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1948

Christoph Rosol

March 24, 1948, New York. 10:00 am. Five speakers assemble in the Grand Ballroom of the Hotel Commodore for a special session on "Advances Significant to Electronics": Norbert Wiener, Claude Shannon, Maurice Deloraine, Isidor Rabi, and John von Neumann. Their talks bear short titles: "Cybernetics," "Pulse Modulation," "Information Theory," "Electronics and the Atom," and "Computer Theory." The panel session is part of the 1948 National Convention of the Institute of Radio Engineers (I.R.E.), the world's largest gathering of electrical engineers to date. According to the organizers, it "appears destined to become known in future years as one of the more important I.R.E. sessions ever to be held."[1] Indeed, the talks at that morning session discuss no less than the very foundations of the coming atomic and digital ages.

The first speaker, Norbert Wiener, believes that a second industrial revolution is imminent. He draws on material from his seminal work *Cybernetics: Or Control and Communication in the Animal and the Machine*, which is about to be published within a few weeks.[2] In it, Wiener, the son of a Polish-Yiddish emigrant and the first Harvard professor for Slavic languages, sets out his vision of self-organizing rhythmic systems, whose governors are distributed over the entire system, regardless of whether this system is a machine or a living organism. While the intellectual concepts of earlier eras mostly corresponded with the principles of mechanical clockworks or thermodynamic steam engines, the present age, he argues, is textured through modalities such as information, communication, organization, and control. However, in order to operate with a structuring entity like "information" a mathematically precise formulation is needed. Later that year, this precise form is provided by Wiener's former student, and son of a German teacher from Michigan, Claude Elwood Shannon. In July and October 1948, the two parts of Shannon's seminal paper "A Mathematical Theory of

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Communication" appear in the journal of his employer, Bell Laboratories.[3] Shannon proposes a measure of information known as the bit, which renders the capacities of radio and other information channels universally calculable. The reduction of the concept of communication to measurable and statistically calculable values will supply the technological foundation for what is known today as digitization.

The answer to the question of how to convert the analog, or continuous, world into the discrete signals of the digital world comes from the high-frequency engineer Maurice Deloraine, who emigrated from France just eight years earlier. His idea of pulse-code modulation will pave the way for the micro-temporal sampling and coding of spoken language – no matter whether it is German, French, Russian, or Jiddish – and, soon thereafter, optical images: nothing less than the digital conversion of media itself. The advancement was made possible thanks primarily to work carried out at the MIT Radiation Laboratory, the most important American electronics research facility during World War II. Its sole purpose was to develop high-frequency and radar technology for "remote sensing" on the scale of a global war taking place both in the upper air and deep into the oceans. The deputy director of the "RadLab" was the physicist Isidor Isaac Rabi, an immigrant from Galicia (now southern Poland and western Ukraine). Rabi was also a consultant for the Manhattan Project, an objective of which was to join, as Rabi's talk at the Hotel Commodore put it, "electronics and the atom." For it was precisely the complex computational effort involved in the construction of the atomic and, later, hydrogen bombs that led to the rapid development of the digital computer.

The mathematician most responsible for the liaison between nuclear physics and computer design was John von Neumann, the fifth speaker on the panel and a German-Jewish emigrant from Budapest. While his concise mathematical shortcuts did help to solve the problem of the critical mass needed to initiate a nuclear chain reaction in various types of bombs with the help of analog punch-card computers, increased computational demands led to the development of the first general-purpose digital computer, the Electronic Numerical Integrator and Computer (ENIAC), an effort which also produced the logical basis of the computer architecture still in use today.

It is unknown whether and to what extent the audience at the Hotel Commodore fathomed the import and the monumental implications of the talks, which, judging by the speakers' backgrounds, must have been delivered in heavy European accents.[4]

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The same day, March 24, 1948, 2,000 km to the south. Representatives of 56 nations sign the Havana Charter. The agreement stipulates the establishment of an international trade organization, an "International Clearing Union," and a supranational unit of account known as the bancor to promote a global trade system. But none of the proposals come to pass because of the refusal of the US

Congress to ratify the charter.[5] As a result, the General Agreement on Tariffs and Trade (GATT), a partial treaty that came into force on January 1, 1948, will remain in effect for a long time to come. Even though GATT is intended as just a stopgap, it will cement the dominance of Western industrialized countries in world trade for decades.

