UKRI TAS Showcase – 5th March 2024

Developing Participatory Futuring Approaches to Design Infrastructural Imaginaries for Sustainable and Trustworthy AS

Dr Michael Stead - Lecturer in Sustainable Design Futures

Team

Mike Stead

Lecturer in Sustainable Design Futures
Lancaster

Ola Michalec

Senior Research Associate
Computing
Bristol

Neelima Sailaja

Transitional Professor
Computing
Nottingham

Nuri Kwon

Senior Research Associate
Design
Lancaster

Paul Colton

Professor of Speculative & Game Design
Lancaster

Andy Crabtree

Professor of Design Ethnography
Nottingham

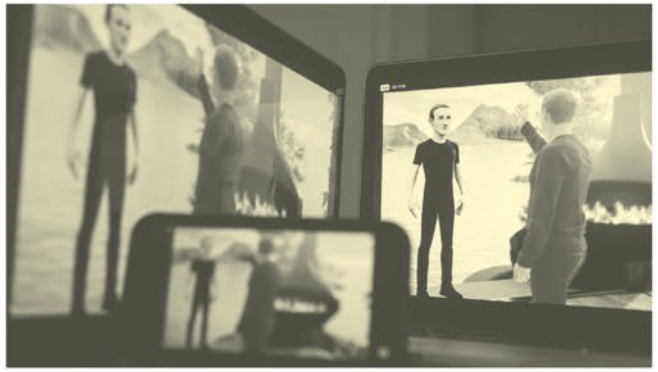
Derek McAuley

Professor of Digital Economy
Nottingham

Everything Everywhere All at Once

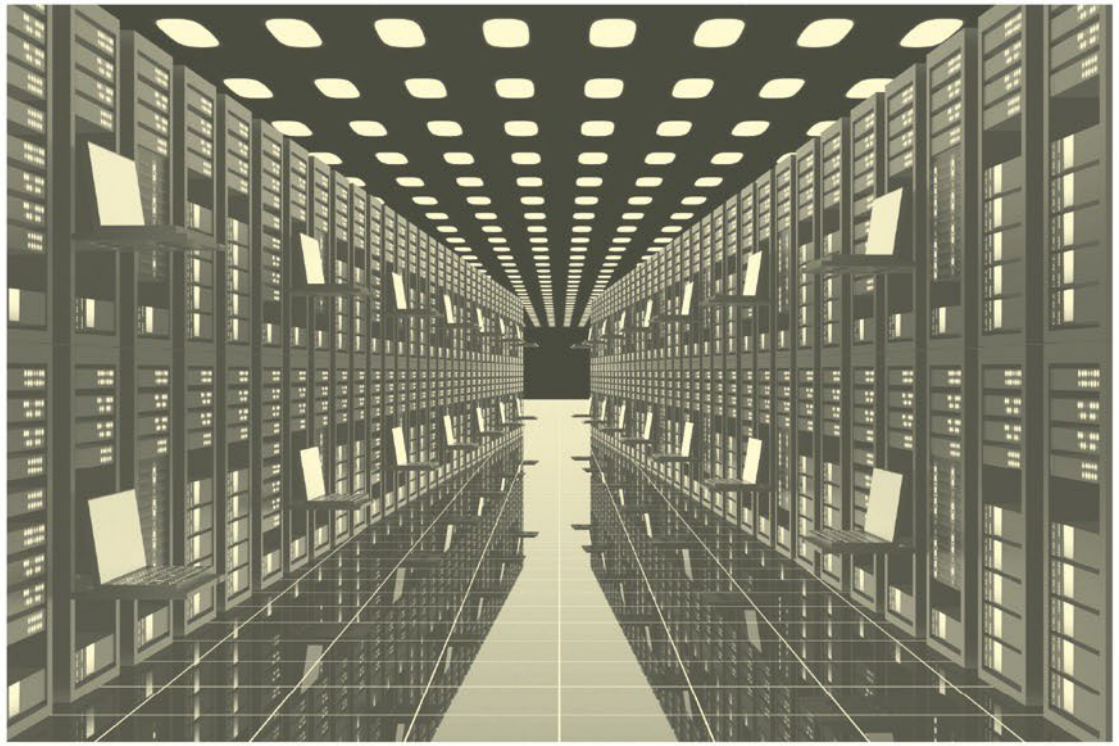
Internet of Things

MMOGs



Videotelephony

VR



The Cloud

Digital Unsustainability

The global carbon footprint of digital technology is around 4% of worldwide emissions – now comparable to the airline industry!

4%

Digital technology carbon footprint (Freitag et al, 2021)

GenAI/LLMs

- Charging an average smartphone uses 0.012kWh of energy, which means that the most efficient text generation model uses as much energy as 16% of a full smartphone charge for 1,000 inferences
- Least efficient image generation model uses as much energy as 950 smartphone charges (11.49 kWh)
- Equates nearly 1 charge per image generation - although variation between models, depending on the size of image.

Luccioni, Jernite & Strubell (2023)

The Problems of Scale

"It’s estimated that a search driven by generative AI uses four to five times the energy of a conventional web search. Within years, large AI systems are likely to need as much energy as entire nations.”

"Generative AI systems need enormous amounts of fresh water to cool their processors and generate electricity… [current estimates suggest] globally, the demand for water for AI could be half that of the United Kingdom by 2027.”

Kate Crawford – Nature (2024)

Moral Agents for Sustainability and Trust?

"A system involving software applications, machines, and people, that is able to take actions with little or no human supervision."

UKRI Trustworthy Autonomous Systems (TAS) Hub (2021)

Algorithm Governance In Energy Sector

- Large numbers of behind the meter devices will be incorporated into smart systems, utilising automation and Machine Learning from the data produced by these devices to optimise for consumers, networks, and whole system outcomes.

- The complexity of consumer choice alone means that automated decision-making based on user inputs, forecasts and models will be necessary for the operation of the energy system.

- This creates ample opportunities for an engaged, dynamic energy system which accounts for the considerable variety in energy use patterns through the transition to a Net Zero economy.

