...and the Earth along. Tales about the making, remaking and unmaking of the world.

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In his essay ‘And the earth along... Tales about the making, remaking and unmaking of the world’, researcher Martin Pogačar (ZRC SAZU, Ljubljana) introduces the framework for the ambitious eponymous publishing project within the context of Museum of the Commons. The project aims to explore how humans and non-human ‘relate to their worlds’ through trans-disciplinary research and diverse forms. Entering through ‘fire, steel and particles’ the essay – and the project to follow – traverses histories and conceptualisations of natural phenomena, technology, industry and extraction, knowledge and the imagination, as well as the politics underpinning ‘cosmotechnics’, philosopher Yuk Hui’s term to describe the coming together of the cosmos and the moral.
This essay is also the occasion to launch an open call for contributions, which can be viewed here. The text is the first in a series dedicated to ‘And the earth along...’ and will be followed by the short story *Indra’s Web* by science fiction writer Vandana Singh.

The Earth undergoes frequent, continuous and radical changes, as does the rest of the universe. Over about four-and-a-half billion years, our home planet has seen the formation and transformation of continents; it has witnessed the emergence of life and six major extinction events, with the penultimate of these unfolding now. [1] From the perspective of a human lifetime, such scales of time and physical change are hardly perceptible, barely conceivable. The dimensions of the expanding universe are difficult to fathom, and it is no easier to imagine the expanses of deep time; the ferociousness of such changes, unfolding incrementally over hundreds of thousands of years; or the abundance of natural and, more recently, human-made events that have contributed to the making, remaking and unmaking of the Earth

1. The author would like to thank Jill Winder, Fiona Shipwright, Nick Aikens, Rebecca Bligh and Hannah Gregory for their suggestions on the text.

into the planet that humans know today – or at least, think and hope they do.

Humans can (only) know the world inasmuch as it is revealed to them through observation and experiment: through probing and poking, tasting and smelling, thinking and contemplating. Along the way, they are continuously reinventing, and are reinvented by, their various tools and technologies: apparatuses and measures that work as exosomatic organs, mediating between the world (experience) and us (contemplation), [2] enabling their creation and understanding, their thinking and doing, and among these are gauges with which humans sort, codify and categorise the world. How they are used is shaped by love–despair–memories–hopes–dreams–disappointments, as well as by material destruction–war–conquest–subordination, and by reconstruction–invention–creation. Yes, it is cyclical.

The Gulf of Mexico photographed from space.
NASA. Source: unsplash.com

Increasingly, humans have come to be seen as a geological force in the Anthropocene and are now urged to recalibrate the stable-world perspective and think about the planet changing in front of our eyes. There is little time to act to mitigate the consequences of what philosopher Yuk Hui calls 'blind modernisation', [3] driven by (western) science and technology and marked by exigencies of 'progress' and 'development', the conquest and subordination of 'nature', and the related extractivism and consumerism. This is what is driving the acceleration of cultural, environmental, social and political disruption and upheaval. [4] Yet 'progress' and change, as well as development, acceleration and destruction, could not have happened were it not for a primordially thorough and radical entanglement of the human and the world through technology, which, in this context, is taken to refer to 'the most basic level of *things* that are selected or made to fulfill a function to a user'. [5] This primordial entanglement constitutes what Yuk Hui terms cosmotechnics: 'the unification of the cosmos and the moral through technical activities, whether craft-making or art-making.' [6]

2. On exosomatic organogenesis see Bernard Stiegler (ed.), *Bifurcate: There is no Alternative*, trans. Daniel Ross, London: Open Humanities Press, 2021.

3. Yuk Hui, *The Question Concerning Technology in China: An Essay in Cosmotechnics*, Falmouth: Urbanomic, 2016, p. 7.

4. See Hui, *The Question Concerning Technology in China*, p. 7; see also Hartmut Rosa, *Social Acceleration: A New Theory of Modernity*, New York: Columbia University Press, 2013.

5. Tsjalling Swierstra, 'The Shock of Technology', in Tsjalling Swierstra, Pieter Lemmens, Tamar Sharon, Pieter Vermaas (ed.), *The Technical Condition: The Entanglement of Technology, Culture, and Society*, Amsterdam: Boom, 2022, pp. 10, 9–41.

