21st ISDE International Lecture

Digital Engineering within the Digital Earth Vision

Digitalisation, Decarbonisation and Productivity - BIM, Open Standards and Digital Earth.

By

Richard Simpson

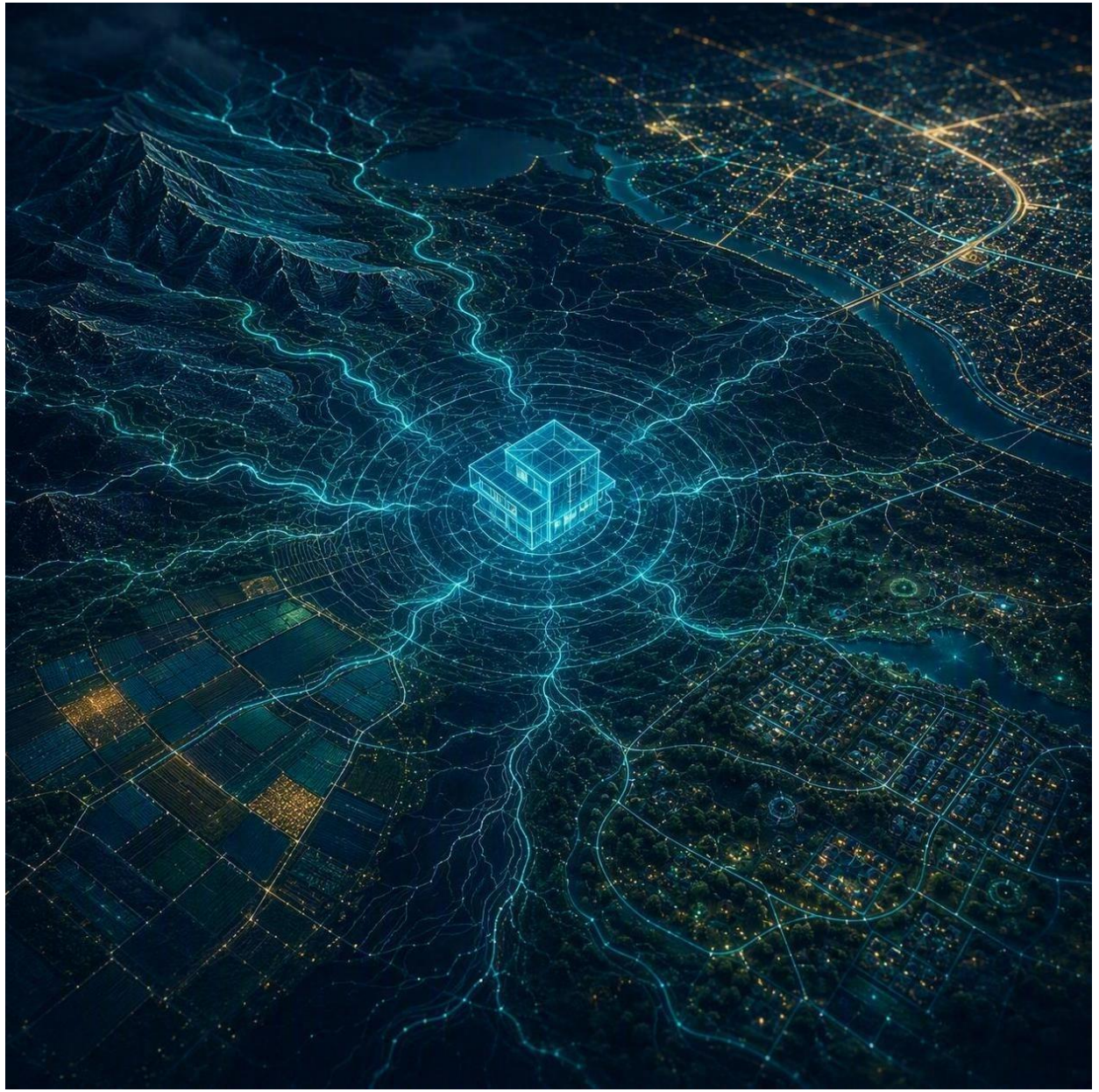
President, of the International Society of Digital Earth | CEO & Founder, Meta Moto

BIM improves a project

Digital Earth connects its consequences

- BIM brings structured information to design, construction and operation.
- Open standards allow information to cross disciplines, organisations and software.
- Digital Earth places assets within the built, natural and social systems they change.
- Framework 9 turns connected evidence into a space for testing possible futures.