Johnston, G. / Energy Systems Catapult (2022)

Opportunities and Challenges

AS benefits could include:

- High frequency decisions without manual intervention to balance energy system
- Opportunities for energy generation or storage at scale
- Increased consumer choice/confidence that their preferences will be catered for
- New markets for bespoke consumer offerings/incentives
- Network managers can transition towards more anticipatory outcomes, rather than reactive

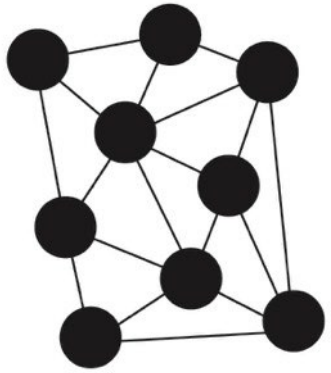
AS negatives could include:

- Bias or discrimination against individuals or groups
- Distortion or manipulation of markets
- Cascading impacts across whole energy system from interactions between algorithms

No mention of sustainable trade-offs or rebound effects!

"What would future sustainable and trustworthy AS look like?"

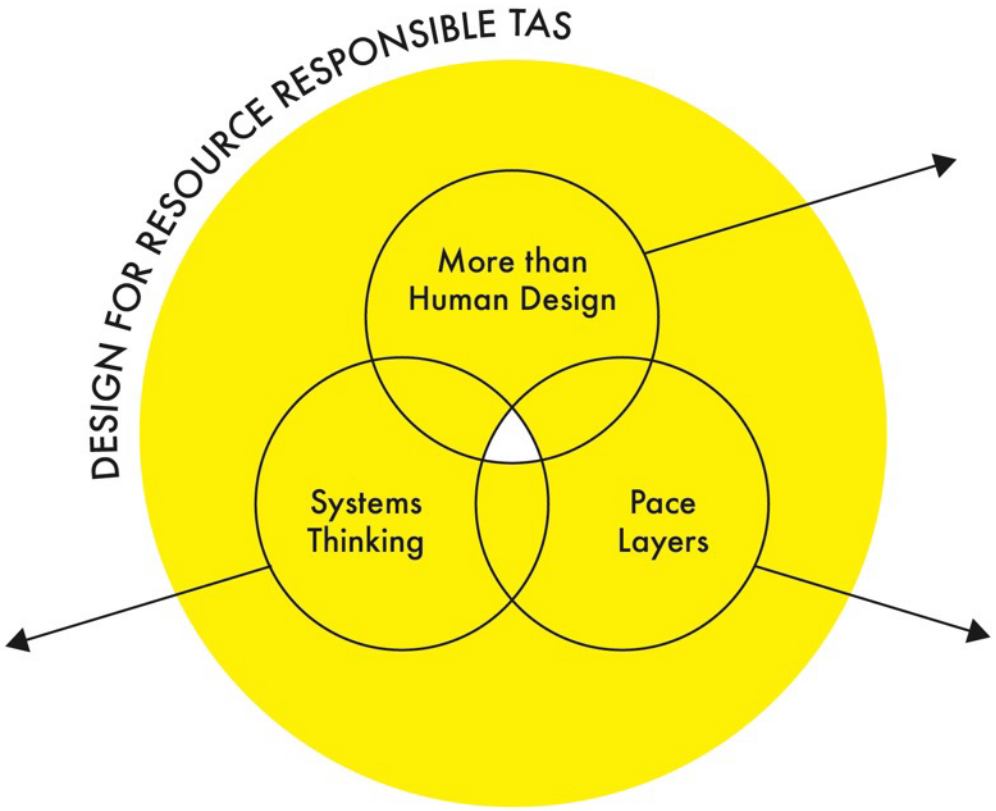
Literature Review

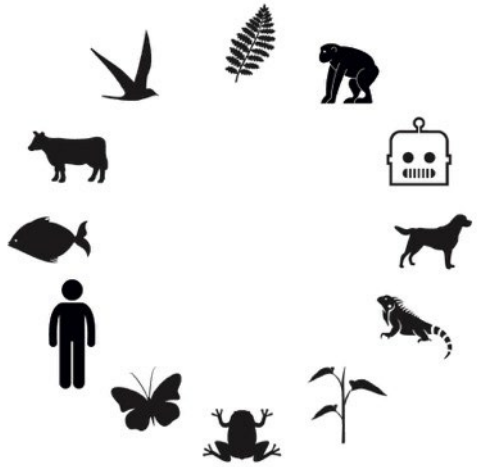


Ceschin, F., & Gaziulusoy, I. (2016). Evolution of Design for Sustainability: From Product Design to Design for System Innovations and Transitions. Design Studies, Volume 47, 10.1016/j.destud.2016.09.002.

Jasanoff S. (2015). Future Imperfect: Science, Technology, and the Imaginations of Modernity. In: Jasanoff, S., & Kim, S. (eds) Dreamscapes of Modernity. University of Chicago Press.

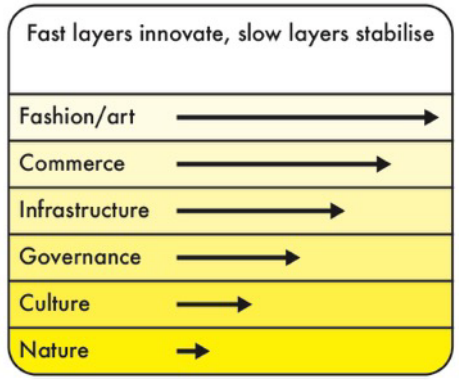
Sevaldson, B. (2011). GIGA-Mapping: Visualisation for Complexity and Systems Thinking in Design. Nordic Design Research Conference, Helsinki. 10.21606/nordes.2011.015





Forlano, L. (2017). Posthumanism and Design. She Ji, 3(1), 16–29. 10.1016/j.sheji.2017.08.001

Wakkary, R. (2021). Things We Could Design: For More Than Human-Centered Worlds. MIT Press.

