Activities and practices include installations, mise-en-scène, intervention, exhibiting.

- Ecological economic institute Human Activities
- Art project Het Blauwe Huis
- Art project Pension Almonde

EMBODIED

The third group of methods revolves around approaches in which artists and researchers place the physical and sensory experiences of the body at the centre of their creative processes and research. This approach emphasises the power of the body as an instrument and source of meaning in artistic expression and offers new ways to generate knowledge and understanding. Research is (still) needed on how the rich knowledge regarding embodiment from art can be utilised for societal transformation. Activities and practices include: improvising, collective working, observing, and drawing.

- Multimedia productions Are you there? and Descending the Mountain
- Artistic research project A Daily Practice
- Interactive theatre productions using Forum Theatre by Inspringtheater

DOCUMENTED

The fourth category involves strategies for the structured recording of artistic processes and creations, including gathering and archiving relevant contextual information. The aim is to create sustainable documentation, preserving not only the work itself but also providing insight into its development, context, and meaning over time. Exploring the effectiveness and impact of documenting artistic practices requires further research efforts, as well as making them accessible beyond the art world. Activities and practices include: photography, video, sound recordings, annotating, curating, re-enactment, sketching, idiosyncratic notation and symbols, using electronic databases, and visual and textual archives.

- Film installation prologue: Squat/Anti-Squat
- Total installation Acknowledge Rebuild – Wunderkammers of Rotterdam's Colonial Past
- Installation Guppy 13 vs Ocean Wave; a Bas Jan Ader Experience

EXPERIMENTAL

The last subclass refers to approaches where artists and researchers consciously take risks and embrace playfulness to foster new artistic insights and creative discoveries. This includes exploring unknown territories, challenging traditional norms, and embracing the unpredictability and trial-and-error process in artistic research. There is a need for more extensive research, particularly focused on exploring the space for experimentation within art practices and transition processes. Activities and practices include, among others: prototyping, arranging and collage, concept mapping, diagrams, using metaphor and analogy, visual diary, personal narrative, critical and speculative design.

- Film and installation Empire's Island
- Installation Pier Pressure
- Artificial intelligence programme Jan Bot

Please note that some methods may contain characteristics of multiple typologies, depending on the context and how they are applied.

10.3 CHALLENGES AND RESEARCH QUESTIONS

Artistic methods underscore the power and necessity of meaning and awareness in transition challenges. They create space for experimentation, imagination, critical reflection, and redefining problems from different perspectives. These methods ensure accessibility and promote diversity, which is crucial for representative and effective outcomes in mission-driven innovation policy.

The integration of artistic methods is relevant for tackling complex transition challenges. Identifying challenges and research questions is the first step to effectively deploying artistic methods within Dutch innovation policy. Leveraging the creative possibilities of artists and designers contributes to a more effective approach to societal transition challenges. There are at least five challenges that require attention:

1. (FURTHER) DEVELOPMENT OF ARTISTIC METHODS

How can we conduct a thorough analysis of artistic methods to identify missing methods, validate existing ones, and address knowledge gaps, considering the optimal utilisation of the power of artistic methods in relation to meaning and awareness in innovation policy? What are the main knowledge gaps regarding the impact, effectiveness, and application of artistic research methods, and how can we systematically research to identify and address these gaps? Known gaps are diverse and include, among others, a lack of attention to diverse cultural contexts and communities within which artistic methods are applied, a shortage of practical guidelines for artists and researchers, insufficient attention to ethical considerations such as cultural appropriation, and limited inclusivity by ignoring overlapping systems of oppression and privilege.

- Which specific artistic research methods are currently missing, and how can new methods be developed?
- How can an assessment framework be established to validate artistic research methods?

2. MEASURABILITY AND EVALUATION

Establishing measurable criteria for the impact and effectiveness of artistic methods in innovation processes is a challenge because conventional measuring tools may be less suitable for the complexity and nuances of artistic contributions to such processes. Especially the subjectivity of artistic experiences, which play a central role in artistic methods, make quantitative measurements difficult. Artistic methods can lead to subtle personal changes,

such as in how an individual views a societal challenge, but also to promoting collective societal engagement. The question arises whether the method can be separated from its user or creator and whether validating artistic processes and methods is actually possible. The intrinsic relationship between method and artist underscores the complexity of this issue.

- How can measurable criteria be established for the impact of artistic methods in innovation processes?
- What suitable measuring tools are available for evaluating the effectiveness of artistic methods?

3. INTERDISCIPLINARY COLLABORATION

To effectively deploy artistic methods outside of artistic research, interdisciplinary collaboration between artists, scientists, and policymakers is essential. However, finding common ground, understanding each other's languages and methodologies, and developing a joint approach is not straightforward.

- How can interdisciplinary collaborations be effectively promoted for the deployment of artistic methods?
- What strategies are effective in bridging differences in language and methodology between artists, scientists, and policymakers?

4. SUSTAINABLE ANCHORING IN POLICY AND PRACTICE

Integrating artistic methods into government policy and the societal context is hindered by structural and financial obstacles. There is an urgent need for sustainable financing mechanisms and organisational structures to support the continuous and broader application of these methods.

- What financial obstacles hinder the embedding of artistic methods in government policy, and how can they be overcome?
- What structural obstacles hinder integration into government and innovation policy, and how can they be effectively addressed?

5. KNOWLEDGE SHARING AND TRAINING

Sharing knowledge about artistic methods and effectively training professionals requires focused efforts and a clear strategy for knowledge transfer. Often, the emphasis when applying artistic methods is on the methods themselves, with less attention to critical reflection. It is important to create more space for this reflection to gain a deeper understanding of the methods and their optimisation for specific applications.

- How can active knowledge sharing and capacity building be promoted for the effective use of artistic methods?
- What strategies effectively integrate critical reflection using artistic methods into training and applications?

Finally, a comparison with international good practices offers valuable perspectives to understand the position of the Netherlands and identify opportunities for improvement. It is essential to gain insights into the development of artistic methods in other countries and to draw lessons for further growth and innovation in the deployment of artistic methods in societal transitions.

