

INTERCHANGE: DESIGN BUILDING BLOCKS FOR COMPLEX SCIENCE-POLICY CHALLENGES

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EXECUTIVE SUMMARY

This paper proposes a new institutional architecture framework — the Interchange — to address complex, evolving governance challenges like climate change, artificial intelligence, and public health crises. These “wicked problems” are too large and dynamic for any single entity to fully comprehend, requiring ongoing learning and action simultaneously. Current institutions struggle to bridge the growing gap between available knowledge and collective decision-making.

The Interchange centers on three essential functions:

- **Represent:** making complex realities legible through assessments, models, and metrics
- **Recognize:** creating structured consideration of knowledge in decision-making contexts
- **Respond:** mobilizing and coordinating action across dispersed actors

These functions can be accomplished through various institutional forms, emphasizing flexibility in design. Interchanges can also be linked together into a larger mesh to accomplish different scales of coordination.

The authors identify **three existing archetypes** based on how tightly knowledge and action are coupled. **North Star Interchanges** (like the IPCC) provide authoritative assessments that shape debate without formal decision requirements. **Entangled Interchanges** (like the UK’s Climate Change Act) formally embed scientific knowledge into governance procedures, creating mandatory feedback loops. **Algorithmic Interchanges** (like India’s eco-fiscal transfers) automatically trigger responses when specific indicators reach predetermined thresholds.

Beyond individual Interchanges, the paper proposes a “mesh architecture” — networks of connected Interchanges operating at different scales and sectors. This allows concentrated attention on critical system dynamics while maintaining coordination across regions and domains.

The authors explore speculative possibilities using AI, digital twins, and citizen assemblies to enhance representation, broaden recognition to include future generations and diverse knowledge systems, and strengthen collective action through coalition-led responses.

Drawing on literature about boundary organizations, co-production of knowledge, and decision-making under uncertainty, the Interchange offers a new possibility for institutional entrepreneurs designing governance mechanisms that can match the scale, speed, and complexity of contemporary challenges.

INTRO

Many of the most stubborn policy challenges call for ongoing, iterative doing and learning. The risks associated with climate change, for example, are well established, but the trajectory of temperatures, rainfall, extreme weather, or ecological change for a particular place can be hard to pin down. The timing, trajectory, and early warning signs for irreversible changes around Earth system tipping points are still being discovered¹. Still, the consequences of inaction are too great for delay to be a reasonable strategy. Artificial intelligence and its impact on polities, economies, and labor markets are unfolding and changing, even as efforts to govern it are being explored. Public health crises, from pandemics to environmental health, often require discovery and interpretation at the same time as developing a response. For all of these, the scale and scope of the drivers, impacts, and unfolding changes may simply be too much for any one person or entity to comprehend or study — even knowing what is to be governed is effectively a group project.

These complex, shifting challenges strain our current institutions. We have more data than ever, as well as an expanding array of tools with which to make sense of it. Developing the social context and institutions to include a wide variety of perspectives and form the right questions lags behind². Learning is faster than ever, but distilling the weight of evidence from still-to-be-tested early lessons remains a challenge. “Evidence-based policy” is also harder when the “evidence” — and even the questions — are still being formed. Doing all of this in public, in the face of interests in particular answers, is even more difficult. Carrying whatever strands of certainty through to build support for action in a time of information wars is a new challenge.

“Evidence-based policy” is harder when the “evidence” — and even the questions — are still being formed.

This paper offers an initial design framework for upgrading and building new institutions to address these kinds of governance challenges. Building more interaction between learning and doing, whether in policy, private sector, community interaction, or all of the above, is a difficult but essential challenge for institutional architecture. Much has been written about the complexity, the variety of forms, and the power dynamics at play as knowledge is created, refined, represented, and used to motivate, justify, and direct action. What is written here leverages insights from some of this literature to widen the terrain for institutional design — recognizing, for example, the tensions around what and who constitutes knowledge. It also tries to narrow the focus to the practically relevant, for example, by identifying some starting points for breaking big, entangled questions into more approachable starting points for experiments.

We pick up on some of the threads raised in Mulgan (2017, 2023) on possible approaches for improving society’s ability to use more of the vast and growing quantities of information and analytical capacity toward more collectively intelligent dynamics. We hope that the paper provides a framework for imagining and designing the action-oriented knowledge exchange mechanisms needed to address deeply intertwined complex challenges.

Our early thinking on institutional design that supports knowledge-to-action has developed around the particular challenge of recognizing and responding to accelerating environmental change. Many of the following examples draw on institutional precedents from environmental science, but the framework and building blocks are, we think, more generally applicable to other challenges in which human collective decisionmaking has to grapple with non-human realities. This is the first public draft, and we welcome comments.

The first section proposes a design vocabulary, the Interchange, for describing the functional building blocks required to build better connections between knowledge and action on complex, evolving challenges. We draw on key themes in the governance literature on boundary organizations, decisionmaking under uncertainty, and the science-policy interface, but distill these ideas into a focus on three social functions: representing the object of governance (e.g., environmental risk, technology impacts), recognizing it at an organizational or group level (e.g., in decision criteria, market metrics, or rules-of-thumb), and organizing and executing a response. Each of these functions can and has been accomplished in a variety of ways. The focus on functions encourages institutional entrepreneurs to consider a broad menu of possible forms that new institutions could take. Interchanges can also be designed for a variety of scopes and scales — and then connected with each other to create flexible mesh architectures across larger spatial scales (as in the case of Earth system tipping points) or interconnected policy areas.