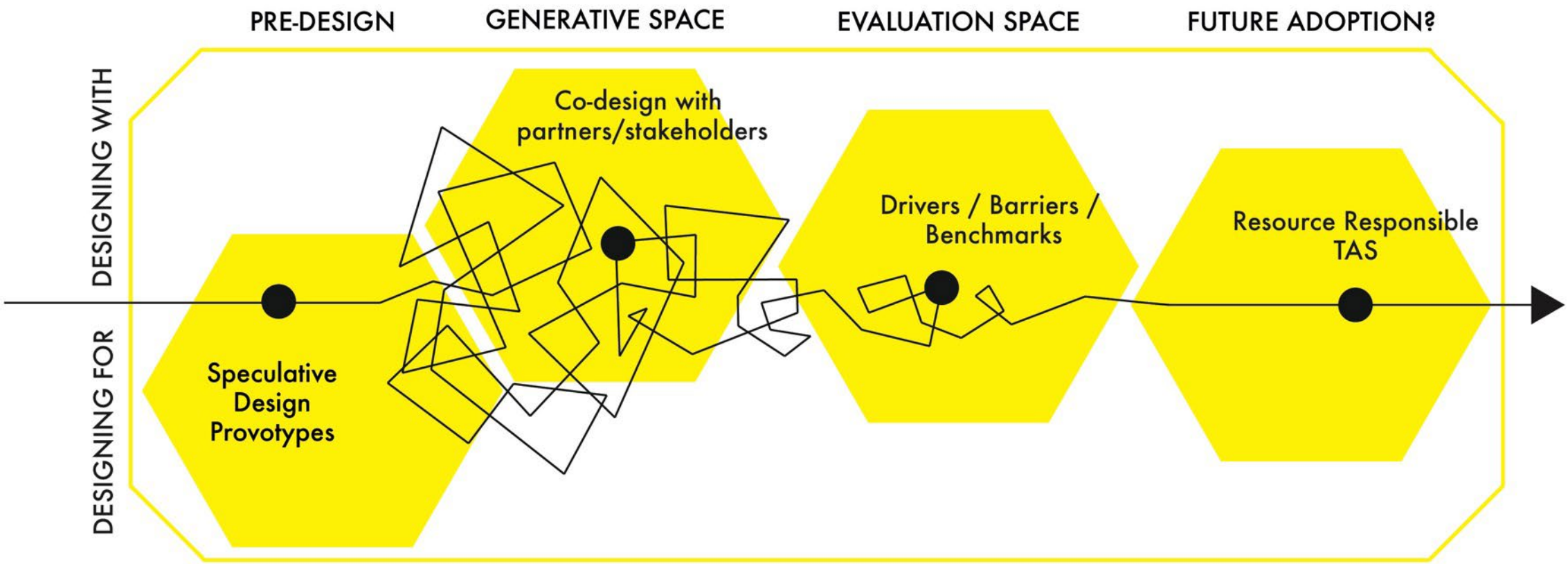


Brand, S. (2018). Pace Layering: How Complex Systems Learn and Keep Learning. Journal of Design and Science. 10.21428/7f2e5f08

Rodden, T., & Benford, Steve. (2003). The Evolution of Buildings & Implications for the Design of Ubiquitous Domestic Environments. 9-16. 10.1145/642611.642615.

Participatory Futuring Workshops

Co-design Approach



After Sanders & Stappers (2014) and Stead et al (2023).

Participatory Futuring

- Combination of speculative, collaborative and systemic design techniques.
- Immersive activities result in a ‘two-way construction’ (Tang & Nakarada, 2023) whereby participants become ‘co-constructors’ of insights and meaning.
- Can empower participants to articulate their expertise, values and desires regarding technology development, plus work together to expose potential barriers, risks and rebounds.
- Aim is to reach common ground regards sustainable and trustworthy AS futures.

Activity 1 – Provotyping

Provocation + Prototyping = Provotyping

Pre-made AS provotypes (using Mid Journey GenAI platform – the irony!)

Micro-server allotments

Personal solar power generator

Community energy interface Ghana

AI driven power supply 2033

Self-sufficient energy village

Home cloud data processing unit

Solar panelled Acropolis

Resource responsible TAS

Group 1

dystopian Blade runner

Provotype A

How does it work?

depends on country, region, wealth

Reality might be in between

PV tech developing energy - pv in glass

Looks cramped - wouldn't pass H&S - proximty of buildings

Living space as well energy production

Health and safety regulation?

highly automated and corporate

Who is involved? Who is responsible of this AS?

Where are people? enjoying nature?

Remote data centre - workplace - noise of windturbines

could be owned by companies or gov.? Or are people going to own the place

Corporate owned - ambitious - innnovation usually comes from private sector - govs pick yp later

Vrtual energy centre -

energy companies it looks ambitious companies innovate

What does this AS do?

Idyllic future that people would like

Not trust this future

Will depend on the country, the region, the jurisdiction

Crammed, not realistic, would not pass carbon safety standards

Too idyllic! :)

Architecture goes well with nature

Utopic - not like Blade runner

Energy management would be autonomous

Could be insidious - don't trust

too perfect people are missing in the image

Generating energy

Cloud, data cloud storage

Title of Provotype

industrial park/workplace water -to cool off the power

What would be the benefits and risks?

Expect fluctuations in the energy as depeddant on wind speed etc.

I want o visit this place

Like architecture of buildings - goes well with nature/surroundings

Could have effect on biodiversity, the location looks near to a water source, so it could be protected?

Clean energy

What kind of data is collected?

Energy management data: wind speed, generator power, demand etc.

6 Keywords & Description of your new AS provotype

Too good to be true

insidious

promising

advanced energy storage

Clean

Corporate

digital cloud or data centre in the cloud

beautiful

Virtual powered plant

Indirect pollution problem (scum/film on water. Focus on wind, neglects water.

light obsorber to create energy

demand and credit

Bottom up approach

Exists already - more realistic - Yorkshire case study

less tech and sophiscated

city future allotment community based a bit more realistic generating thear own energy yorkshire case