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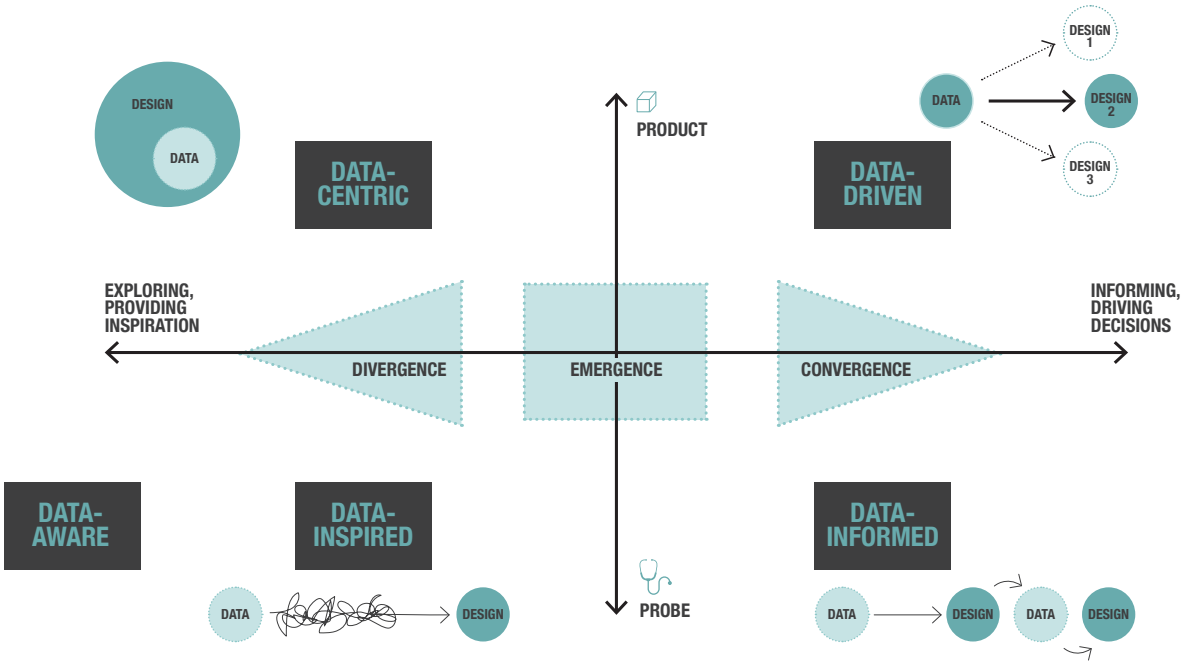
11. DATA FOR INQUIRY AND EVIDENCE

11.1 INTRODUCTION

The KEM category Data for Inquiry and Evidence encompasses a collection of methods and tools for generating insights from data, complementing other qualitative and quantitative design and design research methods. Thereby, it bridges the gap between **Human-Centred Design** and **Data Science**, emphasising the importance of individual context and the stories behind the data. Data for Inquiry and Evidence includes methodologies for utilising data in the design process as well as in the resulting designed products, systems, or services. As a next step these methodologies may be used for generating, analysing or validating data to support mission-driven innovation.



Figuur 1. Overview of different data x design approaches (Funk et al., 2024). Data-enabled design is omitted for clarity, see Figure 3.

Within the KEM category Data for Inquiry and Evidence different methods and tools can be charted in a space divided by the product and probe axis, and the axis of exploring versus informing (see Figure 1). The methods on the left side of the figure realise a divergent movement in a design process, where gradually more information and choices are sought. The methods on the right realise a convergent movement that use data directly or indirectly to make choices and reduce uncertainty.

Left and right side correspond to more explorative and informing design phases, respectively. For instance, where data-driven design is more deterministic about determining product design choices, data-aware or data-inspired design is more creative and explorative. That is, design decisions need to be taken not just from data but back to data collection practices, and the right data types are collected to address the right questions.

The upper half of the figure shows methods that focus on data in relation to a product, either by means of a research product in data-centric design (see below) or by iterating on data-driven products. The lower half depicts approaches that focus on involving data in the design process, not necessarily in its outcomes. Here, we see probing and the use of existing data sets to explore possibilities or inform design decisions. The data-enabled design approach is shown in Figure 3.

Next to identifying different approaches to the use of data, Data for Inquiry and Evidence emphasises selecting and connecting appropriate methods. This is similar to how context, data and the design practice are interconnected. By combining well-chosen methods, these methods generate high-quality data and facilitate meaningful interventions. Other key themes for this category are the nature of the data, the processes of data handling, the methods and experiences of data collection and expression, and the risks, tensions and stumbling blocks of working with data (Lee-Smith et al., 2023). These themes provide areas for exploration and critique in understanding the efficacy and challenges associated with working with data in design processes.