6. Yuk Hui, 'Cosmotechnics as Cosmopolitics', *eflux* (online journal) no. 86, November 2017, available at e-flux.com (last ac-

cessed 11 September 2023).

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Let this introduction set the stage for reconsidering how humans relate to other humans and nonhuman beings, their worlds and the Earth, through elements and related phenomena. Of these, I propose to focus here on fire, steel and particles (while not excluding others such as water, clay, plastic, fabrics, wood) – a set that is, and has been, crucial to substantial changes in human and planetary histories, bridging chemistry, physics, biology, anthropology, history, the arts and the 'humanities'. The mastery of fire meant the birth of technics; steel (its production and its use) is the epitome of industrialisation; and particles, the constituents of everything there is, bear the promise of endless energetic resources. However, inasmuch as these are, and have been, used to make the world, they are also inadvertently involved in the unmaking of the world, life, and even the planet.

This text, then, is a proposition to (re)think, (re)write and (re-)experiment with and about the theories and practices that (not only) fire, steel and particles, their histories and presents, afford; the agency they (de)limit; the world they (re)shape, and how; what they make visible and what they conceal or erase; what injustices they enhance, and what strategies of resistance they encourage.

Anonymous time lapse photograph of firework display. Source: unsplash.com

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Humans have been made so, in and through interaction, mutual influence and coevolution with the environment and (other) human and nonhuman beings, including with technology. The fact that humans are made in entanglement with technics, tools and apparatuses must not be understated [7]– nor should the fact that technology is, by definition, neither good, bad, nor neutral, per Melvin Kranzberg's emphasis. [8] In fact, technology is a *pharmakon*, as Bernard Stiegler states: a remedy and a poison, an enabler and a disabler. [9]

7. See André Leroi-Gourhan, *Gesture and Speech*, Cambridge, MA: MIT Press, 1993; see also Zoë Sophia, 'Container Technologies', *Hypatia* vol. 15, no. 2, 2000.

8. Melvin Kranzberg, 'Technology and History: "Kranzberg's Laws"', *Technology and Culture* vol. 27, no. 3, 1986, pp. 544–60.

9. Bernard Stiegler, *What Makes Life Worth Living: On*

Any interaction with it is necessarily also pharmacological. Technology can be used to create and destroy, to develop and regress, to heal and to hurt – to make, remake and unmake.

This pharmacological entanglement, then, is the backbone of a book-in-the-making, at the interstices of scientific expertise and feats of imagination. Fire, steel and particles, having affected and shaped humans' histories, carry historical, material and emotive resonance, helping us to unravel the social, cultural, political and technological conditions and effects of human interactions with others, and the environment. This perspective is necessary in any attempt to come to terms with the pharmacological condition in thinking about the past, present and future of humans, nonhuman beings and the planet.

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Fire, Prometheus's gift in the western tradition, is arguably the first technology humans have 'conquered' and 'mastered'. According to Bernard Stiegler, it is the *pharmakon* par excellence: a civilising process, it is also a constant threat to civilisation – the risk of being on fire. [10] Although few archaeological records are known to exist that reveal much detail about its early use, it has been humans' adversary and companion for ages. [11] Fire, naturally occurring in the wild due to strikes of lightning, may perhaps have taken care of the first roast and scared away that hungry bear. Still, at first it was in its essence an ephemeral and geographically limited phenomenon. It was more common in the steppes than in the jungle, for example, and once it died, there was no more. [12] When humans domesticated fire, it was used for cooking and preserving food. It made food more tender and easily digestible (and so possible to ingest in larger quantities), freeing up chewing time and energy for other activities. [13] What is more, this is believed to have resulted in an increase in human brain size (from 600 to 1300 cc) during the Pleistocene. And, as a larger brain is more energy-consuming, this, according to J.A.J. Gowlet, then resulted in 'increases in group size and the pressure toward social cognition, which also constitutes a link with language origins.' [14]

Fire provided protection and warmth, and was later also used in making and forging of tools for creating fertile land and weapons for destroying enemy settlements. It was sanctified in religious practices. Later, with the Enlightenment and particularly during the Industrial Age that followed the emergence of cities and ensuing urbanisation, fire was 'intellectually transmuted': 'devoluted from a universal cause to a chemical consequence, the mere motion of molecules, the quantum bonding of oxygen.' [15] Uncontained, it came to be understood as 'alien, a destroyer of cities, a savager of soil, a befowler of air, an emblem (in science and in agriculture) of the hopelessly primitive'. [16]