The next productivity frontier is better decisions across the whole system.

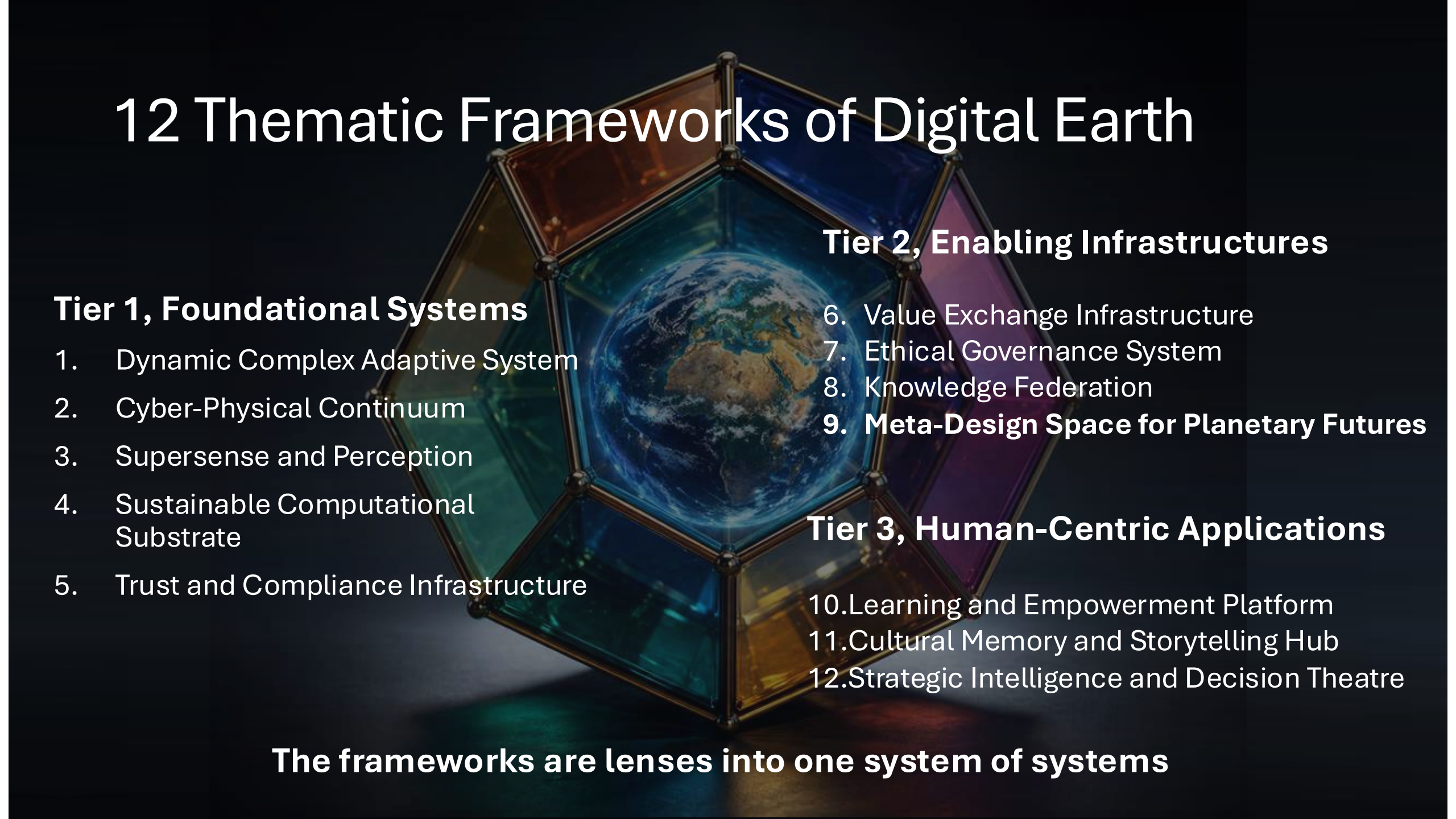


Digital Earth is a Pluralistic Vision

- A cyber-physical infrastructure for Earth systems intelligence
- Built from observations, models, simulations and digital twins/threads
- It connects science, infrastructure, governance, ethics, culture and decision-making.
- Framework 9 is one of 12 lenses; it views an enabling layer, linking evidence, value and trust.

