ESPAS HORIZON SCANNING

SIGNAL CARDS

THE SIGNAL • CARDS FOR HORIZON SCANNING

What is horizon scanning?

Horizon scanning is a foresight exercise to systematically identify and examine early signs of future developments which are at the margins of the current thinking but may have an important impact in the future.

What are the Signal Cards?

The Signal Cards present emerging issues identified during the ESPAS Horizon Scanning activity. The cards are ideal for workshops to expand thinking, foster imagination and explore different potential futures.

How to use the Signal Cards?

The Signal Cards can be used in various settings. Here we propose four different short exercises to be used at the beginning of a workshop to spark imagination and encourage looking forward. A fifth exploratory exercise to imagine future developments of the signals and their potential impacts can e.g. be used at the beginning of a project.

The set of Signal Cards will be updated annually with the new signals. Please provide feedback, ask for support or present your unique way of using the Signal Cards for future editions by dropping us an email at: JRC-HORIZONSCAN@ec.europa.eu

THE SIGNAL CARDS' CATEGORIES

The Signal Cards are categorised by the novelty aspects below, describing the nature of the change.

CONTRADICTION - demonstrates opposing or incongruous forces at play simultaneously

INFLECTION - occurrences that mark a major turning point or establish a new paradigm

EMERGING - emerging behaviours that are becoming more pronounced or gaining in popularity

HACK - inventive, unintended uses of tools, technologies and systems

EXTREME - instances of technologies, functions or concepts being pushed to new limits that might change the nature of their use

NOVELTY - vague developments, which are difficult to interpret

DISRUPTION - ripples through industries, questions best practices and lifelong experiences

TRANSFORMATIVE - game changer, reframes our understanding

ICE BREAKERS / INTRODUCTORY EXERCISES

15-30 min

Short exercises at the beginning of any workshop to broaden the thinking, spark imagination and encourage looking forward.

Choose the one best fitting your workshop goal.

Exercise A: **The most relevant signals**

1. Each participant selects one Signal Card they think is most relevant to the workshop topic.
2. Form groups of 3-4 participants.
3. Each participant presents their chosen signal and explains why they selected it.
4. After hearing from everyone, the group agrees on the most relevant signal.
5. Subgroups present the selected signal to all participants.

Exercise B: **Different aspects of novelty**

1. Form groups of 3-5 participants.
2. Each group selects 4-6 cards from different novelty categories.
3. The group answers the question on each Signal Card.
4. Next, they describe a future where all the signals become reality.

Exercise C: **Changing the perspective**

1. Each participant selects one Signal Card based on curiosity.
2. Form groups of 2 participants.
3. Each group discusses how their selected signals could change the perspective on the topic of the workshop.

Exercise D: **Culminating impacts**

1. Each participant selects one Signal Card based on curiosity.
2. Participants read their signal and reflect on its potential impact on the workshop topic.
3. Form groups of 2 participants.
4. Each group discusses how their two signals together could impact the workshop topic.

FUTURE DEVELOPMENTS IMPACTS

2-3 h

Exploratory exercises to imagine future developments and their potential impacts for example at the beginning of a project.

1. FORM GROUPS: Divide participants into groups of 4-7 people.

2. SELECT SIGNALS: Each group selects 3 signals based on curiosity.

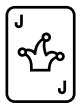
3. IMAGINE THE FUTURE: Groups envision a world where all selected signals have become mainstream and create a headline for a news article that describes this future.

4. POTENTIAL IMPACTS: Identify potential direct impacts of this future using the STEEP (social, technological, economic, environmental, political) framework. Then identify second level consequences for the already listed impacts.

5. ANALYSIS: Select a question based on your needs to further explore the identified potential consequences:

- Which of the consequences needs further analysis?
- What actions should be taken now to deal with possible opportunities and challenges?
- Which possible developments should be considered in future strategies/polices?

PREPARATIONS



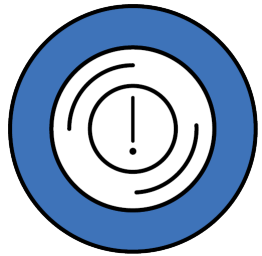
The Signal Cards database contains over 100 cards. **Pre-select** a sufficient number of cards to have **2-3 cards per participant** to ensure there is enough time for reading and reflecting without it being overwhelming.

Random selection often works best to ensure variety and broadness of the topics.

For a more focussed discussion it is better to have a **curated selection of Signal Cards linked to the workshop topic and context**. However, try not to narrow the selection too much, as the goal is to encourage thinking beyond familiar topics.

Print the chosen cards (ideally on thick paper, 2 pages per A4 sheet to get A5 sized cards) or paste them as pictures to a digital platform for online workshops.

THE FUNGI ECONOMY



Fungi, once mainly linked to diseases, are now recognised as a sustainable means to produce resilient food, feed, chemicals, fuels, textiles, and materials for construction, automotive, and transportation industries, as well as furniture. As the field grows and consolidates, mushroom and mycelium production will expand, offering potential for rural areas in developing countries.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

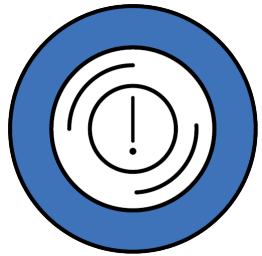
PERSONAL RESOURCE QUOTAS

With the growing climate change crisis and increasing resource scarcity, emission and resource (water, energy, etc.) restrictions or quotas for businesses are becoming more popular. A recurring idea from the late 1990s is to introduce similar quotas for individuals, especially personal carbon trading, but this is usually not adopted due to system costs, lack of public acceptance, and low receptivity among decision-makers. Recent research suggests that technology tools can increase the cost-efficiency and feasibility of such schemes. In 2020, a pilot voluntary scheme was tested for mobility in Lahti, Finland.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

XENOTRANSPLANTATION



With a shortage of organs for transplantation, xenotransplantation, or the use of animal-derived organs and cells in humans, has shown promising breakthroughs. Recent emergency authorisations by the US Food and Drug Administration enabled transplants of genetically modified pig hearts and kidneys. Plans for clinical trials are underway, though challenges like costs, immunosuppression, and genetic engineering remain. This opens possibilities for increased access and personalisation of organs. However, the procedure raises ethical concerns, including medical risks and broader metaphysical and social issues.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

RADICAL TRANSPARENCY

Trust and social capital in societies are decreasing, and the abundance of information has led to increased calls for radical transparency. This involves being explicit about values, open processes, and providing information for scrutiny, such as publishing contracts and sharing salary details. It also includes offering raw content, often through new technologies like livestreaming and body cameras. Currently, radical transparency is driven by strong external pressures on organisations, but it could become the norm.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

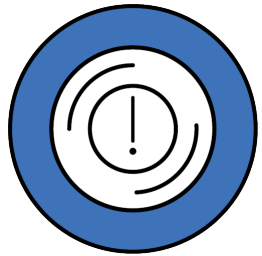
HUMAN BODY AS A RESOURCE

Death remains a principal consideration, but bodies can increasingly serve as resources. Voluntary organ donation is often the first thought, but a bill proposed in Massachusetts suggested organ donation in exchange for reduced sentences. Medical progress makes it plausible to donate bodies for gestational purposes, and preserving sex cells from deceased people for posthumous reproduction is also possible. Finally, the revived interest in cryonics, with over 500 people preserved worldwide, highlights the growing interest in using the human body as a resource.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

RADICAL FOOD PRODUCTION

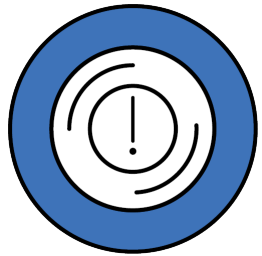


As global food demand rises and climate change makes growing conditions harder, humans are exploring radical methods for better production. New crop varieties cultivated in space could help farmers adapt and boost food supplies. Initial research shows high-quality seeds can withstand challenging conditions. The International Atomic Energy Agency and the Food and Agriculture Organization are analysing seeds exposed to space mutagenesis at the International Space Station. Additionally, underground greenhouses, using geothermal energy, could protect crops from extreme weather and ensure year-round production. Both approaches anticipate increasingly difficult conditions for future food production.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