The second section extends the vocabulary to illustrate some of the varieties of interchange. We identify three broad types of Interchanges based on a spectrum of how tightly knowledge production and action are coupled. “North stars,” may be the most familiar variety: formal knowledge assessments that shape the senses of problems and solutions, but are not specifically linked to any particular process or decision. The formality and investment in assessments give the “north star” more weight and potential to be recognized in decision arenas than a single paper, but there is no formal legal requirement to acknowledge its findings. “Entangled” Interchanges, in which negotiations and decision-making take place with specific reference to an agreed-upon reality, are more common for specific, bounded problems: river-sharing, business decision-making, and treaties. “Algorithmic” Interchanges, in which decisions or actions are automatically triggered by specific events based on an agreed-upon representation, are most common in regulation — but have been discussed by some authors as a possible model for other kinds of policy.

The third section explores the speculative possibilities of the functional framework and how some of the new threads in thinking about governance could be brought together to design Interchanges and meshes of Interchanges.

The last section lists guiding questions for designing Interchanges.

INTERCHANGE

in·ter·change

(verb): (of two or more people) exchange (things) with each other.

(noun): the action of interchanging things, especially information; alternation.

In everyday language, interchange is both a verb and a noun. It is the act of exchanging information and perspectives, as well as the site where these exchanges can happen, to generate new combinations and collaborations. We use the term here to describe a class of institutional architecture designed to connect knowledge with the capacity to act in complex systems such as climate, biodiversity, digital technologies, health, and finance.

An Interchange could take several forms: a single organization, perhaps with branches, or an ecosystem of organizations and routines for interacting. The important point is that the organization or ecosystem can perform three functions:

- representing a complex feature of the world,
- recognizing it along with other considerations in decisions, and
- organizing a response to it — as well as iterate and update over time.

Building an Interchange might mean addressing one, two, or all of the three functions. In some cases, assessments exist, but there are no decision contexts that recognize them. In others, decision rules may incorporate old or outdated information. Sometimes the missing piece is iteration.

The Interchange is an institutional architecture designed to connect knowledge with the capacity to act in complex systems such as climate, biodiversity, digital technologies, health, and finance.

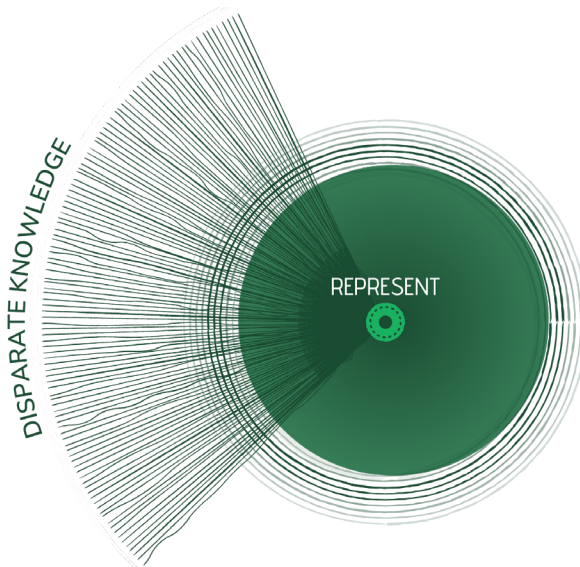
1. Represent

(verb): to give a clear understanding or impression of; to describe or present clearly; to serve as a sign or symbol of; to portray or exhibit in art.

Complex issues are too big or abstract to experience directly. Representation is therefore foundational. It is the process through which institutions make invisible dynamics legible enough to govern³. Also, assessments are finite. Thus, the choices made in modeling, assessments, research protocols, infographics, metrics, and vocabulary mean that some drivers, impacts, and dynamics inevitably become more visible than others. This curation has consequences:

- It can make a difference in how a problem and, hence, a solution are defined. Is a forest a group of trees or a multi-species ecological community? The way it is represented can make all the difference in actions taken to conserve it.
- It can imply common cause and motivate collective action — or highlight discrepancies and drive divisions. Early evidence on long-distance transport of air pollution, for example, motivated the diplomacy that created the Long Range Transboundary Air Pollution Convention.
- It can build empathy and engagement. Evidence from fields as diverse as conservation to community politics to home maintenance shows that communication on “how something works” draws people in more than simply sharing consequences.

Figure 1. Interchanges include mechanisms for the dynamic representation of complex issues



Representation in Interchanges can and should be plural, combining science with lived experience, Indigenous knowledge, and practitioner insight. Complex systems evolve, change, and are often too simplified by any particular way of knowing.

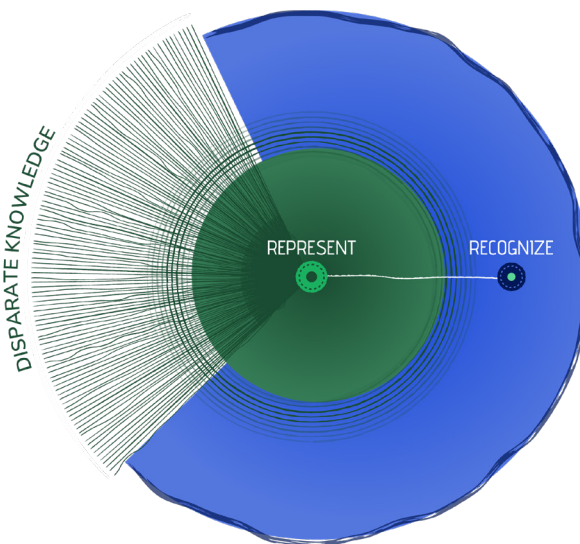
2. Recognize

(verb): identify (someone or something) from having encountered them before; know again; acknowledge the existence, validity, or legality of.

