CHALLENGE WORKS by nesta

Regulation, innovation and the activist state

Anticipatory regulation for an era of mission-driven government

Challenge Works

At Challenge Works, we design and run challenge prizes, spanning science, technology and social innovation. Our challenge prizes catalyse innovation to tackle pressing problems where solutions are lacking.

Challenge prizes offer a series of incentives in return for solving a defined challenge. They create breakthrough innovations, help innovators thrive and unlock systemic change.

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We are innovation experts, experienced in identifying opportunities for new ideas, and deeply embedded in science, technology and entrepreneurship.

We are problem-centred, working with sector experts, drawing on research and engaging with people with lived experience to drive real-world impact.

We are thought leaders, leading in the practice and theory of innovation, and sharing our learning with the world.

Challenge Works is part of Nesta, the UK's innovation agency for social good.

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Any errors or omissions remain our own.

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Introduction

In 2019, in the Nesta and Challenge Works paper 'Renewing Regulation: Anticipatory regulation in an age of disruption' we shaped the emerging concept of anticipatory regulation amid widespread debate about how best to respond to a rapidly changing world.

Following major political shifts, such as Brexit and President Trump's 2016 election win, and the ongoing technological and societal transformations that underpinned them, there were calls in many quarters for greater regulation – of traditional media, social media, and of the new digital behemoths that built them.

We named this an 'age of disruption' characterised by world-shaping innovations that were sources of both anxiety and promise. Regulators found themselves caught between pressures to enable innovation and demands for safety and public protection. Public discourse swung between calls for 'more' or 'less' regulation, with little nuance between these positions.

Anticipatory regulation offered a third way – focusing on what regulators actually do rather than simply more or less red tape. It encouraged distinguishing between harmful and benevolent innovation rather than erecting regulatory barriers indiscriminately.

Six years later, the regulatory landscape has fundamentally shifted. The traditional trade-off between innovation and state intervention no longer defines policy debates in the same way. Now in 2025, we revisit anticipatory regulation in this transformed context.

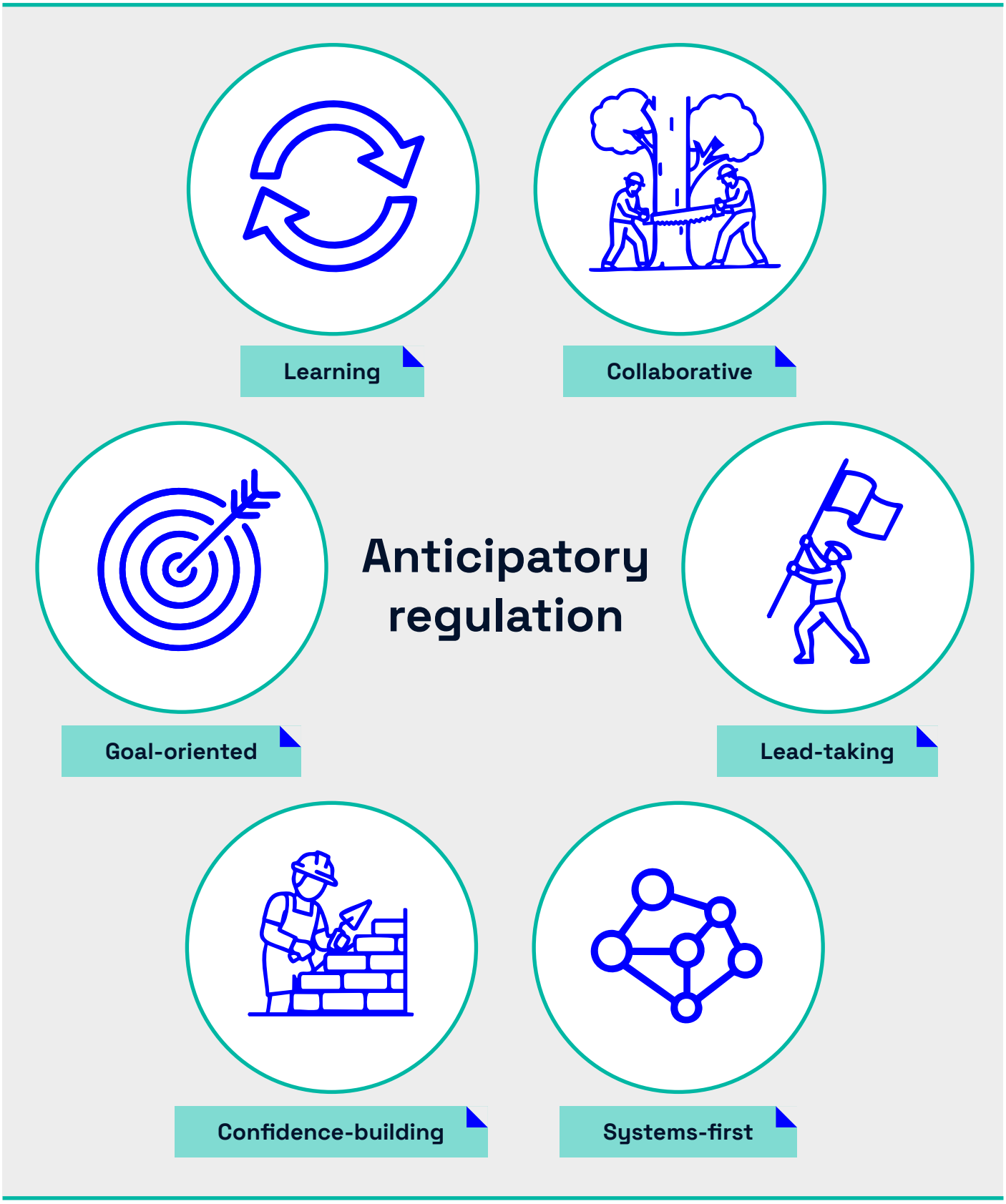
Governments are enthusiastic about innovation while taking an increasingly active role in directing it. The economic consensus around market-led innovation has been increasingly questioned. Global competition drives nations to compete for leadership in emerging technologies such as AI, robotics, quantum computing, space, green energy, and synthetic biology. Recent crises have demonstrated innovation's critical role in addressing major challenges, while concerns about artificial intelligence have emerged as a dominant regulatory challenge.

We are pleased to discover that anticipatory regulation has proven influential. Its principles appear in the previous government's white paper on regulation (2019) and are explicitly integrated into the Agile Nations network (2020), alongside a number of recent papers on regulation. Experimental practices such as testbeds and sandboxes, which we highlighted in 2019, have become standard features of regulatory practice. Regulation is increasingly outcome-driven, and multi-stakeholder collaboration is now common.

However, experience with anticipatory approaches has highlighted new challenges, and given anticipatory regulation's emphasis on learning and adaptation, we should take stock of what has been achieved, in order to improve. For instance, it is argued in some quarters that the shift to outcome-focused regulation has sacrificed certainty in favour of flexibility that is then too risky to act on. Being proactive and future-focused is valuable, but the 'age of disruption' means the future is increasingly difficult to predict and therefore act upon. More collaboration with wider stakeholder groups is welcome, but it can make coordination trickier and action slower, while also complicating life for innovators.

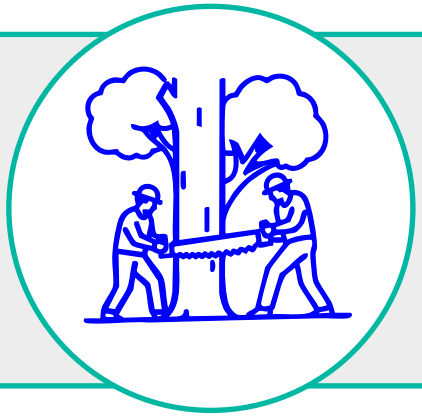
To account for these issues, and to integrate the learnings of the past six years, we present a second iteration of anticipatory regulation and its six principles. Each one retains the spirit and essence of its predecessor, but the names and meanings have been adapted to speak to a new era of mission-driven innovation led by the activist state.

Six principles of anticipatory regulation



Collaborative

Regulators should co-develop new regulatory environments with, not just for, industry, and coordinate with other regulators at home and abroad. Collaboration eliminates bilateral interactions, reducing costs, expediting development, and pooling expertise to produce better informed regulation.