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April 21, 1948, Haifa, Palestine. The Jewish paramilitary organization Haganah seizes the port refineries and the terminal of the British-built Kirkuk-Haifa oil pipeline, securing what was shaping up to be the world's most important strategic commodity and instrument of power.[6] The move marks a turning point in the 1947–1949 Palestine War. By the beginning of the Arab revolt in 1936 – the greatest revolt against British colonial rule in the 20th century – the newly built pipeline had become a target of multiple attacks and acts of sabotage. For its protection, the British established a militia of armed Jewish settlers. The militia makes up the core of the Zionist army that takes control of Palestine in April 1948, which leads to the creation of the state of Israel only three weeks after the conquest of Haifa.

On the same day that the head of the pipeline falls into the hands of the Haganah, Iraqi workers revolt at the K3 pumping station near Haditha. K3 is a strategically important junction where the pipeline delivering crude oil from the Kirkuk oil fields splits into two: one line going to the Lebanese city of Tripoli; the other, to Haifa. The strike is part of a wave of protests that erupted after the nationwide anti-colonial al-Wathbah uprising led by students and the young but influential Iraqi Communist Party was put down in January. The blockade lasts until May 25, when the besieged strikers decide to march on Baghdad and soon afterward become ensnared in a trap. By the end of 1948, the Communist Party is in shambles and its leaders are in prison. Supporters of pan-Arabism argue that the movement is no longer credible after it followed Moscow's doctrine in recognizing the State of Israel and thus gave up on exploiting the oil reserves for themselves.

After the end of World War II, the United Kingdom withdraws from the Middle East on account of their crushing war debt. This allows the United States to emerge as the new dominant power in the region. In the early 1930s, American companies had already secured concessions for oil exploration in all of Saudi Arabia and Bahrain and in half of Kuwait. In 1948, Texaco and Standard Oil of California, the joint owners of the Arabian American Oil Company, or Aramco for short, take on two new partners: Standard Oil of New Jersey (later to become Exxon) and Socony Vacuum (later to become Mobil). In June of that year, the northern part of the Ghawar oil field is discovered near the Persian Gulf. Between 1948 and 2000 an estimated 65% of total Saudi oil production will come from Ghawar, the largest onshore oil field ever discovered. Owing to the enormous quantity of oil found at Ghawar, Aramco becomes the world's most profitable company, and remains so today, accounting for roughly 5% of accumulated global CO_2 equivalent emissions since its establishment.

Mostly because of the extraordinary jump of Middle East oil imports from 1,000 barrels per day in 1947 to 75,000 per day in 1948 US oil imports exceed its exports for the first time that year. Already in January 1948, the Secretary of Defense James Forrestal meets with Brewster Jennings, the president of Socony Vacuum, to discuss how best to handle the coming oil glut from the Middle East. In an effort to keep raw materials scarce and profits high, they encourage American automobile manufacturers to develop inefficient, gas-guzzling engines.[7] In less than a decade, the average horsepower of automobiles produced for the US market will double and be accompanied by an explosive growth in the number of vehicles on the road and the petro-libidinal suburban lifestyles they make possible. Between 1948 and 1972, US oil consumption will triple in an economy that aims no longer to satisfy needs but to increase consumption.

In Europe, meanwhile, the Organization for European Economic Co-operation (or OEEC, the precursor to today's OECD) is created in April 1948 to superintend the Marshall Plan, an initiative recently enacted by the US Congress for the economic recovery of Western Europe. As part of the initiative and in response to the severe energy shortages that befall Europe in 1946 and 1947, the OEEC promotes the switch from coal to imported oil. Around 20% of Marshall Plan dollars go straight to the purchase of oil and oil-processing facilities. The reconstruction of Europe and the rise in oil production in the Middle East go hand in hand.[8]

Meanwhile, a delegation of Venezuelan officials tours the Middle East in 1949 to convince the kingdoms to demand at least a 50–50 split of revenues in their oil concessions to American companies. The blueprint was the 50% profit sharing model implemented by legislation in Venezuela in 1948, itself an outcome of negotiations in which Venezuela originally wanted more (60:40), but had to concede to the powerful interests of big oil. A 50–50 agreement presented an increase in revenue for most Middle Eastern states, however. The eventual adoption essentially helped to cement the presence of foreign oil producers in the region, acting as states within states. At the same it showed how collective action of third-world countries could drive concessions. The Venezuelan delegation visit of 1949 thereby encouraged the way of cartel formation that led to the foundation of the Organization of the Petroleum Exporting Countries (OPEC) in 1960 and the eventual rise of a post-colonial energy world order in which not only Western oil tycoons but also kings, dictators, and ruling elites from petro-states sought to reap the benefits of exploiting Earth's million-year-old chemical energy reservoirs.