SOLAR RADIATION MODIFICATION

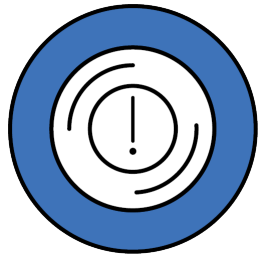


Increasing voices are advocating alternative 'emergency' options to control global temperature rise. One such option is Solar Radiation Modification (SRM), specifically Stratospheric Aerosol Injection (SAI), which aims to cool the planet by reflecting sunlight into space or allowing more infrared radiation to escape, thereby reducing Earth's temperature. These methods vary significantly and are not ready for deployment. SRM is a complex, controversial, and under-researched technology. However, some scientists and companies are moving towards deployment, with research and discussions occurring at high levels, despite incomplete understanding of the implications. This contradicts the precautionary principle, essential for technologies that modify the atmosphere.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

IN-SPACE MANUFACTURING FOR THE EARTH

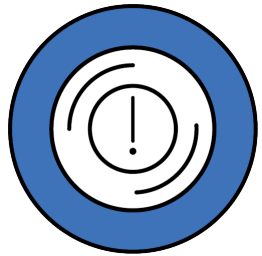


Varda Space start-up has been one of the first to launch a compact space factory, consisting of a commercial satellite platform attached to two modules. One module contains equipment for autonomously manufacturing a product, and the other is a re-entry capsule to return the goods to Earth. In-space manufacturing, primarily for the pharmaceutical, semiconductor, beauty, and health industries, benefits from microgravity, ultra-vacuum, and containerless processing at high temperatures to produce high-quality products difficult to make on Earth. Other efforts to move activities beyond Earth's atmosphere include data centres and space-based solar power.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

VALUING ATMOSPHERIC ECOSYSTEM SERVICES



The Earth provides various ecosystem services, but atmospheric services have historically received the least attention. Previously considered less relevant due to their abundance and renewable nature, there is growing recognition of the importance of quality air for breathing, radiation protection, cleansing capacity, warming, direct use, water redistribution, combustion, sound, communication, power, extraction of gases, tourism, and aesthetics. Increased interest in air for CO2 extraction and utilisation (protein, bio-based chemicals), as well as water extraction or hygroelectricity (electricity from humid air), is changing perceptions of air as a resource.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

NETWORKED MICROBIOMES

A diverse range of bacteria, fungi, archaea, and viruses, totalling trillions of microorganisms, exist on and in human bodies, forming the human microbiome. This significantly impacts human physical and psychological well-being. All other life forms, such as animals and plants, along with their habitats like soil, air, or water, also contain microbiomes. Previously seen as isolated, recent studies focus on interactions between multiple microbiomes. This broader perspective views individuals as symbiotic consortia of many species and ecosystems, or 'holobionts', prompting calls for microbial ethics to engage thoughtfully with the microbial world that shapes human life.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

BIOMETRIC RESEARCH FOR POLICY

Biometric research investigates subconscious body signals to reveal hidden features related to emotion, attention, cognition, and arousal. This method studies both explicit and implicit behaviour in response to stimuli, often used in psychology, consumer research, and neuromarketing to better understand human behaviour. The growing wearables market simplifies using biometric tools, like eye-tracking or portable EEG devices, and broadens their application to policy-related areas. Eye-tracking has been used in analyses of perception of urban environments or information literacy e.g. with studies examining emotions related to car-free streets.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

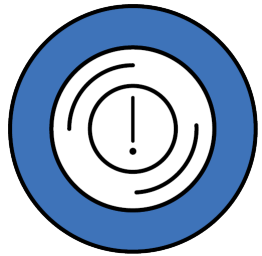
HARNESSING BIOELECTRICITY

Researchers are exploring bio-electricity generation. Electric eels can emit enough electricity to genetically modify small fish larvae, enhancing our understanding of electroporation, a gene delivery method. Electroporation uses an electric field to create temporary pores in cell membranes, allowing molecules like DNA or proteins to enter cells. An electrically conductive substrate called eSoil has been developed. Made from plant-derived cellulose nanofibres and conductive polymer PEDOT:PSS, eSoil boosts plant growth by an average of 50% compared to control groups. Unlike previous methods using high-voltage electricity, eSoil requires a safer, energy-efficient low-voltage current for enhanced plant growth.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

SUDDEN COLLAPSE OF CARBON SINKS

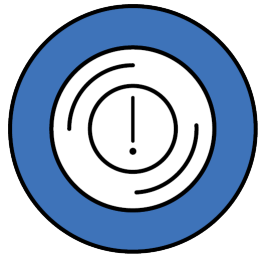


The faster than expected disappearance of carbon sinks signals that climate change tipping points are already upon us. Critical ecosystems like forests and rivers, which once absorbed vast amounts of carbon, are now under severe threat. Intensifying forest fires, particularly in northern regions, not only release stored carbon and disrupt ecosystems but hamper future capacity of forests to capture CO2. Record dry conditions are depleting the Amazon River, threatening biodiversity and reducing its capacity as a vital carbon sink. Global change indicators are flashing direct warnings, highlighting the unprecedented risks to human civilization. With these feedback loops accelerating, With these feedback loops accelerating, urgent massive action is essential to mitigate further damage and protect the planet's remaining carbon-absorbing systems.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

PERSONAL SCIENCE AND SELF-EXPERIMENTATION



Personal science involves answering personal health questions through self-research. The rise of personal medical data and new discoveries has encouraged daring self-experiments. Some technologies enable DIY pharmaceutical production. The Anarchist Four Thieves Vinegar Collective uses machine learning to map chemical pathways and suggest reactions to create molecules, producing costly medicines at lower prices. This also applies to pharmaceuticals that are hard to access or controversial. The collective believes everyone has the right to repair their body, even if it means bypassing professional advice.

WHAT HAPPENS WHEN THIS SIGNAL IS PUSHED TO EXTREME?

EXTREME

VERTICAL SPATIAL PLANNING

The Oversky project suggests semi-floating structures to utilise unused aerial space above cities. Using zeppelin-like technology, these modular structures form clusters of rooms in the sky, linked to nearby buildings for access. They create shaded microclimates by reflecting sunlight and radiation back into the sky, cooling the area below. This could be combined with high-altitude, high-resolution imagery from autonomous devices attached to small weather balloons, aiding autonomous driving and next-generation navigation systems. Organising urban air mobility infrastructure is another potential application.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

COMMUNITY PSYCHOLOGY

With increasing focus on mental health, community psychology is now used to understand collective emotions, thoughts, and feelings. This perspective views community wellbeing as more than just individual wellbeing. It emerges from shared living experiences, including spatial and social inequalities, multiple settings and scales, and temporal choices and legacies. It also considers sustainability and inter-generational issues.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

META-CITIES

For the first time, a significant part of the workforce can contribute to a city's economy without living there. The "Meta City" concept has emerged—networks of distributed communities acting as a single unit, linked to a global economic hub. These communities, in different time zones and locations, function together with a distinct structure. London and New York lead this trend, with other networks emerging. As cities grow into Meta Cities and aim to serve all citizens, including physical, digital, and non-human parties, their governance also requires new models.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

THE GIFT ECONOMY

The term 'sharing economy' often refers to commercial platforms like Uber and AirBnB, but it also includes the rising trend of non-reciprocal giving, lending, and skill-sharing, integral to collaborative consumption. Platforms such as 'Buy Nothing', which grew to 5 million participants across 7,000 communities during the pandemic, and Freecycle, with 9 million members in over 5,000 local groups, exemplify this shift. As people transition from users to providers in collaborative consumption, the focus moves from utilitarian values to prosocial and altruistic ones.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

GLOBAL-FIRST POLICIES

Although most countries and regional organisation approach most of the policy problems from their local perspectives, most of the underlying drivers of these problems are strongly interconnected and have global repercussions. A global-first approach would focus on framing the problem in a global systemic perspective first and then analysing potential ways of addressing them at different spatial levels.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

BRAIN HEALTHY LIFESTYLES

Estimations indicate that the global prevalence of dementia is expected to nearly triple by 2050, rising from 57 million to 153 million cases. This increase is largely due to population growth and ageing, with the smallest rise projected in high-income Asia Pacific (53%) and Western Europe (74%), and the largest in North Africa and the Middle East (367%) and eastern sub-Saharan Africa (357%). The higher ratio of women to men with dementia (1.7) will persist. There are 12 modifiable risk factors, including less education, hypertension, hearing impairment, smoking, obesity, depression, physical inactivity, diabetes, low social contact, excessive alcohol consumption, traumatic brain injury, and air pollution. Promoting brain-healthy lifestyles could prevent or delay 40% of cases.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

