Issue

Brief

ISSUE NO. 687
JANUARY 2024

Science Fiction as the Blueprint: Informing Policy in the Age of AI and Emerging Tech

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Abstract

This issue brief examines the complex interplay between science fiction and technology development in the age of disruptive technologies such as artificial intelligence, virtual reality, and brain-computer interfaces. As the line between science and fiction continues to blur, this brief argues for strategically using science fiction narratives to inform and guide technology development and policymaking. Drawing upon historical precedents of science fiction influencing real-world products, it highlights the genre's role in shaping technological trajectories and governance frameworks. Amid rapid technological advancement and divergent views on future risks, this brief advocates for science fiction to be a vital tool in envisioning and evaluating the societal impacts of emerging technologies, proposing a novel approach to anticipatory policy governance.

Introduction

Emerging technologies like artificial intelligence (AI) will be strategically pivotal in the twenty-first century. The rapid advancement of frontier technologies, including AI, virtual reality (VR), and brain-computer interfaces (BCIs), presents a pressing challenge for governments worldwide. The accelerating pace of technological innovation, the chaotic and sensationalist marketing strategies aimed by AI developers at non-experts, and the potentially asymmetric cross-sector impact of emerging tech platforms demand proactive policy responses and robust sociopolitical discussions. However, policymakers and analysts confront a unique difficulty: engaging in conversations about emerging technologies and platforms that are constantly evolving.

This issue came to the fore in 2017 during discussions on AI policy at the European Parliament. Following talks on possible near-future applications of AI in one of the world's first AI policy documents, the European Parliament adopted its Civil Law Rules for Robotics.[1] The discussions opened with various references to science fiction, such as Mary Shelley's *Frankenstein*, Czech author Karel Capek's coinage of the term 'robot' in 1921, and the three laws of robotics posited in Isaac Asimov's 1943 short story *Runaround*. During the discussion, the Parliament requested the European Commission to submit a proposal for a directive on civil law rules for robots and "creating a specific legal status for robots in the long run".[2] The request was seemingly made under the assumption that the speculated robot workers would be operating on an AI framework that could potentially afford them some form of sentience, thus conflating robots with AI. In another instance, the Parliament recommended that Asimov's three laws of robotics "must be regarded as being directed at the designers, producers, and operators of robots, including robots assigned with built-in autonomy and self-learning."[3] Six years later, no sentient robots or robust AI frameworks have been developed, and neither are there any expectations for them to emerge in the near future, except in science fiction. The European Parliament discussion highlighted the influence of cultural narratives about frontier technologies on attempts at anticipatory governance. This brief argues that due to their influence on the techno-cultural gestalt, science fiction narratives can be used to inform policy frameworks for emerging technologies.

The relevance of science fiction in socio-political discourse is likely to increase due to the exponential rate of technological growth and the wide-ranging opinions regarding humankind's technological future. On one hand, researchers in the field argue that the dream of artificial general intelligence

or superintelligent AI will never be achieved.[4] Some disagree, like computer scientist Geoffrey Hinton (winner of the 2018 Turing Award[a] and often referred to as the godfather of AI), who left his position at Google, citing concerns about the risks of speedy AI development.[5] Furthermore, UK Prime Minister Rishi Sunak recently stated that mitigating the threat of human extinction caused by AI needs to be a global priority alongside pandemics and war.[6] Between these two extremes, recent years have seen unprecedented technological growth with large language model (LLM) text-generation platforms like GPT-4 capturing the world's attention, image-generation AI applications like DALL-E and Midjourney, and the demonstration of real-time photorealistic social interactions in Mark Zuckerberg's Metaverse.[7] Moreover, industry leaders already indicate the high likelihood of AI platforms becoming more autonomous and capable agents in the global economy within the next decade.[8] The convergence of technologists and policymakers on the issue of regulating frontier technologies highlights the need to analyse them critically to anticipate future trajectories.