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May 26, 1948, South Africa. The Herenigde Nasionale Party wins the majority of seats in the parliamentary elections with a minority of the popular vote. In the same year, it begins to enforce systematic racial segregation in all areas of public and private life. It is the start of institutionalized apartheid. Organized by the state apparatus and its arsenal of media technologies of registration, classification, and territorialization, the withdrawal of rights becomes law. Working through the decades of white supremacist rule that follow and subsequent rudiments of reconciliation will only be possible by using similar media techniques: cases, files, databases, microphones, questionnaires, hearings.[9]

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August 31, 1948, Moscow. At a hastily organized session of the Lenin Academy of Agricultural Sciences, its president, Trofim Denisovich Lysenko, delivers an address titled "On the Situation in the Biological Sciences." The powerful agronomist decries Western genetics as an anti-socialist and false doctrine, and endorses instead a neo-Lamarckian view in which the inherited properties of organisms are shaped by their environmental conditions. Even before the end of the meeting, he makes clear that the Soviet Politburo had already approved his speech.[10] In fact, Josef Stalin, himself a passionate hobby gardener and mimosa breeder, personally edited Lysenko's manuscript. In the wake of great famines in 1946 and 1947, the new program aims to increase agricultural yields and put a stop to the bourgeois determinism of Western genetics. This understanding of biology will soon prove to have grave consequences as crop failures ravage not only the Soviet Union, but also the young People's Republic of China that also adopts Lysenko's methods.

In the West, scientists are also working on programs to increase yields. One of their main objectives is to prevent the spread of communism among agrarian countries in the south. The Mexican Agricultural Program of the Rockefeller Foundation established in 1944 under the direction of Norman Borlaug (with money from Standard Oil founder John D. Rockefeller) becomes a global operation in 1947, when embarking on the programmatic goal of the "Green Revolution," which, starting in the 1960s, will fundamentally transform agriculture especially on the Indian subcontinent. Farmers combine newly bred high-yield varieties of rice, wheat, maize, and beans with large quantities of mineral fertilizers and pesticides such as DDT.[11] The industrial-scale strategy proves an effective means of feeding the rapidly growing populations in developing nations – while causing lasting damage to the environment. Amid the burgeoning Cold War, science must enter the service of ideology, even with something as seemingly innocuous as crop breeding. The laboratory-based "green" revolution is meant to act as a bulwark against the power struggle of the "red" revolution.

The genetics that Lysenko spoke out against began in earnest when, in 1944, the Canadian doctor Oswald Avery isolated deoxyribonucleic acid, or DNA, at the Rockefeller University Hospital in New York – just a few blocks north of the Hotel Commodore. The work on molecular genetics was spearheaded by the Rockefeller Foundation, under the direction of Warren Weaver, the head of its natural sciences department – the same Warren Weaver who, in 1949, will co-edit Claude Shannon's collected essays on information theory. Based on Erwin Chargaff's work in 1947, Alfred Hershey and Martha Chase will prove in 1952 that DNA is responsible for the transmission of genetic information. One year later, James Watson and Francis Crick will use X-ray crystallography to develop a double-helix model for the structure of the DNA molecule. The rise of molecular biology culminates in what Watson calls its "central dogma": the hypothesis, still essentially valid today, that describes the sequential copying, transcriptions, and translations of the information encoded in genes by DNA, ribonucleic acid (RNA), and proteins. The process not only recalls text-based media and communication but also very materially represents the idea of a universal, symbolically coded order of living organisms. It is an idea that will later go on to shape theories of language and culture.[12]

Meanwhile, Lysenko's star in the Soviet Union continues to fall as further attempts to deploy socialist Lamarckism fail. One is a scheme to reforest the steppe. The idea is to plant trees close together based on Lysenko's assumption that collectivism will help the saplings survive and grow under the steppe's harsh conditions. On October 20, 1948, just two months after his speech at the Lenin Academy, the Council of Ministers of the Soviet Union pass the "Plan for planting shelterbelts, introduction of grassland crop rotation and construction of ponds and reservoirs to ensure high sustainable crop yields in steppe and forest-steppe areas of the European USSR." Later renamed the "Great Stalin Plan for the Transformation of Nature," the plan comprises a series of large-scale projects, from the planting of 70,000 km of wood belts to the diversion of entire river systems.[13] The Promethean hybris of improving nature by means of a "technocratic ecology" soon spreads to the Central Asian region.[14] Eventually, however, all projects will be abandoned. Only around half of the planned areas will be reforested, and a majority of the seedlings planted between 1949 and 1953 will die.

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October 3, 1948, Göteborg, Sweden. After 15 months of circumnavigating the water planet called "Earth," the Swedish Albatross research vessel returns to its port of registry. On board are more than 200 sediment cores raised from the sea depths of up to 7,900 m from around the equatorial line. Wrapped in parchment, stoppered in aluminum tubes filled with paraffin wax, and cooled to 5°–8°C, they hold geologic and climatic records of the last 3 million years. Thanks to the newly designed "piston corer," cores of unseen lengths of up to 20 m were obtained, storing continuous and undisturbed paleoenvironmental information of the entire Quaternary. An entirely new deep-time vista opens up for deep-sea oceanography.