grassroots / coop

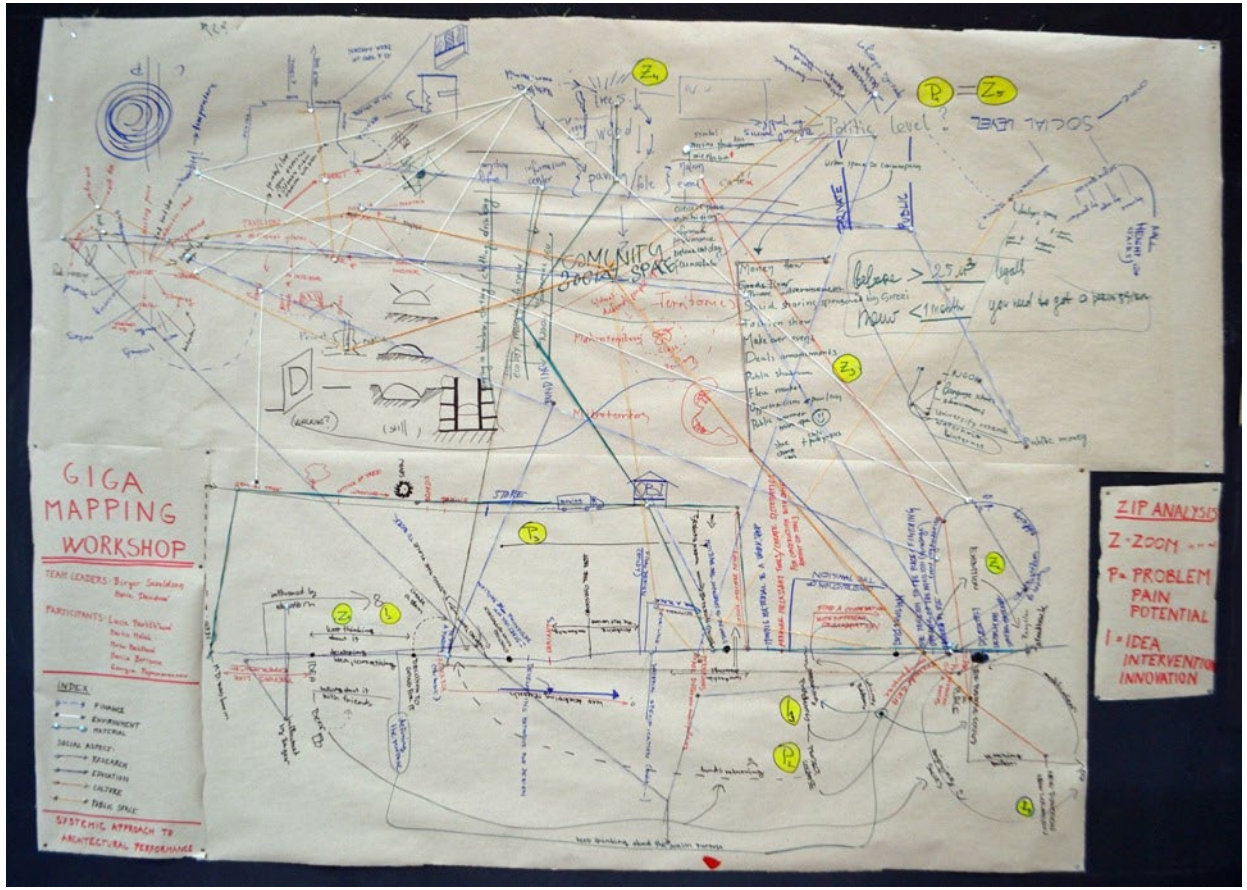
INTER NET ZERO

Giga-mapping

Giga-mapping is...

- *Extensive mapping across multiple layers and scales*
- *Investigating relations between seemingly separate categories*
- *It helps to provide boundary critiques on the conception and framing of systems.*

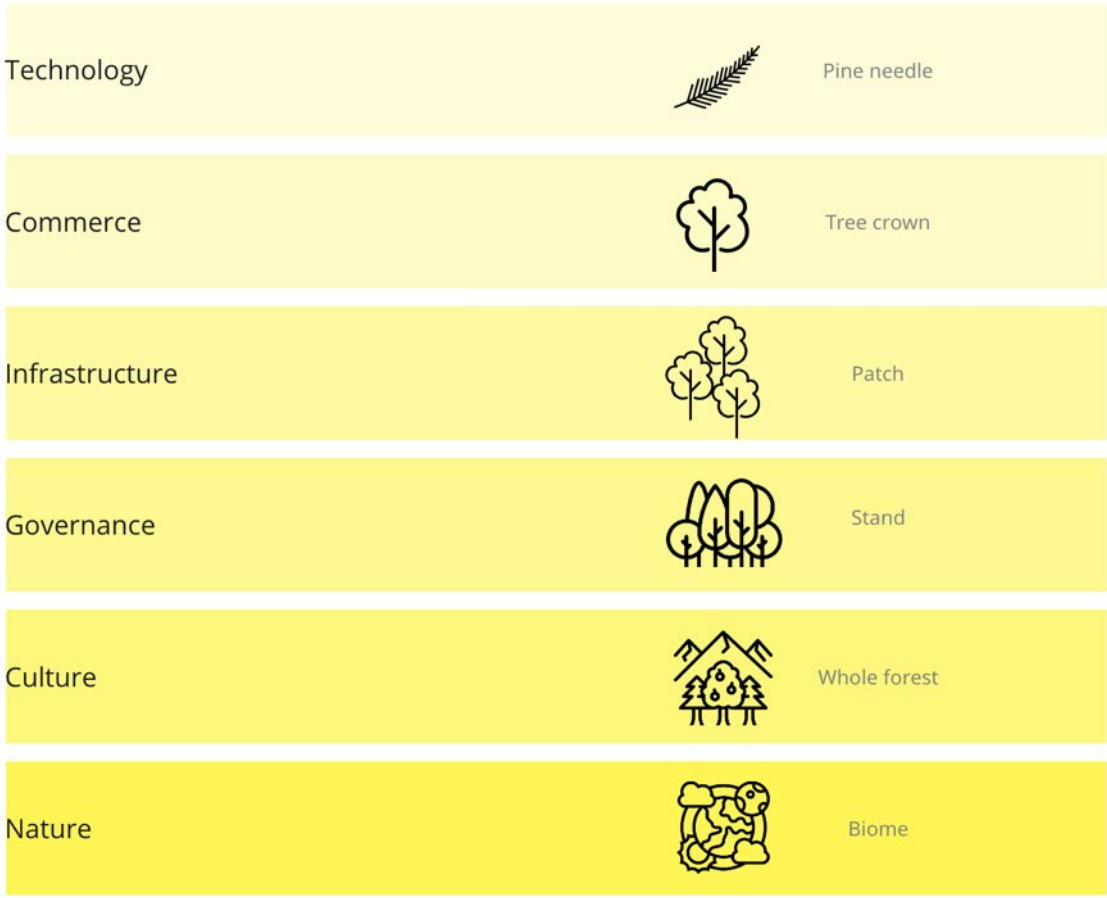
Sevaldson (2011)