Collaboration has often been taken to refer to a 'big tent' approach to regulation, with the regulator acting as a convenor for a broader coalition of civil society actors with a stake in the regulatory issue at hand. Practically speaking, anticipatory regulation has promoted 'better engagement with a wider set of stakeholders' – through, for example, citizens' juries – and for 'leveraging the capabilities' of external actors (NGOs, universities). A good example of this is the **Flying High Programme**, in which Challenge Works convened the Civil Aviation Authority (CAA), innovators, universities, public administrators and citizens in five UK cities to develop municipal visions for urban drone applications and governance.

Flying High: Shaping the future of drones in UK cities

The UK's Flying High project brought together five city-regions (Bradford, London, Preston, Southampton, and the West Midlands), regulators, public services, businesses, and industry to collaboratively develop city-led visions for urban drone applications and regulatory frameworks for safe urban drone integration, demonstrating how cities could use drones for socially beneficial purposes. This includes medical delivery, emergency response, and construction monitoring, while identifying that collaborative challenge prizes could accelerate solutions to the complex technical and regulatory barriers preventing urban drone deployment at scale.

The 'big tent' is no less important in 2025 but given the clamouring to expedite innovation there is an acute interest now in how collaboration can empower innovators specifically. This is tricky because the innovator base is often composed of small, diverse, less-established (and sometimes short-lived) firms, who are hard to identify, have fewer resources, and are less plugged into regulatory systems. As such, anticipatory regulation has long emphasised making regulatory engagement less cumbersome, accessible and open, especially for start-ups. What's more, increasingly the issue is that the emerging technologies intersect the remits of multiple regulators, multiplying the costs of engagement.

The Digital Regulation Cooperation Forum

A joint venture between four UK regulators to improve digital regulation. The four recently completed a one-year pilot of an AI and digital hub, so that innovators who would otherwise need to engage several regulators in parallel can quickly demonstrate compliance through a single point of contact. Engagements with innovators were also published as case studies, providing a secondary source of advice for innovators who had not been engaged directly. The pilot broke new ground in cross-regulatory collaboration, with entrepreneurs reporting significant value and enhanced business viability from the service, helping innovators navigate complex regulatory landscapes spanning data protection, financial services, competition law, and online safety – proving that collaborative regulatory models could accelerate innovation without compromising oversight.

Regulatory collaboration can be thought of as relatively shallow or relatively deep. A shallow collaboration might be a discrete, timebound engagement or one that does not disrupt the day-to-day responsibilities of collaborators. For example, the Digital Regulation Cooperation Forum (DRCF), for example, is a joint venture between

four UK regulators that seek to streamline regulatory engagement for those innovators whose activities concern all of them. To this end, the DRCF piloted an AI and Digital Hub, which worked with innovators for a year and built a catalogue of case studies from that work to inform others.

Other relatively shallow collaborations are those that increasingly occur between regulators across international borders. Innovators trying to cross the valley of death are often hamstrung by the necessity of meeting regulatory requirements in multiple jurisdictions. It is not enough for the UK regulatory environment to be 'innovation-friendly' if compliance only affords access to the UK market and the innovation in question requires a larger pull (or more attractive pulls are available, in say, the EU or USA). For this reason, regulators in novel foods, digital technologies, and autonomous vehicles are increasingly part of international regulatory networks that seek greater coherence across different jurisdictions.

A somewhat deeper collaboration occurs where regulators co-develop technologies and attendant regulations directly with innovators. At the frontiers of innovation, where little is settled and much is unknown, the fastest way to progress is for innovators and regulators to work in lockstep, synchronously developing technologies and the rules that govern them (which are often co-dependent anyway). Sandboxes and testbeds are a common way of operationalising this, as are regulatory frameworks that institutionalise collaboration on a cyclical basis. **Estonia's Experimentation Framework** exemplifies this approach through its pioneering cross-sectoral regulatory sandbox system.

Accelerate Estonia's Experimentation Framework

Europe's first cross-sectoral regulatory sandbox, enabling innovators and regulators to work together across different industries. Companies can test technologies that current laws prohibit – such as autonomous drones for urban delivery or self-service pharmacies – in controlled environments. Through this co-development process, innovators get real-world testing while businesses and government gather valuable data to inform future policies. The cross-sectoral approach means a single framework serves all industries rather than requiring separate sandboxes for each sector, streamlining collaboration between multiple regulators and diverse innovators.

We can think of deep collaborations as those that are either permanent, involve systemic integration of regulators, or in the following case, a blurring of boundaries between regulator and regulatee. This occurs in the increasingly common instances where innovators are involved directly in the development of regulatory standards and are even allowed to self-regulate/enforce. To avoid the apparent risk of regulatory capture this requires high levels of goal alignment and trust. For example, Japan's Ministry of Infrastructure, Transport and Tourism is able to give industry a wide degree of involvement in the development of regulatory standards for autonomous vehicles, because regulators and innovators have a mutual interest in avoiding incidents involving autonomous vehicles on public roads that would be catastrophic for both individuals harmed and public confidence in the technology.

For example, Department for Science, Innovation and Technology (DSIT) convenes the Engineering Biology Regulators Network (EBRN), a voluntary forum attended by fourteen regulators with a stake in engineering biology. Ostensibly the forum was created to share knowledge and best practice – a shallow collaboration – but is increasingly becoming a vehicle for a much more expansive cooperation – in strategy, public affairs and governance. One could see the aforementioned Digital Regulation Cooperation Forum (DRCF) deepens along such lines, but for now it illustrates the difference between a shallow and deep collaboration.

To a great extent therefore, collaboration remains important but often follows a different rationale. Where the emphasis was previously about widening participation to develop more inclusive and well-informed regulation, collaboration is now increasing deploying as a means of streamlining – by reducing duplication of efforts or even delegating some regulatory control to innovators. Our view is that both rationales have a role to play in regulatory innovation, but regulators should be mindful of the purpose and utility of a given collaboration.

Idea: regulatory co-design for emergent space activities

Perhaps more than any other industry, international collaboration has been prized in the space sector as a way of pooling resources to achieve very grand but expensive ambitions – most notably through the International Space Station.

As the space sector is expected to grow in value to $1.8tn by 2035, the attendant increase in space activity creates a host of regulatory issues. There is little agreement on how to manage orbital congestion and space debris, which represents a collective action problem to which many nations are contributing. Countries more willing to collaborate on this may gain an advantage in shaping the content.

Rather than competing to offer the most favourable regulatory environment for launch providers, countries could collaborate to develop regulatory frameworks that deal with issues like the environmental implications of increased launch frequencies and space sustainability. Finally, new kinds of space activity in In-Situ Resource Utilization (ISRU), mining and power generation will require regulation, which in turn will be legitimised by through cooperation.

Suggested interventions

- International regulatory alignment for launch providers to reduce costs, and collaboration to develop environmental regulations for launches and guidance on space sustainability.
- Collaboration to draft regulation for ISRU, mining and power generation (e.g. nuclear and solar), and seek international cooperation on space debris and orbital congestion.

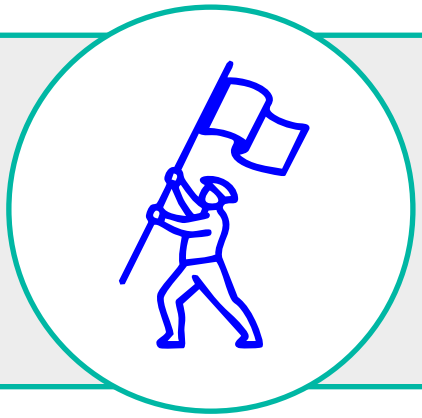
Outcomes

- Pooled (reduced) compliance costs for launch providers.
- New regulation for new space activities, and legitimised through collaboration, with agenda-setting advantage for collaborators.

Photo by Bill Jelen on Unsplash

Lead-taking

Regulators must go beyond merely enabling innovators and instead lead them in desirable directions. This will cause markets and industries to mature in ways that support the public interest, and to achieve outcomes that markets could not reach on their own.



Anticipatory regulation encourages regulators to go beyond their traditional stewardship roles and be proactive and future-focused in their efforts to expedite innovation. Practically speaking, this has meant that governments should seek to apprehend the future through practices like horizon-scanning and speculative design, and proactively aim to track emerging issues, engage industry and assess possible opportunities. This implies an intelligent regulator, one that adapts and anticipates change rather than waiting to be invited, but within a framework where markets themselves still determined their ultimate direction.