There is a growing realisation in policy circles that the range and speed at which new tech platforms are emerging makes it exceedingly difficult to distinguish scientific speculations from science fiction expectations.[9] Additionally, the rate of technological innovation has caused alarm in various sectors of the global economy as policymakers and technologists try to grapple with their implications. For instance, in response to the developments in generative AI over the past year, the US Congress held its first AI regulation forum in September 2023, which was attended by the CEOs of Tesla, Google, Microsoft, and Meta, among others.[10] Furthermore, in October 2023, US President Joe Biden issued an executive order to ensure the development of safe and responsible AI platforms using a risk-based approach.[11] However, China is arguably leading the race towards governance of AI and frontier technologies. Following the near-constant growth of computing technologies, in 2021, the Chinese government published regulations on recommendation algorithms in social media and search engines. In 2022, rules for synthetically generated content were released, followed by draft regulations on generative AI

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a   The Turing Award, often referred to as the "Nobel Prize of Computing," is an annual award given by the Association of Computing Machinery to individuals for their significant contributions to the field of computing. The award is named after Alan Turing, the British mathematician and computer scientist who is considered the father of computer science and AI.

platforms akin to ChatGPT in 2023.[12] In addition to conventional policymaking frameworks, this brief asserts that cultural products, particularly science fiction narratives deeply embedded in tech culture or "engineering culture,"[13] can serve as invaluable conceptual sandboxes to stimulate and shape sociopolitical dialogues concerning the trajectory of technological innovation globally.

As a genre, science fiction has a rich history of envisioning and reflecting upon emerging technologies while influencing societal perceptions and policy considerations. Science fiction, often perceived as a realm of exaggerated and sensationalised technological capabilities, is pivotal in elucidating the latent risks and biases inherent in evolving technologies by extrapolating various forms of their implementation in the future. This genre's importance is exemplified in George Orwell's *1984*, which, despite predating the technological feasibility of a panopticon-like surveillance state, has become a globally recognised metaphor warning against government overreach. Similarly, the portrayal of AI in popular media, notably the Skynet from the *Terminator* film franchise, has ingrained the notion of a machine-dominated future in the public consciousness. Indeed, the concept has contributed to ongoing activism to regulate the development of autonomous weapon platforms.[14] While the idea of a global AI uprising remains as speculative as it was in the 1980s, its enduring presence in the cultural zeitgeist underscores the criticality of narratives in developing technological frameworks. Such science fiction narratives are crucial as they "are central to the understanding of our world and its reconfiguration, because stories, imaginations, epistemologies and materialities are intimately linked."[15] These compelling narratives not only captivate but also shed light on the long-term socio-cultural and ethical implications of technologies in development, thereby underscoring the genre's contribution to policy discourse. To support this argument, this brief explores science fiction's unique role in facilitating policy decisions by examining its impact on the conceptualisation of technologies under development.

Introduction

Science Fiction and Technological Innovation

Scientists and technologists often view science fiction as exaggerating current scientific abilities and skewing public expectations about future technologies. Although many futuristic visions remain unrealised, the genre's true purpose is not to predict but to explore potential futures, acting as a creative playground for emerging tech trends. For instance, since 2011, the critically acclaimed series *Black Mirror* has taken current technologies like VR, social media, robot dogs, and drones, and used them to extrapolate radical futures based on current trends.[16] However, the genre is not limited to sociopolitical commentary and has historically spurred innovation, influencing even everyday objects like cell phones; notably, Martin Cooper of Motorola credits the flip-phone design to the communicator in *Star Trek*. Science fiction thus continues to inspire real-world technological advancements by pushing the imagination to its limits.[17]