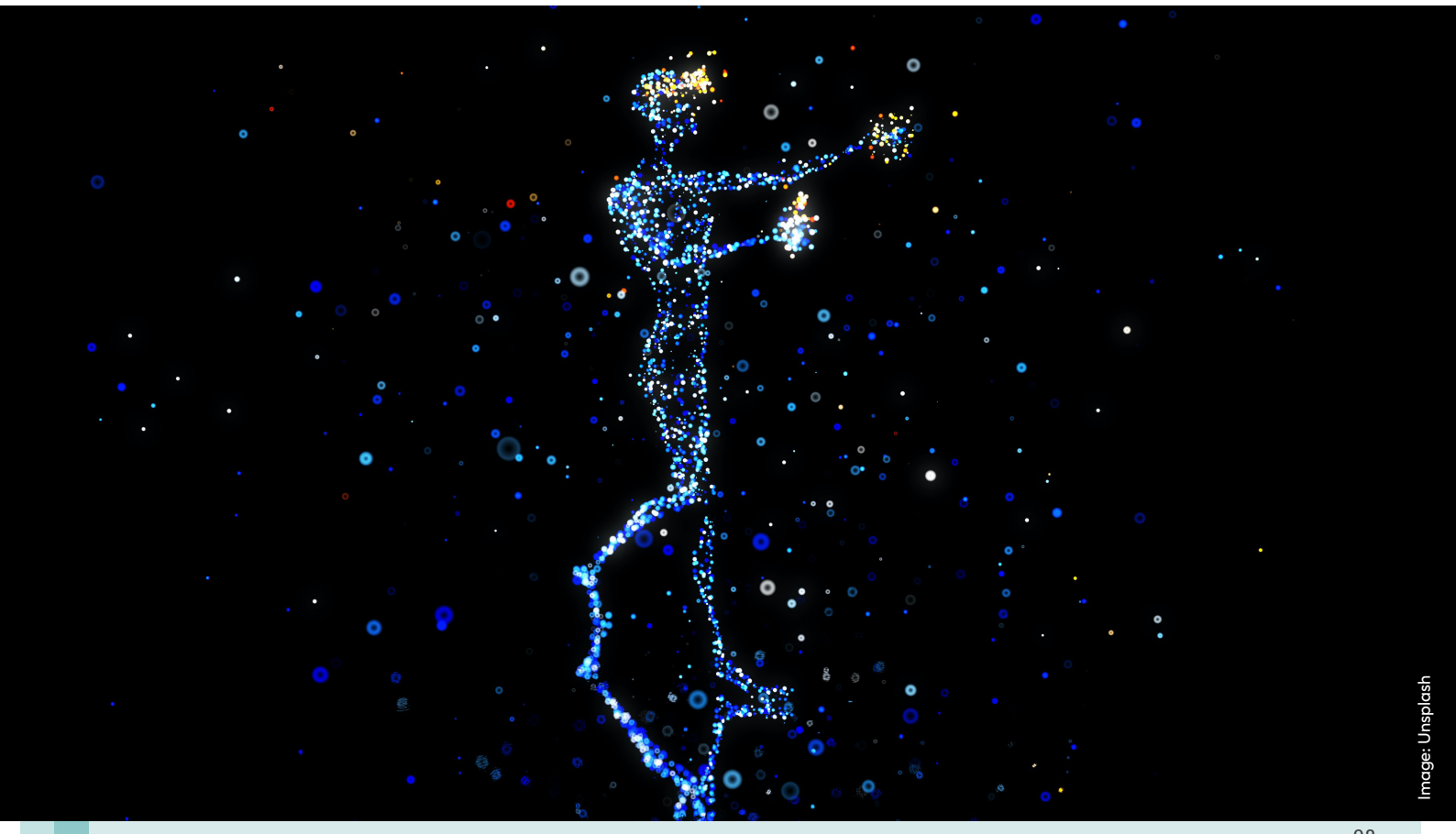


Image: Unsplash

11.2 STATE OF THE ART

The current state of the art can be charted by general terminology, human-data interaction, published methods such as data-driven and data-enabled design, and emerging sets of methods on data-informed and data-centric design. The **Ablative Framework**, introduced by Speed and Oberlander (2016), aims to assist designers in understanding and working with data in various ways. It categorises data into three types of value: raw measurements, commercial and social value, and moral and ethical value. The framework distinguishes between designing from, with, and by data:

- Designing from data refers to using data as a source of design inspiration.
- Designing with data involves considering how data flows through systems and its impact on human values.
- Designing by data suggests the possibility of data itself becoming a designer, generating new products and services through data-intensive analysis.

Immediacy is another lens to explore the landscape of methods leveraging data. Gorkovenko et al. (2023) map this spectrum from the operational use of data as a direct function, the data as a quantitative material driving the design process, towards data as material for subjective and contextual inquiry (Figure 2).

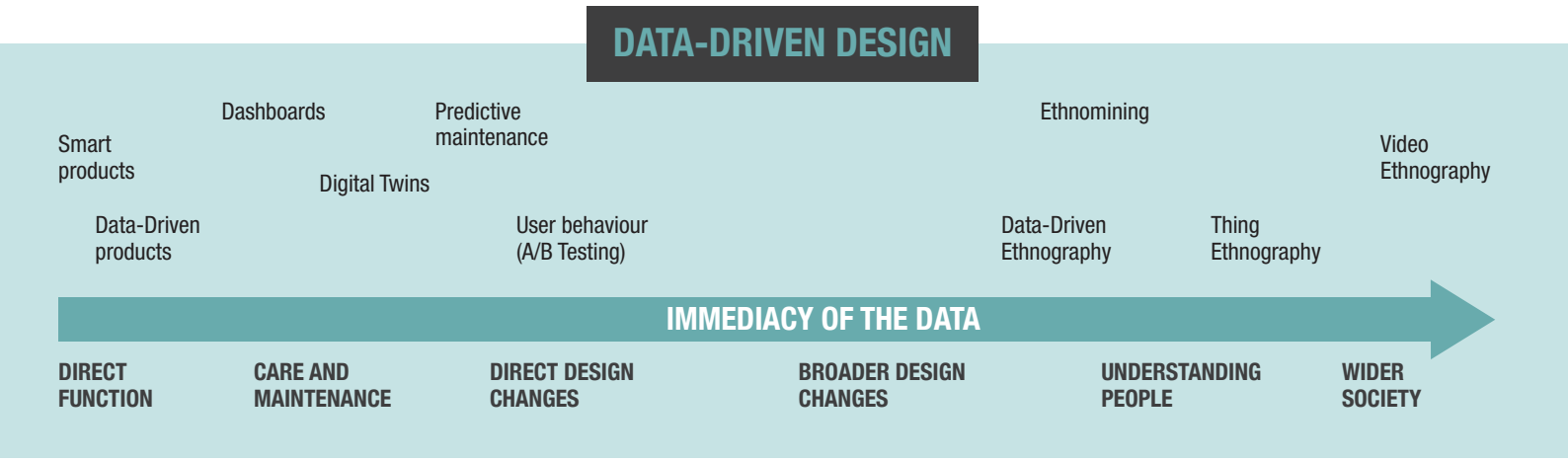


Figure 2. A spectrum of related practices based on how closely the data in question is made use of by the objects of inquiry (Gorkovenko et al., 2023).