Pharmacology, **Cambridge: Polity, 2013.**

10. Stiegler, *What Makes Life Worth Living*, **p. 24.**

11. J.A.J. Gowlet, 'The Discovery of Fire by Humans: A Long and Convoluted Process', *Philosophical Transaction of the Royal Society*, **vol. 371, no. 1696, 5 June 2016, available at royalsocietypublishing.org (last accessed 11 September 2023).**

12. See Gowlet, 'The Discovery of Fire by Humans'.

13. See Adam van Casteren, Jonathan R. Codd, Kornelius Cupczik, Guy Plasqui, William I. Sellers, Amanda G. Henry, 'The Cost of Chewing: The Energetics and Evolutionary Significance of Mastication in Humans', *Science Advances*, **7 August 2022, vol. 8, no. 33, available at science.org (last accessed 11 September 2023); Richard W. Wrangham,** *Catching Fire, How Cooking Made Us Human*, **London: Profile, 2010, p. 42.**

14. Gowlet, 'The Discovery of Fire by Humans', p. 4.

15. Stephen J. Pyne, 'Fire in the Mind: Changing Understandings of Fire in Western Civilization', *Philosophical Transaction of the Royal Society*, **vol. 371, issue 1696, 5 June 2016, p. 5, available at royalsocietypublishing.org (last accessed 11 September 2023).**

The historical transformation of fire was substantial:

16. Ibid.

> **Ancient fire practices had mimicked nature; now technology provided the model for how nature worked, or ought to work. Not flame but the heat engine was the exemplar for animal metabolism and the source of inspiration for how heat was created and transferred. Natural philosophy found conceptual surrogates for fire. Chemistry subordinated fire to the atomic bondings of oxygen. Thermodynamics segregated fire from motion and heat. Electromagnetic theory divorced it from light. The concept of energy replaced the universal suffusion of fire throughout nature.** [17]

17. Ibid.

The once fleeting spark of fire could be harnessed in science and industrial technology to trigger reactions and create new materials, driving the heat engine and the Industrial Revolution. Fuelled by wood and fossil fuels, it burned in furnaces and in locomotives; it illuminated streets and, in early industrial plants, teased out from various materials and new compounds their hazardous and sometimes deadly fumes. [18] Fire has 'underpinned the development of all modern technologies – from ceramics, to metal working, to the nuclear industry.' [19] Once contained, and once it can be kindled at will, fire can be used for a myriad of purposes. Properly fed, it reaches temperatures higher than those needed to cook food or heat up a house: it can melt quartz into glass and it can be used to melt and then to shape metals.

But fire – 'the symbol of technical knowledge, the fabrication of arms … but also the fire of desire that takes care of its object' [20] – also freed up time: it opened up space to ponder and think, to be bored and to dream. Having affected the brain by means of altering nutrition and exposing it to new chemicals (smoke, food), thus affecting the exosome, [21] fire contributed to the rewiring of neurons that started 'firing' fiction, poetry, narratives, history; it illuminated cave walls that became the artist's proto-canvas, while the hearth became the site of communal life and storytelling.

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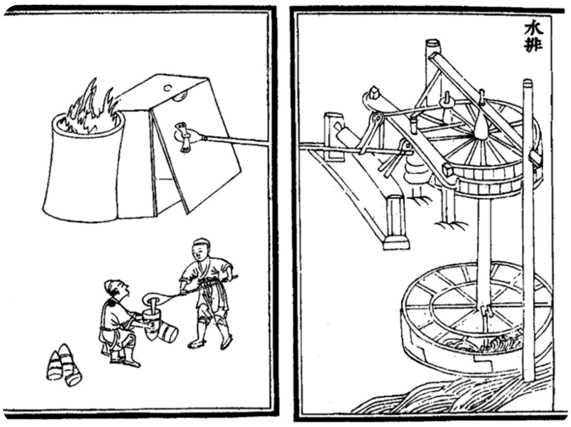
18. See Benjamin C. Trumble and Caleb E. Finch, 'The Exposome in Human Evolution: from Dust to Diesel', *Quarterly Review of Biology* vol. 94, no. 4, December 2019, pp. 333–94, available at ncbi.nlm.nih.gov (last accessed 11 September 2023).