Almost exactly one month later, a paper by the nuclear chemist Harold C. Urey appears in the journal *Science* showing how the ratio of different oxygen isotopes found in geological sampling material can reveal temperatures at the time of its formation.[15] Just a little earlier, Urey's colleague at the University of Chicago Willard Libby had already proposed a method for dating organic materials by measuring their content of carbon-14 (14C or C-14), a radioactive isotope of carbon. The German-Danish physicist Hilde Levi, who visited Libby and Urey for several months in early 1948, carried this method to Copenhagen, establishing the Copenhagen Isotope Colloquia series in the same year and the first C-14 lab on European soil in 1951.[16]

However, the radiocarbon dating method extends only back to archaeological and prehistorical times, not geological. Here, correlations between different dating and proxy methods are of essence. With high-resolution sediment cores available from the deep sea and the new technique of deriving "paleotemperatures" through measuring isotope compositions Cesare Emiliani, a micropaleontologist and oceanographer hired by Urey, will be able to meticulously chronicle the dramatic ice age temperature swings before Neolithic humans came to dominate the surface of the planet.

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Two days later, October 5, 1948, Fontainebleau, France. The International Union for the Protection of Nature (IUPN) is founded at the renaissance castle of Fontainebleau. The international organization is a building block in the co-emergence of international bureaucracy, transnational science, and the idea of a "global environment" in the aftermath of World War II.[17] A dispute arises among its founders about whether nature should be *protected* from human interference or be strategically *conserved* as a warehouse of raw materials for agriculture, the production of goods, and future conflicts. Two publications published in 1948 by individuals involved in the dispute give the modern environmental movement of neo-Malthusian imprint a fulminant start: William Vogt's *Road to Survival* and Fairfield Osborne's *Our Plundered Planet*.[18] Ultimately, the conservationist attitude prevails, and in 1956 the IUPN will be renamed the International Union for the Conservation of Nature and Natural Resources (IUCN).

Meanwhile, another dispute about protection finds a home in Fontainebleau, this time focused on the specter of nuclear war and the total annihilation of all of higher life on Earth: in 1952, the command of the Allied Forces Central Europe of NATO (founded in 1949) established their headquarters in the French castle. However, it was not only the global strategic risks of atomic warfare that featured prominently in the discussions of these Cold War strategists, much of whose thinking was informed by the scenario planning groups of the RAND corporation (founded in 1948), and their embracing of game theory as well as operations research and linear programming (which found its first real-world application in the Berlin Airlift of 1948–1949). The decade following the end of World War II is also the heyday of environmental warfare scenario planning, turning the newly established concept of the environment not in an outside object to be protected but to be used against other humans. Various military considerations of crop destruction through pests, contamination of strips of land through radioactive waste, and weather and climate modification are fueled by a frenzy of lab experiments and thought experiments among industrial scientists, many of whom give rather hyperbolic assessments of their potential application. Crucially, the imminent threat of environmental manipulation prompts the rise of "catastrophic environmentalism" and the understanding of resilience and security as something gained through conserving ecosystem variety and complexity.[19] The International Geophysical Year of 1957–1958, in which scientists from East and West work together and share a hitherto unseen wealth of environmental data, extends that view up to the planetary scale. It helps to propel a systems-oriented understanding of the global environment as a space in which radioactive tracers can cycle as much as biogeochemical substances through Earth's varied reservoirs such as the biosphere, atmosphere, and hydrosphere.[20] In turn, this understanding raises the question of how such cycles can be artificially altered – and this time not by intended interventions but through the unintended consequences of human activities.

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October 1948, Arnhem Land, Northern Territory, Australia. A team of American and Australian scientists complete what is now widely considered the last of the great expeditions: an eight-month exploration of Arnhem Land, located at the upper tip of Australia's Northern Territory. They return from the journey with thousands of plant and animal species along with other data such as indigenous tools and bark paintings, but also 16 mm film recordings and color photographs documenting the Yolngu tribe and other Aboriginal peoples who have lived there for tens of thousands of years. Despite the use of modern media, the expedition is an anachronistic undertaking, a kind of historical re-enactment of the natural and ethnographic explorations of the 19th century.[21]