While data refers to raw measurements and information, capta refers to the contextual understanding and interpretation of data. Data is often seen as objective and detached, while capta acknowledges the subjective and interpretive aspects of deriving meaning from data. Capta incorporates the idea that data needs to be actively captured and understood within its specific context, taking into account the nuances and complexities of the information being analysed. Any act of data collection is a translation from data to capta, and at the same time an act of modelling reality and of what was extracted from contextual reality by means of sensing, reporting, and recording. This modelling step is a necessary step towards agency (compare human-data interaction) in sensemaking and designing with data. In what follows, an overview of methodologies is presented.

HUMAN-DATA INTERACTION

Human-Data Interaction (HDI) encompasses the principles of legibility, negotiability, and agency. Legibility focuses on making data understandable and accessible to users through visualisations and interfaces. Negotiability involves involving users in decision-making processes regarding data collection and usage, allowing them to negotiate terms and conditions. Agency emphasises users' control and autonomy over their personal data, enabling them to determine how the data is accessed and used. Haddadi et al. (2016) further delve into these concepts, discussing the importance of transparency, interactive consent processes, and user empowerment within human-data interactions. Related to HDI, we can further distinguish methods and tools to use data in creative ways.

Data Physicalisation. Leveraging the tangible property of materials, Data Physicalisation combines haptic and visual senses to foster playful and exploratory activities with data. Data Physicalisation can achieve a deeper sense of engagement through unfamiliar and attractive materials (Nissen et al., 2015; Desjardins et al., 2020), enabling the physical construction of visualisation (Huron et al., 2014) or through responsive physicalisation that senses and reacts to the user input.

Data Fiction, for example, in the form of **Epics** (Desjardin & Biggs, 2021), is also an important approach to combine and contrast with data science-focused approaches as a way to actively take perspective and to foreground the conversation. Dourish and Gómez Cruz (2018) disentangle and relate the datafication trend with the data fiction, highlighting the narrative as the common core of both approaches.

The time element is central to all data-capturing behaviours. This is leading to an emerging strand of research on the awareness and the perception of this temporality as a core element of **Data Interaction**. As the soma design approach is increasingly used in human-computer interaction, **Somaesthetic Data** (Alfaras et al., 2020) brings a new way to creatively engage with biosensing technology and the biodata it generates, namely interacting with the digitised response of the body.

DATA-DRIVEN DESIGN

In Designing with Data: Improving the User Experience with A/B Testing, King et al. (2017) delve into the concept of **Data-Driven Design**. The core idea behind data-driven design is leveraging user data and insights to inform and guide the design process, ultimately leading to improved user experiences. The authors use **A/B testing** as an example, which is a method that compares two different versions of a design to see which one performs better. This allows designers to make evidence-based decisions rather than relying solely on intuition or assumptions. Data-driven design also involves working closely with other teams, such as data analysts and researchers, to integrate quantitative and qualitative data. King et al. (2017) highlight the value of combining these different data sources to gain a holistic understanding of user experiences. A different form of data-driven design is the use of **Digital Twins** (see Figure 2), both in industrial application ('care and maintenance') and societal awareness and participatory decision making. Digital Twins are data-driven and provide their users with strong immediacy of data.

Another perspective on data-driven design by Van Steenbergen et al. (2019) emphasises the integration of data analysis and design processes to understand user behaviour through data collection and analysis. By examining user interactions and preferences, designers can gain valuable insights into how their designs are being used and into the effectiveness of different design elements. This data-driven approach allows designers to make informed decisions about design improvements and optimisations. By continuously evaluating and refining designs based on user data, designers can create more user-centred and tailored experiences. This iterative process allows for constant learning and improvement, ensuring that the design meets the evolving needs of the users. The integration of different types of data, such as quantitative and qualitative data, helps to gain a comprehensive

understanding of the user experience. By combining data from surveys, interviews, and user feedback with quantitative data from analytics tools, designers can better understand the user's motivations, emotions, and needs, which can inform design decisions.

DATA-INFORMED DESIGN

In contrast with data-driven, **Data-Informed Design** is an approach that uses data to support convergence but does not yet drive decision. What is done in this approach informs the way designers and design researchers think about the problem and the problem space (King, 2017). It is rooted in iterative data prototyping and interventions, where data is used to prompt the many roads of the solution space. For example, **Entangled Ethnography** is defined as a general practice of bringing together users, objects, and machine learning to support design processes. **Real Time Contextual Inquiry** uses data streams to trigger moments of discussion and create material for rich analysis (Gorkovenko et al., 2019). **Data-Driven Ethnography** uses trace data from interactions to build rich contexts (Anderson et al., 2009). **Data Probes**, building on cultural and technology probes, are prototypes of concepts which help us prompt and immerse people in some capabilities of data to observe and learn from their reactions (Bourgeois et al., 2014a).

DATA-CENTRIC DESIGN

Data-Centric Design is an emerging mindset that takes opportunity from the many data trails generated by existing products, services, and infrastructure. In contrast to the data-driven approach, data is repurposed from an operational and deterministic process to an exploratory and divergent design process. It revolves around three principles – circularity, participation, and reflexivity – which are bridges to open science and data feminism. **Circularity** aims to minimise extra data collection and instead encourage data reuse and repurpose by accessing and leveraging existing data through mechanisms that adequately inform and ask consent from people represented in the data. **Participation** focuses on actively engaging in partnership with people to collaboratively make sense of and enrich their data. **Reflexivity** aims to foster reflection of people on their data and reflexivity of designers on their design process.

The Designerly Data Donation (Gomez Ortega et al., 2022) and its tangible representation **DataSlip** (Gomez Ortega, 2024) is a platform that lets designers call for participation in the form of data and active engagement into participatory sense-making. It leverages the data-centric design mindset, seeking alternative ways to participate and demonstrates how data can be a vehicle for contextual inquiry as well as a path towards understanding what responsible data use can mean in practice. With **Telemetry-Informed Design**, Zhang et al. (2016) show how naturalistic 360-degree videos can be leveraged in the design process, by repurposing the camera sensors. Finally, the **Participatory Data Analysis** (Bourgeois et al., 2014b) is an example of active collaboration with people represented in the data to reflect and enrich the meaning of data.