To “recognize” means to create space for consideration — for respect, for valuation, for acknowledging as relevant, along with other matters. Recognition is the structured act of seeing something as relevant, material, and requiring at least some form of response. Recognition bridges knowledge and authority. As individuals, we can sense the changes around us: fewer insects, different temperatures, hazier skies, and more. We can read the scientific papers or their media coverage. And what we recognize matters: it shapes popular pressures, voting, patterns, and choices about what to buy, eat, and wear.

The act and forms of “recognition” as a general concept are not as extensively theorized as representation, but the blind spots of institutions and organizations are familiar and well documented. Stock market capitalization rises and falls on financial returns more than on environmental impacts. Risk registers discount future climate impacts, especially over long time horizons. National wealth and economic growth are measured in accounting terms that overlook natural capital. Courts and legal systems adjudicate property rights, often without considering that the property may have rights. The systems for impact at scale have blind spots.

Figure 2. Interchanges include mechanisms for recognition to bridge knowledge and use of authority



We see early templates for extending recognition. Natural capital accounting is moving from concept to implementation. Rivers and forests are gaining legal rights in a growing number of jurisdictions. Metrics for evaluating policy and public investment are starting to recognize the future costs of emissions and the rights of future generations. Parameters for intergovernmental transfers embed consideration of environmental achievement in a growing number of countries. Cultural narratives are shifting toward re-recognizing “the planetary.”

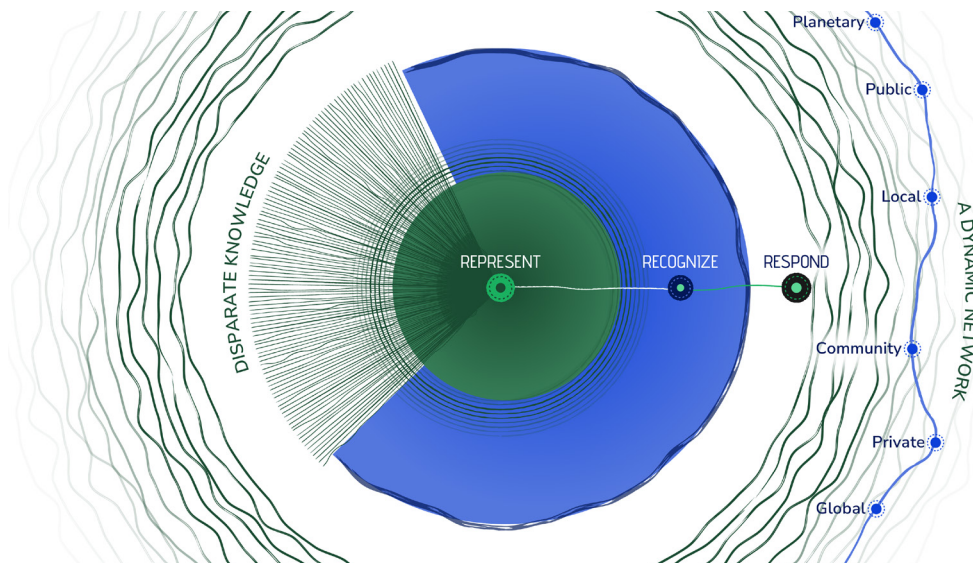
3. Respond

(verb): to say or do something as a reaction to something that has been said or done.

Humans are an incredibly capable species. As individuals, communities, cities, companies, nations, tribes, empires, and other collectives, we have transformed our surroundings and ourselves, at local to planetary scales, over and over again. These transformations have been driven in part by policy, but also by commercial interests and cultural narratives. They have not always relied on collaboration or explicit recognition of shared goals — human social dynamics in the aggregate can be quite different than any particular individual or organization's intentions.

The challenge is how to mobilize and direct this capacity in response to complex realities. The Interchange framework acknowledges the distribution of power across spatial scales and public and private actors. It acknowledges the role of competition and the facts of competing priorities. The point is to be pragmatic and strategic in guiding, coordinating, and stabilizing action across dispersed centers of power, ensuring that knowledge and recognition translate into meaningful societal movement rather than episodic reaction or symbolic commitment.

Figure 3. Interchanges include mechanisms for coordinating a response



What are networks of the imperative, for example, beyond simply coalitions of the willing? Building the “response” function is critical when challenges cross borders, sectors, and generations. In such contexts, no actor holds the full mandate or capability to act alone, yet inaction by any one actor can stall progress for all. They enable learning and iteration, recognizing that effective response is rarely linear and that strategies must evolve as knowledge and circumstances change.

Mesh for flexible scale

Governing complex systems requires institutional arrangements that can concentrate attention around key system dynamics while remaining more loosely linked across broader regions, sectors, and mandates. Developing a mesh of Interchanges offers a way to build this capacity.