It soon becomes apparent that the expedition is likely to be the last opportunity to study a pre-modern human ecosystem on the continent. A good ten years earlier, the cane toad, a species native to South America, was introduced in Queensland in an effort to control pest infestations on sugar cane plantations. The measure was unsuccessful, but the cane toad thrived. An invasive species with poison glands, few natural predators, and a high rate of reproduction, the toad spread exponentially, displacing other species and threatening the survival of monitor lizards and other predators. The amphibian species will reach Arnhem Land within two decades. Today, the toads' distribution extends from Northern Australia to New South Wales and CRISPR gene editing efforts – descendant techniques of the molecular biology paradigm of the mid-20th century – are underway to detoxify the toad and put an artificial end to the environmental havoc created by the artificial introduction of the toad into the Australian gene pool.[22]

The Western Pacific is a melting pot of geo-historical time in 1948. In January the aforementioned Albatross expedition has taken samples from the deep-sea floor in the western Pacific to chronicle a natural history of that region before the advent of humans. Just a few weeks later the Arnhem Expedition set out to study the result of tens of thousands of years of prehistoric migrations in that same region, investigating a confined area still largely untouched by modern extractive cultures and technologies. At the same time, less than 2,500 miles away from Arnhem and just a few hundreds of miles north of the Albatross route, around 10,000 American army employees and scientific personnel prepare for bantering natural history in turning an entire area into an experimental site for high-tech investigation. On Enewetak Atoll, they relocate the indigenous population, raze the islands of Enjebi, Aomon, and Runit, and build a causeway for running cables between a test site on Aomon and the control station on the neighboring island of Bijire. As part of Operation Sandstone, the army conducts three nuclear weapons tests on Enewetak between April and May 1948. Unknowingly and quite narrowly, the Albatross expedition had managed to capture the very last instance of ocean history free of contamination with artificial plutonium.[23] The inhabitants of the Marshall Islands, meanwhile, embark on the intergenerational traumas of nuclear colonialism, not being permitted to return to Enewetak until 1980, when radiation levels still remain dangerously high.

The primary purpose of the Sandstone tests is to update the design of the "Fat Man" bomb, the implosion-type nuclear device that exploded over Nagasaki on August 9, 1945 after a similar model was tested at the Trinity site in New Mexico. It was none other than John von Neumann who, working at the Los Alamos National Laboratory, calculated the density of the fissile material needed to prompt a nuclear chain reaction in Fat Man and determined the detonation height for maximum destruction. Fat Man ended the Pacific War only to usher in a new war against the Pacific ecosystem and its human and non-human inhabitants.

The nuclear tests of Operation Sandstone will lead to significant improvements in bomb design and efficiency. Forty more tests will follow, including, in 1952, the detonation of the first hydrogen bomb, which will completely destroy Elugelab, another island in the atoll. By that time, the mass production of nuclear weapons that ignited the Cold War arms race is already on. On June 1, 1948, the Soviets have begun the manufacturing of weapons-grade plutonium at the Mayak plant near Chelyabinsk. One year later they detonate a bomb based on the Fat Man design in the unforestable steppes of Kazakhstan. Over the following decades, the US and the Soviet Union will carry out some 500 aboveground nuclear tests. The resulting global radioactive fallout will spell the end of the Holocene epoch.[24]

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December 4, 1948, Barnhill, Scotland. George Orwell sends the completed manuscript of *Nineteen Eighty-Four* to his publisher.

The Crystallization of the Technosphere

The year 1948 is a historical magnifying glass of the present. It is a moment in history that condenses a diffuse period chronicling the transition into the planetary situation of today. The various historical-geographical vignettes outlined above chart a strikingly similar origin and mutual unleashing of the digital, the nuclear, and the environmental age. They show the synchronous rise of electronic computation, molecular genetics, of petro power and petro chemistry, the commodification and universalization of global relations under the West's domination, as well as the emergence of new concepts of humans in nature and new concepts of engineering as information engineering. The numerous technoscientific fragments left by a modernity torn asunder during two world wars recombined into a new, mutually reinforcing technological, scientific, cultural, and global environmental order, which surpasses previous waves of globalization, greatly accelerating the merciless, destructive, and unstoppable drive of the juggernaut of modernity.[25] The year 1948 – or, more accurately, the period spanning from 1945 to 1950 – marks a decisive moment not only for the reconstitution of the *world* as a hypermodern and geopolitical project. More than that, it is a moment in which the *Earth* became a guinea pig in humanity's experiment with an industrialized global economy, resulting in many unintended "geopolitical" consequences that our societies are now stuck with when facing the multiple crises of the Anthropocene.