Digital Earth turns data into shared intelligence for planetary stewardship.

12 Thematic Frameworks of Digital Earth



Tier 1, Foundational Systems

1. Dynamic Complex Adaptive System
2. Cyber-Physical Continuum
3. Supersense and Perception
4. Sustainable Computational Substrate
5. Trust and Compliance Infrastructure

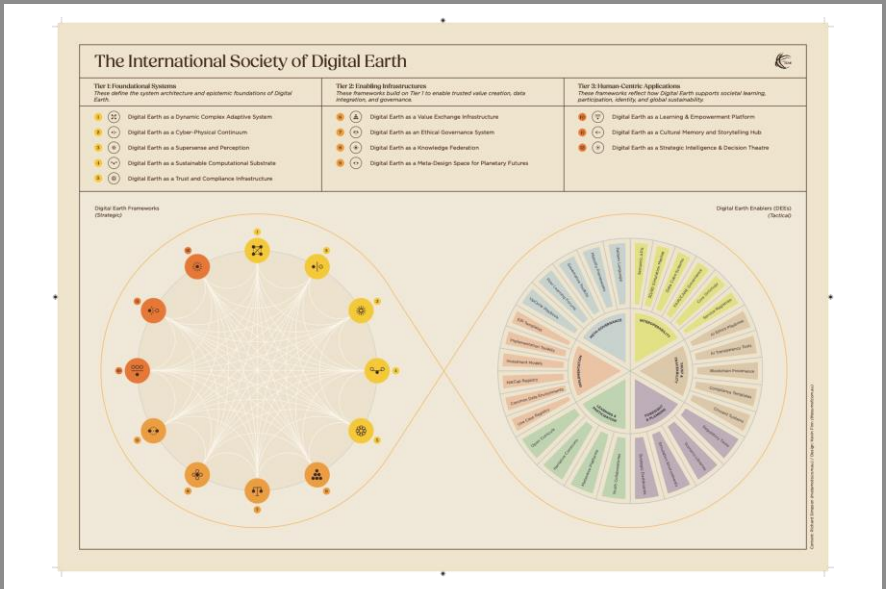
Tier 2, Enabling Infrastructures

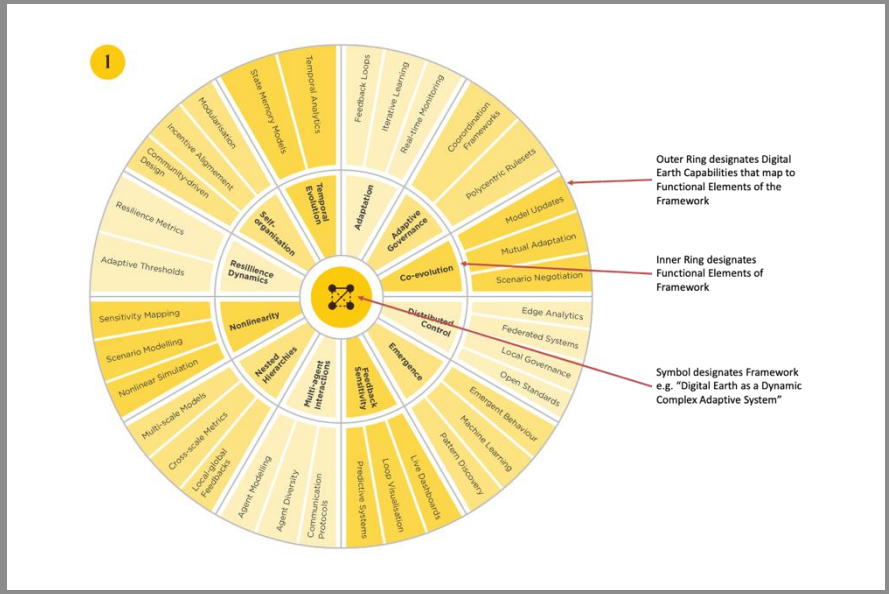
6. Value Exchange Infrastructure
7. Ethical Governance System
8. Knowledge Federation
9. **Meta-Design Space for Planetary Futures**