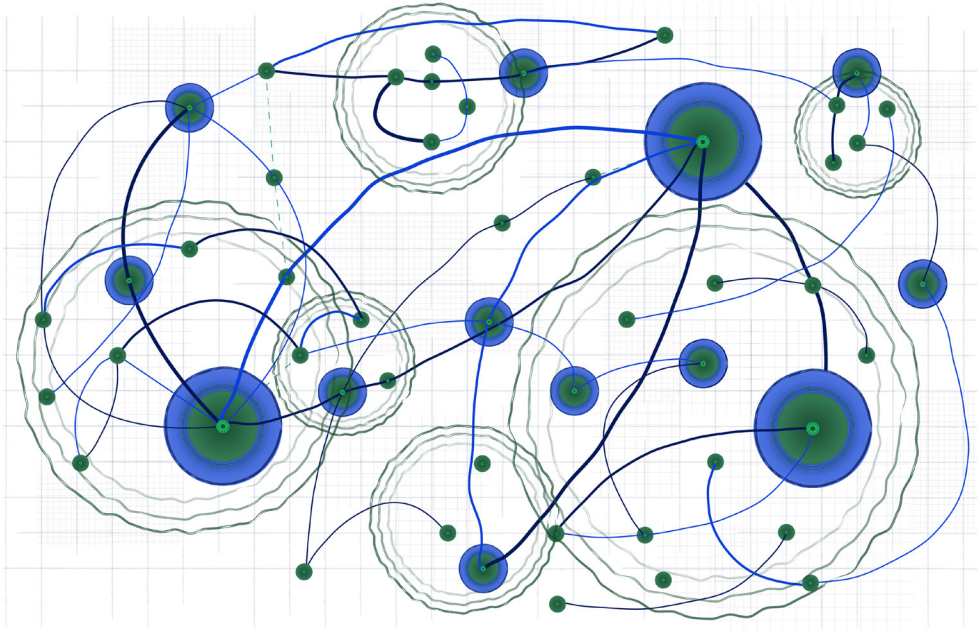
In the concept note for Tipping Element Monitoring and Response Facilities⁴, one application of the Interchange framework, Milkoreit, Seddon, and Villasante outline a mesh structure in which there is a dedicated Interchange for each Earth system tipping element and a larger mesh framework for cooperation, peer learning, and data sharing across Interchanges. Each TEMRF would focus on deepening analytic and technical capacity to anticipate and monitor relevant system dynamics, advancing policy, private sector, and other recognition of the risk, and organizing responses. The specific scientific challenges for monitoring coral reefs, forest stability, and ocean currents vary, as do the arenas and protocols in which risk recognition is most important. The specific response requirements also differ: in some cases, it may be intense advocacy for mitigation or carbon removal; in others, it may be integrated efforts to reduce climate and ecological pressures.

In the concept note for Tipping Element Monitoring and Response Facilities⁴, one application of the Interchange framework, Milkoreit, Seddon, and Villasante outline a mesh structure in which there is a dedicated Interchange for each Earth system tipping element and a larger mesh framework for cooperation, peer learning, and data sharing across Interchanges.

The broader framework could start as a cohort for peer learning and develop into more structured approaches to data sharing and coordination based on the underlying interaction between tipping elements. A broader constellation of Interchanges could operate at national, regional, and sectoral levels. Their relationship is shaped by periodic learning exchanges, shared foresight exercises, and agreed triggers for action. This structure allows diversity in institutional design and political context while maintaining shared signals and collective sensemaking.

The figure below illustrates this architecture. Dense clusters indicate intense coordination around key risks. Smaller nodes represent distributed sites of sensing, learning and adaptation.

Figure 4. A Mesh Architecture



This design supports diversity in institutional forms, political settings, and knowledge systems, while enabling local autonomy and innovation. Also, it can move and learn as systems shift. In a world where interdependence is structural, a mesh of Interchanges offers a practical path to meet complexity with organised, adaptive capability.

Interchange in other words

“Science-policy” or “the science-policy interface” are more commonly used terms, but are limiting in several ways. Most importantly, they imply a narrow exchange between scientific expertise and formal policy actors. In reality, contemporary challenges draw on multiple knowledge systems (scientific, Indigenous, experiential, computational) and require multiple levers of action (policy, markets, civil society, technology, norms). Interchanges reflect this broader observation. They bring together observation, interpretation, and steering capacities so that diverse actors can build a common view of reality and mobilize around it.

The term interchange draws inspiration from architecture and applications of architecture theory. Easterling (2014) describes how network infrastructure elements (e.g., highway interchanges, dams, telecommunication hubs) act as switches that route flows and exert influence beyond their immediate locale. A highway interchange, for example, redirects and recombines traffic, effectively modulating conditions across a wider network of roads and flows.

We borrow this imagery to describe an institutional architecture that connects two critical “flows”:

- **knowledge** (including scientific information, practical expertise, traditional ecological knowledge, and raw data)
- the **capacity to act** (including the policy, market, and social levers for directing and implementing change)

In governance terms, an interchange is a structured node that can redirect and modulate flows of information and authority across different scales.