Looking back at this historical inflection point, it is then possible to see how the planet became a space activated by technology, and media technologies in particular. Until about the middle of the 20th century, the Earth bore mainly the traces of geophysical, biological, and biogeochemical activity. Since then, however, a new, technical-industrial force unfolded, whose impact finds no equivalent in the history of the Earth. The fusing of several rapid and unchecked technological advancements helped to crystallize a new player in the planetary metabolism: a technosphere interlacing with and rivaling the great natural spheres like the biosphere or hydrosphere. Technologization in conjunction with a social contract that bound the fate of populations, elections, and five-year plans to an extractivist program to "plunder the Earth" (Osborne), locked in a path in which humanity has become a decisive factor in the current making of geological history.

The ensemble of graphs tracking the Great Acceleration – the exponential growth across a range of parameters measuring socioeconomic activities and their effects on the Earth system since around 1950 – paint a diagrammatic signature portrait of this watershed moment. At no previous moment in human history did anthropogenic impact on the environment grow as explosively and has had effects on a planetary scale as it did since the middle of the 20th century AD. Fossil-fuel-powered machines undertook the extraction, converting and scattering of hitherto unimaginable amounts of raw materials and thereby dissipated critical elements globally; artificial radionuclides and huge quantities of synthetics and chemicals began to accumulate in the geosphere; the carrying capacities of the planetary ecosystem commenced their rapid decline, headed by a human-led degradation of the biosphere, essentially initiating a sixth mass extinction in Earth history; the burning of fossil fuels enabled humans to break through the photosynthetic energy barrier, only to catapult Earth's climate into regimes last seen millions of years ago.

The technosphere, this amorphous ensemble of global resource and energy infrastructures, built environments, transport systems, financial institutions, state-led bureaucracies, and human workforces dramatically reconfigured the earthly circulation of matter and energy. It did so, mainly, by exploiting the lithosphere, biosphere, atmosphere, and hydrosphere as an energy source and a waste dump at the same time. But it is one decisive part of the technosphere, namely the media systems that orchestrate, manipulate, and culturally encode all these anthropogenic structures and energy conversions, that has remodeled not only the quasi-stable environment of the Holocene Earth but also the epistemic representation of the environment – both the global and the varied local articulations of it – as such to the technosphere's liking. Even expressing "Nature" in terms of spheres and systems that circulate and converse energy, like just done, gives witness to this epistemological remodeling.

Knowledge about the environment and the technosphere are enmeshed or "moored" together: they condition and serve, sustain and propel each other. Without a modern scientific approach to natural resources and forces there would be no technosphere; without the technosphere there would be no contemporary knowledge. On the one hand, natural science and engineering allows for the theoretical understanding and technical mastery of energy and matter, both living and inert, and thus the existence of a technosphere. On the other hand, it is the technosphere that enables modern science and engineering to exist.

Such knowledge, however, is always contained and available in some form of media and socio-technical arrangement. Current science and engineering are linked to the devices and metrics of a fleet of technical media, of certain institutional configurations and methodologies: data formats, building technology, patents, impact factors, remote sensing satellites, greenhouses, campuses, curricula. Ultimately, these kinds of technospherical practices, instruments, and facilitations of knowledge creation and management are also the ones that form the basis of our understanding of the environment and its cardinal changes that are underway.

Coming back to the pivot point 1948, it seems only logical that the Anthropocene Working Group – the group of geologists, geochemists, paleobiologists, archaeologists, and Earth system scientists that is tasked with reviewing the evidence for and against an Anthropocene boundary in recent Earth strata – identified the mid-20th century as the most likely starting date of the new epoch.[26] Their preferred method? The very same isotope analysis pioneered in the late 1940s by fusing nuclear chemistry with geology and oceanography. If one takes into account the further fact that also climate and Earth system modeling grew out of developments starting in that very same period – namely the origins of general circulation models spearheaded by John von Neumann's fusing of computer design and numerical weather forecasting in Princeton between 1946 and 1955 – and the rise of cybernetic-styled global systems ecology, the beginning of the Anthropocene and the beginning of its scientific realization are stunningly coeval.[27] Around 1948 a new sense of planetary affairs is "environed" through mass spectrometry, general circulation models, piston corers, nuclear tracers, chemical pollutants, and human-led alterations of biogeochemical cycles.