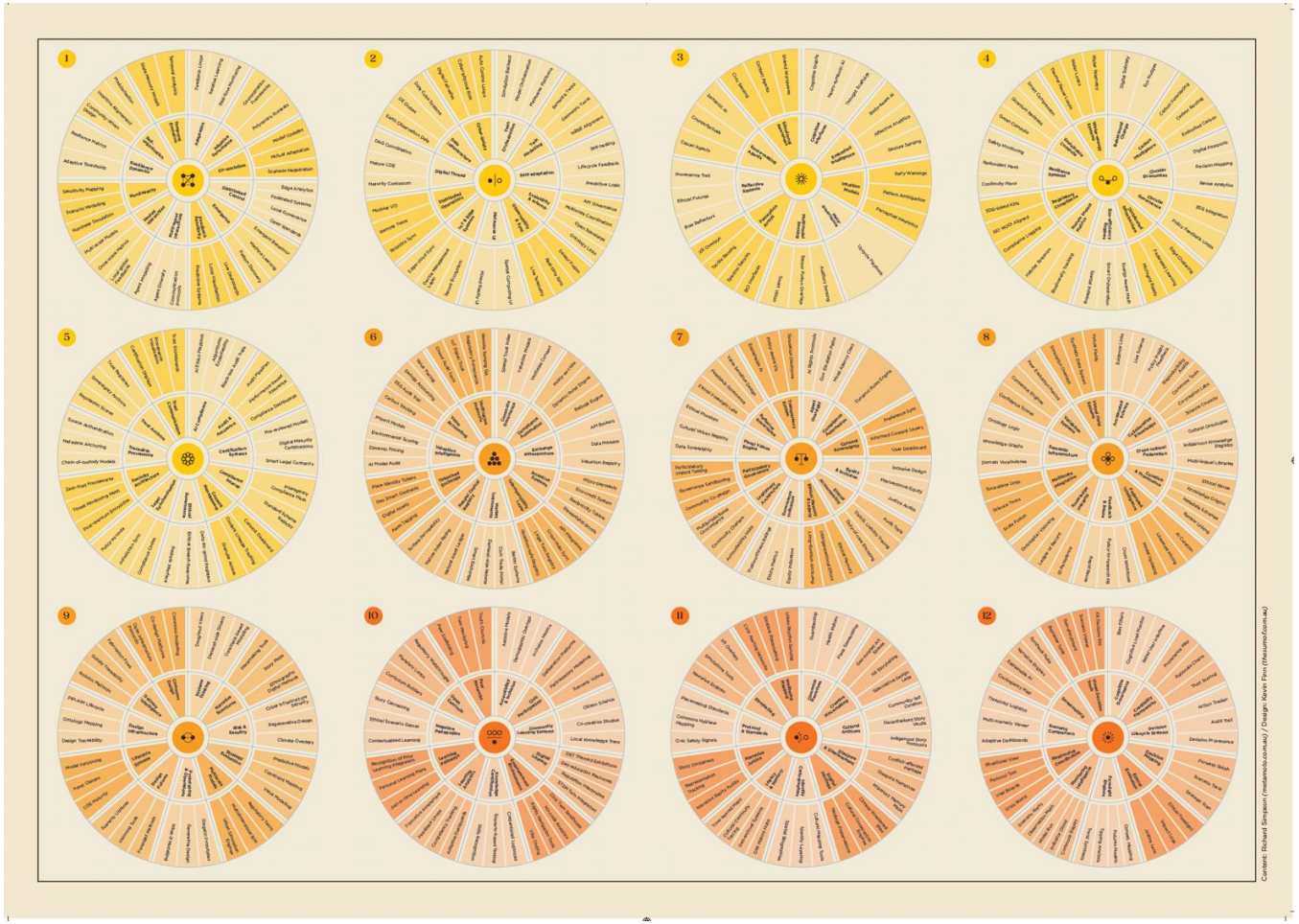
Tier 3, Human-Centric Applications

10. Learning and Empowerment Platform
11. Cultural Memory and Storytelling Hub
12. Strategic Intelligence and Decision Theatre