The feedback loop between science fiction and science is not new and can be traced back to the late nineteenth century. For instance, a company started by the American inventor Simon Lake created the first operating submarine in 1898 called the Argonaut. Lake attributed his motivation for building submarines to his fascination with underwater travel and exploration after reading *Twenty Thousand Leagues Under the Sea* by Jules Verne.[18] Science fiction also had a crucial influence on spaceflight. Specifically, stories by Jules Verne and H.G. Wells had a tangible impact on the work of early rocketry pioneers Konstantin Tsiolkovsky, Hermann Oberth, and Robert H. Goddard. After reading Verne's 1865 novel *From Earth to the Moon*, Tsiolkovsky formulated the idea of producing incremental acceleration to achieve escape velocity for exiting Earth's atmosphere using chemically fueled multistage rockets. The work of Verne also influenced Oberth, but his work remained theoretical.[19] Conversely, Goddard managed to build the world's first liquid-fueled rocket that launched successfully in 1926 and stated that he dedicated his life to spaceflight after reading *War of the Worlds* by Wells.[20]

As the twentieth century progressed, the overlap of science fiction with technology grew, especially with the rise of computers, telecommunications, and mass media since the 1980s. At the same time, new iterations of the science fiction genre started entering the mainstream. Instead of galaxies 'far, far away', fictional narratives started presenting near-future technologies like AI, VR, BCIs, and the internet. The emergent subgenre was called 'cyberpunk' and spawned various books and well-known films.[b] Narratives depicting the

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b   Some popular examples are Neuromancer (1984) by William Gibson, Do Androids Dream of Electric Sheep? (1968) by Philip K. Dick, Akira (1988), Ghost in the Shell (1995) by Mamorou Oshii and The Matrix (1999).

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transition from space operas to more intimate urban technological imaginary were generated primarily in the West, particularly Silicon Valley, as it was the axis mundi of tech innovation in the late twentieth century. In India, occasional cyberpunk stories only emerged following the economic liberalisation of the 1990s and the resultant IT boom.[21] Some notable works include *The Calcutta Chromosome* (1995) by Amitav Ghosh, *Harvest* (1997) by Manjula Padmanabhan, *The Simoqin Prophecies* (2001) by Sumit Basu, and *The Beast with a Billion Feet* (2008) by Anil Menon. Given India's position as a developing economy in a Western global order, Indian science fiction narratives at the turn of the century depicted a struggle between the need for industrialisation, globalisation, and technological development and the fear of a cultural neocolonialism emerging with the adoption of Western technological imaginaries.[22] Some prominent examples of Western cyberpunk works that dominated the global techno-cultural gestalt in their heyday are *TRON* (1982), *Blade Runner* (1982), *The Terminator* (1984), *RoboCop* (1987), and *The Matrix trilogy* (1999-2003). The narratives occurred in heavily urbanised dystopian future worlds with large, sprawling cities controlled by powerful corporations that wielded more sociopolitical and economic authority than governments. The stories generally depicted characters with bodies existing co-dependently with technological prostheses like BCIs.

This subgenre has had a lasting influence on cultural imaginations about the future of digital technologies and the technological lexicon commonly used today. For instance, consider the European Parliament's AI policy discussions in 2018, which stated that "AI-based systems can be purely software-based, acting in the virtual world."[23] The use of the term 'virtual world' is intriguing because such a world does not exist. The term ascribes spatial properties to the internet and information displayed on computer screens. However, there is no space or "world" where digital information exists. The notion originates from William Gibson's 1984 novel *Neuromancer*, which introduced 'cyberspace' and other concepts like superintelligent AIs and VR into mainstream culture.[24] Gibson was embedded in the tech culture of Silicon Valley in the 1980s and onwards and exchanged various ideas with technologists and entrepreneurs. Gibson's interactions with Silicon Valley figures, including VR pioneer Jaron Lanier, who acknowledged Gibson's dubious influence on tech development, demonstrate the mutual exchange between science fiction and technology.[25]

Mark Pesce's development of VRML in the early 1990s, inspired by Gibson's cyberpunk literature, aimed to give the internet a spatial dimension.[26] VRML