These recommendations stand, but they speak to an age in which markets were expected to chart their own course. In the UK context, governments today are expected not to simply unleash market energies, but stimulate and direct them towards objectives of national and global importance. Governments now, especially mission-driven ones, have strong ideas about where markets should go and expect regulators to help take them there. Aside from the general imperative for productivity and growth, the UK government aims lead markets through the energy transition, in housebuilding and housing policy, adopt artificial intelligence safely and revolutionise transportation. As the gatekeepers of various market-shaping powers and resources, and governments' good source of market intelligence, regulators have an important role to play in leading innovators towards desire futures.

Ofwat: Mainstreaming nature-based solutions project

Ofwat funded the "Mainstreaming nature-based solutions" project, bringing together 23 partners including water companies, environmental NGOs, and the Rivers Trust to explore the barriers and opportunities for nature-based solutions. Drawing on the programme's emerging findings, the review of the Price Review 24 draft determination contributed towards an increase in sector-wide funding for nature-based solutions from £2.2 billion at draft to £3.3 billion at final determination – an additional £1.1 billion investment over the next five years.

To explain, a future-facing regulator would recognise the opportunity presented by nature-based solutions for ecologically responsible water management. But to lead on this, Ofwat brought together twenty-three partners – water companies, NGOS, innovators and the Rivers Trust – in the **'Mainstreaming nature-based solutions'** project to investigate barriers and opportunities to nature-based solutions. This is less a case of enabling industry to move in the direction it was already travelling and more the regulator identifying a strategic priority and leading the industry towards it through funding support and mutual learning. The evidence generated ultimately led Ofwat to release a further £1.1bn of investment into nature-based solutions through their price review process.

Open Up 2020 Challenge

The Open Up 2020 Challenge for the Open Banking Implementation Entity was a £1.5 million prize designed to unlock the potential of open banking for UK consumers. While open banking legislation had created the technical framework for innovation, consumer adoption remained limited and the transformative potential of new financial products was unrealised. The challenge enabled the creation of a diverse range of consumer financial services – from automated savings and investment tools to alternative credit solutions and mortgage preparation services – by supporting 15 innovators with financial grants, technical support. Crucially, it also targeted demand-side barriers through a national awareness campaign that reached 7.7 million consumers and increased open banking usage by 10x among exposed audiences. The financial sector now has both innovative consumer products and established consumer adoption pathways, while the regulatory approach has demonstrated how authorities can actively shape market development. Building on this approach, the subsequent Open Up 2020 Challenge for the Open Banking Implementation Entity focused on consumer banking products and driving adoption. Without this sustained regulatory leadership it is doubtful many of these now-successful financial products would exist.

Of course, market-shaping doesn't need to be limited the supply-side. A key aim of the **Open Up 2017 Challenge** on SME banking, for the for the Competitions and Markets Authority (CMA) was to shape consumer behaviour, a fairly unorthodox activity for a regulator. The CMA identified a public interest in better current account products enabled by open banking, but current account switching is a notoriously weak consumer behaviour and persistently failed to drive innovation in products. The Open Up 2017 and 2018 Challenge, supported a dozen innovators to create new products, but also ran a digital awareness campaign to help drive uptake. Building on this approach, the subsequent Open Up 2020 Challenge for the Open Banking Implementation Entity focused on consumer banking products and driving adoption. Without this sustained regulatory leadership it is doubtful many of these now-successful financial products would exist.

A final dimension of lead-taking is in the international arena. For instance, a major obstacle in the development of drone applications was the absence of any kind of regulation for drones carrying dangerous goods – anywhere in the world. The Civil Aviation Authority (CAA), working with the Vehicle Certification Agency and Viking Drone Packaging developed a world-first certification for crash-proof containers (and a corresponding container), which has since driven the development of similar global standards, catalysing market development.

Crash-proof drone containers

Dangerous goods require a certified crash-proof container, and a significant obstacle to the development of such a container is the absence of a regulatory framework for its certification. The CAA, with the Vehicle Certification Authority and Viking Drone Package, led a project to develop the world's first such container and certification process for such containers. The drone industry now has the key components – physical, regulatory, administrative – to develop the transportation of dangerous goods, Viking has a world-first container, and the regulatory process has influenced the global development of such standards.

All of these examples highlight regulators that are setting and pursuing strategic objectives, rather than simply taking the initiative to help innovators meet their commercial ones. Perhaps regulator proactivity alone is sufficient in a stable world where more innovation leads organically to one of many benign possible futures. In our present unstable one, it falls to regulators to lead industries towards futures that are fair, benevolent, prosperous and minimally precarious.

Idea: TeenOS

There is widespread public concern over harms associated with children owning smartphones. Cyberbullying, dangerous content, misinformation and a diminished social life are chief among parents and policymakers' concerns.

At the same time, it not an easy thing for any one parent to deprive their child of a smartphone when the better part of their social life may exist on it. Exclusion could be just as damaging, and in any case there are also many advantages of having one: easy communication, access to the online world (which isn't all bad) and basic digital literacy. Furthermore, the extant policy response has so far been to build clunky, draconian systems of content regulation, which are dubious with respect to both efficacy and civil liberties.

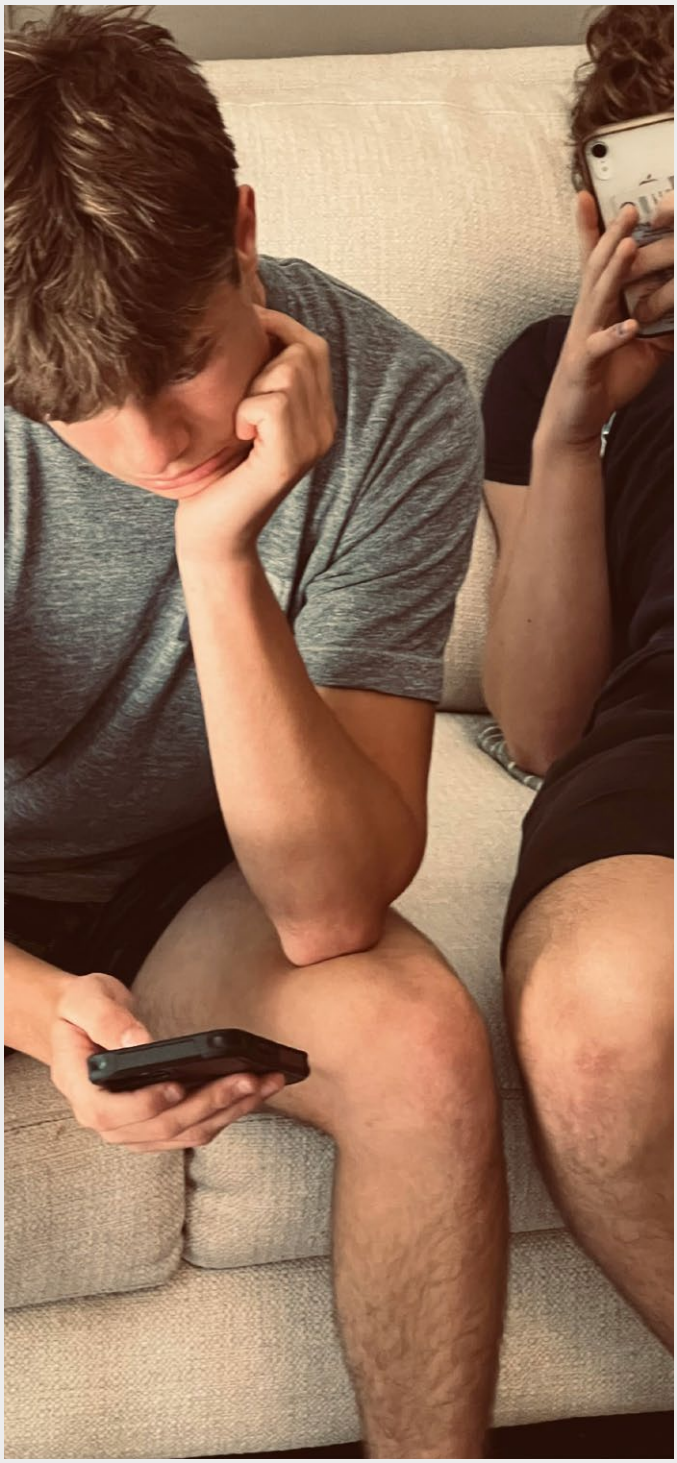
This begs the question: can a smartphone for teens exist that separates the good from the bad? Technologically, this is certainly plausible, but despite widespread public concern and presumably, demands, tech giants have not offered a solution. Could a regulator take the lead on this?