The frameworks are lenses into one system of systems







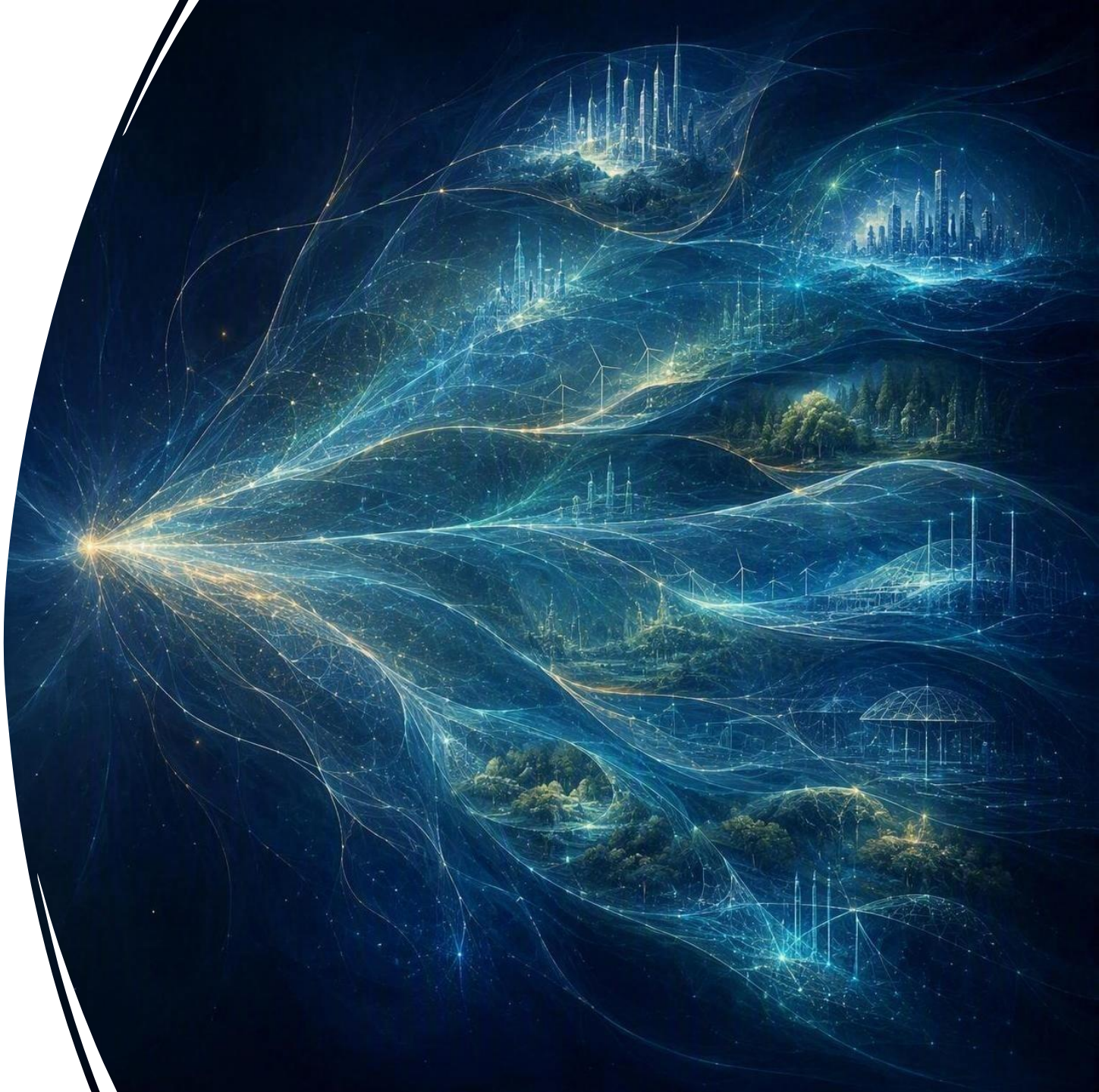
Kevin Finn, Richard Simpson (2025)

Tomorrow Today

Framework 9: Designing the future before it arrives

- A generative and participatory environment for envisioning, testing and refining possible futures.
- A shared space where infrastructure, policy, regulation, science and lived experience can interact.
- A means to compare pathways, stress-test interventions and coordinate transitions within ecological and social limits.

It transforms Digital Earth from a map of what is into a shared canvas of what could be.



The Question at the Heart of Framework 9

How can infrastructure learn and adapt while remaining accountable for its effects on Earth systems and communities?

- **Resilience**: anticipate stress, recover intelligently and avoid repeating failure.
- **Coordination:** connect built, natural and social environment needs across scales.
- **Accountability:** preserve what was known, assumed, changed and authorised.
- **Productivity:** reuse trusted information and reduce rework, delay and dispute.

Productivity should follow from continuity and learning, not drive design.

What if our infrastructure could learn?