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was designed to graphically add a third dimension to the internet's web of hypertexts, URLs, and webpages. Though it did not take off due to technical and cost barriers, the idea of a perceptual internet persisted, influenced by Neal Stephenson's works like *Snow Crash* (1992) and *Cryptonomicon* (1999). Stephenson's narratives, steeped in cyberpunk elements like AI and VR, extended his impact beyond literature. In his seminal novel *Snow Crash,* the story unfolds in a near-future US dominated by a virtual reality space known as the Metaverse. The protagonist juggles his life as a pizza delivery person for the Mafia in reality and as a warrior and hacker in the Metaverse. His path crosses with a young skateboard courier and together, they uncover a conspiracy revolving around a new drug and computer virus called 'Snow Crash.' This virus uniquely affects users in both the Metaverse and the real world. As they delve deeper, they uncover its connections to ancient Sumerian culture and language, exploring themes of language, consciousness, and control. The novel vividly depicts a dystopian world fragmented into corporate franchise states, devoid of a central government. John Hanke, ex-director of Google's Geo division, credits *Snow Crash* with inspiring 'Earth Viewer,' which evolved into Google Earth.[27] Additionally, Stephenson's role as a 'futurist' at Blue Origin, Jeff Bezos's aerospace company, underscores his dual influence on tech innovation and fiction. Stephenson's coining of the term 'Metaverse' in *Snow Crash* is his seminal contribution to technology, envisioning the internet as an immersive realm. His involvement in merging science fiction with tech policy further highlights his influence.

Contemporary Examples

Stephenson's 1990s concept of an immersive Metaverse coincided with the rise of graphic user interfaces (GUIs) and the 1989 creation of the World Wide Web by Sir Tim Berners-Lee.[28] Based on GUI platforms, Stephenson's narrative extrapolated what it would feel like to inhabit and experience cyberspace in the future. Stephenson's background in programming enriched his portrayal of the Metaverse, leading Mark Pesce to compare sections of *Snow Crash* to "detailed software designs" at a 1999 MIT forum.[29] Not only did Stephenson receive various literary awards for his work, but he was also able to create a conceptual framework or a use case from which engineers and developers could derive inspiration.

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Snow Crash has had a pervasive influence on Silicon Valley culture since its publishing, with journalists stating that there is perhaps no established entrepreneur untouched by its ideas.[30] Even Google co-founder Sergey Brin said in 2000 that the book greatly influenced him as it anticipated technological development a decade ahead of its time.[31] In recent years, however, the most influential manifestation of Stephenson's ideas has been Zuckerberg's project to create a real Metaverse, announced in December 2021. He stated that the Metaverse project aims to create an "embodied internet where you're in the experience."[32] The emphasis on being on the internet experientially is a clear parallel to Stephenson's vision in the 1990s. Dean Eckles, a scientist at the company, has stated that, at one point, Zuckerberg made *Snow Crash* compulsory reading for all product managers.[33] This fascination with *Snow Crash* in particular and science fiction in general has led some to associate it directly with Meta's acquisition of the VR company Oculus in 2014 for US$3 billion.[34]

Zuckerberg's 2021 Metaverse announcement spurred hype and speculation, with ventures like 'Metaverse Fashion Week' in 2022 showcasing digital fashion.[35] Estimates suggest the Metaverse could yield up to US$5 trillion by 2030 across gaming, online retail, and marketing.[36] Yet, Meta's stock fell 70 percent by October 2022, partly due to strategic uncertainty under Zuckerberg.[37] Consumer concerns also focus on the Metaverse's initial cartoon-like avatars.[38] Meta has prioritised enhancing photorealism, paralleling marketing issues in Stephenson's *Snow Crash*, where software was created to map real facial expressions onto avatars.[39] In an October 2023 podcast, 'First Interview in the Metaverse', Zuckerberg showcased Meta's facial-tracking technology, impressing audiences, leaving the interviewer overwhelmed with the virtual interaction's lifelike quality and reviving interest in the Metaverse's potential.[40] The objective of the interview was to provide a glimpse of the next generation of digital social interactions where it would be possible to have increasingly in-depth, intimate, and meaningful social interactions in virtual spaces. Zuckerberg mentioned in the interview that foundational AI models will play a crucial role in the evolution of VR technology. The pivot away from Metaverse and towards AI over the past year has allowed Meta to make a turnaround in the market. The company's share prices have risen by over 250 percent since last year;[41] on 25 October 2023, the company reported revenues of over US$34 billion in the third quarter marking a 23 percent increase from last year. The constant ridicule aimed at the Metaverse softened as the year saw a storm of generative AI hitting the market. Zuckerberg initiated an "internal