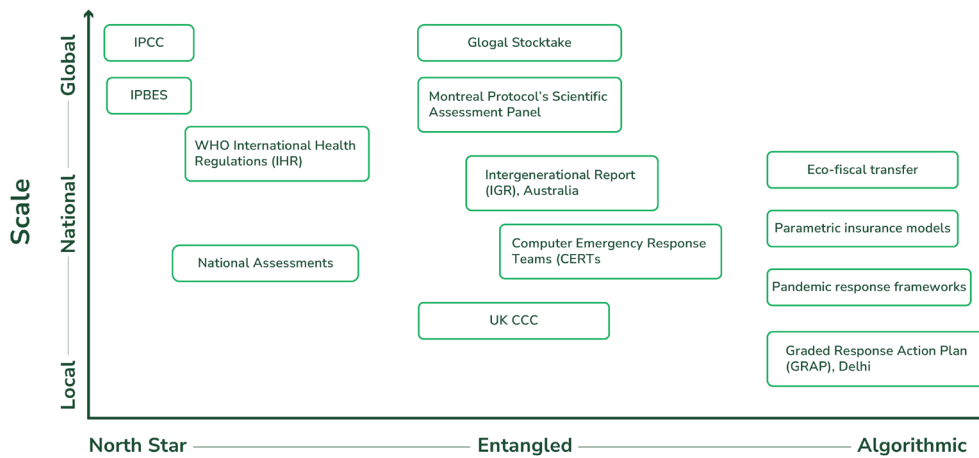
An interchange can also be understood as a boundary structure with formalized pathways for two-way exchange between knowledge and response. Knowledge flows into action as experts, data, and models inform decision-makers and implementers. At the same time, the mandates, priorities, and values of decision-makers shape which knowledge is produced, collected, and used. The idea of interchange also builds on and attempts to translate insights from other theoretical frameworks and research work on science–policy interfaces, such as boundary organizations⁵ and modular network governance theory⁶, which have long noted the need for bridging mechanisms to connect scientific and technical expertise with policy action.

While the term interchange is new, its underlying logic can be seen in several existing institutions and governance mechanisms that bridge science and policy. The examples below illustrate this logic in action, through recurring and shared representations of complex systems, structured convening of diverse actors, and mechanisms that ensure natural and social realities are systematically integrated into decision-making.

CATALOGUE OF INTERCHANGES

Across domains, the building blocks of what we call Interchanges can be seen in how societies link knowledge to action. Yet, these mechanisms often remain isolated within specific sectors or scales. The idea of an Interchange brings these elements together in a more intentional, connected way. Based on the degree of coupling between knowledge and response, we identify three main archetypes: the **North Star**, **Entangled**, and **Algorithmic**.

Figure 5. Illustrative Mapping of Interchanges



North Star Interchanges provide a shared vision. At the global level, they usually exist in the form of science-policy interfaces that synthesize expert knowledge into broad consensus targets. At the national or subnational level, they appear as independent advisory councils, strategic assessments, or independent commissions. Their purpose is to sustain a long-term perspective, depoliticize expert knowledge, and ensure continuity across electoral cycles.

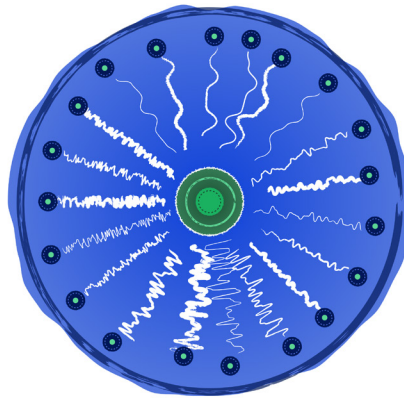
Entangled Interchanges represent a more formally embedded coupling of knowledge into the policy or governance process. In this case, scientific knowledge is officially integrated into governance procedures, rules, or institutions. Their designs ensure that knowledge has a required seat at the table during the decision-making process, while still leaving room for deliberation, negotiation, and adaptation. The primary aim of Entangled Interchanges is to ensure that responses are continuously learned and adapted in response to new information.

The **Algorithmic Interchange** is the most tightly coupled form, where specific knowledge indicators are tied to pre-agreed automatic responses or near-automatic decisions. It is “algorithmic” in the sense that the decision protocol can be codified like a simple algorithm or formula. For example, in this model, the institution 7Up is essentially an if-then rule system: if measured conditions reach a certain threshold, then a specific action is deployed. This type is often used when speed is critical (emergencies), or when actors seek to commit in advance to specific actions to enhance credibility or prevent politicized delay.

North Star

At the global level, the **Intergovernmental Panel on Climate Change** (IPCC) is the archetypal North Star. It convenes scientists to produce periodic assessments — sometimes at the request of the UNFCCC based on open policy questions — and provides governments with authoritative knowledge on the state of climate change, without dictating action. There is no formal requirement for any business, national government, or other actor to recognize its findings, but many do refer to it as a reference point for infrastructure and other planning. The way that it frames discussions and describes findings is sufficiently powerful to be contested and critiqued in media commentary and academic analysis alike.

Figure 6. North Star Interchange



The **Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services** (IPBES) plays a similar role in biodiversity conservation, incorporating both scientific and indigenous knowledge to inform regional and global conservation priorities. It represents knowledge differently from the IPCC as it seeks to represent more specific, contextualized ecological points rather than claim widely applicable global findings. Both IPCC and IPBES have early input from policymakers and other knowledge users in outlining the areas for synthesis.

Comparable structures exist in other domains. In health, the **WHO International Health Regulations** (IHR) establish a global baseline for outbreak preparedness and reporting capacities. In finance, the **IMF World Economic Outlook** and the **OECD Economic Outlook** are recurring assessments that orient fiscal and monetary policy debates worldwide. In food systems, the **FAO's State of Food Security and Nutrition in the World** (SOFI) report serves as the primary global assessment of hunger and malnutrition, loosely informing donor strategies and government planning.

Many countries have science advisory councils or national assessments. For example, national academies that produce strategic vision reports, or institutions focused on topics such as sustainable development (e.g., SDG India Index by the NITI Aayog in India).