- **Observe:** Measure actual performance and changing environmental conditions.
- **Compare:** Test what occurred against design intent, thresholds and expected outcomes.
- **Explain:** Trace deviations to assumptions, decisions, components and system interactions.
- **Adapt:** Improve operations, maintenance, renewal and the design of the next asset.
- **Remember:** Retain evidence, provenance and reusable patterns across projects and generations.

Infrastructure learns through governed feedback from use to design, not unchecked autonomy

The Built Environment exists inside other Earth systems

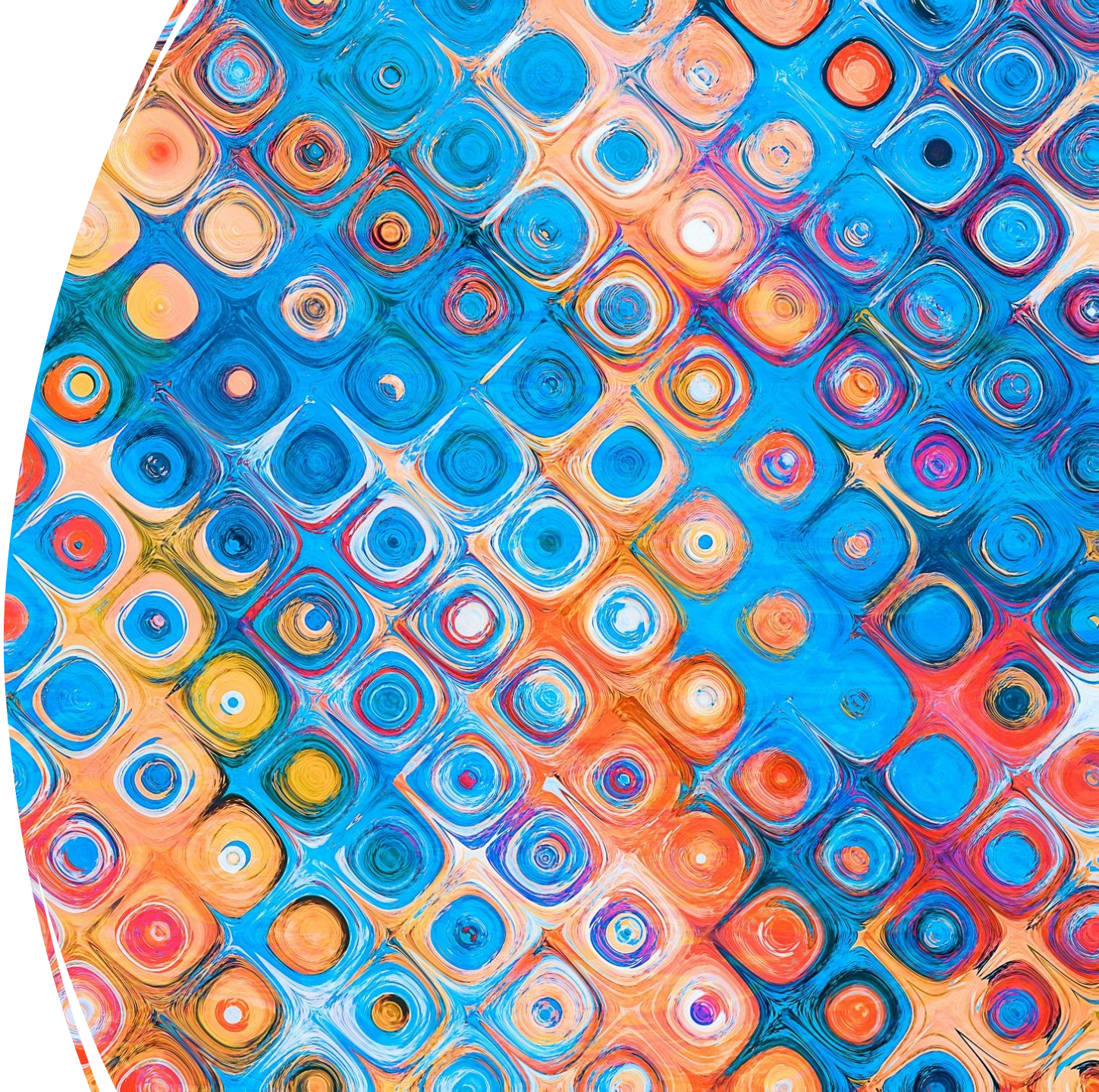
- Every asset sits within catchments, ecosystems, climate, communities, economies and law.
- Carbon, water, heat, biodiversity, mobility, equity and culture are design parameters, not background conditions.
- Spatial and temporal context reveals effects that disappear at the project boundary.
- Federated models can connect components, assets, precincts, networks, regions and planetary systems without forcing them into one monolith.