One almost paradoxical constellation is worth mentioning here: the role of the minute and small in leveraging the big and systemic. As much as measuring isotope compositions and running digital bits of information on electronic computers were instrumental in creating vistas on a changing planetary environment, human activity's large-scale effects on the planetary condition became possible only because of the manipulation of small-scale, elementary building blocks: genes, atoms, bits, and molecules. What is true for monitoring Earth system change is also true for driving these changes. Propelled by capitalist and communist ideologies – themselves shaped by two centuries of extensive industrialization as well as several hundred years of internal and external colonialism – the new technical mastery of the microscopic world produced enormous economies of scale. The control of nuclear fission, the digitalization of symbolic representations, the functional design of molecular polymer chains, and the manipulation of genetic material enabled self-reinforcing operations of ceaseless multiplication and duplication. Atomic bombs became produced en masse, Saudi oil became consumed en masse, data became calculated en masse while interconnected in multiplying networks: a technosphere xeroxing itself.[28]

The revolution in microelectronics initiated by the invention of the point-contact transistor at Bell Labs in December of 1947 gave rise to a drive for miniaturization which itself became an empirical law, Moore's law. Today, human agency is scarcely conceivable without the, maybe, octillions (1048) of transistors photolithographed onto integrated circuits. In the chemical sector, the most momentous change was the development of a global hydrocarbon system extending from oil fields and refineries to internal combustion engines and food additives. The precise breakdown and recombination of simple carbon-based chemical compounds and their respective polymerization products brought about the "molecular mobilization" of fuels and plastics.[29] Although this process began before 1948, it did not experience an explosive expansion until after World War II and the advent of "Hydrocarbon Man."[30]

Other large-scale consequences of the radical discretization of the world into smallest, mass-duplicated units[31] began to occur outside science. The supranational currency bancor was the premature attempt to create a global transaction space structured by the circulation of universal markers or tokens, intended to standardize nothing less than a global economy. What was ultimately left of it, GATT, produced the trade policy framework of the Great Acceleration, along with a host of political, economic, and cultural imbalances that favored the North. Alongside it arose other efforts to order Earth as an industrial-bureaucratic space. The most obvious examples are standardization systems such as the International Standard Industrial Classification of All Economic Activities, introduced by the UN in 1948 to classify statistical data across various economic areas. But they also include codifications of values such as the Universal Declaration of Human Rights, which was also adopted in 1948.

These examples of manipulation at the micro-level and its massive effects at the macro-level are tied to technologies that increasingly populate and saturate the planet as a whole. The historical result of this technological autopoiesis is that not only economic output and growth but also culture, politics, and science reoriented themselves to supporting the structural formation of the technosphere.[32] The crises we face today were born of this operational closure between the technosphere and the former "natural" spheres such as the biosphere, atmosphere, and lithosphere. The massive investment in research and technology that accompanied World War II catalyzed enormous creative power based on a capital-fueled market logic and East-West antagonisms. Though intellectuals in the immediate postwar era already remarked on this development,[33] the political will over the last decades to curb it has so far failed – too great are the infrastructural and political path dependencies of the technosphere and its ever-deepening grooves in the new planetary metabolism of humans and machines.

What the five speakers addressed at the Hotel Commodore[34] in March 1948, therefore, represented a major medial turn as part and parcel of a still larger turn of earthly matters. In close association with the global availability and distribution of raw materials and goods, with the development of nuclear weapons and defense systems, with an oil-based Pax Americana, with globalized science, and with international bureaucracy, the turn birthed a technology and a way of thinking that did much more than just optimizing electronic components. Engineers and CEOs alike fell gradually for the charms of the new cultural technique of digitally automated number processing whose credo is the representation of highly complex processes in binary circuit logic. Now it moves the world, effectively steering material and energetic flows within a technosphere spanning the globe from satellite orbits 40,000 km above the Earth's surface to 10 km into the lithosphere. Founded on the fundamental asymmetry between coded information and its physical effects – micro-energy inputs leveraging macro-energy impacts in the material world – digital media technologies have had a tremendous stake in the unleashing of Anthropocene drivers.[35]

At the same time, these media constitute the very same technologies that are key to detecting and understanding this transition. Monitoring and modeling the human-impacted Earth system are today squarely performed by digital technologies, but also shaping scientific, cultural, political, and even legal perception and the sense of place of living on a planet that has already transgressed its "boundaries of a safe operating space for humanity."[36]

Shortly after the turn of the new millennium, many believed that we had entered a new scientific era, one in which nanotechnology, biotechnology, information technology, and cognitive science would converge into a single, unified program. While this outlook may have been fueled by a megalomanic techno-optimism, the reality today is not far from what they predicted: bio-informatics, gene editing techniques like CRISPR, the creation of synthetic organisms and the engineering of metabolic pathways, new functional materials, synthetic minerals and chemical compounds, algorithms that code real-world phenomena and everything else that powers the dreams of post-cybernetics, from the buzz words of yesterday like Industry 4.0 and the Internet of Things to the buzz words of today like smart farming and the coming climate-tech economy. What we are witnessing now, in other words, is the gradual fusion of developments that were made possible in and around 1948. We are at the provisional end of a cascading process that started to gain momentum in the middle of the 20th century. The confluence of events in and around the year 1948 established a technical and social lock-in situation. Despite the astonishing speed of technological progress, the LP whose cover bears this epoch-making and hitherto neglected year continues to play.[37]

Notes

1 1948 I.R.E. National Convention Program, *Proceedings of the IRE* 36, no. 6 (1948): 754.