NEUROMORPHIC ENGINEERING

Neuromorphic engineering involves designing computing technology inspired by biological neural systems. It replicates aspects of these networks as analogue or digital forms on electronic circuits, enabling deep-learning algorithms. Its main advantages include energy efficiency, speed, robustness against local failures, and learning capabilities. Beyond electronic devices, neural network hardware can be developed from any controllable physical system, such as optical or mechanical systems.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

WORKING ANIMALS' PERSONALITIES

Animals play a vital role in ecosystem services like pollination, seed dispersal, pest control, and ecotourism. Efforts are ongoing to integrate animals into service provision in human-made environments, using circular business models like sheep mowing lawns or crows cleaning cigarette butts. As tasks become more cognitive, research into animal personalities—behavioural differences consistent over time and context—can help identify and collaborate with animals of different traits.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

LIFE-PHASE ORIENTED WORK

The new ways of working, characterised by digital transformation, remote work, agile project-based approaches, and evolving attitudes towards work, are leading to innovative working time models. There is growing interest in individualised working time, job-sharing arrangements (where two or more people share one full-time job), and life-phase oriented working time. Increasingly, these are supported by personalised career advice systems using machine learning to create tailored roadmaps of learning, resources, and work opportunities. Not only are life-long careers changing with telework and flexible work, but productivity periods are also shifting. In addition to the typical work peaks before and after lunch, a 'third peak' has been observed between 18.00 and 20.00.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

CHANGING LANDSCAPE OF HUMAN REPRODUCTION

Decreasing fertility rates worldwide are linked to economic development and women's empowerment in fertility decisions. New factors are emerging: declining reproductive health due to toxins and pollution (chemicals in plastics, medications, food, air) and lifestyle choices. Psychosocial stress and mental health issues, such as anxiety and depression, also impact fertility. Eco-anxiety and climate change concerns influence reproductive decisions, as do economic and public health uncertainties, evidenced by the rise in egg-freezing. Additionally, more people are choosing not to have children, supported by a growing no-kids online movement.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

REPOSITIONING OF SAUDI ARABIA

Saudi Arabia is trying to change dramatically its image. The kingdom aims to lead a civilisational revolution by redefining urban development with carbon-neutral smart cities like The Line and Oxagon. It seeks to diversify its economy away from oil, investing in R&D-intensive sectors such as electric vehicles and video gaming. These investments are paired with some social reforms to boost workforce participation. The country is also reshaping its foreign policy by restoring relations with Iran and enhancing involvement with BRICS, especially China. Saudi Arabia's repositioning could impact regional dynamics especially in Middle East - Africa relations and establish it as a global linchpin and urban development trendsetter.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

ENDINEERING

Designing the end of a product or service is crucial for a circular economy and the transition approach, where phasing out unwanted practices is as important as introducing sustainable ones. The role of an "endineer" is to consider the phasing out and off-boarding processes in the initial design. This phasing out should create a satisfactory experience when removing the product/service from one’s life, including its disassembly, recycling, and emotional engagement. As transformation requires changes to lifestyles and processes, designing and celebrating finales can change consumer attitudes.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

YOUNGER PEOPLE GETTING CANCER

Adult diseases like cancer are increasingly diagnosed in younger people. Although the numbers remain low, a clear trend is emerging. Global data models predict a 30% rise in early-onset cancer cases from 2019 to 2030, particularly affecting the digestive system. Colorectal, pancreatic, and stomach cancer rates are rising sharply. The causes are complex, involving genetics, lifestyle, and environmental factors. Obesity and early screenings partly explain this increase. Early-onset cancers have surged fastest in wealthier countries, highlighting lifestyle influences.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

DIPLOMATIC IMMUNITY CHALLENGED

The immunity of diplomatic posts and staff is less certain in current geopolitical conflicts. Two recent attacks on diplomatic sites highlight this: the bombing of Iran's consulate in Damascus and police entry into Mexico's embassy in Ecuador. Meanwhile, 'Havana syndrome', a mysterious illness among US diplomats, has been linked to Russian activity. Diplomatic immunity is increasingly questioned just as the role of diplomacy becomes crucial for maintaining peace in a fragmented world.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

NON-BIONORMATIVE PARANTAGE

The bionormative view on parenting, focusing on genealogy and biology and genetics, becomes increasingly detached from the increasingly diverse and pluralistic family forms (e.g. LGBTQ couples starting families with donations from friends) - where parenting intent and care become distinctive factors. Procreation technologies such as mitochondrial transfer, artificial sperm or human ectogenesis or gestation outside the body could further lead to disentangling gender from reproduction, redefining human reproductive roles.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

DIGITAL TECH GIANTS AS STATE ACTORS

The digital technology giants increasingly act like state actors, wielding influence comparable to national governments. Figures like Elon Musk exemplify this shift, with ventures spanning space exploration, social media, satellite communications, AI, and even a brief stint in government, shaping global infrastructure and policy. Meanwhile, Donald Trump's engagement with social media platforms highlights how these entities influence political discourse by amplifying or restricting voices. This dual dynamic — tech leaders acting as policymakers and platforms shaping political narratives — blurs the line between corporate and governmental power. As tech giants not only assume roles traditionally held by states but also shape public opinion, questions about accountability, regulation, and democracy become urgent, challenging societies to rethink power structures in the digital age.

CAN THIS SIGNAL POINT TO A MAJOR TURNING POINT?

INFLECTION

EMBEDDED FINANCE

As online commerce and digital payment methods become the norm, many production and service companies and platform ecosystems are including financial services in their offerings—accounts or wallets, payments, and lending—to serve their customers (both businesses and consumers). This process is simplified with banking as a service (BaaS) provided by fintech companies and can include 'buy now, pay later' lending models or embedded insurance. This model is projected to grow fivefold over the next five years, from USD 200 million to USD 1.3 billion. Starbucks exemplifies this new model with its mobile app, where over 24 million members load more than USD 10 billion annually, with over USD 1 billion stored as unused card value.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

THE SAND CRISIS

The United Nations Environment Programme released a report warning that sand extraction exceeds replenishment rates, causing shortages, socio-economic conflicts, and environmental harm. With an annual use of 50 billion tonnes, sand is the second most used resource after water. The report urges recognising sand as a strategic resource and developing regenerative and circular strategies, establishing ownership and access rights, sourcing responsibly, and restoring ecosystems. Modelling shows a 45% increase in global building sand use from 2020 to 2060, with a threefold rise in low- and lower-middle-income regions.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

TOKENISATION OF OWNERSHIP

Distributed ledger technologies are driving a trend to virtually fragment real-world assets into tradeable shares or digital tokens. These smaller, more affordable units offer increased liquidity and investment opportunities, with blockchain platforms providing a secure, transparent way to store and transfer tokens. The primary focus is on real estate markets, but experiments are also occurring in art, agricultural production (like tokenising a cattle ranch), insurance, automotive, and other sectors. The Boston Consulting Group estimates the industry could be worth USD 16 trillion in the future. Fractional ownership could transform the sharing economy, shifting from shared consumption to shared ownership.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

FUSION ENERGY

Fusion energy is generated when nuclei of lighter atoms like hydrogen collide and fuse, forming heavier atoms such as helium and releasing vast energy. Recent research breakthroughs and increased private investment could bring us closer to a new source of safe, low-carbon energy within the next decade. As prospects become more tangible, research into the commercialisation of fusion energy is starting.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

LUNAR ECONOMY

Beyond Low Earth Orbit, the Moon is a key target for space activities. A lunar economy involves economic activities related to producing, using, and exchanging lunar resources on the Moon's surface, in lunar orbit, and on Earth. It is estimated to be worth USD 170 billion by 2040. This includes space resource utilisation, transportation markets (resource prospecting, mining, processing, cargo transport), in-space manufacturing, and data markets. Economic opportunities are central to NASA's Artemis and China's CNSA missions for Moon base development. In July, the European Space Agency established the European Centre for Space Economy and Commerce.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

EMPLOYEE DIGITAL TWIN

Efforts are underway to introduce more 'virtual humans' into the workplace. Virtual clones that mimic real people using text, voice, video, imagery, and interaction are being adapted for business use. Hour One is among the growing number of companies in the 'digital twin' market. Users can create videos from text in minutes on any device, delivering messages through an avatar with a matching voice and graphics. After a short filming session, users can create digital twins that capture their likeness. These avatars can be used in various roles. The company plans to integrate this capability into any software product for real-time use via API.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