DATA-ENABLED DESIGN

Data-Enabled Design (DED) is a novel approach that aims to innovate by using reliable contextual insights and designing adaptive systems that meet individual user needs (Van Kollenburg & Bogers, 2019; Funk et al., 2024). Data-enabled design views data as an active component in the design process, collected from the context and real end-users through creative methods. The objective is to create complex products and services embedded within intelligent ecosystems, which comprehend users within their context and adapt based on data collection and processing. The data-enabled design process consists of six steps: 1. situating prototypes in everyday life, 2. data collection, 3. analysis to gain insights, 4. design synthesis, 5. using data as a creative design material, and 6. adapting prototypes remotely. These steps ensure that the solutions developed are data-oriented and capable of learning and adapting to user needs within an intelligent ecosystem. The data-enabled design process facilitates two types of explorations: research-oriented contextual exploration and solution-oriented informed exploration. In this way, data-enabled design allows for flexibility and adaptability within the design process. In summary,

data-enabled design leverages data as a creative design material to inform the development of adaptive systems that align with user needs and contextual insights (see Figure 3). Through an **Iterative Data-Enabled Design Loop**, designers can continuously engage with users, collect, and analyse data, and refine their solutions to create personalised and effective design outcomes. This approach bridges the gap between creative, data-inspired or data-centric explorations, and data-driven design processes. This enables designers to create innovative and user-centred products and services within intelligent ecosystems.

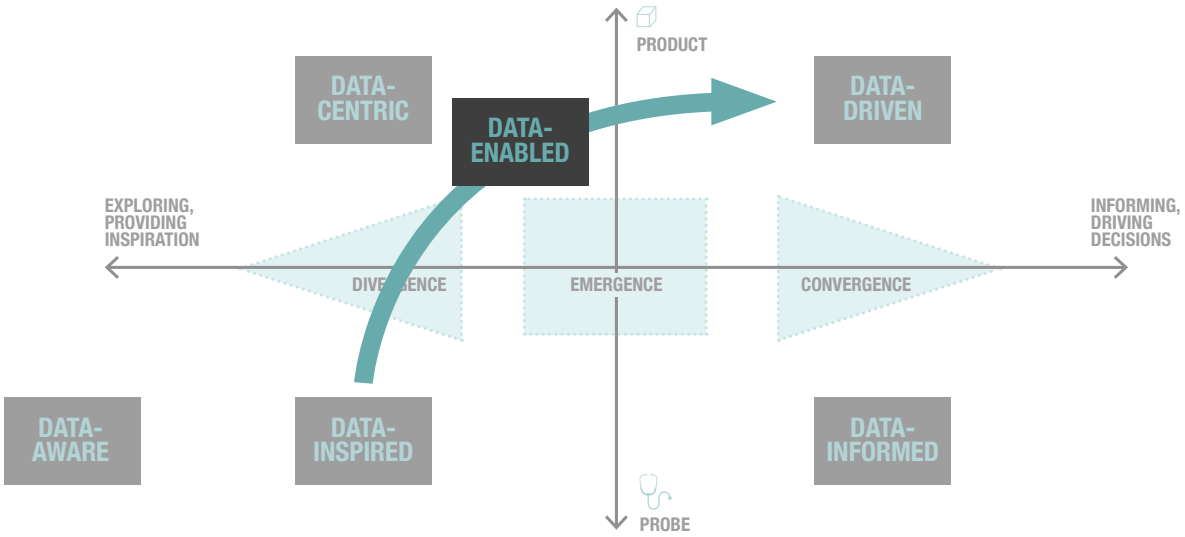


Figure 3. Overview of how data-enabled design fits into the diagram of data x design approaches (also see Figure 1), extending from lower-left to upper-left to the upper-right quadrant. In other words, moving from divergent probe-based explorations to solution focused explorations (Funk et al., 2024).

11.3 CHALLENGES AND RESEARCH QUESTIONS

Data for Inquiry and Evidence is emerging within the disciplines of design research, organisation and transformation science, et cetera. On the one hand, the foundation of human-centred design lies in democratic processes and in a strong focus on user needs (and user agency or participation in data-informed design practices). Digitalisation is a trend in design that enables data to be a central part of the design and design research process; digitalisation is often about making reality machine-readable and opening opportunities for automation and machine learning. Inevitably, this creates concerns, tensions, and friction between the design solution and the use of data. On the other hand, designers must recognise the power of these data opportunities to inform, drive, and evaluate their design. Therefore, a number of core research questions remain.

DATA CREATION AND ACCESS

The way in which data is captured shapes the conversations it supports. How do we collect or generate data? Designers and people, whose behaviour is captured in the data, can often not meaningfully access it. In some problem spaces, design-led data is scarce, while in many cases, data is abundant. But gatekeepers prevent designers and other data stakeholders from using it first-hand. Data is currently explored in isolation because of the (organisational) silos it is captured from, the privacy-preserving processes it must comply with, and the complexity arising from data trails. This keeps the focus on 'thin' data while much human-computer interaction research benefits from 'thick' data. The means of leveraging data as a boundary object to connect and collaborate remain limited. This prevents tapping into the expertise of data participants, leveraging personal data with

appropriately informed consent, and supporting meaningful and reciprocal exchange of values. Research should focus on new data access mechanisms that depart from the data consumption attitude of purely data-driven approaches. These mechanisms should empower stakeholders to leverage available data in collaboration with the relevant parties. Access to data often relies on the design and development of probes and prototypes (Van Kollenburg, 2019).

- How do prototypes shape the data?
- Can we rely on alternative data access methods, such as crowdsourcing or data donation (Gomez Ortega et al., 2022)?
- How do these approaches fit and challenge existing data protection regulations and privacy considerations (for example, the European General Data Protection Regulation)?
- What methods lead to a fair exchange of values and robust insights, as opposed to research driven by data consumption?
- To what extent do these approaches reinforce or mitigate existing inequalities?

DATA MEDIATION AND INTERACTION

Additionally, attention should be devoted to the design and implementation of tools that facilitate the integration of data trails that combine multiple data streams into more comprehensive context mapping, ways of immersion to foster holistic reflections, and pragmatic approaches to complement rather than replace design tools and practices. The way(s) we represent the data to support interpretation and discussion plays a critical role in what insights emerge.