Suggested intervention

Digital regulators convene software developers, childrens' charities, educators, academics, and the general public to co-design and develop a smartphone (hardware, OS, and/or applications) that would offer young people an enriched relationship with the digital world without so many of the harms – and without the elaborate structure of content regulation.

Outcomes

- Improved online wellbeing for young people.
- Less onus on contentious digital regulation.
- An OS built in the public, not commercial, interest. A flagship state-led public works.



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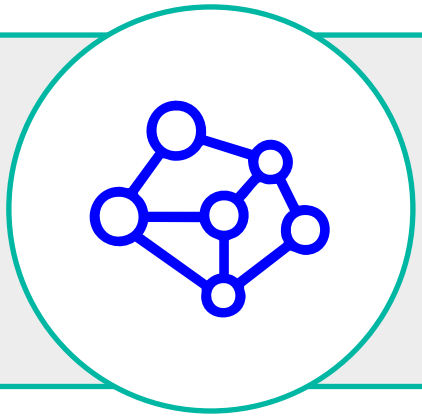
Systems-first

Regulators have their own priorities, responsibilities and powers that were defined in specific technological and societal moments. As technology and society evolves, regulators must think and act with concern for whole systems, rather than just the part they were designed for.



A hallmark consequence of innovation is the dissolution of boundaries. This happens in technologies themselves, for example, in how engineering biology breaks the traditional dichotomy between what is natural and what is artificial, and in society, in how AI threatens to redraw the boundary between human and machine labour.

Regulators are, by definition, bounded organisations, given clear and specific remits in statute. Those remits reflect what are perceived to stable and identifiable areas of concern at the time they are laid down. For example, when Ofcom was created, its purpose was, and still is, to regulate broadcast media, in anticipation of the digitisation of such services and the proliferation of new channels. It absorbed several other legacy regulators from an era of regional television networks and a clean technical distinction between radio and television.

Still, it was not foreseen that everyone in Britain would become a producer of online content, as well as a consumer. Responsibility for digital regulation in the UK is distributed but the Online Safety Act 2023 puts much of the onus onto Ofcom. At the time of writing, there is a heated public debate occurring about the ethics and efficacy of the Act and its de facto requirement that porn sites implement robust age and identity verification. Should a site fail in its duty to protect children from harmful content, Ofcom would be required to intervene. Whatever, the rightness of this policy, it is a long way from issuing spectrum licences for freeview channels.

A related question regards how regulators who share a domain manage their differing priorities. In 2021, **Nesta observed** that a key policy decision in digital regulation has been to hand the issue of 'harms' to Ofcom and the issue of competition to the Competition and Markets Authority (CMA). Meanwhile, non-broadcast news media continues to be regulated by the Independent Press Standards Organisation (IPSO), and the Department for Digital, Culture, Media and Sport (DCMS) retains a broad slate of other responsibilities. Online Safety Act 2023 focuses squarely as its name suggests, on safety, and makes this a core feature of Ofcom's remit. But safety is but one characteristic the digital realm must embody, and must be balanced against others such as freedom of expression, transparency, privacy, diversity, competition, and fairness. Without passing judgement on what the right balance is and whether the UK achieves it, our national preference for independent, arms-length regulators does not always lend itself to systemic thinking beyond their individual remits, or to the championing of values that they were not built to prioritise.

Consider for example, the case of airborne drones that carry – and release – payloads. Whilst such drones are airborne their operations fall under the purview of the Civil Aviation Authority (CAA). But as soon as it drops its payload, it becomes the problem of the Health and Safety Executive (HSE). These are two separate regulators, with little pre-existing overlap in responsibilities, are suddenly asked to collaborate and understand each other's domains and priorities. This is a particularly stark example, but speaks to the way that emerging technology will continue to outgrow static regulatory arrangements, and how regulators must find ways to align and coordinate their interests. The Civil Aviation Authority is also worth mentioning because in 2021 it became the UK's space regulator. This makes sense now, while the majority of space regulatory activity concerns launch and spaceport licensing. But as UK space operations grow and diversify, will the CAA evolve to manage orbital congestion and power generation, too? What about lunar activity?

Flights and falls: Who regulates?

A curious case of regulatory dissonance is that of airborne drones that release payloads. While a drone is in UK skies it is the purview of the Civil Aviation Authority. But when it drops a payload, it literally falls into the authority of the Health and Safety Executive. Assuming these regulators have distinctive functions and should not be merged, and that drones will continue to perform operations that blur the boundary between aerospace and human working environments, regulators involved must find ways to work in concert: combining their expertise, but providing a singular and coherent strategy for things like heavy lift drones.

One obvious and important response, prescribed under our first principle, is that regulators collaborate where there is overlap. However it will not always be plausible or desirable for regulators to do everything together – it seems sensical that the CAA and HSE still have very different domains and expertises and would make strange bedfellows in most other situations. Another growing feature of the regulatory landscape is increasingly systemisation to manage transboundary issues and complexity.

For example, The Regulatory Horizons Council's recent report on a **systemic approach to governing the products of engineering biology** recommends that engineering biology products should be governed according to their properties, as they emerge, rather than the platform technology from which they originate. In other words, a genetically modified (GM) food product should be evaluated with respect to relevant biological properties it possesses, rather than because it is the product of genetic modification (a platform technology), significantly blurring traditional lines of accountability based on technological distinctions.

This promises a world in which innovators with low-risk products are not trapped in regulatory limbo for years simply because their innovation is nominally classified as 'GM'. But it is also a very demanding world for regulators. The same report recommends, to make this model possible, that "regulators, standards bodies, metrology organisations, and policy makers have a good systemic understanding" of EB products and their properties – in short that all regulators have a good awareness of all products and their properties all the time, and thus can determine their own proper level of involvement.

This is a lot to ask of each regulator in the system and begs the question of how such complexity can be managed. Part of the answer is to have regulatory networks develop shared, centralised functions allowing them to behave in a systemic and purposive way. Thus the Regulatory Horizons Council (RHC) recommended that the Engineering Biology Regulators Network (EBRN) also ought to co-ordinate "to optimise governance decisions" and have its own public-facing narrative for the development of novel foods. The same report also recommends integration of the latest pro-innovation advice from the Regulatory Innovation Office (RIO), and ensuring compliance with the Nagoya protocols. This is evidence of a network developing system-level capabilities functions – in strategy, oversight and public affairs.

Such developments are a logical consequence of the turn toward a more interventionist approach to regulation: if the state is to take a more active role in innovation through anticipatory regulation, it must develop relevant competencies it did not possess in its laissez-faire configuration. The establishment of the Regulatory Innovation Office in 2024 is itself an innovation in this regard, insofar as it provides strategy, guidance, best practice, experimentation and convening for a range of high-priority technology areas. This is consistent with what The Institutional Architecture Lab (TIAL) has called embedding **"intelligence as a core function"** into institutions. It has less to do with regulators collaborating – across domains and priorities – and more to do with specialisation and differentiation – across competencies and functions.

Engineering Biology Regulators Network

The Engineering Biology Regulators Network is a voluntary organisation convened by DSIT that provides a forum for sharing knowledge and best practice on pro-innovation regulation among regulators who have some stake in engineering biology. The network enables a coordinated system to guide technology from early research to market deployment. Increasingly, however, this network is developing systemic capabilities that allow it to act as one with respect to specific regulatory functions: public affairs, governance and integration of Regulatory Innovation Office guidance.

The Regulatory Innovation Office

The establishment of the Regulatory Innovation Office in 2024 reflects a recognition of the need for greater systemic support for regulators if they are to fulfil their innovation functions. The RIO was created to expedite the development of frontier technologies by working with regulators and innovators to overcome obstacles to innovation, initially focusing on space, AI, autonomous vehicles and engineering biology. Practically, this might involve developing cross-sectoral insights and recommendations for regulatory innovation, directly funding innovation practices, or convening stakeholders to test new approaches and work on shared problems. In short, it performs a range of intelligent regulatory system functions that individual regulators might struggle to perform in isolation.