A better asset performs well within the systems it depends on.

A CDE can mature into a digital thread

- **1. Controlled exchange:** Named information states, versions, reviews and approvals.
- **2. Coordinated models:** Disciplines work against a current federated context.
- **3. Structured information:** Common identifiers, classifications, semantics and explicit requirements.
- **4. Digital thread:** Decisions, the Project Information Model, delivery evidence, the Asset Information Model and change remain connected.
- **5. Learning system:** Operational outcomes inform renewal, standards, procurement and future design.

A CDE is the governed starting point. It becomes a thread only when relationships endure.



A Digital Thread can turn supply chains into learning networks

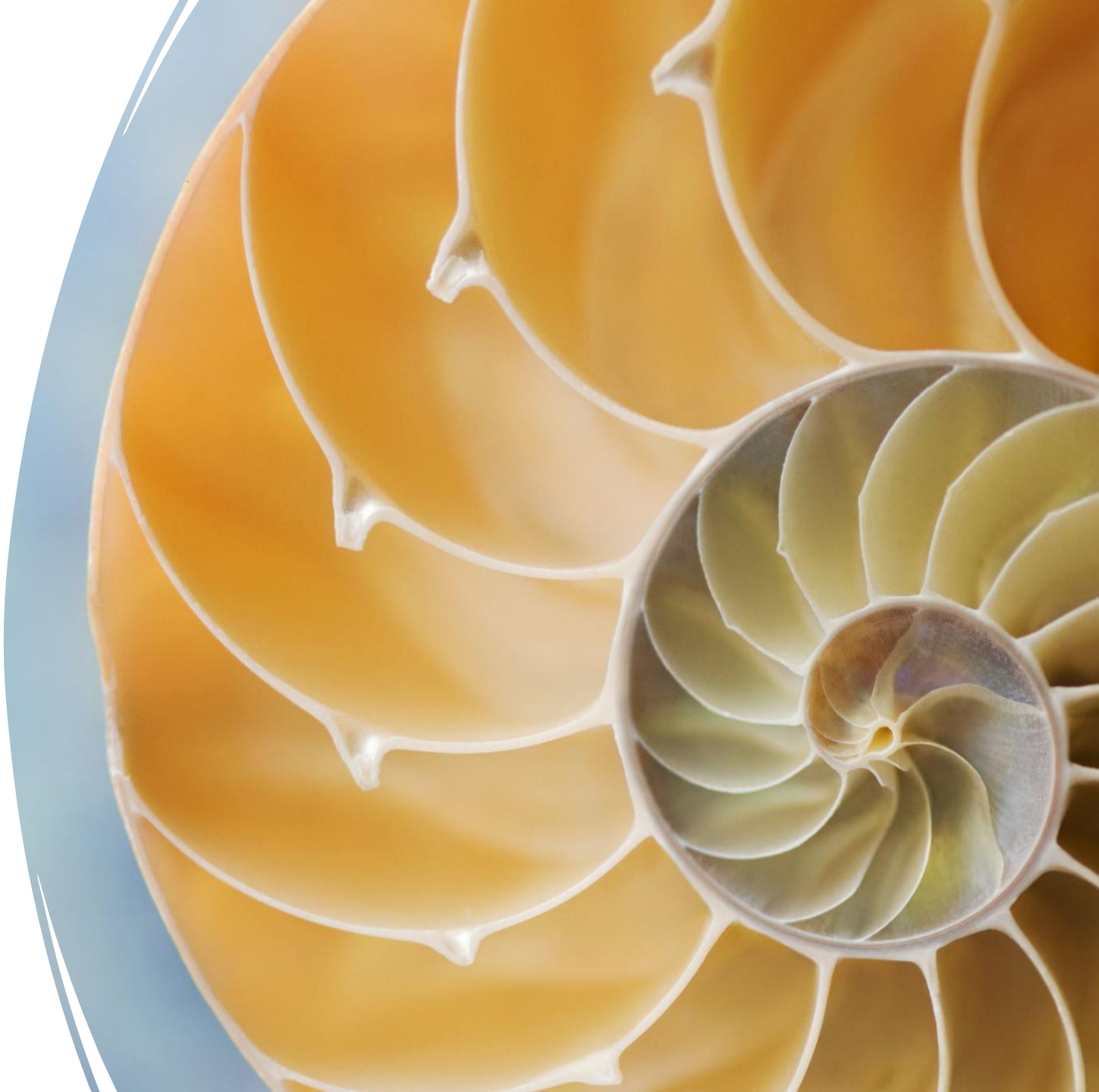
- Requirements, design, materials, manufacture, logistics, construction, commissioning and operation share stable identifiers and classifications.
- Each participant receives the current information needed for its decision, with permissions appropriate to its role.
- Provenance records what was supplied, changed, accepted and verified.
- Operational evidence tests material claims, component performance, maintenance assumptions and prospects for reuse.