- How do we represent and shape data?

Data is often represented visually through static and dynamic data visualisations (Kurze, 2020) and dashboards (Bogers, 2016).

- How does the way we represent data influence our design (processes) and our interactions with stakeholders?
- What factors influence the way we represent data?
- What tools and techniques do we rely on?
- What are other ways and means we could use to represent and shape the data (for example, physical and tangible (Bae, 2022), and audible (Young, 2019))?
- How do we leverage the various data modalities and materialities to support fair representation and participation with data?

DATA AS A CREATIVE MATERIAL

To say that data, and the technological 'things' that interact with them, are quotidian to the lives of many humans is axiomatic. However, this ubiquity of presence, of availability as a resource, has yet to be met with diversity or plurality of use, craft, and experience. Much of how we see the use of data is still rooted and siloed in utilitarian and analytical perspectives of data. To labour the metaphor, if data were wood, we have only been using them to make simple tables and chairs, not buildings, sculptures, boats, and paper. Data is braided into the fabric of our everyday lives. Our interactions, entanglements, and encounters with data run deep, occur with and without technology, and exist in physical and digital contexts. For some, data is seen as a vital component for the utilitarian improvement of said everyday lives. To garner, aggregate, analyse, and communicate metrics, insights, and knowledge underpins how we see data and the technology that interacts with it. However, the data-interaction design space is expanding. Recent and ongoing research is challenging current conventions and proposing alternative narratives. These alternative narratives explore a variety of concepts and values such as ephemerality, decay (Gulotta et al., 2013), negotiation (Cheng et al., 2019), diffraction and (re)interpretation (Desjardins & Biggs, 2021; Sanches et al., 2022), subjectivity (D'ignazio, 2020), locality (Loukissas, 2019), invisibility (Desjardins et al., 2020) and the interaction with analog data. When these narratives are embodied in design 'outcomes' they allow us to experience other possible worlds where data is not only a straightforward means to an end but a malleable material that can be shaped to create a diverse range of experiences. These worlds do not only question what we can do with data, but what we can expect of the technology that collects, handles, and expresses these data.

- What alternative possible worlds of human-data-technology already exist?
- What design strategies and tactics can enable diverse uses and expressions of data in our everyday lives?
- What are the potential design outcomes when data we create and express need not be immediately practically 'useful'?

COLLABORATION AROUND DATA AND INTERDISCIPLINARY DATA COLLABORATIONS

While the lens is focused on data, the research processes are fundamentally human-centred and participatory (Van Kollenburg, 2019; Kurze, 2020; Clarke, 2018). The design field needs data participatory tools and methods that engage, protect, and credit all parties. But who is involved and how? When reporting our experiences with behavioural data, we often fail to shed light on the many hands involved in generating, collecting, storing, processing, analysing, and visualising the data. Bringing visibility to those involved throughout a data-centric design process can better inform and support future designers and researchers engaging in similar activities.

- What is beyond data privacy and open data?
- How do we empower and foster value exchange through data?
- What are mechanisms and tools to facilitate data conversation at scale?

DATA AS EVIDENCE SUPPORTING MISSION-DRIVEN INNOVATION

As a next step for use of data in combination with design and design thinking, the methods and tools presented may also be used to support the inquiry into design options and creation of evidence for mission-driven innovation. This is still a rather new field, with not many established methodologies yet. Still, some explorations of experimental methodologies have been undertaken. For example, in relation to the use of **Data-Driven Predictive Analyses** to get real-time insight on the effects of interventions (Geurts et al., 2022), thereby supporting monitoring. Others have experimented with the use of data-inspired methodologies for policy making (Giest, 2017). For example, they can be used to explore the use of new data sources, or experimenting with data for policy options (Veenstra & Kotterink, 2017). Questions that arise from this use of data for supporting mission-driven innovation are:

- How to use data to guide decisions regarding transitions, which are often complex and have many interlinked aspects?
- Which data sources are suitable for which types of decisions and which data processing tools and algorithms may be used for different types of decisions?
- Which stakeholders and datasets to involve in decision making?
- Which ethical challenges emerge, such as privacy, bias in data, risks to fundamental rights?

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IMPLEMENTATION OF THE AGENDA AND APPLICATION OF KEMS

In this final chapter, we briefly discuss the application of KEMs (Key Enabling Methodologies) and their role in societal transitions and the Dutch Mission-Driven Innovation Policy. This chapter thus provides insight into how this agenda can be implemented and can underpin methodological issues in research programming.

PROGRAMMING AND KEM RESEARCH

To clarify the pivotal role of KEMs in transitions, it's important to understand the nature and process of the development of new KEMs and the further development of existing KEMs.

KEMs are often developed, tested, and proven in research settings at knowledge institutions. KEM development is – especially in the initial phase – the result of fundamental, methodological research, where theoretical models and considerations form the basis. However, the practice in which KEMs are applied is unpredictable. Often, variants of existing methods arise; the methods are further developed through their use in specific contexts. Therefore, KEMs are never 'finished' and must be constantly tested for (context-dependent) usability, effectiveness, validity, and so on.

Research into, and the further development of methods, therefore, unlike technology, preferably takes place in the application in concrete innovation processes. By studying the effect of the interventions achieved with a specific KEM, insights are gained that help to validate the method, better contextualise it, and combine methods. The application of KEMs in the Dutch Knowledge and Innovation Agendas (KIAs), in which the missions of the innovation policy are fulfilled, is thus not only necessary for the success of those missions; the application of KEMs is also indispensable for the validation and further development of the KEMs themselves.

KEMs bridge domains to arrive at integral solutions. This cross-over character of KEMs calls for a multidisciplinary effort in the area of KEM research and development. The complex and multidisciplinary issues of the missions therefore offer excellent opportunities to work on KEM development. The KEM research agenda is thus intended as a basis for the programming of methodological issues within the KIAs of the mission themes. Research and innovation programmes will focus on transition issues, where existing methods are applied and thereby further developed, or where new strategies and methods are developed. The programmes can draw from this agenda and the research questions that have been marked as the most urgent questions to address in the short term.