Idea: Regional Maritime Sandboxes

As a large maritime nation with busy territorial waters, UK regulatory costs are comparatively high. Autonomous marine innovators such as ACUA Ocean have found Estonia's Baltic waters to be a much more permissive environment. This illustrates how regulatory costs tend to scale with the size and busyness of a given jurisdiction.

However, there are highly industrialised areas like the North Sea and the English Channel, the UK's territorial waters are not uniform. Areas with less activity and risk could be designated as sandboxes for maritime innovation. Impending devolution also deepens the opportunity for smaller jurisdictional/geographical sandboxes within the UK.

Suggested intervention

Regulators work with central government and new devolved authorities to create localised maritime sandboxes. This may involve business incentives for innovators in coastal cities and regions focussing on technologies that correspond to local industries (e.g. fishing, shipping, defence), and favourable regulatory arrangements for maritime innovation in surrounding waters.

Outcomes

- Faster, cheaper innovation in low-risk environments.
- Boost to innovation in regional economies, especially outside London and the South-East.

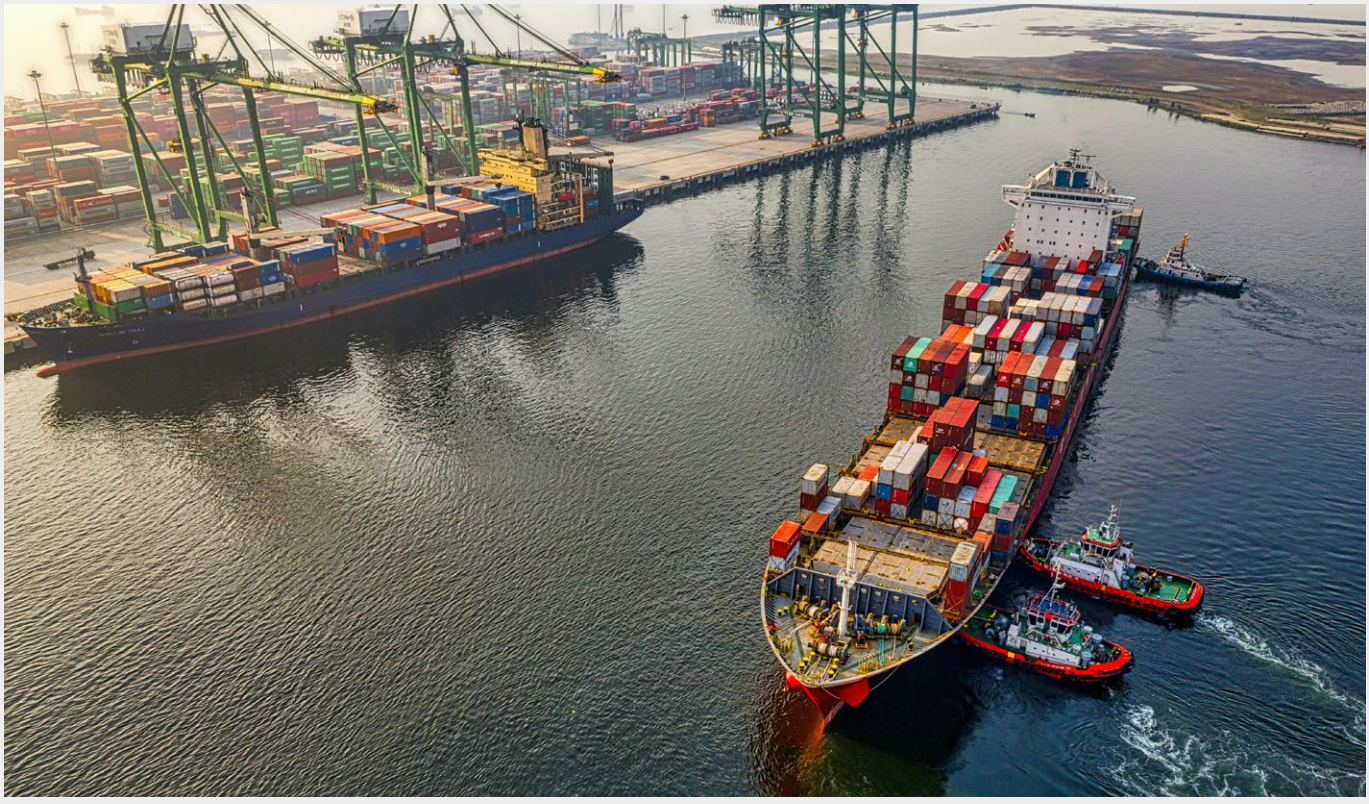


Photo by William William on Unsplash

Confidence-building

Regulators need to build confidence in new technologies through evidence generation and public engagement. This will give industries the knowledge to advance new technologies, investors the confidence to invest in them, and the public the trust and understanding to demand them.

Pro-innovation regulation recognises that innovation is driven by more than just money and permission. In several respects, innovation demands confidence – public, private and scientific. Without a robust foundation of trust, the benefits offered by emerging technologies may be missed.

Traditionally, the primary way regulators were understood to produce confidence was clarity and stability for investment. A major feature of the Chancellor's 'securonomics' philosophy has been the aim to restore a stable business environment that is conducive to private investment. The previous government's announcement that new combustion-powered cars would be phased out by 2035, the subsequent scrapping of that target, and its reintroduction at a new target date of 2030 is often cited as a high-profile example of regulatory turbulence that has undermined investment. There is a tension there: anticipatory regulation prioritises adaptation, iteration and flexibility, but we should recognise that – whether the consequence of political turbulence or not – even in emerging technologies industry may still seek stability from regulators over flexibility.

However, regulators have a much wider role to play in building confidence, especially with respect to novel technologies. Artificial intelligence, autonomous vehicles and engineering biology are platform technologies that face significant challenges with respect to public confidence. At what point are we comfortable removing humans from the loop in routine medical screening? How low must a self-driving car's error rate be to take our children to school? Are lab-grown meats safe to eat?

The principal way that regulators build confidence is through evidence-generation. In the first instance this means confidence for regulators and innovators about technologies, standards and their consequences. Much of the motivation for increased collaboration between regulators and innovators, (through, for example, testbeds) has been about generating shared understanding of risks and opportunities and a consensus about a path forward. The **UK's MHRA AI Airlock** regulatory sandbox exemplifies this approach. The pilot, launched in 2024, has the objective of identifying regulatory challenges specific to AI as a Medical Device (AIaMD) and fostering collaborative work to understand and potentially mitigate any uncovered risks. It promotes increased collaboration with partners such as the NHS AI team and UK Approved Bodies, and generates product reports to share knowledge and findings that assist manufacturers and inform regulatory progress. The insights from the AI Airlock are intended to inform considerations for future changes to medical device regulations and the design of subsequent regulatory sandboxes, demonstrating to innovators that regulatory pathways can adapt to emerging technologies while maintaining safety standards, thereby building confidence among regulators, partners, and innovators about AI's safety and effectiveness and contributing to its safe integration into healthcare.

MHRA AI Airlock programme

The UK's MHRA AI Airlock is the first MHRA's first regulatory sandbox for AI as a Medical Device (AIaMD) products. It aims to identify and address regulatory challenges for AIaMD through collaborative assessment with UK Approved Bodies, NHS partners, and device manufacturers. The project enhances understanding of AIaMD risks and opportunities while developing solutions that balance patient safety with innovation agility. The successful pilot phase tested four breakthrough AI technologies, with participants gaining valuable regulatory insights and accelerating their development progress. The programme has now expanded to a second phase, with pilot results expected to inform broader regulatory approaches to AI in healthcare.

Regarding the public, given the significant public confidence challenges facing novel technologies like AI, and the growing awareness of their potential pervasive societal impact, regulators are increasingly crucial in guiding innovation towards beneficial societal outcomes and building this confidence. This involves a fundamental shift from only preventing harm to actively encouraging beneficial results for the public good. One approach to building confidence focuses on proactive public engagement that goes beyond informing audiences. Organisations like Sciencewise facilitate deliberative dialogues that actively involve the public in exploring emerging technologies alongside policymakers, supporting the delivery of socially responsible policy. For instance, their dialogue on **Modular Nuclear Technologies** involved key regulators including the Office for Nuclear Regulation, with participants becoming more willing to consider the technology after learning about its role in reaching net-zero, while expressing expectations for robust and independent regulation. Such engagement helps develop technology strategies that reflect societal values and address public needs, recognising that legitimacy stems from both inclusive processes and beneficial outcomes.