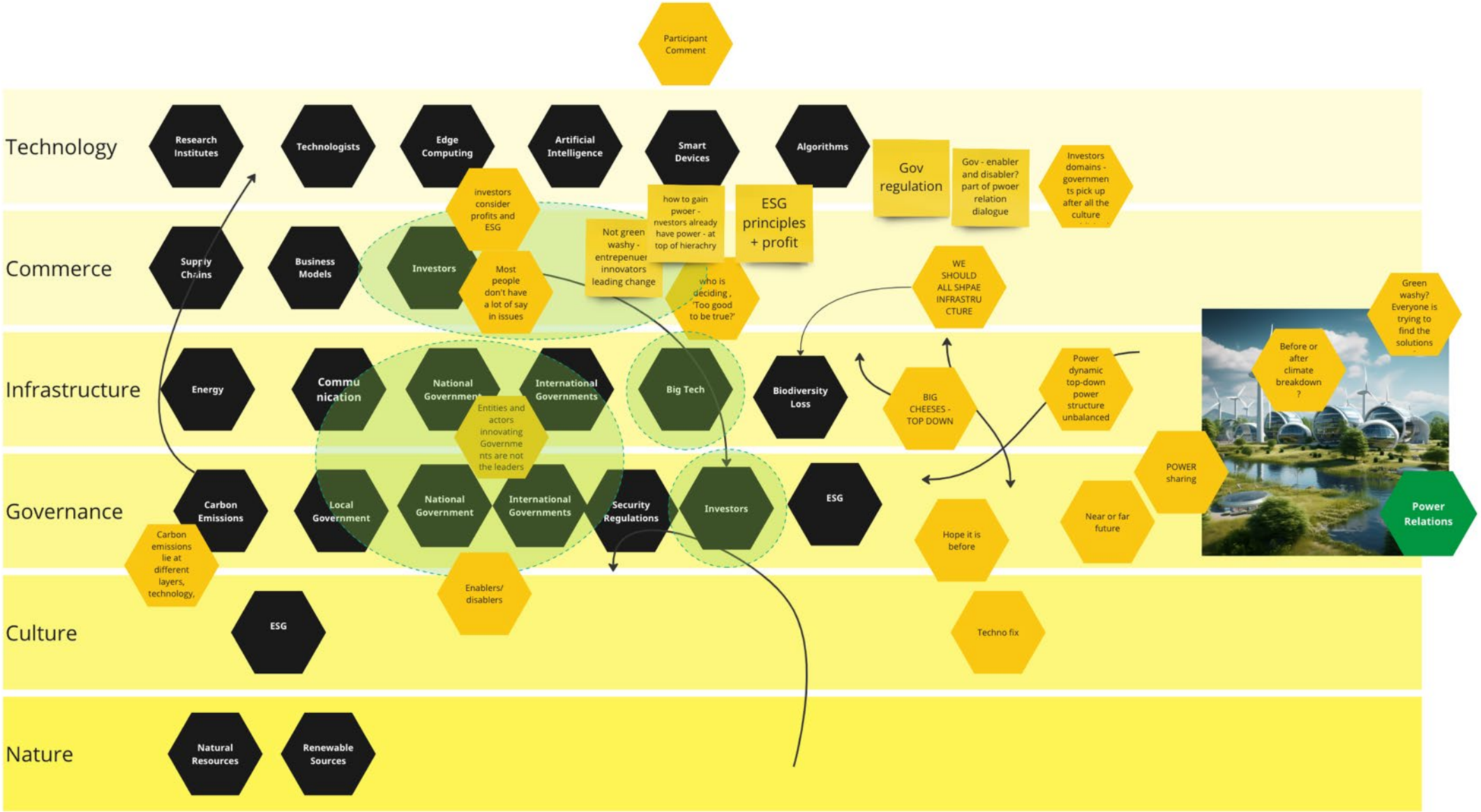
Pace Layers

Pace layering (Brand, 2018) is a framework to think about a complex system and how it works.

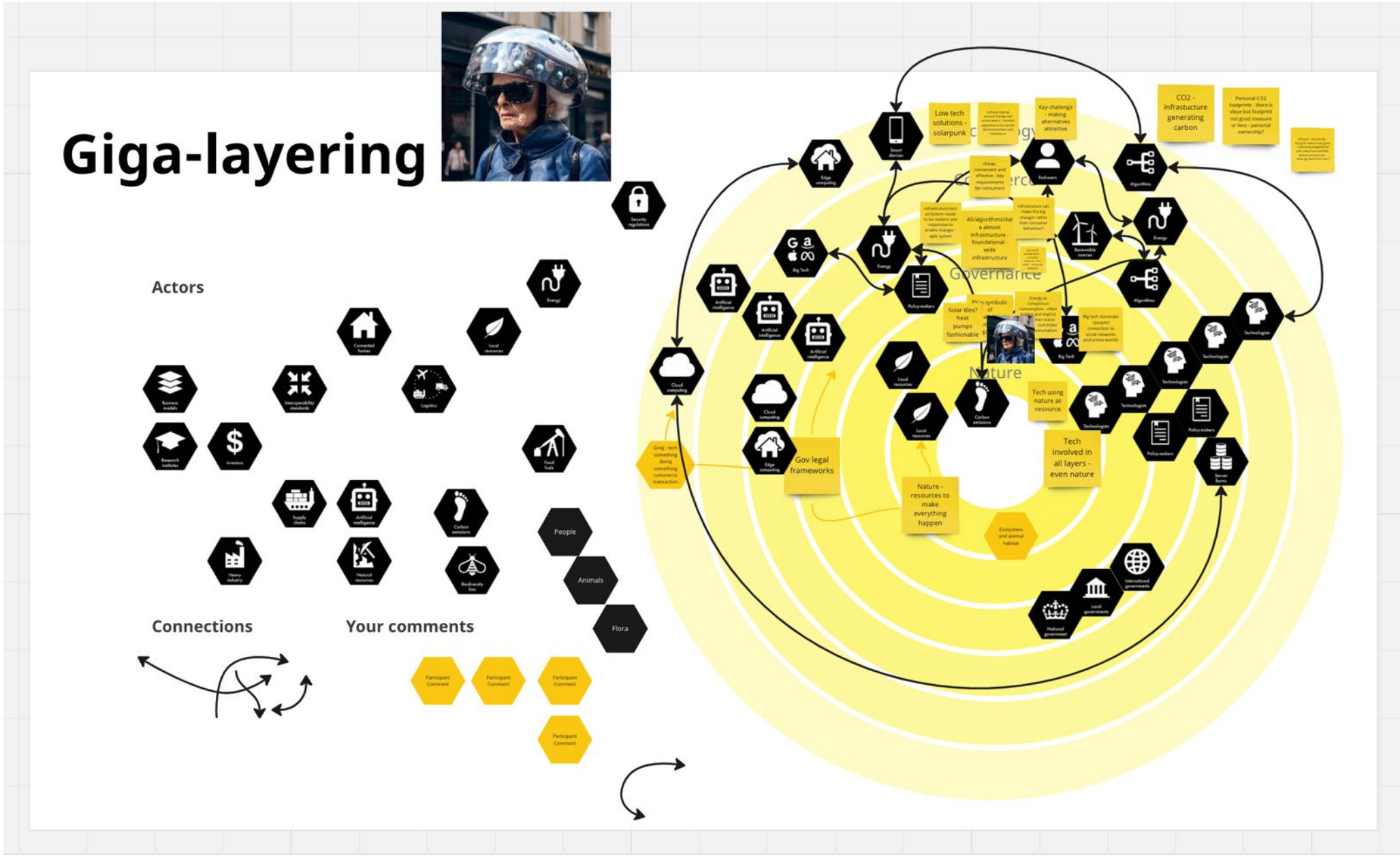
- *Each layer is functionally different*
- *Each layer operates independently*
- *Each layer is not disconnected from the other which makes the system more resilient*
- *The fast layers innovate; the slow layers stabilise*