COGNITIVE LIBERTY

With significant advancements in technology and brain implant safety, non-invasive brain monitoring, and neurotechnology applications are increasingly used beyond the medical field. Employee surveillance tools, or "bossware," utilise neural sensors to gather productivity and well-being data from workers' brains, promising increased productivity and safety, as offered by start-ups like InnerEye or Emotive. These "brain wearables" (earbuds, headbands, watches, tattoos) are also marketed as consumer devices promising improved focus, reduced cravings, creativity, or relaxation. Significant ethical issues arise, particularly concerning privacy. The concept of cognitive liberty is emerging to protect our freedom of thought, mental privacy, and self-determination over our brains and mental experiences.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

GENE EDITING FOR THE MASSES

CRISPR initially only made cuts in DNA, but now it's used to modify genetic code, inserting new DNA or entire genes. These advances could treat more conditions, not just genetic ones. While lab and animal studies continue, CRISPR treatments have reached human trials. In July 2022, Verve Therapeutics began a CRISPR-based therapy trial to permanently lower cholesterol using base editing, as do other experimental therapies. Beam Therapeutics uses this method for potential sickle-cell and other disorder treatments. Prime editing, or 'CRISPR 3.0', allows DNA replacement or insertion of new genetic code. Though new and tested in animals, its potential is vast.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

PLATFORM ORGANISATIONS

The platform economy has introduced new business and operating models. Companies adopting platform business models share principles: data-driven, agile, design-led, team of teams, and customer-focused. Some Chinese firms, like Haier and Handu Group, reorganise internally for innovation through 'digitally enhanced directed autonomy'. These organisations grant employees large-scale autonomy, supported by digital platforms instead of middle management, and pair autonomy with single-threaded leadership. Teams form naturally to develop products or ideas, accessing technology and service platforms. Instead of middle management, they are openly monitored and ranked. Leaders concentrate on achieving specific, temporary goals.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

TREE EXTINCTION CRISIS

Reforestation programmes are vital for climate change mitigation, carbon capture, and renewable energy targets. However, many poorly managed projects have negative consequences. One issue is "phantom forests"—failed initiatives to plant millions of trees. Another problem is the spread of invasive tree species, harming ecosystems and incurring costs. Additionally, climate-induced tree mortality is rising due to pathogens, droughts, heatwaves, fires, bark beetles, and pollution. The Global Tree Assessment indicates that one-third of the world's tree species are threatened with extinction, highlighting a tree extinction crisis.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

DE-DOLLARISATION

In the late 1970s, 85% of global foreign exchange reserves were in dollars. According to the latest IMF data, the dollar's share in allocated reserves was about 59% in 2022. The global preference for the dollar is linked to its robust infrastructure and legal certainty that facilitate payments. However, this is challenged by structural changes. Countries maintaining economic ties with Russia cannot use the dollar or euro due to sanctions. Central bank digital currencies, in development in 114 countries, can aid the shift away from the dollar. The impact of de-dollarisation will be significant once alternative payment systems are established, with major financial, economic, and geopolitical implications.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

YOUTH'S IDEOLOGICAL GENDER DIVIDE

A global gender divide is emerging among young people, with young women increasingly embracing progressive views while young men lean towards conservatism. Previously, changes were relatively uniform across age groups, but now the gender differences within them are growing. This ideological gap is evident in various countries and extends beyond gender issues, potentially affecting societal cohesion and political landscapes. Additionally, there is a rising perception of women's rights as threatening to men. Three in ten young men believe it will be harder to be a man than a woman in 20 years. The UNDP Gender Social Norms Index shows no improvement in biases against women over a decade.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

WEATHER MANIPULATION AND ITS CONSPIRACIES

Climate change is causing more extreme weather events, particularly destructive tornadoes, prompting renewed interest in weather modification. Norway-based OceanTherm suggests cooling the sea surface by piping chilled water from below 200 metres. Another proposal is aerosol injection, which involves injecting water-attracting particles into the atmosphere to reflect sunlight and trigger rainfall. However, questions arise about governance, unintended climate consequences, and potential conflicts from altering cyclone paths. Despite previous failures, these ideas continue to be explored. At the same time, recent extreme weather in Dubai, the UK, and the US has led to conspiracy theories about governments manipulating weather for political purposes.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

GREEN HYPE BUST

Following the previous greentech hype bust from 2008 to 2014, the renewable energy boom is showing cracks. Lithium prices are plummeting, signalling waning demand for electric vehicles and batteries. Once-ambitious projects like offshore wind farms and heat pump installations are slowing, with companies like Northvolt scaling back expansions and facing bankruptcy due to cost pressures. Public enthusiasm for net-zero goals is giving way to scepticism as energy narratives shift towards abundance, affordability and reliability over environmental sustainability. Policymakers and industries are grappling with the fallout, questioning if the push for renewable electricity can maintain momentum or if a shift to easier short-term energy strategies is inevitable. The previous boom and bust, however, spurred a second wave of improved technologies, cutting costs and creating more robust business models through research investment.

WHAT CAN THIS SIGNAL DISRUPT IN OUR SOCIETIES?

DISRUPTION

NEURODIVERSITY IN ORGANISATIONS

Neurodiversity considers variations in the human brain regarding learning, mood, attention, sociability, and other mental functions. The term originated with Australian sociologist Judy Singer, shifting the focus from deficiency to difference for various neural conditions (autism, ADHD, dyslexia, etc.). Since then, it has been increasingly used in innovative technology, finance, and defence sectors as part of their talent management strategy, and specialised companies for placing neurodiverse employees have emerged. As the concept evolves from a voice of activists and campaigners to a term increasingly present in education, training, work, labour markets, and inclusion, relevant policies will also need to address it.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

CONSUMERS-TRADERS

Consumers are increasingly becoming producers (or prosumers) in a do-it-yourself, circular, and side-job economy, and they are also taking on the role of traders. Second-hand resale is rising significantly in sharing-economy platforms and social marketplaces, particularly in second-hand fashion, with sustainability objectives. Investment trading apps have made trading stocks, currencies, and crypto assets accessible to many people on a small scale. New business models are emerging based on energy resale; for example, Vehicle-to-grid (V2G) systems allow feeding energy stored in electric car batteries back to the electricity network.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

NEUROECONOMIC EVIDENCE FOR POLICY

Neuroeconomics and social neuroscience, using brain imaging, provide insights into the neural mechanisms underlying decision-making processes and social behaviour. This field aims to address questions vital to policy implementation. Neuroeconomic data characterise choices at both individual and market levels, aiding in the development of new neurocomputational models of decision-making. This approach has been used to examine factors influencing climate change risk assessment, individual actions, social preferences, and collective action in environmental and energy policies.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

PREDICTING SOCIAL PHENOMENA

Computational Social Science (CSS) is an emerging discipline that stems from increased computational resources and data. It applies data science and simulation methods to social sciences, addressing a wide range of policy issues such as mobility, climate change, demography, migration, macroeconomic policy, and political analysis. As new computational models develop, predictions will increasingly be generated, shifting the debate from perceived trade-offs to the complementarity between explaining and predicting.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

DECENTRALISED AUTONOMOUS ORGANISATIONS

A Decentralised Autonomous Organisation (DAO) is a member-owned entity without centralised leadership. Decisions are made by voting and executed through smart contracts, ensuring transparency and verifiability. A DAO's financial transactions and program rules are recorded on a blockchain. DAOs enable decentralised movements to simplify governance and financing. Protocol DAOs facilitate decentralised lending, borrowing, and operational decisions. Grant and philanthropy DAOs crowdsource grant decisions. Social DAOs build communities with distributed governance. Investment and collector DAOs manage pooled resource investments.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

SCALABLE WORKFORCE

With new work methods and employment forms, organisations are developing an "on-demand," "liquid" workforce that can expand or contract in response to a volatile environment. Workers approach gig work differently: some are "searchers" (temporary solutions seeking permanent jobs), "lifers" (a career choice), "short-timers" (to finance a specific goal), and "long-rangers" (second job or supplemental family income). Issues around job crafting and organisational commitment for this decentralised workforce will become prominent. Job fragmentation and platform work enable this but evoke both autonomy and digital nomadism as well as precariousness and alienation.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