Trust depends on reliable exchange, governed access and clear accountability.

Digital Earth and Better Design Outcomes

- Does it work as part of a connected system, not only as an isolated asset?
- Does it reduce whole-life carbon, materials, water use and avoidable harm?
- Will it remain safe, useful and adaptable under plausible future conditions?
- Does it respect Country, place, communities and ecological limits?
- Can the evidence and judgement be traced, reviewed and challenged?
- Can the lesson be reused without importing the original context blindly?

Good design is no longer only fit for purpose. It must be fit for place, time and consequence.



Design becomes a search across futures

- Parametric and generative design can explore many feasible options rather than refine one early answer.
- Whole-life carbon, water, ecology, resilience and social performance can become design constraints and evaluation criteria.
- Design for Manufacture and Assembly and platform approaches can reuse proven components and patterns.
- Participatory simulations allow communities, engineers, owners and regulators to examine trade-offs together.

Digital design should expand choice and expose trade-offs, not replace human judgement.

Regulation can move upstream

- Express information requirements and selected rules in computer-interpretable form where this is lawful and useful.
- Check proposals earlier against planning, building, accessibility, safety and environmental requirements.
- Test proposed policy changes against representative buildings, infrastructure and places before adoption.
- Retain human authority, explainability, discretion, review and appeal.

A regulatory twin should expose judgement, not conceal it.

A city can rehearse a century before pouring concrete

- Thousands of viable combinations are explored for alignment, form, materials, staging and operation.
- Each is tested for heat, flood, energy, crowds, shade, biodiversity, carbon and access under decades of plausible change.
- Planning and technical requirements are checked before formal submission, while contested judgements remain visible.
- After opening, actual performance updates the assumptions and improves the next project.

Framework 9 shows what their federation could become.

The Built Environment is Answerable to Earth

- Infrastructure decisions alter places and endure across generations.
- Digital engineering can make consequences visible before they become fixed in concrete, contracts and institutions.
- Digital Earth supplies cross-scale context, plural knowledge, provenance and feedback.
- Framework 9 makes design a continuing public act of learning and stewardship.

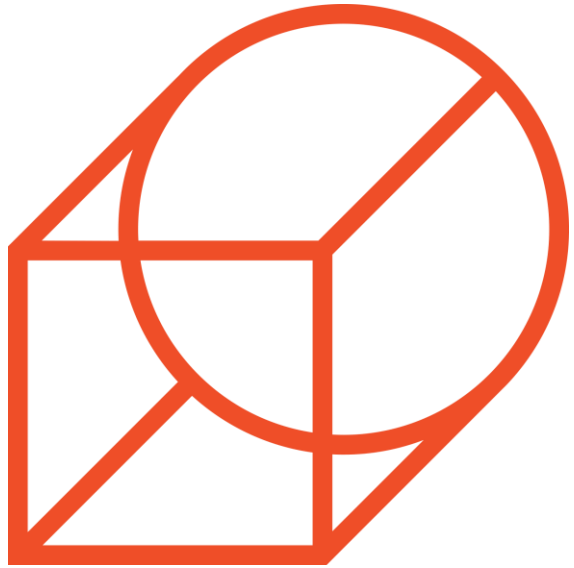
We should not ask only whether we can build it. We should be able to show what it changes, for whom, for how long and within what limits.

Framework 9 within the Digital Earth Vision

International Society for Digital Earth

Infrastructure that learns

A city that senses, remembers and adapts is no longer a set of assets we maintain. It becomes a system we are in conversation with.



Thank you

Richard.Simpson@metamoto.com.au

www.metamoto.com.au