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revolution" focusing on the company's AI infrastructure and, by February 2023, produced the open-source Llama 2 LLM.[42] By September, Zuckerberg introduced a line of AI- and VR-related products, such as smart glasses made in collaboration with RayBan, replacing the Metaverse rhetoric with investment in tangible products and expanding AI capabilities to Meta's family of apps (Instagram, WhatsApp, and Facebook).[43] Even though the ubiquitous adoption of the facial-tracking technology Zuckerberg demonstrated is not currently feasible due to the long setup time required for face scans and photorealistic conversations,[44] the renewed investor faith in Meta's products, and Apple also joining the VR and AR field with its VisionPro headset indicates VR still has a viable future. The developments in VR and AR technologies, alongside the concurrent rise of generative AI platforms like ChatGPT, have been precipitous occurrences for industry leaders and policymakers. It is no surprise, then, that the reverberations of these platforms have been felt globally. For instance, in 2021, the Chinese government included the Metaverse in its fourteenth five-year plan for developing its electronic information industry.[45] Furthermore, in September 2023, China's Ministry of Industry and Information Technology announced a three-year investment and development plan to grow three to five metaverse-related companies and create three to five industry cluster districts by 2025.[46]

The future configurations of VR, AR, and AI are still under discussion, but the influence of science fiction on their development—and the global economy at large—is undeniable. Historic innovations like the first submarine, suborbital rocket, and the concept of the Metaverse owe much to science fiction, which provides engineers with imaginative prospects rather than predictions. This genre's power lies in envisioning the potential applications of emerging technologies.

> " Science fiction's true purpose is not to predict but to explore potential futures, acting as a creative playground for emerging tech trends. "

Feedback Loops, Science Fiction Prototyping, and Policy

The examples of feedback loops between science fiction and technological innovation provided in the previous section fall into two general categories: loops that lead to the creation of new technological platforms and those that extrapolate from existing technologies. The influence of stories written by Verne and Wells on submarine design and rocketry led to the creation of new global industries of underwater travel and space exploration. On the other hand, science fiction concepts like the *Star Trek* communicator, VR programming languages, and the Metaverse were iterative as they extrapolated upon existing technologies like telecommunications, television, and the internet. The latter deserves more attention as it is the more common of the two feedback loops.

A growing body of research regarding the iterative relationship between science fiction and technology has been developing since the late 2000s. To analyse this relationship, science and technology researcher Brian D. Johnson developed the concept of 'science fiction prototyping'.[47] The concept aims to develop methods to anticipate future technological innovations by blending fact and fiction to create idealised and normalised visions of future technological interfaces.[48] Science fiction prototyping can be seen in the examples explored in the previous section. Telecommunications existed at the time when *Star Trek: The Original Series* (1966-1969) aired. By presenting the flip-top communicator as a perfected ubiquitous technology in various use cases, the series enabled product designers at Motorola to create a successful product line. Similarly, *Snow Crash* presented a VR space called the Metaverse in which many global commercial transactions and activities occurred. Like *Star Trek*, the Metaverse in *Snow Crash* was a perfected technological platform that was also ubiquitously available. The story depicted a variety of normalised use cases for VR, ranging from recreational activities and social gatherings to hosting international conferences, interpersonal communication, and so forth. Zuckerberg's vision for the Metaverse is undoubtedly influenced by Stephenson's narrative and represents a good example of science fiction prototyping.