OCEAN INDUSTRIALISATION

The rapid growth of the marine economy leads to an increase in the number and intensity of economic activities, known as the 'blue acceleration', and heightens pressures such as acidification, marine heatwaves, plastic pollution, and ecological connectivity. These activities—oil and gas extraction, renewable energy production, pipelines and cables, shipping, tourism, fisheries, aquaculture, blue biotechnology, and sand and mineral extraction—often conflict, though sometimes they are mutually beneficial, with various forms of marine spatial planning and governance. New aquaculture techniques, deep-water fishing, mining, and geoengineering ideas will further intensify these pressures.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

HUMANS AS SENSORS

Human biomonitoring measures exposure to chemicals in body fluids or tissues, including the substances themselves, their metabolites, or markers of health effects. This data, linked to sources and epidemiological surveys, informs research on human exposure-response relationships. It is already used in occupational and exposure assessments, and harmonising guidance and common data platforms is leading to more extensive use in regulatory risk assessments. Viewing humans as sensors can influence participants' experiences in their environments. On a broader scale, moving towards biosurveillance of human populations changes how we conceptualise the nexus of environment, health, and disease.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

DIGITAL CO-WORKERS

The rapidly increasing use of collaborative robots in manufacturing and logistics, and AI chatbots in office work, raises issues of human-machine interactions at work. AI as a teammate could enhance coordination, knowledge sharing, learning, decision-making, and performance evaluation. However, concerns exist about social interaction, design, privacy, and ethics. While focus is on acceptance and effectiveness, long-term impacts on work meaningfulness and job satisfaction are significant. Initial research suggests working with humans is more motivating, yet hybrid teams' success depends on AI's role. Delegating tasks to AI can improve both efficiency and job satisfaction.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

AWESCAPES

In a world full of stimuli, people seek ways to escape and rest. Some enjoy nature and peacefulness, but a growing number long for more stimulating experiences. Yearning for moments that transcend daily life, people seek 'awescapes'—instances of jaw-dropping wonder. Companies try to bring consumers closer to these moments through disruptive green encounters or monumental installations, while virtual worlds offer endless alternatives. Whether numbed by isolation, burned out by grind culture, or shocked by crises, people long for re-enchantment. Awe, now a cutting-edge research subject in emotional psychology, may improve resilience and combat burnout. Awescapes may bring relief but could lead to stimulus overload.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

EXTENSIONS OF CITIZENSHIP

The concept of citizenship extends beyond the nation-state to global, digital, and environmental domains, linked to education, rights, and obligations. In the EU, a 2023 Eurobarometer showed 72% of interviewees feel they are EU citizens, but only 58% were aware of their rights. The United Nations defines global citizenship as the social, political, environmental, and economic actions of globally minded individuals. Climate and digital citizenships emphasise rights and responsibilities in these domains. Another form of citizenship - Tuvalu, threatened by climate change, seeks to preserve its nation and culture digitally as a 'digital nation'.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

POLARISATION OF VIEWS AROUND BIODIVERSITY

Societal polarisation around biodiversity is growing. Some call for urgent action to protect ecosystems, while others remain sceptical or resistant due to economic concerns, ideological differences or misinformation. This fuels debates over renewable energy, conservation policies and lifestyle changes for sustainability. Polarisation hinders consensus and delays action, worsening environmental damage. Disparities between nations and social groups — tied to wealth, resource access and historical responsibilities — deepen these tensions further.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

MILITARY GRADE SOCIETY

As the definition of what is considered ‘critical infrastructure’ broadens to include an ever-growing range of assets, the demand for military-grade protection will intensify. This shift will require advanced security features to guard against threats such as cyberattacks, terrorism, war, and natural disasters, including increasingly extreme weather events and phenomena like earthquakes. The drive for more resilient infrastructure will lead to the use of cutting-edge technologies and robust design principles to ensure durability and adaptability. By prioritising military-grade protection, societies can improve preparedness, reduce vulnerabilities, and secure essential services, fostering stability in an unpredictable world. However, these enhanced measures may make many societal infrastructures less inclusive due to the need to profile users to deter potential disruptors.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

CHRONOWASHING

More structured and organised approaches to thinking about the future, such as foresight or futures literacy, have gained popularity. The UN Pact of the Future highlights strategic foresight capacities in public and international institutions to ensure long-term planning, with countries like the UAE using it as part of their soft power in global affairs. However, as more future scenarios emerge, accusations of 'chronowashing' arise. This involves focusing on long-term thinking and superficial solutions, distracting from urgent issues like extractivism, racism, inequality, and environmental injustice.

WHAT HAPPENS WHEN THIS SIGNAL BECOMES MORE WIDESPREAD?

EMERGING

INTELLECTUAL PROPERTY AS AN ASSET CLASS

In the current volatile economic situation, assets not correlated to economic activity with stable yields are of particular interest to investors. Music royalties have been the first to gain recognition as an asset class, with financial markets creating specific funds and marketplaces like ANote Music in Europe. Expanding this to other intellectual property, such as patents and copyrights, requires increased standardisation, clear valuation, and reliable revenue streams or derivative products like IP insurance. Modern business practices focus on intellectual property, and linking it to financial markets may foster new business models and innovation financing.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

PERSUASIVE DESIGN IN POLICIES

As changing individual habits is increasingly seen as crucial for policy effectiveness, and digital tools are more frequently used in policy delivery, employing persuasive design is a logical step. Persuasive technology refers to systems designed to change behaviour based on psychological theories. Initially developed to make apps more addictive, its health-related uses have grown, with success in tackling obesity and promoting physical activity. While effective for individual welfare, it also has potential for social welfare, such as energy use and sustainability. However, ethical concerns arise regarding manipulation, autonomy, and user interests. The use of AI amplifies the potential of these technologies.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

WEB 3.0

Trends to decentralise the internet using blockchain are accelerating. Web 3.0 refers to trends towards distributed services based on digital assets, unlike web 2.0, where user-generated content is centralised on digital platforms. New decentralised applications mainly focus on games and decentralised finance, but others like crowdsourcing, privacy, and social media are slowly following. However, these are increasingly scrutinised by law enforcement and tax authorities due to their use in criminal activities, money laundering, and tax evasion.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

LONELINESS TECH

Loneliness and social isolation harm mental and physical health and significantly affect social cohesion and community trust. With the COVID-19 outbreak, the proportion of surveyed people who frequently felt lonely doubled. Various assistive systems for socialising, from apps to robotics, have emerged during COVID-19 to tackle this issue.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

MULTI-SENSORY DIGITAL

The visual, audio, and haptic input/output elements are crucial for immersive digital experiences like augmented or virtual reality. Increasing research is focusing on digitising other senses. Thermal and vibrotactile stimuli can simulate wetness, liquid, or wind sensations when combined with visual and sound effects. Digital taste is achieved through electrostimulation, and digital scent technologies enable users to smell in digital environments. These techniques will also influence information experience design, shaping how people engage with information.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

ENERGY SCAVENGING

Driven by the need to reduce reliance on fossil fuels, individuals in various sectors are striving to use energy more efficiently. This includes developing small heat engines without moving parts, thermophotovoltaics, lightweight hydrogen tanks for aircraft, and engineered crystals to cut computer power consumption. The goal is consistent: consume less energy. Energy harvesting, or scavenging, generates energy from the environment for sensors and wearables. Sources include solar, thermal, wind, hydro, mechanical (vibration), and human-based. While current gains are insufficient for short-term transformation, they hold long-term potential.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

HOLOGRAM BREAKTHROUGHS

Breakthroughs in holographic projection, the virtual representation of 3D images in the real world, are making this technology more applicable for everyday telepresence. More realistic holograms are being created using three-dimensional scattering-assisted dynamic holography (3D-SDH), offering over three orders of magnitude greater depth resolution. Tensor holography efficiently allows real-time hologram creation, while new AI algorithms reduce costs and complexity in crafting 3D representations of humans or objects. This technology can aid volumetric 3D printing, microscopy, medical imaging, and visualisation. In the long run, it can foster remote services and the dematerialisation of consumption.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

PURPOSEFUL HOUSEPLANTS

Literal "power plants" are small, leaf-shaped generators that produce electricity using wind and rain. These generators, combining various small-scale sensors and electrodes, can be placed among fake plant leaves, offering a new source of clean, self-powered energy for cities and homes. If integrated into real plant leaves, opportunities expand further. In biological computing, plants are being transformed into data storage to reduce digital infrastructure's carbon footprint. Non-fungible plants (NFPs) encode digital data in their DNA, potentially forming decentralised eco-data centres. NFTrees in the metaverse are digital twins of real trees' health data, allowing human purchase and plant-directed spending. Such innovations assign new roles to plants, possibly earning them income.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