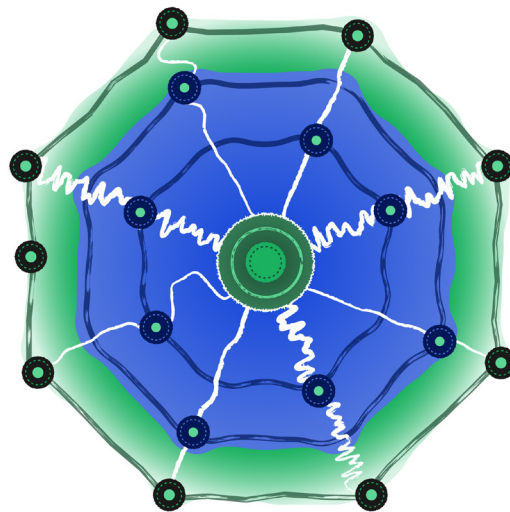
Across these diverse fields, North Star Interchanges serve as recurring reference points. They are mostly designed to create authoritative knowledge baselines that reduce uncertainty and focus debate on “what must be done” rather than “what is happening.” In doing so, the expected return on investment is increased likelihood of recognition and some effort to respond.

Entangled

At the global level, the **Paris Agreement's Global Stocktake** represents a paradigmatic Entangled Interchange. Under the Agreement, countries collectively assess progress toward long-term temperature goals every five years and then submit updated national targets. The process institutionalizes a knowledge–policy feedback loop. A similar structure is embedded in the **Montreal Protocol**. Its **Scientific and Technology Assessment Panels** periodically review ozone-layer recovery and technological alternatives to harmful substances. This process enables real-time policy evolution in response to emerging evidence.

At the national level, the **United Kingdom's Climate Change Act** (2008) demonstrates how Entangled Interchanges can be built into domestic law. The CCC's assessments and progress reports are legally recognized, and the government must either act on them or publicly justify deviations. This legal and procedural entanglement of science and policy ensures continuity across political cycles and has been widely emulated internationally.

Figure 7. Entangled Interchange



Fiscal and economic policy also relies on Entangled Interchanges. In Australia, the **Intergenerational Report** (IGR) serves as a statutory instrument linking long-term analysis to near-term decisions. Every five years, the Australian Treasury is required to publish projections of demographic, economic, and fiscal trends spanning a period of four decades. The IGR compels policymakers to confront the long-term consequences of current choices on pensions, infrastructure, and taxation, and has become a focal point for public debate about fiscal sustainability.

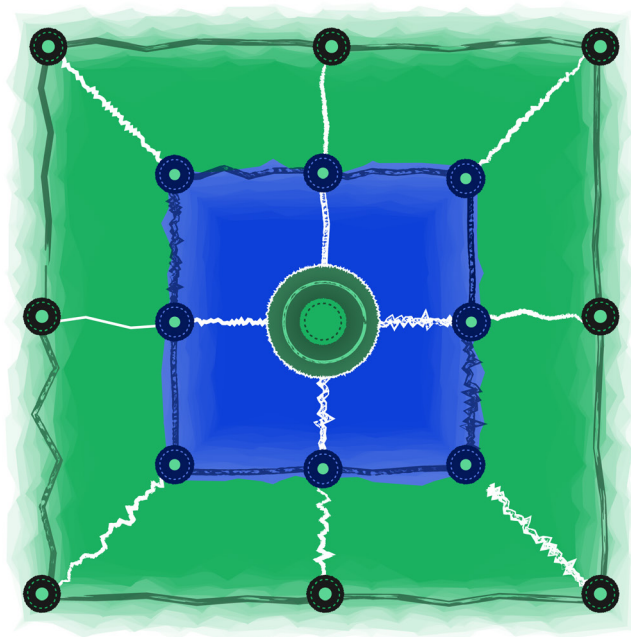
Emerging domains, such as cybersecurity, are beginning to exhibit similar patterns. The global network of **Computer Emergency Response Teams** (CERTs) operates as a continuous interchange between technical experts and policy authorities. CERTs detect and analyze cyber threats, share vulnerability alerts, and coordinate responses across borders. In critical cases, this knowledge triggers immediate policy actions, such as regulatory advisories, patch mandates, or defensive measures, effectively transforming near-real-time technical monitoring into a global collective security governance framework.

Algorithmic

India's **Finance Commission** and its tax-sharing formula. Since 2015, a share of central tax revenues transferred to states has been tied to each state's proportion of national forest cover. This indicator directly translates ecological performance into fiscal reward. This simple mechanism embeds environmental incentives in fiscal policy without requiring continual political negotiation. Similar "eco-fiscal transfer" mechanisms in Brazil and China follow the same principle: measurable environmental indicators serve as algorithmic triggers for financial flows.

The same underlying logic was evident during the COVID-19 pandemic, when several countries introduced tiered public health frameworks governed by quantitative thresholds. Exceeding a defined threshold triggered stricter lockdown measures; sustained declines over two weeks lowered restrictions. These systems replaced political discretion with data-driven escalation rules for proportionate response to changing conditions.

Figure 8. Algorithmic Interchange



Urban air-quality management has institutionalized a similar approach. Delhi's **Graded Response Action Plan** (GRAP) links each Air Quality Index (AQI) band to a corresponding package of interventions. Each response level is automatically activated once data crosses the threshold.