Methodologically, science fiction prototyping has been described as a process of "controlled imagination" and an "opportunity recognition process" that facilitates the development of marketable products.[49] In simpler terms, science and technology scholar Christoph Ernst has characterised it as a "mirror-inverted complement of product development."[50] Similarly, filmmakers and science consultants create literary or cinematic representations of speculative

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technologies to foster the desire for such technologies in the audience and to raise funds for research and development of tech products.[51] In this process, the purpose of presenting speculative technologies is to detect unidentified use cases and "future markets."[52] Science and technology studies scholar David A. Kirby highlights that the depiction of speculative technologies in fiction is based on manipulating three variables: need, harmlessness, and viability.[53] The need for certain speculative technologies is demonstrated in science fiction by contextualising them as necessary within a social sphere and associating them with specific user bases or demographics.[54] For instance, the *Star Trek* communicator is indispensable for strategic and tactical planning, AI and cyberspace are inextricably connected with the global economy in *Neuromancer*, and the Metaverse is the primary space for social and commercial interactions.

Science Fiction Prototyping and Policy

One crucial feature of science fiction prototyping is that it allows researchers and engineers to extrapolate the consequences of their work through the process of controlled imagination and assessment of the need, harmlessness, and viability of technologies in the genre. For instance, an ethnographic study conducted in 2023 questioned 20 AI researchers about the influence of science fiction on their work. Three categories of influence identified in the study relevant to the paper are ethical thinking, pedagogy, and anticipatory modelling. The presentation of speculative technologies in science fiction as necessary and viable artefacts functioning within specific socio-economic contexts with varying degrees of harm allows developers to think about the consequences of their work.

The interviewed researchers stated that science fiction allows them to think through various issues, such as AI-related safety and privacy risks caused by facial recognition and physiology tracking technologies.[55] Science fiction prototyping also allows literary and scientific scholars to create pedagogical models and frameworks that use the ethical perspectives of the texts in education and practice.[56] Based on these features, science fiction narratives provide the tools required for anticipatory modelling, which means allowing the reader to examine possible socioeconomic futures. Take the novelette *Folding Beijing* by Hao Jinfang, a Chinese science fiction author and economist. The story presents a Beijing with a hyper-futuristic architecture in which the populace is divided into three sections based on how much time they are allowed on the surface. Expectedly, the poorest and the largest chunk of the populace—called Third

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Space and comprised of sanitation workers, vendors, and labourers—is allowed the least amount of time. The jobs performed by the Third Space population are not automated for the simple reason of allowing some sort of employment and meaning to the people. Scientist and investor Kai-Fu Li has used Hao's story to warn against the potential displacement caused by automation, particularly in labour-intensive economies.[57] In 2019, Li warned of narrow AI platforms like GPT as paving the way for economic displacement.