Activity 2 – Giga-Layering

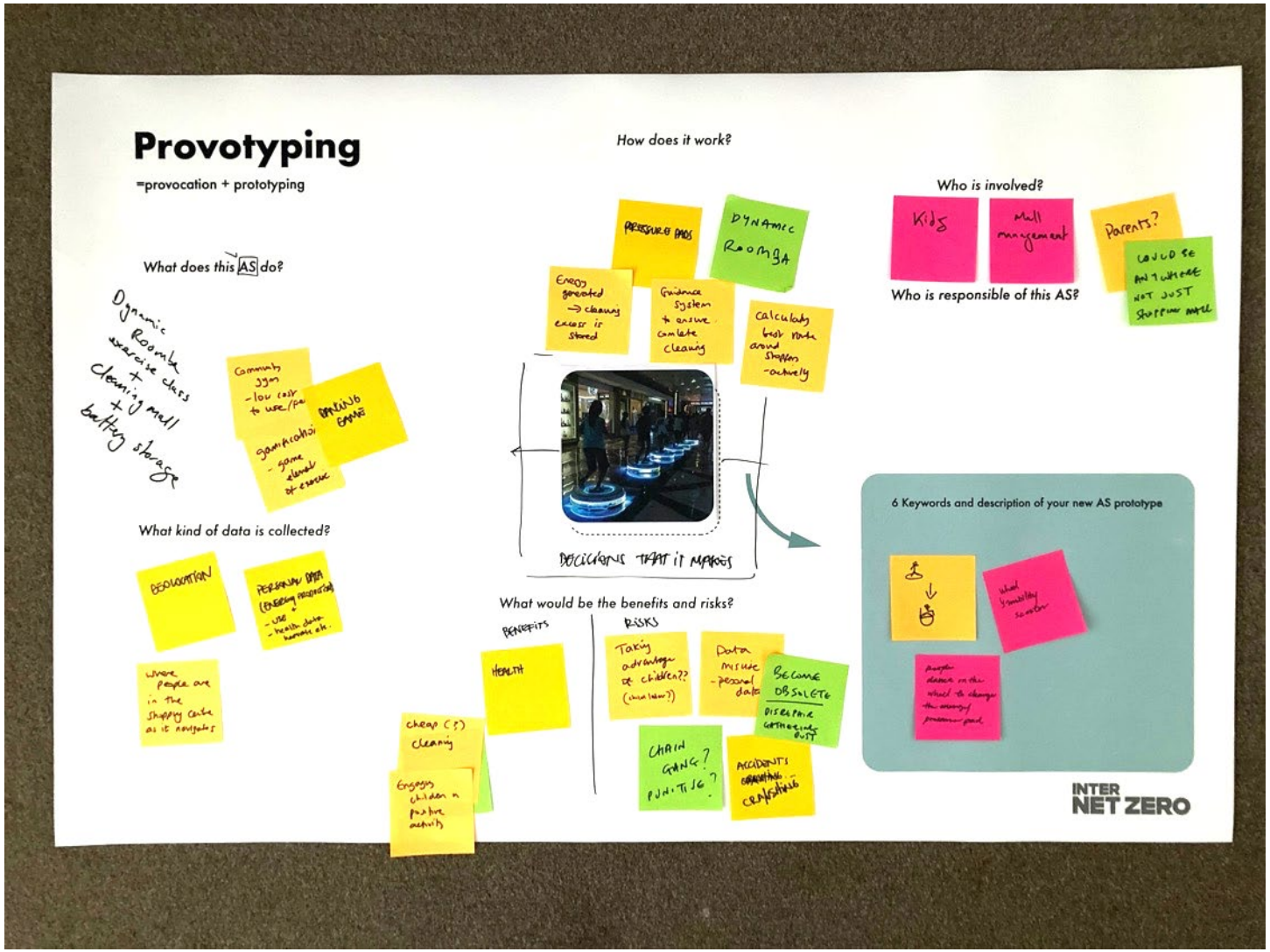


Activity 2 – Giga-Layering

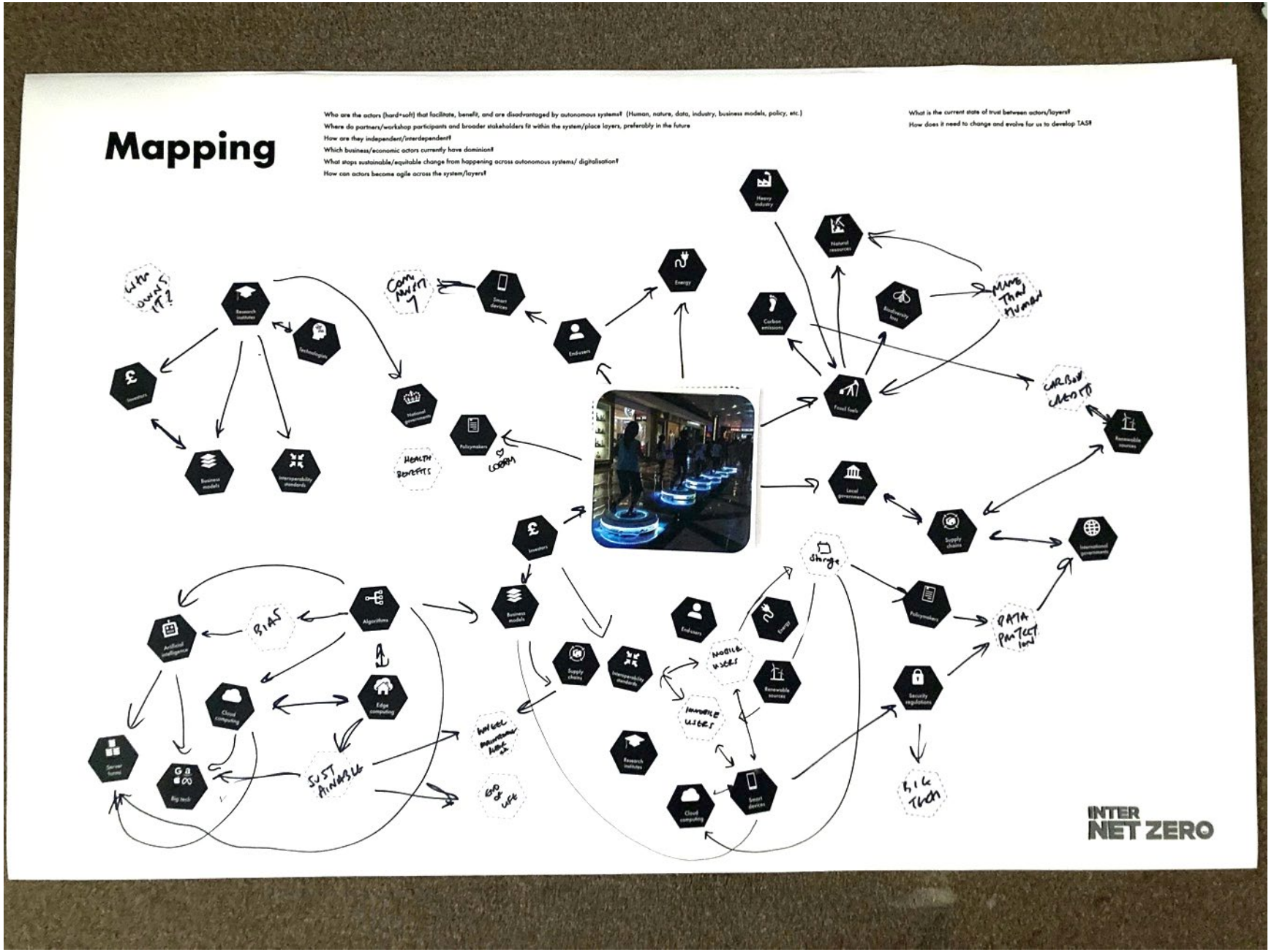


In Person Workshops

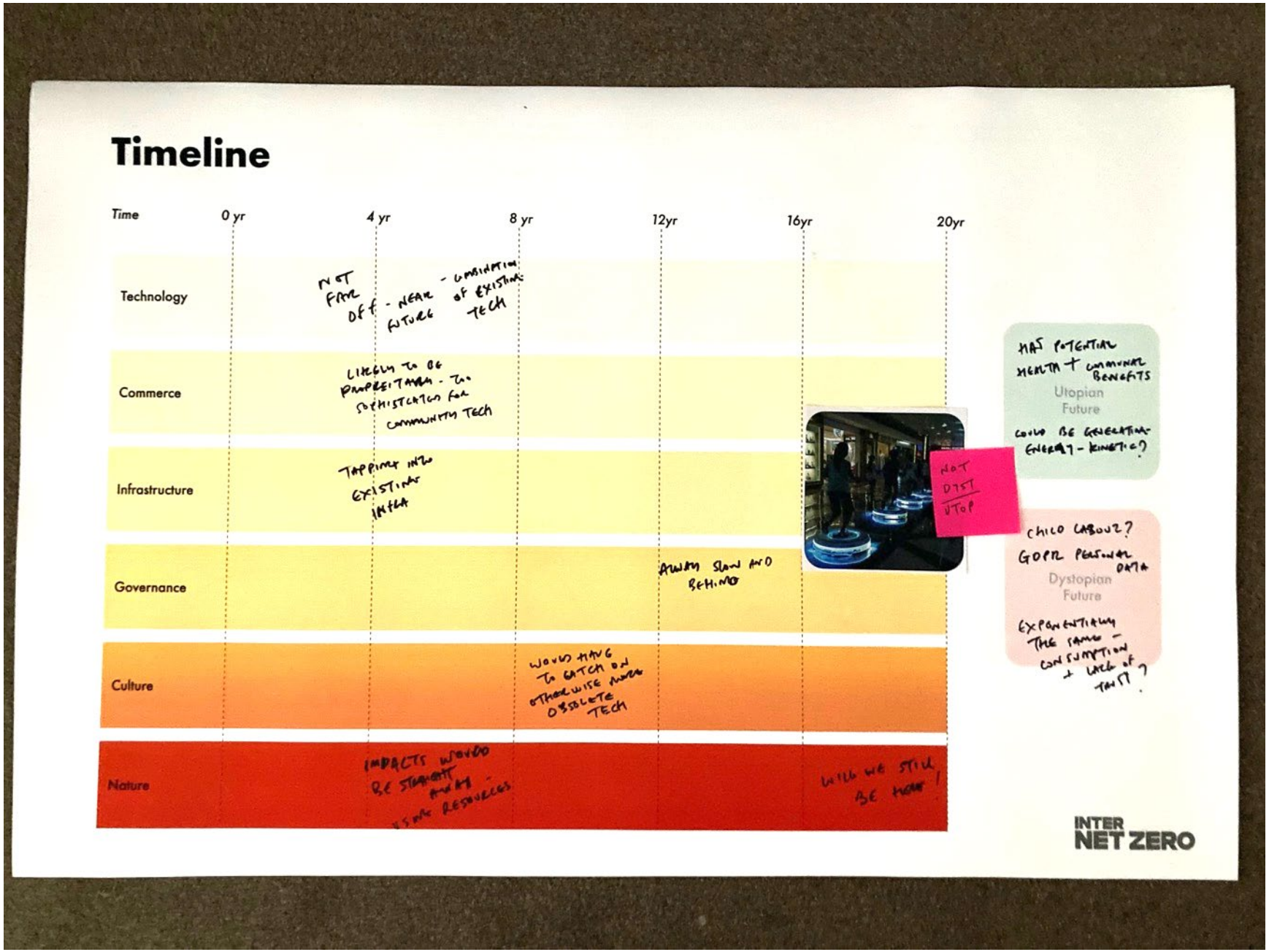
Provotyping



Mapping


Mapping
Who are the actors (hard+soft) that facilitate, benefit, and are disadvantaged by autonomous systems? (Human, nature, data, industry, business models, policy, etc.)
Where do partners/workshop participants and broader stakeholders fit within the system/place layers, preferably in the future
How are they independent/interdependent?
Which business/economic actors currently have dominion?
What stops sustainable/equitable change from happening across autonomous systems/ digitalisation?
How can actors become agile across the system/layers?
What is the current state of trust between actors/layers?
How does it need to change and evolve for us to develop TAS?
Who owns it?
Research institutes
Technologists
Investors
Business models
Interoperability standards
Community
Smart devices
End-users
Energy
National governments
Policymakers
HEALTH BENEFITS
LOBBY
Heavy industry
Natural resources
Carbon emissions
Biodiversity loss
More than Human
Carbon costs
Fossil fuels
Renewable sources