Modular Nuclear Technologies Public Dialogue

The Department for Businesses, Energy and Industrial Strategy (since restructured in 2023 to form the Department for Business and Trade (DBT), the Department for Energy Security and Net Zero (DESNZ), and the Department for Science, Innovation and Technology (DSIT)), co-funded a public dialogue on Modular Nuclear Technologies to understand public views on deployment of these technologies. Key regulatory bodies including the Office for Nuclear Regulation and Environment Agency participated as partners in the dialogue process. The project engaged citizens through structured deliberative sessions to understand public insights and expectations regarding these emerging technologies. Findings revealed public expectations for robust and independent regulation, with participants becoming more willing to consider the technology after learning about its role in reaching net-zero. The dialogue outputs directly inform future policy development and public engagement strategies.

Another approach involves establishing responsible innovation principles. According to UK Research and Innovation (UKRI), responsible innovation is a process that takes the wider impacts of innovation into account, seeking to ensure that unintended negative impacts are avoided and that societal benefits are fully realised. The UK's government's new **framework for AI regulation** aims to bring clarity and coherence to the AI regulatory landscape, making responsible innovation easier, strengthening global leadership, and increasing public trust in its use and application. This framework is underpinned by five cross-sectoral principles: safety, security and robustness; appropriate transparency and explainability; fairness; accountability and governance; and contestability and redress. By applying these principles, regulators ensure that AI development and deployment are trustworthy and consider environmental, ethical, and societal impacts beyond just economic benefits.

This approach helps build public confidence by being explicit about ethical frameworks and involving public engagement, fostering trust in emerging technologies. **DSIT's Model for Responsible Innovation** exemplifies this confidence-building approach as a practical tool that helps innovators rapidly identify risks and prioritise actions to ensure trustworthy innovation. The Model enables the UK to advance data-driven technologies while simultaneously addressing risks and building the public trust necessary for successful innovation adoption.

DSIT's Model for Responsible Innovation

The Model operationalises responsible innovation through eight fundamentals – transparency, accountability, fairness, safety, security, privacy, human-centred value, and societal wellbeing – that teams assess through workshops. Used across government from policing to social care, these structured sessions help teams identify ethical risks and develop tailored mitigations. By transforming abstract principles into actionable safeguards through workshops and reports, the Model demonstrates how responsible innovation frameworks build justified trust, not through principles alone, but by systematically anticipating and addressing risks throughout development.

However, principles-based regulation inevitably involves navigating tensions between competing values. The government increasingly uses principles to provide regulators with guidance and legitimacy without dictating specific actions, but this approach presents challenges. When transparency conflicts with security, or fairness with efficiency, how should regulators manage these competing values? Unavoidably, regulators need to make choices. Additionally, regulators face implementation challenges in translating abstract principles into concrete standards and finding effective ways to encourage compliance across diverse sectors and technologies.

Idea: Public tastings for novel foods

Under current UK law, there exists a process to exempt novel foods from certain food standards for the purpose of trialling them.

However, innovators cannot conduct public tastings because it would constitute placing products on a market, which is not permitted under the provisions of such trials. This regulatory gap is particularly problematic given the fact that consumer demands are changing towards more sustainable food options, driving increased demand for new food products and creating pressure for faster approval of novel food applications. For novel foods to succeed, there must be facility by which innovators can trial products in a way that builds public confidence and enables them to understand how well-received their products would be with consumers.

Suggested intervention

A series of trial public tastings with selected UK novel foods innovators, accompanied by a public campaign (and perhaps consultation) to promote awareness and understanding of novel foods and gauge public perceptions. Could partner with major UK supermarkets/distributors.

Outcomes

- Co-develop appropriate regulation for public tastings of novel foods in the UK.
- Build consumer awareness, confidence and understanding of novel foods.
- Gauge public attitudes and perceptions, help develop public facing narrative/strategy.
- Signal to investors that the UK is actively preparing the market for novel foods, on both supply and demand sides.

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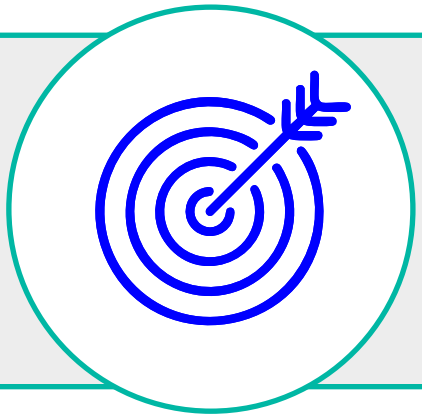
Goal-oriented

Regulators need to use all the tools of pull innovation – not just rulesetting – to incentivise progress towards outcomes, including for example mission-driven innovation and challenge prizes. This will give innovators freedom to experiment in ways that do not compromise regulatory clarity.



In 2024, as Labour was establishing its five mission boards, **an anonymous civil servant was quoted** as saying "Starmer appears to confuse process with outcome. You can set up a child poverty taskforce, OK. But what do you want to do about the two-child benefit cap? You still have to make political choices and officials can't do that for you." This observation highlights a persistent tension: the government's mission-driven approach is to reorient the practice of government around outcomes, and away from a civil service consumed by esoteric processes.

Regulators face similar problems. Outcome-based regulation – that is, regulation that eschews hard rules on what firms may do in favour of mandating outcomes (via for example, voluntary standards or performance metrics) – has become increasingly prevalent since the first iteration of Anticipatory Regulation. This approach is intended to increase flexibility for firms, but like the civil servant, there are those who argue it does so at the expense of regulatory clarity and by simply passing on hard choices.

Whilst we cannot answer this question decisively here, we can offer some suggestions as to when being goal-oriented is advantageous. For example, rules-based regulation is supposed to provide clarity for innovators, but this is not realistic for developing emerging technologies with unknown implications. Very little is known, though much is speculated, about the near and medium-term risks of AI and thus what rules are appropriate. What the UK government has said with confidence is that AI should operate in a way that is 'fair', 'explainable and transparent', 'accountable', 'robust and secure' and 'private'. The UK's AI regulation framework gives regulators voluntary discretion over the application of these principles, with a view to their being legally entrenched in the future. Our civil servant might counter that this is all very well, but at some point, a hard trade-off in a concrete situation – say between privacy' and 'fairness' – will be thrown up by the course of technological progress and a regulator will have to make an – inevitably political – decision one way or the other.

Five principles for AI regulation

The UK's AI regulation principles are designed to ensure responsible AI development and deployment across all sectors. It aims to balance innovation with safety, fairness, and public trust. The framework is underpinned by five cross-sectoral principles: safety, security, and robustness; transparency and explainability; fairness; accountability and governance; and contestability and redress. These principles guide regulators in their sector-specific implementation while maintaining consistency across the regulatory landscape.

Even if true, regulators should favour outcome-based regulation where technological uncertainty makes clarity unachievable. Artificial intelligence illustrates this point especially well because the precise ways in which AI makes decisions is often inscrutable and thus cannot be regulated according to 'how' or 'why' they do things, leaving outcomes as the only alternative. This applies to other fields too: if it is not clear precisely what error self-driving cars might make leading to a collision, then it makes little sense to proscribe this or that class of actions and instead require developers to meet certain performance outcomes, which are sometimes more predictable. Examples like this explain the increasing proliferation of voluntary standards and other forms of soft law, which lack enforceability but codify norms, rules and practices to a great enough extent that they can guide innovators towards desirable outcomes.

More importantly, the trickiness of determining how best to set the rules means that regulators should not rely on rulesetting as their primary means of incentivising innovators towards outcomes. We have called this principle goal-oriented because there is more to it than favouring outcome over process. Regulators should pursue goals with the full range of tools in the box of innovation methods besides rules-that-prescribe-outcomes.

In the UK, the government's goals are expressed at the highest level through its five missions. As explained, privileging missions over directives or rules can have the effect of reducing rather than enhancing clarity. Despite this criticism, some government authorities are succeeding in finding ways to operationalise missions as concrete activities. The West Yorkshire Combined Authority committed itself to mission-driven innovation as part of its **(Leeds City Region) innovation framework** in 2021, and allocated £1.6m to fund three Mayor's Innovation Challenges to grow the region's innovation ecosystem whilst tackling a major societal challenge connected to one, or more, of the Mayor's five missions. The largest of these of recently launched as **The Mayor's big ideas challenge**, and is supporting nineteen local SMEs to develop solutions to reduce health inequalities in the region.