19. Gowlet, 'The Discovery of Fire by Humans', p. 1.

20. Stiegler, *What Makes Life Worth Living*, p. 24.

21. See Trumble and Finch, 'The Exposome in Human Evolution'.



Medieval printed illustration depicts waterwheels powering the bellows of a blast furnace in creating cast iron. Illustration taken from the treatise *Nong Shu*, written by Wang Zhen (1313 AD) during the Chinese Yuan Dynasty. Date 1313 AD. Source: Wikipedia

Metals do not normally appear 'out there' in pure form, but have to be extracted, separated and purified. Still, the first metals to be used by humans, the archaeological record shows, fell from the sky. A meteorite apparently brought some iron to the Earth, where it was found and wrought to make King Tut's dagger – one of the first such finds. [22] Only later was it discovered, in the Near East about 2500 BCE, that metals were also hidden in Earth's underworld, mixed with other elements. To obtain them in their pure form required practice and knowledge of how to apply heat to purify the ore. This necessitated the development of metallurgy – perhaps one of the oldest crafts, which built on the conquest of fire. Yet, as much as fire contributed to evolutionary change in humans and gave them an advantage (in terms of subjugation) over nonhuman animals and the environment, the use and application of metals presented an additional advantage (in terms of subjugation) over other humans, other groups. This range of applications had substantive cultural and civilisational effects that necessitated radical shifts in the understanding and conceptualising of human existence, during the metal ages and beyond. The use of metals proliferated, not only in warfare and fashion but also in civil engineering, housing, transport and trade.

22. Jonathan Schifman, 'The Entire History of Steel', *Popular Mechanics*, 9 July 2018, available at popularmechanics.com (last accessed 11 September 2023).

Iron, however, is brittle until the addition of carbon makes it (just as hard, but also) more resistant to pressure. This was the birth of steel, with early attempts dating back to the time of the first furnaces. Massive production, however, only became possible after an engineer, Henry Bessemer, came up with a method to produce steel in larger quantities. [23] Steel meant a fusion of fire, iron and carbon; with the addition of water, it drove the Steam Age, particularly marking the development of the capitalist imperial and colonial regime in Britain, where the *heat machine* drove ships and trains and weapons and large architectural constructions ... *and* the Enlightenment myth of exponential progress, industrialisation and unhindered modernity.

23. Ibid.

Steel is most clearly associated with the Industrial Revolution and the Industrial Age. Steam could not have been contained in boilers, leading to pistons that transformed its power into movement, were it not for this strong, durable, yet pliable material that made up the heat engine. There would have been no trains, no massive bridges, no skyscrapers; likewise none of the advances in science and technology that, today, are quite invisible, yet without which many of our daily lives would be inconceivable. The Age of Steam might have been fuelled by wood and coal, but the energy created by burning them drove metal machines, tools, vehicles.

Boggy Creek Bridge, Oklahoma, Bairnsdale-Orbost line, circa 1914, Museums Victoria. Source: unsplash.com

Then again, it was also fuelled by the subjugation of labour – a literal repositioning of labour underground; by extraction, and the Enlightenment decoupling of nature and culture so as to relegate the status of the former (and also the latter) to that of a mere resource, there for the taking. Nigel Clark and Bronislaw Szerszynski argue that the growing importance of subterranean resources led to those doing the work to be viewed as a 'kind of human subspecies: coal-blackened, benighted, degenerate.' [24] What is more, this stratification helped to 'legitimate – or at least obscure – horrific death rates, crippling health problems and all the indignities [Lewis] Mumford gathers under the term "brutalization"'. [25] Steel, then, was a material substrate and epitome of colonial conquest and subordination, demonstrating that the heroic narrative of discovery and exploration also has an oppressive dark side.