In recent years, multiple policy initiatives intend to use science fiction to inform policy discussions on how emerging technologies are defined, regulated, and assessed. The US-based Centre for Science and the Imagination has been working with authors like Stephenson to devise pedagogical and research initiatives to harness the feedback loops between science fiction and technology to align scientific innovation with cultural goals and expectations.[58] Scholars and educators have undertaken several projects to include science fiction in the school curricula. Researchers Isabella de Oliveira Moraes, Rafaela Magalhães Aires and Andréa Carla de Souza Góes noted an increased level of engagement and motivation in students after implementing an interdisciplinary didactic programme in 2017-2019 for students aged 14-16 years that involved a supplementary reading of *1984* by Orwell for the subjects of biology, arts, and philosophy.[59] International relations scholar Jiun Bang used *The Expanse*, a science fiction series about an interplanetary human society with shifting political blocs and alliances, in his classes and has argued that this inclusion led to higher levels of analogical reasoning and metacognition with regard to the lessons. In 2017, legal scholar Adam Jardine used the film *Planet of the Apes* (1968) to teach and analyse two cases of non-human personhood rights.[60] He noted that doing so made legal theory accessible to students and demonstrated how law can interact and respond to novel situations. Similarly, literary scholar Anastasia Pease has stated that her modules on ethics at Penn State University always include ethics case studies from the works of science fiction authors like Ursula K. Le Guin, Stanislaw Lem, and Ted Chiang, and the *Star Trek* series.[61] Furthermore, the benefits of including science fiction in science education have been attested to in case studies conducted for the European Union project 'Science Fiction in Education' from 2012 to 2014. According to researchers Charalambos Vrasidas, Lucy Avraamidou, Katerina Theodoridou, Sotiris Themistokleous, and Petros Panaou, the use of science fiction caused increases in student engagement and interest in science by creating immersion and a sense of agency. The fictional tech imaginaries helped students visualise and mentally contextualise the purpose of scientific development and learning.[62]

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In the realm of policy, the Leverhulme Centre in the UK has been advocating a set of global AI initiatives that identify various cultural frames, such as science fiction, that influence cultural perceptions and policy regarding the governance of AI.[63] For example, member researchers Stephen Cave and Kanta Dihal have studied four pairs of hopes and fears associated with advanced AI and intelligent machines in popular cultured public consciousness: the prospect of life extension ('immortality') versus the fear of losing one's identity ('inhumanity'); the prospect of a reduction in the need for work and employment, and the fear of becoming redundant; the prospect of quickly fulfilling one's desires, alongside the fear that humans will become alienated from each other; and the prospect of AI offering geopolitical dominance, and the fear that it will turn against humanity ('uprising').[64] Cognisant of the longitudinal impact of science fiction narratives on public consciousness, in February 2023, the UK's defence ministry and the Defence Science and Technology Laboratory published a document titled 'Stories from Tomorrow: Exploring New Technologies Through Useful Fiction'.[65] In the document, fiction writing is combined with extensive research and interviews with researchers to provide insight into the future of technology. The document was published as a complement to defence ministry policies and strategies relating to technology.

The dynamic interplay between science fiction and technological innovation has crucial implications for aligning cultural goals and expectations with governance. Science fiction prototyping grants researchers and policymakers a unique lens through which to anticipate the consequences of emerging technologies. It serves as a crucible for ethical deliberations, a catalyst for innovative pedagogical models, and a potent instrument for crafting anticipatory frameworks illuminating potential socio-economic futures.

> "Science fiction prototyping aims to develop methods to anticipate future technological innovations by blending fact and fiction to create idealised and normalised visions of future technological interfaces."

Recommendations for the Way Ahead

In an era where the pace of technological innovation is accelerating, and the boundaries between present reality and science fiction are blurring, there is a pressing need for forward-thinking policies that embrace the imaginative foresight of science fiction. This genre holds untapped potential for driving innovation and shaping the trajectory of technological development. Science fiction prototyping, a concept that leverages imaginative frameworks to anticipate future technologies and their societal impact, offers a powerful tool for research and development (R&D). The following recommendations encompass a multifaceted approach to integrating the foresight of science fiction into real-world strategy, ethical considerations, and education to meet the challenges and opportunities presented by emerging technologies.

- **Promoting Science Fiction Prototyping in Research and Development**

Research institutions and technology companies, especially startups (as they are more operationally flexible than legacy companies), should be encouraged through research grants and incentives to incorporate the concept of science fiction prototyping into their innovation processes. Startups can leverage the creative freedom of science fiction to envision new technologies and explore the implications of future inventions in a structured way. This can lead to developing products and solutions that might not emerge from traditional R&D approaches, potentially positioning startups favourably for technological advancement and market disruption.