POLITAINMENT

Politainment, the blend of politics and entertainment, is an effective form of political communication. Mass and social media require adapting media logic to politics, increasing spectacularisation (e.g., Ukrainian President Volodymyr Zelensky's social media strategy). This trend is evident in political activism, from recent farmers' protests using tractors to climate activists targeting art. The rise of spectacularised politics may lead to greater societal fragmentation and distrust in the political system. Digital narratives will focus on interactivity and user participation (augmented reality, games), with content production becoming decentralised, affecting the diversity and quality of political information available online.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

GAMIFYING VOTING

Gamification, or using game mechanics to boost participation, is increasingly applied in digital government tools, especially at the municipal level. It engages citizens in consultations, shares information, and encourages sustainable behaviours. To address declining voter turnout, gamification is explored in politics, particularly the voting process. VoterCat, created during a ‘Code the Vote’ hackathon, turns voting plans into an engaging adventure. In US elections, campaign apps use gamification for voter outreach, awarding points for sharing campaign info. Meanwhile, the voting process is gamified, with political gambling markets gaining popularity and ‘horse race’ election coverage - focusing on winning odds rather than policy positions.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

NEUROAESTHETIC INTERVENTIONS

Neuroaesthetics research examines brain, body and behavioural responses to art and sensory experiences, supporting health, well-being and learning. Social isolation during Covid increased appreciation for the arts. Ireland extended the Basic Income for Arts programme, paying EUR 325 per week to 2 000 randomly selected artists. A Dutch neurological study using eye-tracking and MRI scans found brain stimulation was 10 times stronger when viewing real art in museums than posters. This highlights the potential of linking health, social and education policies to cultural and creative sector initiatives.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

DIRECT-TO-DIVICE SATELLITE SERVICES

Direct-to-device (D2D) communication in satellite networks connects smartphones and Internet of Things (IoT) devices without relying on terrestrial infrastructure, using cellular technology (4G, 5G). Building space-based rather than terrestrial infrastructure for digital services will challenge telecommunication business models and bring space infrastructure directly to users. Providing space products to consumers sparks imagination. Reflect Orbital promises ‘sunlight as a service’ via a constellation of orbiting mirrors that beam sunlight after dark. Although the business model targets solar power stations, its consumer-focused marketing made the idea go viral.

HOW CAN THIS SIGNAL HACK OUR SYSTEMS?

HACK

EMODIVERSITY AND COMPLEX EMOTIONS

Emotion is integral to human decisions, enhancing and sustaining reasoning. We cannot separate the two; thus, in policy-making, we should consider policymakers' emotions and citizens' emotional needs. Sentiment analysis and emotion detection have been applied to large datasets, mostly social media. Most current approaches focus on simple emotions, but the role of complex and diverse emotions is increasingly explored. Emodiversity (richness of emotional experience) and complex emotions (mixed emotions, meta-emotions) are linked to integrating complex information, creating new expressions, and wiser reasoning. As we understand them better, future policy narratives are likely to be based on more complex and diverse emotions.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

PHYSICAL SPACE FOR THE VIRTUAL WORLD

As our lives extend into the virtual world, our physical spaces adapt to support our online presence. Engaging in the virtual realm demands significant physical space, whether on the road in a car, on a bicycle, or in public transport, at work in an office or a collaborative space, or at home. Solutions aim to smooth transitions between work and home while expanding habitable areas globally. Data centres and the technology sustaining the digital world consume physical space. How accessible is the virtual world to those lacking extra space? How do virtual constraints align with sustainability requirements?

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

COMPUTER-DESIGNED ORGANISMS

In 2020, a method was developed to design biological machines from the ground up. AI automatically designs diverse candidate lifeforms to perform desired functions. Transferable designs are then created using a cell-based construction toolkit to realise living systems with predicted behaviours. The first such organisms, xenobots, were derived from cells harvested from Xenopus laevis embryos. In a recent report, the team showed that these robots could replicate by combining loose cells into self-copies. Developments in synthetic morphogenesis have applications in biomedicine and bioengineering.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

STORYLIVING

Storytelling and narratives are essential communication tools. Storyliving adds an experiential element, allowing participants to live through stories via interactive, embodied, and immersive experiences. Virtual reality lived stories can enhance learning, teaching empathy, and healthcare. It is a valuable tool in journalism and corporate and political communications. In these stories, there is no teller; the audience has some agency but not full control and can access multiple perspectives. Storyliving is not limited to the virtual world. Disney plans a storyliving residential community with hospitality, entertainment, and design features to immerse inhabitants in the Disney universe.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

DREAM-SHAPING

Influencing and inducing dreams has long attracted interest, and new technologies are being developed to make it possible. During hypnagogia, the stage of sleep when the brain transitions to unconsciousness, it is most suggestible to external prompts. Targeted dream incubation uses sensory stimulation with a glove-like device to induce specific prompts at sleep onset. Another approach involves using pre-sleep stimuli, such as virtual reality tasks, to influence dream content, while transcranial alternating current stimulation induces lucid dreams. These methods can interrupt nightmares and address anxiety disorders. However, brands are experimenting with embedding advertising prompts in consumers' dreams.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

MICROBIAL PROTEIN

Amid the rising demand for food and sustainability concerns with traditional agriculture, interest in alternative proteins is growing. Single-cell proteins (SCP), derived from yeast, fungi, bacteria, and algae, are one option. Biomass fermentation leverages the rapid growth and high protein content of algae or fungi to produce substantial protein quantities efficiently. Precision fermentation uses microorganisms as cell factories to create specific proteins, enzymes, vitamins, or fats, such as casein, whey, and honey, producing bio-identical animal-free products. Solein, developed by Solar Foods, is a protein ingredient made by microbes from carbon dioxide, with a demonstration facility set up in 2023.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

TAUMA-INFORMED POLICIES

Trauma-informed approaches recognise that trauma affects mental wellness, cognition, and decision-making. This approach is based on six principles: safety; trustworthiness and transparency; collaboration and mutuality; empowerment, voice, and choice; peer support; and intersectionality. Initially developed in healthcare, social services, and education, it provides a framework for various policies. For example, by viewing food insecurity as trauma, these principles can enhance a city's food system resilience. Trauma-informed design and computing apply these principles to designing spaces and technologies that might trigger trauma. It's increasingly relevant in journalism and organisational development, and is applicable in all fields involving people.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

HUMANID ROBOTS AT WORK

Industry and services have successfully incorporated robotic automation in manufacturing and tasks like logistics, inspection, maintenance, and surface cleaning. However, advances in humanoid robots could disrupt roles focused on human interaction, not just manual, repetitive tasks. Walking, talking machines will soon serve as guides, companions, and deliverers. Companies are exploring various approaches to creating and utilising humanoid robots. This trend may significantly impact the job market, affecting job availability and the need for new skills, such as supervising service robots in customer care.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

AI-GENERATED AR/VR CONTENT

Augmented and virtual reality are key to merging digital and physical worlds, but cost and skill barriers have limited their use. Generative AI, however, enables real-time creation of virtual worlds by generating images and 3D representations. Early experiments, which require significant computing power, are expected to become more cost-efficient in a few years, inspiring ideas about creating virtual worlds in real time or developing 3D worlds from any video. These virtual worlds can be used for training, simulations, education, learning, and healthcare.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

FOBO – FEAR OF OBSOLESCENCE

FOBO, or the fear of becoming obsolete, is a growing concern among employees, especially those with a college education, as emerging technologies threaten to make their skills irrelevant. This fear results in stress, anxiety, and reduced job satisfaction, affecting work-life balance. With the introduction of AI, FOBO is likely to worsen employee burnout. Addressing FOBO is crucial for employee well-being and a positive work environment. Companies must invest in continuous learning and development to prepare employees for technological advancements and reduce FOBO's impact. This enables them to face the future with courage and skills, not fear and ignorance.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

BIOENGINEERING GUT MICROBIOME

While CRISPR has been extensively used to modify individual microbes, research is now targeting entire microbiomes. The focus is on gut microbiomes, which have the potential to promote health and treat disease. The ecology of the trillions of organisms in the human gut impacts health, cognition, and sleep. Recent studies also identify the gut microbiome as an important source for antibiotic discovery. However, understanding the roles and challenges of various microbial communities and their influence on the host organism is still at an early stage.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