Local governments
Supply chains
International governments
Shrigs
Algorithms
BIAS
Artificial intelligence
Cloud computing
Edge computing
Server farms
Big tech
SUSTAINABLE
Interoperability standards
Mobile users
Immobile users
Security regulations
Big Tech
Data protection law
INTER NET ZERO

Timeline


Timeline
Time
0 yr
4 yr
8 yr
12yr
16yr
20yr
Technology
Commerce
Infrastructure
Governance
Culture
Nature
NOT FAR OFF - NEAR FUTURE - COMBINATION OF EXISTING TECH
LIKELY TO BE PROPRIETARY - TOO SOPHISTICATED FOR COMMUNITY TECH
TAPPING INTO EXISTING INFRA
ALWAYS SLOW AND BEHIND
WOULD HAVE TO CATCH ON OTHERWISE ALWAYS OBSOLETE TECH
IMPACTS WOULD BE STRAIGHT AWAY - USING RESOURCES
WILL WE STILL BE HERE?
NOT DYST/UTOP
HAS POTENTIAL WEALTH + COMMUNAL BENEFITS
Utopian Future
COULD BE GENERATIVE ENERGY - KINETIC?
CHILD LABOUR?
GDPR PERSONAL DATA
Dystopian Future
EXPONENTIALLY THE SAME - CONSUMPTION + LACK OF TAX??
INTER NET ZERO

Findings

Lots of insights

- AS is becoming part of critical national infrastructure
- Big tech hold dominion
- In midst of land grab for ‘smart’ automated digital energy infrastructure
- Regulation imperative for public and planet’s long-term interest