The West Yorkshire Combined Authority is not a regulator, but their activities represent a good example of a public authority explicitly doing goal-oriented innovation, and how challenge prizes are proving an increasingly popular means of doing so. A challenge prize is a type of innovation funding that offers innovators financial rewards for developing successful solutions to given social problems, rather than, by contrast with a grant, carrying out the activities prescribed by the milestones of a contract. Prizes mirror outcome-based rule-making insofar as they are advantageous where we can make only very weak assumptions about how to approach a problem. Thus they remain agnostic about what innovators ought to do, and intend to reward them for the outcomes they achieve rather than the processes they follow.

The Mayor's big ideas challenge

The West Yorkshire Combined Authority is committed to 'mission-driven innovation', which seeks to simultaneously close the region's economic productivity gap whilst also providing a positive societal impact for West Yorkshire citizens. This has manifested in a trio of Mayor's Innovation Challenges which are supporting young entrepreneurs and local SMEs and startups to scale solutions connected to the Mayor's five missions for West Yorkshire. The programme is designed to address important social challenges, grow the innovation ecosystem and promote and develop West Yorkshire as destination for innovation all at once.

Furthermore, regulators have a special role to play in challenge prizes because they are responsible for important resources for innovation, such as data or licences, which can be operationalised as part of a prize. The Department for Business and Trade's (DBT) ongoing **Smart Data Challenge** places finalists in a specially designed testbed with exclusive access to data and a compute allowance to develop their innovations for the duration of the challenge. This discrete, controlled exercise in regulatory relaxation will allow innovators to develop their innovations to meet the outcomes specified by the prize's judging criteria, but will also help DBT develop the policy framework for future innovation and regulation in this space.

Smart Data Challenge Prize

The Smart Data Challenge Prize is a £600,000 challenge prize funded by the Department for Business and Trade, designed to identify and develop Smart Data use cases across the economy. Ten teams have been given the opportunity to prototype their Smart Data solutions in the specially created Data Sandbox, as well as grants totalling £50,000, and a winner and two runners up will receive further awards. This demonstrates that there's more to enabling smart data usage than just forcing regulators to open up, regulators can create structures to 'pull' innovation as well as 'push'.

Challenge prizes and testbeds are but one of a number of exercises increasingly deployed by regulators to drive innovation in a goal-oriented fashion. Another common activity is the regulatory sandbox, and hackathons are becoming a popular tool for collaborative, time-bound problem solving. What unites these methods is a proactive approach to steering innovation, using a diverse toolkit to pull the market towards defined goals.

Idea: Cross-Sector Energy-Transport Data Challenge Prize

The government's mission to make Britain a clean energy superpower by 2030 – with targets of 95% low-carbon electricity generation and accelerating towards net zero – requires coordinated action, which is currently prevented by data silos. Additionally, The Smart Data Roadmap identifies energy and road fuels as a priority sector for smart data scheme development, where smart data could significantly benefit citizens.

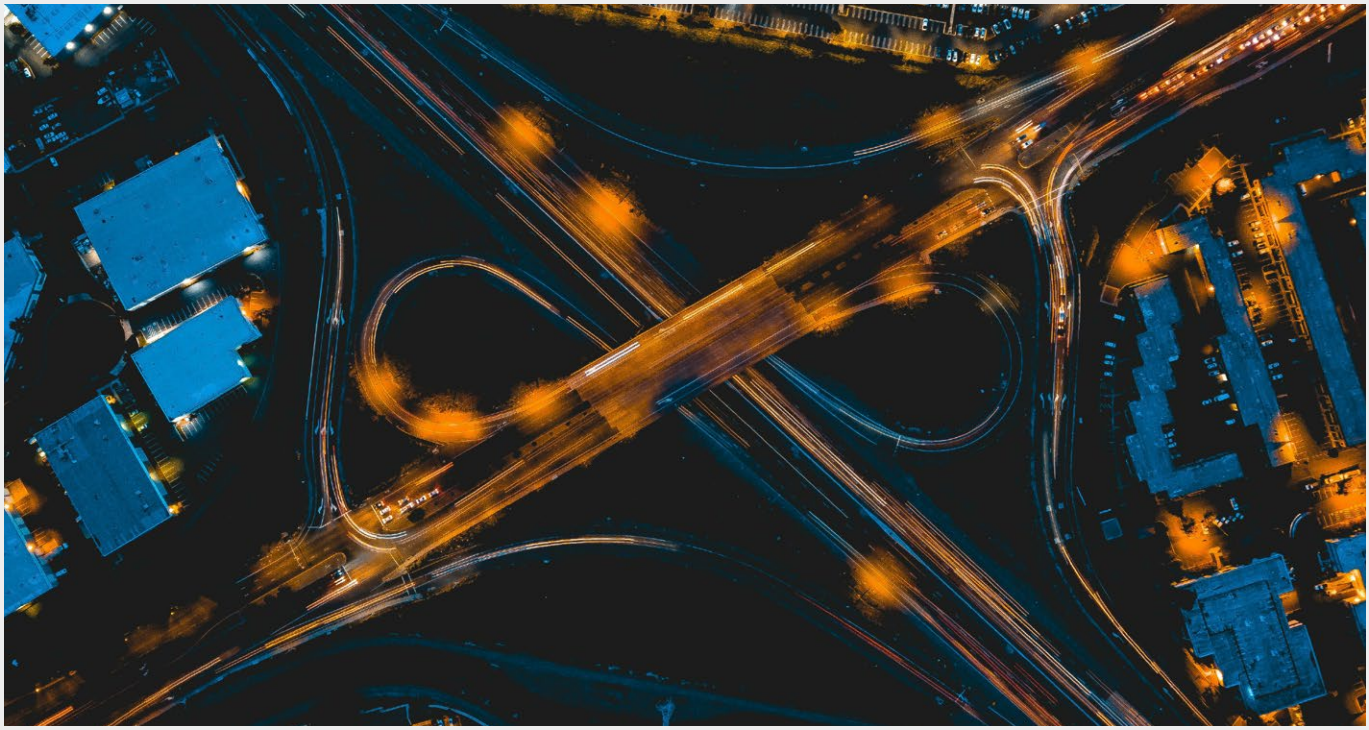
However, the current approach treats energy and transport data separately, preventing citizens and businesses from accessing integrated insights from smart meter data, transport patterns, and energy pricing to optimise progress toward the low carbon target. Without cross-sector smart data solutions, the government risks failing to deliver on its net zero commitments and smart data ambitions.

Suggested intervention

Energy and transport regulators deploy a challenge prize as a tool to achieve demonstrable carbon reduction through integrated data solutions, moving beyond traditional rule-setting to goal-oriented regulation. Regulators would set targets for measurable carbon reduction through optimised energy-transport coordination and provide access to data sandboxes and clear outcome metrics. Data innovators, consumer groups, businesses, and technology developers would then co-design integrated smart data solutions, ranging from household energy-transport optimisation platforms to community demand management tools. Regulators would reward solutions that demonstrate verified carbon reduction outcomes for end users.

Outcomes

- Generate tested solutions that contribute to the 95% low carbon generation target through diverse, innovative approaches
- Demonstrate how regulators can achieve quantifiable environmental targets through goal-oriented innovation tools
- Build regulatory capacity for cross-sector collaboration to achieve measurable carbon reduction outcomes
- Generate an evidence base for scaling up integrated smart data approaches to support broader clean energy mission objectives



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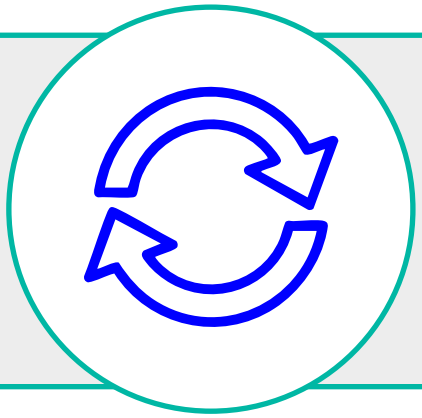
Learning

Regulatory innovation should be developmental for regulators, not just innovators. The real value of testbeds, sandboxes and other regulatory novelties lies not just in expediting new products and services but lasting change in the regulatory environment, and establishing learning and change as part of regulatory culture.