The situation continues to this day in the case of the rare metals and earths used in digital technology: cobalt mining in Congo and lithium-related devastation in South America, and similar attempts in Serbia and elsewhere, infamously demonstrate the precarity of the relationship between the social and the cultural and the environment, as well as the excessive planetary power *dis*-balances of today. The latter have been ongoing at least since the colonisation of the world by western empires after Columbus's landing in America, leading up to the end of unilateral globalisation and the Anthropocene. [26] What is more, what Nigel Clark and Bronislaw Szerszynski call 'geological othering' reveals that 'capitalist accumulation at once – inadvertently – brings to light the evidence of an unstable Earth and – equally inadvertently – exacerbates this instability.' [27]

24. Nigel Clark and Broniwlaw Szerszynski, *Planetary Social Thought, The Anthropocene Challenge to the Social Sciences*, **Cambridge: Polity, 2021, p. 111.**

25. Ibid.

26. Hui, 'Cosmotechnics as Cosmopolitics'.

27. Clark and Szerszynski, *Planetary Social Thought*, **p. 113.**

Malachite, Heterogenite, from Kolwezi, Western area, Katanga Copper Crescent, Katanga (Shaba), Democratic Republic of Congo. Size: 12.4 x 10.4 x 6.6 cm. Source: Wikipedia

Colonialism, a 'constitutive element of what it meant to be modern and to be European', [28] resulted in the confiscation of territory, subordination of bodies, and the extraction of resources and energy. The necessary condition and effect of this is that, alongside extraction of resources, it also builds, as C. Thi Nguyen maintains, the 'social, economic, cultural and even attentional environment in ways that get us to follow its [the system's] game plan'. [29] A further consequence, Amílcar Cabral states, is that for its security, imperial domination 'requires cultural oppression and the attempt at direct or indirect liquidation of the essential elements of the culture of the dominated people'. [30]

Following these thinkers, Olúfémi O. Táíwò argues that culture, as a collective ability to design and organise our lives, is the engine of history and, as such, conflicts directly with the aims of imperialists to be the ones doing the designing and controlling. [31] It is not just about the capture and extraction of land and resources, but also of bodies and minds – that is, the creativity and culture which, in order for any material conquest or subordination to succeed, must effect (to quote Cabral again) 'permanent, organized repression of the cultural life of the people concerned.' [32]

Although, to a large extent, colonialism was enabled and driven by the means of western technological advances, among them the steam engine and steel, its history also shows the power of the entanglement between human-made objects and resources. Particularly, it reveals the subjugating power of technology in the dynamics similar to that which Táíwò terms 'elite capture': in 'technology capture', economic and political power structures emerge out of the imbalances in, restrictions and prevention of, access to technology and resources. This also reveals the conditions that such dynamics require and the effects that they have on planetary sociopolitical, neo-imperialist and neocolonial relations today.

The 'implements of progress', however, were also used 'at home'. For example, the levels of biological and material destruction inflicted by steel-driven World-War-I warfare were such that, even today, large amounts of ammunition, bombs, stretches of barbed wire, and other remnants resurface or are excavated. Recently,

28. Ibid., p. 111.

29. In Olúfémi O. Táíwò, *Elite Capture: How the Powerful Took Over Identity Politics (And Everything Else)*, **London: Pluto Press, 2022, p. 83.**

30. Quoted in Táíwò, *Elite Capture*, **p. 83.**

31. Táíwò, *Elite Capture*, **p. 83.**

32. Quoted in Táíwò, *Elite Capture*, **p. 83.**

with global warming, bodies and objects that have been buried under ice in northern Italy since World War I have begun to surface from underneath the retreating ice and snow. [33]

33. Angela Giuffrida, 'Melting Ice Reveals First World War Relics in Italian Alps', *Guardian*, 4 May 2021, available at theguardian.com (last accessed 1 September 2023).

The elite capture of technology also necessitated the continuous development of various intra-continental modalities and manifestations of subordination and resistance, notably across the East-West divide. In the latter part of the twentieth century, the divide came to symbolise ideological, political, cultural and technological differences and divisions, but was also reworked in the Non-Aligned Movement, which in the context of anti-colonial and anti-imperial politics and practices demanded more balanced access to, and the development of, technological and economic systems. In light of post-war reconstruction and its offshoot of modernisation, metal was indispensable to civil engineering, the automotive industry and the military-industrial complex.