ADOLESCENTS ON FINANCIAL MARKETS

Increasingly, teenagers aged 13 to 17 are investing in financial and cryptocurrency markets through online apps, often via custodial or parents' accounts. A US study shows that 23% of teens in this age group are already investing, with 75% believing it is important. The UK Financial Conduct Authority reports that 8% of 13- to 16-year-olds hold high-risk crypto assets, sometimes confusing gambling, trading, investing, and entertainment.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

GRIEF TECH

Emerging AI technologies offer a form of 'digital afterlife', creating avatars or chatbots of deceased loved ones for grieving individuals. These 'grief tech' services include AI-generated messages, interactive avatars, and VR-based recreations, enabling ongoing interactions. Innovations like QR codes on graves link to digital profiles, while some services combine AI with therapy to mimic a loved one's presence. However, these technologies raise ethical concerns, including privacy, consent, and psychological effects. Critics argue they exploit grief, risk manipulation, and blur humanity's boundaries. As personal data grows, AI recreations become more realistic, deepening these issues.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

CELLURAL INTELLIGENCE

Biology’s multiscale architecture, from molecular networks to cells, tissues, organs, whole bodies, and swarms, can be seen as collective intelligence solving problems at cellular, tissue, and whole-organism levels. This approach suggests examining tissues, organs, and molecular pathways for learning and proto-cognitive abilities, such as training cells for specific gene expression levels, physiological states, or anatomical outcomes. From this perspective, cancer could be analysed as an intelligent species.

WHAT OPPORTUNITIES CAN THIS SIGNAL BRING?

NOVELTY

MODULAR MANUFACTURING

The reorganisation of supply chains and the increasing volatility of the business environment have led companies to adopt more agile production and distribution strategies. Modular manufacturing, where production is divided into modules and easily rearranged, follows the trend of the fast-growing modular construction sector. Instead of achieving economies of scale with large plants, a modular approach starts at a smaller scale for testing and demonstration, then builds hundreds or thousands of modules in distributed systems. Nestle Foods plans modular food processing factories in Africa and Asia, while Nokia has developed a factory-in-a-box concept—a manufacturing space in large cargo containers.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

ADVANCED FRUGAL INNOVATION

Frugal innovation typically focuses on simplifying solutions and reducing costs for bottom-of-the-pyramid markets. However, there is increasing interest in advanced constraint-based innovations promoting sustainability and resilience. These advanced frugal innovations rely on sophisticated engineering, involving research, design principles, and systemic optimisation to create novel products and services. Technologies like 3D printing, mobile applications, cloud computing, machine learning, and artificial intelligence can significantly aid these innovations. In a world of limited resources, financial and human constraints, and technological and geopolitical disruptions, competitive advantage may arise from advanced frugal innovations with fewer dependencies and lower maintenance.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

ARTIFICIAL PHOTOSYNTHESIS

The commercial viability of 'fuel from the Sun', generated through artificial photosynthesis, is advancing due to recent developments. This technology is among the most promising for providing sustainable alternatives to current fuel supplies. It uses sunlight, water, and carbon from the air to produce hydrogen or carbon-based fuels, collectively known as solar fuels, which offer an efficient and transportable means of storing solar energy. In 2021, it was the subject of an EIC prize.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

TECH FOR HUMAN-ANIMAL RELATIONS

Research into animal cognition and behaviour is advancing with new tools and technologies for interacting with companion and farm animals. Innovations such as wearable technologies, smart accessories, video connections, and augmented/virtual reality are fostering interspecies information systems. The emerging field of animal-computer interaction research focuses on user-centred design from the animals' perspective, enabling co-design of systems with animals. This approach helps us understand how animals perceive the world and aims to enhance their welfare and conservation.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

RIGHTS-BASED APPROACHES TO RESOURCES

In October 2021, the UN Human Rights Council passed a resolution recognising access to a healthy and sustainable environment as a universal right. During COP26, civil society organisations strongly advocated for rights-based approaches to climate change, food, energy, water, and technology governance. These approaches focus on the human dimension of resource governance, acknowledge the human rights obligations of states and private parties, and provide access to judicial or administrative recourse. Another trend involves granting rights to nature by assigning legal personality to natural entities, such as rivers.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

FOOD DEMOCRACY

The concept of food democracy addresses “the transformation of established structures, processes, and practices of food governance, i.e., the way in which common and collectively binding goals are formed, agreed upon, and implemented.” Democratic control over the food system links to other ideas about its functioning “ food sovereignty, food justice and food citizenship . Many citizen-based food initiatives aim to empower the actors involved and new tools are being created which enable policy makers, stakeholders and citizens to talk about and operationalise social justice, for example within an urban food governance context.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

HUMAN WASTE REVOLUTION

Dubbed the ‘economics of excrement’ or the ‘urine revolution’, novel methods for on-site sanitation treatment are emerging. Urine diversion, which separates urine in the toilet, holds particular promise. Urine treatment technologies can enhance nutrient, phosphorus, and nitrogen recovery while also boosting energy production, thereby supporting the circular economy and agriculture. Transitioning from off-site, water-borne sanitation systems with treatment plants to on-site systems requires a significant shift in both sanitation design and public attitudes.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

GOVERNANCE OF GLOBAL COMMONS EXPLOITATION

People are taking unconventional routes to access energy and mineral resources. Biogas production, once overlooked, is now gaining EU interest. Building renewable energy infrastructure increases demand for metals, prompting exploration of new mining frontiers like deep-sea and asteroid mining. These costly practices raise environmental concerns, geopolitical competition, and the management of global commons. Institutional designs for benefit sharing are essential to avoid conflicts. Countries like Luxembourg and Nauru are using their sovereignty to attract private capital and redefine exploration and access rights.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

MACHINE-READABLE WORLD

The trend towards the 'smartification' of our surroundings means our environment must be interpretable to non-human agents. With the rise of autonomous agents navigating the physical world, such as autonomous transport, robots, and drones, infrastructure must adapt to their needs. Proposals like adding a fourth, white traffic light for autonomous vehicles and smart road signs focus on machine-readability over human needs. Digital twins of physical objects and systems further support this shift. Additionally, social and legal systems are evolving with initiatives like 'law as code' and machine-readable reporting standards.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

BATTERY-FREE ENERGY STORAGE

The world is set to add as much renewable power over 2022-2027 as it did in the past 20 years, according to the International Energy Agency. This makes energy storage increasingly important, as renewable energy cannot provide a steady, uninterrupted flow of electricity. Beyond batteries, other energy storage systems are being developed, including electrochemical (supercapacitors), electrical (superconducting magnetic energy storage), thermal modules, and mechanical (compressed air, hydro storage, flywheels) or combined in hybrid systems. Although these technologies still need significant improvements, they will likely play a more important role in the energy transition.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

EVOLUTION OF KINSHIP STRUCTURES

Younger generations will have more living great-grandparents and fewer cousins. In 1950, a 65-year-old woman had an average of 41 living relatives. By 2095, a woman of the same age will have only 25. As societies age, family structures will change. With longer life spans, grandparents may play bigger roles in families and stay longer in the workforce. Some companies offer grandparental leave as childcare costs rise and fewer relatives are available. However, they may also need care themselves. Young people struggle to afford homes and often stay with parents longer. Families will need to adapt to having more older members.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

MANAGING NEURAL DATA

Colorado is the first US state to anticipate the need for personal data protection from brainwaves, passing a law in April 2024. Citizens now have the right to access and delete their neural data, and can opt out of its use for targeted ads. Neural data use cases are vast, with brain analysis potentially playing a significant role in societal organisation. Advanced AI LLMs can already consider emotions in communication. If AI accessed neural data directly, it could tailor communication to emotional needs. Algorithms could predict superspreading content on social media, and combining this with neural data offers unprecedented opportunities to influence individual and social behaviour.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

MORAL OFFLOADING TO AI

Despite concerns about AI, many trust it when vulnerable. A University of California study found two-thirds of people changed their minds in simulated life-or-death decisions based on a robot's advice. This shows excessive trust in AI and a tendency to avoid responsibility during crises. Participants followed the robot's advice, despite warnings about its limited abilities and potential errors. The robot influenced decisions in two-thirds of cases. Similar to cognitive offloading (relying on external aids to reduce mental effort), moral offloading may rise as artificial moral agents emerge. Greater reliance on them could lead to societal issues like moral deskilling, hindered moral progress, and responsibility gaps.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

WEAKENING ANIMAL PROTECTION

As tensions between food security and biodiversity protection grow due to climate change and an unstable geopolitical situation, animal protection regulations are being weakened. In the EU, downgrading wolf protection has been proposed due to livestock damage. Namibia and Zimbabwe opted to cull elephants to address a food emergency caused by drought. The 2020 Animal Protection Index shows that since 2014, animal protection has stagnated or declined in many countries. Similarly, the World Organisation for Animal Health observatory reports a significant drop in new animal welfare regulations since 2020.