Mechanisms such as the **African Risk Capacity** (ARC) and the **Caribbean Catastrophe Risk Insurance Facility** (CCRIF) use parametric insurance models that trigger payouts based on real-time environmental data rather than post-disaster assessments. When rainfall, wind-speed, or drought indices exceed pre-agreed thresholds, funds are automatically disbursed to member governments. These mechanisms ensure that scientific data directly activate financial relief, bringing predictability and credibility to disaster response.

SPECULATIVE POSSIBILITIES

In this section, we explore speculative design possibilities for future Interchanges that could transform how we share knowledge, build evidence, and govern together.

Expanding how we represent reality

As systems become more interconnected and dynamic, representation must evolve to match the complexity. Static formats struggle to show non-linear change, cross-scale interactions, and emerging risks. New capabilities in artificial intelligence, immersive media, and computational modelling provide ways to construct more layered, adaptive, and experiential representations of shared risks and possible futures.

AI-powered observation and pattern detection

New possibilities are emerging to transform how we represent and monitor complex realities. Machine learning models can now process satellite imagery, sensor data, and social signals to detect emerging patterns. Projects like Climate TRACE⁷ and Global Fishing Watch⁸ already use AI to monitor emissions and resource extraction independently. Future Interchanges could use similar methods to generate continuous situational awareness.

Digital twins and simulation models

Several new initiatives are developing dynamic, AI-driven “digital twins” that link data and decision-making. The EU’s Destination Earth⁹ and Singapore’s Virtual Singapore¹⁰ projects use continuous data feeds to model urban and environmental systems in real time. Such models could serve as the analytical core of future Interchanges, functioning as living systems.

AI-mediated dialogue and negotiation

Large language models (LLMs) can create immersive visualizations, narratives, and simulated futures. These tools also enable rapid prototyping of “what-if” scenarios. For example, an AI might instantly illustrate how a restored forest might look in 2050 or visualize the implications of different policy pathways. Within Interchanges, such tools could enable continuous synthesis of perspectives, supporting collective reasoning and more evidence-informed decision-making.

Personalized knowledge systems

LLMs can also localize and personalize global knowledge. This is crucial as most global assessments (e.g., IPCC reports) are not easily translated to local contexts or individual decisions¹¹. It also points to a shift from one-size-fits-all reports to systems capable of generating many truths from the same evidence base.

Broadening who and what is recognized

Interchanges can be designed for recognizing not only more diverse knowledge holders, but also different temporal and societal perspectives. They expand the boundaries of whose perspectives are acknowledged, whose interests are legitimized, and whose realities shape the agenda.

Anticipating the needs of future generations

Today's decisions on climate, technology, biodiversity, and infrastructure will have long-term consequences that stretch far beyond the current electorate. Yet, most political systems are structurally biased toward the present. To address this asymmetry, some governments are beginning to institutionalize future-facing mechanisms. **Wales' Well-being of Future Generations Act** (2015) created a legal obligation for public bodies to consider long-term effects and appointed a Future Generations Commissioner to champion those interests. The European Union also announced a new commissioner-level role to represent future citizens.

Beyond formal institutions, speculative governance methods are being explored to “bring the future into the room.” For example, proxies for future generations are being prototyped. Some have proposed assigning symbolic parliamentary seats to non-present stakeholders, with appointed stewards tasked with representing long-term interests. Others envision AI agents trained on principles of intergenerational equity that could participate in simulations or policy reviews.

Democratizing recognition through citizen assemblies

There is also a growing recognition that legitimate governance must consider the perspectives of ordinary people, not just experts or elites. Citizen assemblies are among the most promising institutional responses to this need. Citizen assemblies function as structured spaces for collective interpretation and values-based negotiation. In Interchanges, such assemblies could be integrated more systematically. For example, they may become permanent features of the evidence-policy interface, helping evaluate scientific assessments or co-design governance options. This marks a shift toward broader recognition of experiential and civic knowledge, grounding interchanges in both scientific insight and public legitimacy.

Translating knowledge into collective action

As challenges grow more interconnected, responses must become more coordinated, adaptive, and mission-driven. This requires institutional scaffolding that helps diverse actors turn shared understanding into shared priorities and joint movement.

Coalition-led response systems

Despite global uncertainty, multi-stakeholder coalitions are already emerging as the default structures for addressing complex, cross-sectoral challenges. These alliances bring together governments, civil society, scientists, private sector actors, and multilateral bodies around shared goals. Initiatives such as **Gavi**, the **Vaccine Alliance**, **COVAX**, and **Digital Public Goods Alliance** highlight this shift. These efforts mix science, policy, and operational delivery in structured ways. Interchanges could function as coalition incubators, helping actors coordinate resources, narratives, and strategies across sectors and geographies.

INTERCHANGE DESIGN CONSIDERATIONS

This section outlines some design considerations for each component of the Interchange and the linkages between Interchanges in a larger mesh.

Representation is an ongoing act of making some aspects of an underlying phenomenon visible, while leaving some less visible. Any act of research, science, or narrative makes this choice; the coastline on a map, for example, is a finite line representing an infinite length.

The design considerations for representation include acknowledging and structuring the power inherent in the choice of what knowledge to focus on, as well as the technical aspects of acquiring and sharing this knowledge with the speed, scale, timeliness, accuracy, and other characteristics to be useful and represented in the decision arenas and by those whose actions shape the outcome.