The massive production of steel and steel objects historically reinforced the workings of the capitalist regime, in terms of the interrelation of over-production and over-consumption, which became apparent in the production of both weapons and quotidian objects (knives, hairpins, boxes and flasks, cars, etc.). The former entails the need to extract-to-produce (resources and labour), disregarding the consequences, and, on the consumptive end, not only consumer-consumption but also the need for the energy-to-produce. The history of steel production and its uses presents a precursor to the drive to produce-to-consume whose extreme formation became radically apparent with the invention, popularisation and mass production of plastic. Plastic, in its ready availability, multi-applicability and non-degradability, further concealed the destructive power of excessive energy demand as well as the planetary injustices, disbalances, disregard and disrespect – perhaps most painfully visible in the mountains of discarded clothes exported to Ghana or the vortex of plastic in the Pacific Ocean, only the most mediated examples of displaced industrial-scale waste and pollution.

Nicolas Bourriaud notes we are in a situation where 'things and phenomena *used* to surround us. Today it seems they threaten us in ghostly form, as unruly scraps that refuse to go away or persist even after vanishing into the air.' [34] The obsession with the production of stuff and the dispensation of waste and energy seems like a sinister offshoot of that other contemporary obsession with feeding the insatiable archive – one that knows no boundaries, and that colonises capacities and resources in order to store and retrieve. Bourriaud continues: 'Ours is also an epoch of squandered energy: nuclear waste that won't go away, hulking stockpiles of unused goods, and domino effects triggered by industrial emissions polluting the atmosphere and oceans.' [35]

34. Nicolas Bourriaud, *The Exoform*, London: Verso, 2016 (my emphasis).

35. Ibid.

As much as humans overproduce, then, they also overconsume – not just objects but energy too, which puts the human:world relationship in a particularly precarious frame. This precarity not only exposes the disbalances of power and the subjugation of and by other humans, but also the fragility of the Earth as a system. Further, it unmasks the unimaginable forces of nature, which can crush concrete and deform steel, as we've most recently seen with the massive fires and floods of the summer of 2023.

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Particles, in terms of visibility and timescales, are the constituent elements of the universe. Hidden 'behind', 'beneath' or 'within' stuff, particles are the first and least complex 'thing' to be formed when the universe big-banged into existence. As such, they comprise everything in existence and mark the birth of cosmic history and time stretching back fourteen million years.

The cosmic evolution, however, was neither deterministic nor progressive, states astrophysicist Eric J. Chaisson. Rather, it was the interplay of 'chance and necessity [that] meander throughout all aspects of the cosmic-evolutionary scenario, whose temporal "arrow" hereby represents a convenient symbolic guide to natural history's varied changes.' [36] And change seems to be happening in the direction of the rise of 'order, form, structure, complexity, organisation, information, inhomogeneity, clumpiness', meaning the development and evolution of localised material assemblages – 'systems' – throughout the history of the universe. [37]

It took thousands of years to develop instruments and knowledge to enable humans to detect and understand the invisible composition of the universe or cosmic expansion. According to Chaisson, along with the 'gravitational force in physics, natural selection in biology, and technological innovation in culture', cosmic expansion is one of the preconditions for the evolution of order and the emergence of increasingly complex systems. The organised dynamics 'established the temperature gradients, began the free energy flowing, and fostered environmental changes literally everywhere.' [38] Thus, we can see its systemising effects on humans' perception of and relationship to 'nature', as well as on the formation of society and culture.

Yet, particles as carriers of energy have likewise been subject to attempts at subordination in human:tech activities. Light, the condition of life itself (and symbolically related to the acquisition of knowledge) is used in solar electricity production. Radiation, the least visible and most fearsome manifestation of particles in action, bears the promise of endless energy supply; but also of destruction, as was seen when the US dropped A-bombs on Hiroshima and Nagasaki in 1945, not to mention the destructive post–World-War-II nuclear testing in the Pacific and elsewhere, or the nuclear plant disasters in Chernobyl and Fukushima, or most recently, the fear of nuclear power plants being weaponised in the war in Ukraine.

36. Eric J. Chaisson, 'Particle Evolution', ***Advanced Track Epoch 1*** **(.pdf), Harvard University, available at lweb.cfa.harvard.edu, p. 2 (last accessed 11 September 2023).**

37. Ibid.

38. Ibid., p. 26.