HOW CAN THIS SIGNAL CHANGE HOW WE THINK AND ACT?

TRANSFORMATIVE

GREEN TRANSITION POLICIES FOR THE 1%

Present and future innovations offer solutions and freedoms but can create new inequalities when social, ethical and accessibility considerations are overlooked. As the richest 1% capture an increasing share of newly created wealth, they gain access to powerful tools beyond the reach of most. This applies to genome editing for therapeutic and enhancement purposes and access to longevity treatments. It is also evident in tech billionaires building private luxury bunkers or engaging in vaccine tourism to secure privileged positions amid rising man-made and natural disasters.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

SILENT CITIZENSHIP

Empowering and engaging citizens is key to building resilient democracies, yet many do not participate in politics. Increasing attention is paid to political absence and silence as expressions: beyond involuntary silence, there is strategic absence (boycotts or secessions) and strategic silence (silent protests, vigils, withholding verbal support, or showing indifference or anger). This communicative silence, a form of agency, can also be considered as a fundamental element of democratic institutions.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

NEW SOURCES OF EXTREME INEQUALITIES

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WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

GROWTH MINDSET INTERVENTIONS

A growth mindset is the belief that personal traits, such as intellectual abilities, can be developed, unlike a fixed mindset, which views these traits as unchangeable. In the face of difficulty, a growth mindset encourages improvement, while a fixed mindset may lead to giving up. Research shows that fostering a growth mindset is achievable, with educational experiments demonstrating strong achievements for students facing adversity and stereotype threats. Growth mindset is increasingly explored in education, innovation, leadership, poverty reduction, and ageing.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

HUMAN-SWARM TEAMING

Robotic swarms, coordinated robots performing collective tasks, have rapidly developed recently. They have diverse applications, including exploration, search and rescue, surveillance, agriculture, air defence, area coverage, real-time monitoring, wireless services, and goods delivery. These swarms utilise swarm intelligence, where intelligent behaviour emerges from element interactions. Semi-autonomous swarms, controlled by humans, are reliable, effective, and ethically sound, but require effective human-swarm interaction. These systems resemble shepherding, with humans providing high-level planning and AI handling task-level planning and execution.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

SYNECOCULTURE

Synecoculture is a novel method of market gardening, based on a high-density mixed association of edible plants without the application of tillage, fertilizer, and chemicals. Developed by Sony Computer Science Laboratories, the approach focuses on artificial creation of ecosystems for cultivating a rich diversity of crops (200 species, 700 varieties in 1000m2) for year-round sustainable harvests while also enriching local biodiversity. It leverages big data and machine learning for better understanding of ecosystems, allowing human augumentation of ecosystems, and the use of robots for sowing, pruning and harvesting in such a complex environment.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

CRIMILEGAL POLITICAL ORDER

The crimilegal order is a hybrid political system where moral, legal, and social boundaries blur between legality-legitimacy and illegality-criminality. In Latin America, over 13% of people live in areas where criminals like paramilitary groups, vigilantes, drug cartels, and gangs assume state roles, governing territories and populations. They maintain public services, infrastructure, and justice systems. An unstable geopolitical situation, regional conflicts, and weakening states may strengthen this trend elsewhere.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

SOCIETAL ASPECTS OF PAIN

The notion of pain is increasingly seen as both a personal and societal issue. Socioeconomic, psychosocial, and behavioural factors, along with social stressors like economic insecurity, are strongly linked to pain. This has led to calls for governments to include pain as an indicator in wellbeing debates. Conversely, some argue that modern "painless civilisation" systems, which focus on comfort and pleasure while eliminating pain and suffering, deprive people of life's joys, a fundamental source of meaning. This trend could result in a society overwhelmed by pleasure.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

DIGITAL SWEATSHOPS

A new crime is rising in Southeast Asia: transnational abductions to force individuals into internet scams. Myanmar, Laos, Cambodia, and Thailand are hotspots where tech-savvy workers are promised tech jobs but are then held captive by organised crime groups. These workers are coerced into scamming potential victims online. In countries like the Philippines, low-paid workers process data for American AI and tech companies, highlighting a trend where people are exploited for their tech skills, creating ‘digital sweatshops’. Automation won't eliminate poor working conditions, as exploitation shifts from labour to tech skills.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

SLOW SCIENTISTS IN FAST SCIENCE

The slow science movement mirrors the broader slow movement's call to decelerate life, prioritising quality over quantity and valuing rewarding and pleasurable aspects. It responds to the pressure for faster publishing in science. However, the COVID-19 pandemic highlighted the need for rapid evidence collection, and machine learning is increasingly speeding up scientific processes, potentially improving living standards and addressing societal challenges. Scientists' roles should evolve to consider longer timescales and broader perspectives, focusing on quality and higher-order evidence in science, and promoting teamwork and interdisciplinarity.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

EMBRACING DEINDUSTIALISATION 2.0

Europe's industrial base is being challenged by decreased global demand, subsidies in Chinese and US industries, and soaring energy costs. Nearly one million manufacturing jobs were lost in Europe between 2019 and 2024. Some experts suggest embracing deindustrialisation in energy-intensive, uncompetitive sectors and focusing on emerging industries. These new sectors, like smart industry 4.0 and human-centric industry 5.0, offer distributed, modular production with fewer workers and human-machine collaboration. Although they contribute to GDP, they will impact less digitally advanced regions. These industries will be smaller, employ fewer people, and have a reduced effect on landscapes and resources.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

WOMBFARE

Geopolitical tensions highlight the role of population growth in projecting power and maintaining territory. India overtaking China in 2022 as the most populous country has made headlines, while many nations face population decline. In political demography, there's extensive analysis of migration weaponisation, but the weaponisation of population growth is gaining recognition. This can significantly influence ethnic, religious, and international conflicts. 'Wombfare' refers to using fertility as a political weapon to overpower rival ethnic and religious groups. Both religious and secular groups employ it to gain political influence, as differing demographic growth rates can lead to state collapse and violent conflict.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

MODULAR SOVEREIGNTY

At the start of 2024, the Egyptian government signed a USD 35 billion deal with Abu Dhabi's sovereign fund to develop the Ras al-Hekma peninsula, seen as selling land amid an economic crisis. As sovereign funds invest more in land and real estate, and with Chinese state investment in global infrastructure, questions of territorial sovereignty arise. While territorial sovereignty remains a key state element, actual power relations can make sovereign power modular—adaptable, partially exchangeable, and highly mobile, operating through crises and emergencies.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

DETERIORATING LATE ADULTHOOD CONDITIONS

Current demographic and healthcare trends indicate a significant increase in the number of people aged 65 and over with complex health issues and limited resources. Providing appropriate health services will be challenging due to workforce shortages, budget deficits, and the shift from 'cure-seeking medical care' to 'cure-and-support seeking medical care'. Older individuals will also be disproportionately affected by climate change and pollution. Additionally, the pension-to-average wage ratio in the EU is projected to decrease from 43% to 36% by 2070. Retirees with high private debt, such as ultra-long mortgages, face economic insecurity and may increasingly rely on the gig economy.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION

AUTHENTIC BELIEF POLITICS

The desire for authenticity influences all areas of life, including experiences, brand marketing, and entertainment. It has become significant in political discourse, playing a decisive role in campaigns and elections. Citizens judge politicians' authenticity based on ordinariness (being down-to-earth), consistency (staying true to themselves), and immediacy (spontaneously expressing their thoughts). These aspects shape perceptions of political truth. Politicians' approach to honesty has shifted, with authentic 'belief speaking', often detached from evidence, becoming more prominent and distinct from evidence-based fact speaking.

WHAT TENSIONS DOES THIS SIGNAL SUGGEST?

CONTRADICTION