Testbeds and sandboxes were very much at the cutting edge of regulatory innovation when we spotlit them in 2019, and now they have become a ubiquitous feature of the regulatory landscape in finance, law, life sciences, and autonomy. The benefits to innovators of being able to experiment under relaxed regulatory conditions is now well-understood, and emphasis is beginning to shift to ensure these discrete, time-bound exercises can have lasting impact on regulatory environments themselves.

There is increasing recognition that experimentation and iteration ought to be for regulators as well as innovators. Testbeds should drive innovation not just in participating products and services but in the regulations that govern them. For example, the **Food Standards Agency's Cell-Cultivated Products Sandbox** is a two-year programme that has been divided into four six-month sprints, to allow for learning and reflection on the development of the regulatory environment. Increasingly, sunset clauses are built into regulatory arrangements to necessitate cycles of development and review.

The Food Standards Agency (FSA): Cell-Cultivated Product Regulatory Sandbox

The Regulatory Sandbox for Cell-Cultivated Products (CCPs) is a £1.6m sandbox with a strong emphasis on mutual learning. The 24-month programme is organised in four six-month sprints with opportunities between sprints for innovators and the FSA to evaluate their progress and develop new standards, with a special focus on how their findings can influence international regulatory arrangements.

Some regulatory sandboxes are now generating methodologies that can be applied beyond their initial scope. The UK's **Regulatory Sandbox for Rendezvous and Proximity Operations** brought together regulators and industry to test licensing processes through fictitious but realistic mission scenarios – using simulation rather than live trials to identify 61 regulatory challenges within months. Beyond these immediate findings, the sandbox produced a transferable methodology for testing other emerging space activities – essentially creating a template for future regulatory learning exercises. This development suggests that sandboxes can deliver value not only through their specific outputs but by establishing replicable approaches that embed experimentation into regulatory practice.

UK Regulatory Sandbox for Rendezvous and Proximity Operations (RPO)

The UK's RPO Sandbox demonstrates how simulation can accelerate regulatory learning for complex space operations. Rather than waiting for real satellite servicing missions to expose gaps, regulators (CAA, UK Space Agency) and industry operators (Astroscale, ClearSpace, D-Orbit) collaborated to stress-test existing regulations using a fictitious but realistic mission scenario. Through mock licensing exercises, they identified 61 regulatory challenges and developed actionable recommendations in just four months. Crucially, the sandbox produced a replicable methodology that can be applied to other emerging space activities, transforming one-off learning into systematic regulatory development.

Challenge prizes offer another avenue for regulatory learning by attracting diverse innovators to test regulatory boundaries. The Legal Access Challenge delivered by the Solicitors Regulation Authority (SRA) and Challenge Works demonstrates how regulators can use different innovation mechanisms to better understand the innovation landscape and identify regulatory barriers. Through supporting applications from a mix of regulated law firms, unregulated tech startups, charities and social enterprises developing digital legal services, the SRA discovered that regulation wasn't a hard barrier but that softer barriers existed – such as innovators' lack of understanding about regulatory requirements and coordination challenges across overlapping regulatory regimes. This learning directly informed regulatory strategy, with the challenge format allowing observation of multiple approaches simultaneously while building relationships across the innovation ecosystem.

Legal Access Challenge

The Legal Access Challenge was a £500,000 challenge prize delivered in partnership between the Solicitors Regulatory Authority (SRA) and Challenge Works that attracted 117 applications for digital technology solutions to help individuals and SMEs access legal services. Through supporting eight finalists over six months, the SRA learned that its principles-based regulation wasn't blocking innovation, but that innovators needed better guidance on navigating regulatory requirements. The challenge directly informed the SRA's 2020-2023 corporate strategy, making technology and innovation one of three core strands, and established lasting connections between the regulator and both regulated and unregulated innovators.

These diverse approaches are complemented by other emerging mechanisms. Italy's 'Right to Innovate' which allow innovators to apply directly to government for bounded derogation from specific regulations for innovation purposes. Again, the intention is as much about experimenting with regulatory arrangements as much as it is about experimenting with new innovations, but hands the initiative to innovators to approach government about specific regulatory changes.

Meanwhile, continuous engagement models, such as the Monetary Authority of Singapore's FinTech Regulatory Sandbox, demonstrate how iterative dialogue between firms and supervisors can create a constant flow of information and learnings that directly shapes policy evolution, such as updates to the Payment Service Act and digital banking licenses.

What unites all these examples is a fundamental shift in regulatory culture: from learning as an occasional activity triggered by crisis or technological disruption, to learning as an embedded practice. The approaches being developed – whether replicable sandbox frameworks, sprint-based iterations, or challenge prizes – are creating institutional knowledge about how to learn, not just what to learn. This shift towards continuous regulatory learning is becoming essential as the pace of technological change continues to accelerate.

Idea: Housebuilding ‘sprints’

The government has set itself the target of building 1.5m new homes by 2025.

There is widespread skepticism that this target can be met, and it is a regulatory challenge insofar as UK planning laws make building protracted, uncertain and costly. At the same time, however, the quality of many recent new build projects are increasingly the subject of high-profile scandals in which housebuilders are avoiding liability. The medicine, it seems, is both more regulation and less – how can the government ramp up the quantity of housebuilding whilst also boosting quality?

Suggested intervention

The Building Safety Regulator is a new regulator within the Health and Safety Executive. If the government is serious about meeting its 1.5m homes target, it should engage in some collaborative regulatory innovation (e.g. a sandbox with housebuilders and local planning authorities to investigate where regulation is impeding progress, and how and why quality control often fails. Specific housebuilding projects or planning processes could be operationalised as ‘sprints’ to test new regulatory arrangements, evaluate post-build, then iterate.

Outcomes

- Lasting change to the regulatory environment informed by mutual learning by regulators, housebuilders and local planning authorities.
- Expedited housebuilding balanced against carefully designed environmental protections and building control.

Photo by James Feaver on Unsplash

Concluding remarks

Why revisit anticipatory regulation now, six years after the original report? Because we believe innovation in regulated sectors matters deeply, and through our work with regulators, we've gathered valuable insights and perspectives – learnings worth sharing.

Anticipatory regulation has always been an effort to draw attention to the importance of regulatory practice, rather than the mere presence, absence or structure of regulation. While structural questions about public ownership and institutional boundaries matter, these sometimes eclipse the diverse and powerful practices that regulators can employ to drive innovation from within existing arrangements.

Challenge Works is a part of Nesta that has built out a large and diverse portfolio of work with regulators that both informs and enacts our understanding of anticipatory regulation. This revised incarnation of its principles are the product of reflection upon work delivered over the last six years in partnership with Ofwat, the Civil Aviation Authority (CAA), the Competitions and Markets Authority (CMA), the Solicitor's Regulation Authority (SRA), the Department for Science, Innovation and Technology (DSIT) and the Department for Business and Trade (DBT), and dozens of non-regulators with an interest in catalysing innovation.

Each principle is in the spirit of its predecessor but has evolved to meet the challenges of a mission-driven government committed to innovation as a national priority. The purpose of collaboration is now agility, as well as inclusion. Where we once implored regulators to enable industry to walk the path, we now implore them to lead it. This also requires building societal confidence in emerging technologies and acting with regard for their broader systemic consequences, rather than just those within one's remit. To achieve such goals, regulators should deploy a fuller arsenal of complementary innovation practices, not just outcome-based regulation, and use them to learn - to instigate lasting, permanent change in regulatory systems.

The six ideas presented here – collaborative frameworks for space debris, TeenOS, regional maritime sandboxes, public tasting for novel foods, cross-sector energy-transport data challenge prize, and housebuilding sprints – are practicable recommendations that illustrate how the principles would work in practice. We're interested in working with regulators and others in exploring approaches to innovation that align with these principles. The new government's mission-driven approach, the establishment of RIO, and growing international interest in regulatory innovation create the conditions for ambitious programmes.

Our aim in renewing anticipatory regulation has not been to solve every regulatory bottleneck or offer conclusive judgements on debates about the state's role in innovation policy. Rather, observing the current preference for an activist state and expedient innovation, we advise as to how regulators can fulfil these objectives effectively and responsibly, without disregarding other priorities.

We write this because regulators have a crucial role to play in shaping innovation towards societal ends, and the programmes and practices outlined here can help them fulfil that role. We hope this report helps others working to make regulation better for innovation.

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