Working on (the revision of) this agenda has made it clear that in the Netherlands we have several strong research communities around the KEM categories addressed in this agenda. These communities have organised themselves to a greater or lesser extent and also enjoy international renown in their specific domain. Connecting these strong research groups to private parties offers interesting opportunities for tackling the missions and forming consortia for PPP (Public-Private Partnership) projects.

CONDITIONS AND THE USE OF KEMS

Methods, processes, and strategies are indispensable in achieving missions and transitions. They provide the professional with an action perspective, clarify what to do and what not to do, which steps should be taken, and which paths may lead to a desired outcome. At the same time, KEMs are not a panacea. Many steps in a transition process can also take place without methods, based on knowledge and logic. Or intuitively, fueled by years of experience, or simply through trial and error. KEMs are supportive, a tool. Sometimes the key to a breakthrough, but no guarantee of success.

KEMs provide so-called 'changemakers' with support in tackling transition issues. It's therefore important to be aware of the context-dependent nature of KEMs. The contexts in which methods are applied and the way they are used ultimately determine the quality of the intervention and thus the effectiveness of the method. These contexts are shaped by various variables related to the nature of the issue, the involvement of users, consumers, and citizens ('quadruple helix'), and the situation in which the issue is addressed.

The mission-driven transition issues at hand cover a broad spectrum of topics and contexts within which the desired interventions must land. Variables characterising these challenges and contexts and which are relevant to the choice of KEMs to be deployed include:

- **The nature of the intended impact:** from incremental to radical impact. The energy transition is a targeted radical change. Financial incentives to get people onto renewable energy sources, for example, are often incremental.
- **The nature of the intervention:** from instrumental to institutional intervention. Instrumental interventions directly aim to affect behavioural change. Institutional interventions, for example, involve new or strengthened regulatory bodies.
- **The level at which the intervention takes place:** from individual to collective level, also referred to as micro and macro level. Installing a smart metre is an intervention at the individual level (household). A new regulation to protect privacy is an intervention at the collective level.

Additionally, the situation in which the issue is addressed is relevant for choices in how the selected KEMs are applied. Variables here include:

- The degree of politicisation
- The degree of technological steering
- The degree of substantive uncertainty
- The level of societal attention and urgency
- The degree of entanglement with other challenges
- The readiness for change or expected societal resistance
- The involvement of the client and other stakeholders
- The availability of time and resources

The conditions formed by these variables, and the choices made based on them for the deployment of certain KEMs and how they are used, determine the extent to which a specific KEM – or a combination of KEMs – leads to successful results in specific issues and situations. Although in theory, any method is applicable to any issue and in any situation, some methods are more effective for certain issues and situations than others.

The success of the use of KEMs is thus dependent on many variables and thus requires a professional approach. It is important to consider these variables and to always pay attention to the conditions of the issue, the context, and the situation. Change professionals, such as designers and other creative professionals, have developed the competencies to make such choices thoughtfully and also possess the experience and skills to apply the chosen methods effectively and creatively. This is also discussed in the introduction to the KEM agenda, which focuses on the competencies of the professionals themselves, and the complementary agenda Design Power (CLICKNL, 2024).

APPLYING IN COHESION

Transition challenges are complex and comprehensive, requiring a thoughtful application of KEMs in addressing them and in developing interventions and/or innovations. Often, multiple KEM categories will be relevant to an issue, and methods from several categories will be needed to achieve a successful process and result.

These different methods may be employed at different stages of the process, but it will frequently occur that methods are combined in the context of the specific issue. The art is to select a mix of methods that achieves optimal synergy. As mentioned in the introductory chapter, this requires experience and craftsmanship in selecting and applying the KEMs. An adopter of KEMs must be well aware of the strengths and weaknesses of the different methodologies, be able to estimate when which KEMs reinforce each other or not, and understand how they can be combined and adapted.

There are various KEMs that, due to their generic character, already ensure these combinations. These belong in multiple KEM categories. Examples are Reflexive Monitoring (see categories **Systemic Change** and **Monitoring and Effect Measurement**) and Transition Arenas (see categories **Systemic Change** and **Participation and Co-creation**). Both (groups of) methods were therefore covered in two categories in this agenda. Each category, however, has its own view of the methods, and that perspective yields different challenges and research questions.

COHESION AMONG THE KEMS

In the descriptions of the KEM categories, connections between the KEM categories have been indicated, whether explicitly or not. Because the correct deployment of combined methods and the synergy that arises from it can contribute to a successful approach to complex issues, it is recommended to pursue such interactions between KEM categories in the development and execution of KEMs. Therefore, we would like to highlight a few examples of relationships between KEM categories to illustrate how KEMs can strengthen each other mutually.

Vision Development, Participation and Co-creation, and Awareness and Meaning

The framing of a joint innovation task (Shared Vision Development) can only lead to successful interventions if it finds support among stakeholders. By paying attention to creating a basis for joint meaning attribution in a co-creation process with stakeholders, a perspective of a future desirable for every party can be developed to create this support.

Participation and Co-creation, and Experimentation Environments

In the co-creation process in multi stakeholder settings, experimental environments offer a relatively ‘safe’ setting. The feasibility and scalability of initiatives can thus be tested flexibly, allowing the lessons learned to be immediately fed back into the development process. Experimentation environments also offer opportunities to explore how participation and co-creation can work in settings where these methods are new, as seen now in the Policy Labs (exploration of citizen participation in government).

Institutional Change, Ethics and Responsibility, and Behaviour and Empowerment
The context in which behaviour occurs is coloured, among other things, by institutions. The rhetoric of institutional change often involves providing 'incentives' to individuals, hoping for behaviour change. Institutions, ethics, and behaviour are therefore almost inseparable. Current behaviour is linked to current institutions, and the effectiveness and moral responsibility of institutional change always depend on behaviour change. For example, the effectiveness of imposing additional taxes on meat to reduce meat consumption ultimately depends on whether people actually adjust their behaviour.