- What's important to know? At what speed, scale, timeliness, accuracy, and cost?
- Who chooses this agenda and how often should that choice be revised?
- What are ways to revise and update the choice of what's represented — to incorporate new findings, new ways of knowing, new needs, or for other reasons?
- What are ways to protect continuity of methods — to generate comparable time series, without disruptions, even as innovation takes place? Who guarantees upkeep and continuity?
- How is legitimacy ensured?
- What needs to be more visible, or more sharply visible? And what are the investments in observations, analytical tools, and expertise needed to make this happen?
- How will Indigenous, practitioner, western scientific data, and other forms of knowledge be integrated?
- What forms of representation are most likely to be visible to those with the power to act? What investments are needed in synthesis and presentation to generate this representation?

Recognition is the act of acknowledging a representation as relevant for a decision about budgets, resources, policies, infrastructure, or anything else. For knowledge to be integrated with action, there needs to be an exchange — a signal (representation) that is received (recognized).

The design considerations for recognition start with the technical and political questions of which decisions are implicated in perpetuating the problem or moving toward a preferred outcome. Are these public policy decisions, investment decisions, community tendencies, or all of the above? The second part lies in deciding how tightly specified recognition needs to be. The difference between the Interchanges above, from North Star to Algorithmic, is mostly in terms of recognition.

- What kinds of decisions need to change?
- What kind of information formats, scales, and types do these venues already recognize?
- Who is missing from the table, and how do we ensure diverse representation?

Response is an act of coordination. The key questions are who, and how — with “how” being a small word that includes everything from motivating to sustaining to adjusting a response.

- What is the kind of response that needs to be organized?
- Whose behavior has to change, or whose support must be mobilized to address this problem? What decision rights do they have in routine vs. emergency conditions? And what will motivate and enable them to act?
- What triggers or thresholds activate predefined responses, and who authorizes exceptions?
- What accountability and learning loop will verify outcomes and update models or indicators (after-action reviews, timelines, owners)?

Connecting Interchanges for a mesh enables scaling without centralizing control. However, not every Interchange needs the same degree of linkage. Some will require tight coupling, while others may benefit from looser coordination. Design considerations for connecting Interchanges include:

- Which Interchanges require sustained, close coordination, and for what purpose?
- Which links can remain light, focused on periodic learning and shared signals?
- What shared data, modelling, and foresight practices ensure interpretability?
- What minimal agreements support update, iteration, and learning throughout the network?
- How do we ensure accountability across distributed authority?

CONCLUSION

There are various names for these kinds of challenges: Rittel and Weber (1973)'s "wicked problems" are complex challenges that can neither be fully nor uniquely articulated. The description of the problem is always incomplete, but it points to some solutions more than others. There are better and worse directions that wicked problems can evolve in, and policymakers and other leaders do have influence, but there are no definitive solutions or stopping points when the effort is "over." Morton (2013) describes these as "hyperobjects," or objects or events that are massive in relation to human lives. The similarity between these and "wicked problems" is that defining the problem is inherently incomplete, as well as a group effort. The "too big to comprehend" is effectively equivalent to "incompletely articulatable" when it comes to describing what is to be governed and deciding what to do about it.

The Interchange idea is offered as a practical contribution to the ongoing effort to govern complex, fast-changing systems. Many institutions already perform parts of this function. Some observe and assess. Some interpret and advise. Some coordinate and steer. Interchanges are about strengthening the capacity of distributed actors to recognize shared risks and align action over time.

The ideas here will evolve as new experiments unfold and as practitioners adapt them to different domains and contexts. As real-world prototypes develop and as new tools and knowledge systems emerge, we will continue to strengthen and update this work.

Interchanges are about strengthening the capacity of distributed actors to recognize shared risks and align action over time.

This will remain a living document. We aim to develop it alongside others who share the goal of building governance architectures that match the scales, speeds, and complexities of the challenges ahead.

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ENDNOTES

- 1 Lenton et al, 2025. The Global Tipping Points Report 2025. University of Exeter, Exeter, UK.
- 2 Verhulst, Stefaan, 2025. Inquiry as Infrastructure: Defining Good Questions in the Age of Data and AI.
- 3 The idea of science as co-produced with social orders, shaped by institutions, and curated by individuals or interests is far from new. From Jasonoff (2004) to Hajer and Oomen (2005), Galison and Daston (2007) to Carton and Malm (2024), there is a large literature on how particular “truths” rise to the top while others never get started. There is a field of “agnotology,” or the study of ignorance — Kourany and Carrier (2024) provides a contemporary overview.
- 4 <https://global-tipping-points.org/governance/>
- 5 Guston, D. H. (2001). Boundary organizations in environmental policy and science: An introduction. *Science, Technology, & Human Values*, 26(4), 399–408
- 6 Jha, Srivardhini K and Gold, E. Richard and Dube, Laurett (2020) Modular Network Governance: A Conceptual Framework for Addressing Complex Social Problems. IIM Bangalore Research Paper No. 615, Available at SSRN: <http://dx.doi.org/10.2139/ssrn.3592400>
- 7 Climate TRACE, independent global emissions-monitoring coalition: <https://climatetrace.org/>
- 8 Global Fishing Watch, open ocean activity intelligence platform: <https://globalfishingwatch.org/>
- 9 Destination Earth (DestinE), European Commission digital-twin program: <https://destination-earth.eu/>
- 10 Virtual Singapore, national digital-twin platform: https://en.wikipedia.org/wiki/Virtual_Singapore
- 11 Koldunov, N., Jung, T. Local climate services for all, courtesy of large language models. *Commun Earth Environ* 5, 13 (2024). <https://doi.org/10.1038/s43247-023-01199-1>



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