- **Establishing Ethical Guidelines for Emerging Technologies**

Comprehensive ethical guidelines for emerging technologies based on Kirby's variables for science fiction prototyping can be developed with a specific focus on those influenced by science fiction narratives. International organisations can play a key role in this arena. UNESCO, with its focus on science and culture, could spearhead the development of ethical norms for emerging technologies and concepts prototypical of science-fiction narratives. Known for its multistakeholder approach, the World Economic Forum could leverage its network of business leaders, policymakers, and academics while integrating these guidelines into its agenda, promoting them at its annual meetings as a standard for technology firms worldwide.

Recommendations for the Way Ahead

- **Integrating Science Fiction in Educational Curricula**

National governments can implement the integration of science fiction into STEM education by supplementing curricula with science fiction literature and films that provoke ethical debates and critical thinking. The case studies mentioned previously can be used to model didactic programmes that are methodically standardised but with content and stories that are socio-culturally relevant to the context or country in which they are implemented. This could involve collaboration between education ministries and academic experts to select the content that aligns with learning objectives and encourages interdisciplinary exploration. International organisations like UNESCO could play a pivotal role by developing an international educational framework that suggests science fiction works for different educational levels, promoting the use of speculative narratives to illustrate complex scientific and technological concepts. They might also facilitate international seminars and workshops for educators, focusing on the pedagogical methods of teaching science fiction in a STEM context. The objective is to foster a generation of technologists and policymakers who are not only skilled in their disciplines but also philosophically and ethically informed about the broader implications of emerging technological landscapes.

- **Fostering Collaboration Between Policymakers and the Creative Industry**

A persistent tension in Indian science fiction is the need for the country to advance industrially and technologically without coopting or being subverted by visions of the future generated in and by Western countries. To address this, startup-focused bodies like the Technology Services Industry Association in India can establish partnerships with the creative industry, including authors, filmmakers, and artists. These collaborations could facilitate connections between filmmakers and government agencies to produce content that engages the public in technological discourse in culturally specific ways. Such efforts could model their approach on the Centre for Science and the Imagination's initiatives in the US and UK, creating think tanks or joint projects that produce tangible outcomes such as anthologies, films, or educational series that are used as resources for policy development and public engagement.

Recommendations for the Way Ahead

- **Enacting Evidence-Based Policy Informed by Fiction**

National governments could integrate speculative fiction into their policy research agenda, creating task forces that include science fiction authors and public policy experts to envision the longitudinal implications of policy decisions. The same approach can be used by bodies like the G20 and UN to inform their policy drafts and to test and challenge policy ideas. Policy initiatives, similar to the UK defence ministry's 'Stories from Tomorrow,' can serve as valuable tools for guiding decision-making, ensuring that regulations and strategies align with the evolving technological landscape while also reflecting societal values.

- **Fostering Global Collaboration for Ethical Regulation of Emerging Technologies**

Collaborative intergovernmental efforts on a global scale are needed to formulate and implement regulatory norms for emerging technologies. For example, the AI Safety Summit held in the UK in October 2023 was attended by officials from Canada, the US, EU, and China among others. Participation by friendly and adversarial nations should be encouraged as technological platforms often transcend national borders, requiring unified guidelines and convergent tech development standards.

> " As the pace of technological innovation accelerates, and the boundaries between present reality and science fiction blur, there is a pressing need for forward-thinking policies that embrace the imaginative foresight of science fiction. "

Conclusion

Proactively embracing science fiction in policymaking, research, and education is a strategic imperative in the current age of rapid technological change. The recommendations presented in this issue brief advocate for a holistic integration of science fiction prototyping, ensuring that innovation is not only inspired but also ethically guided and educationally supported. Fostering collaboration between policymakers, creative industries, and international bodies can establish a future that balances technological advancement with contextualised societal norms. These measures will help create a compass to navigate the complex trajectory of emerging technologies, securing a future that balances technological innovation with socio-economic prudence and human values. ORF

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