Systemic Change, and Monitoring and Effect Measurement
KEMs focused on learning about the system and systemic change are inseparably linked to KEMs to monitor the same system and the effects of interventions. Through Reflexive Monitoring, insight into the progress of systemic change can be used to adjust the goal and strategy of the change. Additionally, the use of appropriate monitoring methods can help map and understand the long-term effects of interventions on systemic change.

Value Creation and Upscaling, and Participation and Co-creation
The societal interpretation of 'value creation' has become much broader over the last decade, especially due to the need for orientation on and operationalization of a broader concept of value. This is often referred to with the term 'well-being' (SER, 2024). One of the consequences is that value creation is necessarily defined by multiple actors. This directly makes (alliance) governance relevant and turns (design) processes participatory. As a result, overlap with other themes, such as participation and co-creation, occurs.

Although the mentioned relationships between KEM categories are intrinsically guaranteed, much additional research is needed into this cohesion. Questions that arise include:

- How can KEMs from different categories enhance each other's application and results?
- Which KEM categories (or KEMs from which categories) are conditional for the success of KEMs from other categories?
- How can KEMs from various categories be combined into an overarching methodology?

MANAGING TRANSITIONS

The large societal transitions targeted by mission-driven innovation policy are only partially knowable and controllable. However, transitions result from various types of agency and are thus influenceable. The direction and pace of transitions depend on our actions. Transition management, therefore, concerns how we can move from an undesired state to a desired situation, or undergo a (sustainability) transition, as smoothly as possible. Giving this concept substance ultimately means developing a toolkit for indirect management: stimulating learning processes, experimentation space, destabilising inert structures, assisting in phasing out undesired elements, finding common direction and ambition, and adjusting one's position and routines in relation to other parties. This process of coherent activities is called transition management, and KEMs from all categories can play a role in it. Transition management thus forms an overarching or integral approach that helps, for example, strategically deploy KEMs around Participation and Co-creation, Monitoring and Effect Measurement, and Vision and Imagination as part of a broader transition strategy (see Loorbach et al., 2017).

In recent years, the demand for such an overarching, integral approach, where various types of KEMs are deployed in a sequentially logical manner, has greatly increased. The coherence in which KEMs are deployed reflects the strategic or ideological starting point of the party leading the transition. For example, in a top-down approach, a vision of a desired future is first developed before other methods are deployed for system or behaviour change. If a more bottom-up-like approach is chosen, it makes sense to start with a participative approach to involve as many stakeholders as possible in directing the transition. In such an approach, experimentation is central, and Experimentation Environments, for example, are set up to monitor the effects of interventions. The choice of the appropriate transition strategy will be partly determined by the context and the nature of the task (see the previous section on conditions and the use of KEMs) and it is important to recognize how KEM categories intrinsically relate to each other. Regardless of the transition strategy chosen, it is likely that methods from all KEM categories will be employed at some point to influence the transition.

With KEMs, we can shape and accelerate transitions in an informed, systematic, and in many cases evidence-based manner. The expansion of the KEM toolkit with three new categories of methods and the underlying areas of expertise, in this revised KEM agenda, provides additional tools. Thus, we are increasingly capable of addressing transitions in areas such as healthcare, energy, sustainability, or digitalization adequately and proactively. The necessity of this, referred to as 'transition or transformation failure', was aptly summarised by the director of the Netherlands Environmental Assessment Agency, Marko Hekkert (2023): "To procrastinate and then address the required change as a crisis is a cruel way of managing changes."

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www.clicknl.nl
www.kems.nl

REVISED VERSION EDITED BY
Martijn Arnoldus - CLICKNL
Rik Braams - TNO
Kees Dorst - University of Technology Sydney
Paul Hekkert - TU Delft / Topsector Creatieve Industrie
Anne Fleur van Veenstra - TNO

AUTHORS
Frank Berkers – TNO / Hogeschool Rotterdam
Mieke van der Bijl-Brouwer - TU Delft
Jacky Bourgeois - TU Delft
Miguel Bruns - TU Eindhoven
Rik Crutzen - Universiteit Maastricht
Michel van Dartel - Avans Hogeschool / V2_Lab
Kees Dorst - University of Technology Sydney
Koen Frenken - Universiteit Utrecht
Mathias Funk - TU Eindhoven
Amber Geurts - TNO
Paul Hekkert - TU Delft / Topsector Creatieve Industrie
Sander Hermsen - Radboudumc
Tom van der Horst - TNO
Caroline Hummels - TU Eindhoven
Jos Kraal - TU Delft
Kees Krul - Erasmus Universiteit Rotterdam
Derk Loorbach - Erasmus Universiteit Rotterdam
Geke Ludden - Universiteit Twente
Anja Overdiek - Hogeschool Rotterdam
Deger Özkaramanlı - TU Delft
Linda Rindertsma - CLICKNL
Nynke Tromp - TU Delft
Merel Willemsen - Avans Hogeschool

COURTESY OF

Flor Avelino - Universiteit Utrecht
Roy Bendor - TU Delft
Mieke Bernink - Amsterdamse Hogeschool voor de Kunsten
Nazli Cila – TU Delft
Marcel Cobussen - Universiteit Leiden
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Oscar Tomico - TU Eindhoven
Erik Viskil - Universiteit Leiden
Liesbet van Zoonen - Erasmus Universiteit Rotterdam

FINAL EDITING

Dorien van Alphen - CLICKNL
Martijn Arnoldus - CLICKNL

ORIGINAL INITIATORS

Bart Ahsmann - CLICKNL
Hans de Bruijn - TU Delft / NWO
Marco Hekkert - Universiteit Utrecht
Paul Hekkert - TU Delft / Topsector Creatieve Industrie
Tom van der Horst - TNO
Janneke van Kersen - NWO
Nico van Meeteren - Health Holland / Topsector Life Sciences and Health

DESIGN

Danique van de Rakt - Raaqt

ENGLISH TRANSLATION

Jeff McNair - McNair vertalingen

CONTACT

CLICKNL • kems@clicknl.nl

CLICK NL

AGENDA
KEY ENABLING METHODOLOGIES
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CLICKNL • kems@clicknl.nl
WWW.KEMS.NL