- Sustainability – Jevon’s Paradox – efficiency creates bigger demand and rebound
- Trust – need to remove top-down power dynamics
- Desire for lower-tech solutions – decentralisation, hyper-local, community driven alternatives
- ‘Participatory Futuring for Infrastructural Imaginaries’

Next Steps

Workshops and Synthesis

- Workshop at Energy Systems Catapult / Energy providers
- Embed insights into interactive engagement prototype
- Disseminable toolkit based on workshop tool
- Impact/engagement at industry/public events (e.g. V&A Digital Design Festival)
- Publications

Engagement Prototype

An ‘experiential future’ (Candy & Dunagan, 2017) – interactive, immersive experiences with visual, kinaesthetic, and auditory modalities to highlight socio-technical issues to participants.

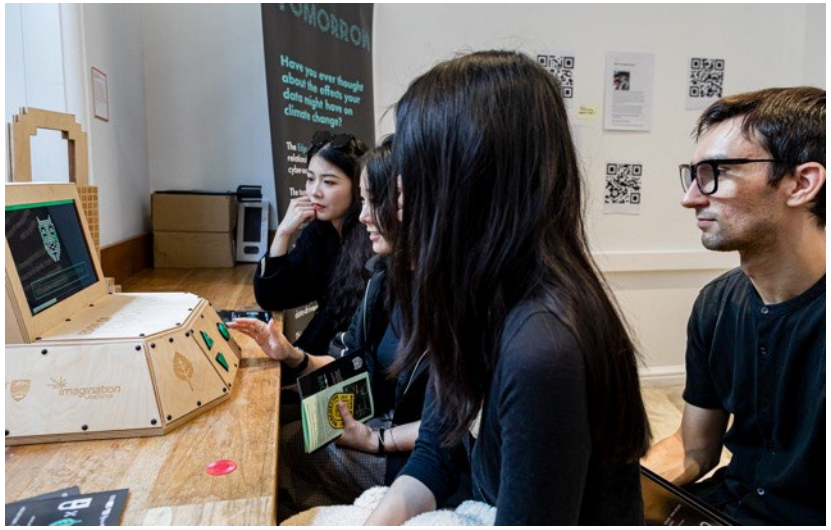
EDGE OF TOMORROW

EDGE OF REALITY

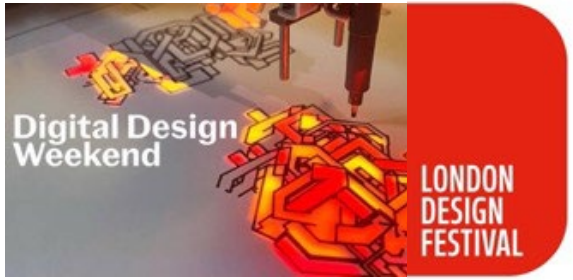
PETRAS

BBC R&D

Interactive Dissemination



BRITISH SCIENCE FESTIVAL



ESRC 20 FESTIVAL OF SOCIAL SCIENCE

Thank you!

Engineering and Physical Sciences Research Council
UKRI Trustworthy Autonomous Systems Hub
imagination LANCASTER
Lancaster University
University of Nottingham
University of BRISTOL
CATAPULT Energy Systems
THE MAKING ROOMS
SUBAK