2 Norbert Wiener, *Cybernetics or Control and Communication in the Animal and the Machine* (Cambridge, MA: MIT Press, 1948). Wiener came up with the idea for the book during a meeting with the publisher Enrique Freymann, who operated a small bookstore at the Sorbonne. Under contract with Freymann, Wiener wrote his most famous work for the small publishing house Hermann et Cie. It was only later that MIT Press acquired the rights.

3 Claude E. Shannon, "A Mathematical Theory of Communication," *Bell Labs Technical Journal* 27 (1948): 379–423; 623–656. The complete essay appeared one year later with a general introduction by Warren Weaver in Claude E. Shannon & Warren Weaver, *The Mathematical Theory of Communication* (Urbana: University of Illinois Press, 1949).

4 Twenty years later, on the occasion of the anniversary of the founding of the Association for Computing Machinery, Jay Forrester – the inventor of the magnetic-core memory for computer RAM and the founder of the Institute for System Dynamics at MIT, entrusted with simulating the "limits of growth" for the Club of Rome – spoke of the disconnect between Old World intellectualism and Yankee engineering:

> Many years ago, I found myself seated at the end of a table about this wide at lunch and on one side was John von Neumann and on the other side was Norbert Wiener and they totally ignored me but they spent the…entire lunch discussing how you would translate modern tabloid headlines into four letter renaissance English words

(*ACM Annual Meeting*, Computer Oral History Collection, Archives Center, National Museum of American History, Washington, D.C., Transcripts, 1969–1973, 1977, Box 2, Folder 3).

5 In early 1948, Louis Bean, a Lithuanian-born advisor in the US Department of Agriculture, published the book *How to Predict Elections*. Using a novel approach based

on statistical observations of election cycles, he correctly predicted – contrary to the projections of America's political pundits – that Harry Truman would be reelected and that the Democrats would take control of Congress. It was the very same Democrat-led Congress that did not allow a vote on the Havana Charter, which proposed restrictions on the global trade of agricultural goods to protect local farming communities and ensure regional diversity.

6 See Timothy Mitchell, *Carbon Democracy: Political Power in the Age of Oil* (London & New York: Verso, 2011), 100ff.

7 See Mitchell, *Carbon Democracy*, 41f.

8 See Daniel Yergin, *The Prize: The Epic Quest for Oil, Money & Power* (New York: Simon & Schuster, 1991), 409 and 422ff.

9 Anne Fleckstein, "'Nothing but the Truth': Bezeugen in der südafrikanischen Wahrheitskommission," *Politik der Zeugenschaft*, eds. Sibylle Schmidt, Sybille Krämer, & Ramon Voges (Bielefeld: Transcript, 2014), 311–330.

10 See Nils Roll-Hansen, "Wishful Science: The Persistence of T. D. Lysenko's Agrobiology in the Politics of Science," *Osiris* 23, no. 1 (2008): 115–135.

11 The Swiss chemist Paul Hermann Müller was awarded the 1948 Nobel Prize in Medicine for discovering DDT's insecticidal properties. Also in that year, the Nobel committee considered giving Josef Stalin the Nobel Peace Prize but ultimately decided not to name a recipient.

12 See Hans-Jörg Rheinberger & Staffan Müller-Wille, *Vererbung: Geschichte und Kultur eines biologischen Konzepts* (Frankfurt am Main: Fischer, 2009), 248.

13 See Paul Josephson, "The Stalin Plan for the Transformation of Nature, and the East European Experience," *The Name of the Great Work: Stalin's Plan for the Transformation of Nature and its Impact in Eastern Europe*, ed. Doubravka Olšáková (New York: Berghahn Books, 2016), 1–41. See also Paul R. Josephson, *Industrialized Nature: Brute Force Technology and the Transformation of the Natural World* (Washington, D.C.: Island Press, 2002).

14 Stephen Brain, "The Great Stalin Plan for the Transformation of Nature," *Environmental History* 15, no. 4 (2010): 670–700.

15 Harold C. Urey, "Oxygen Isotopes in Nature and in the Laboratory," *Science* 108, no. 2810 (1948): 489–496. On this episode see Christoph Rosol, "Hauling Data. Anthropocene Analogues, Paleoceanography and Missing Paradigm Shifts," *Historical Social Research* 40, no. 2 (2015): 37–66.

16 Emily M. Kern, "Archaeology Enters the 'Atomic Age': A Short History of Radiocarbon, 1946–1960," *The British Journal for the History of Science* 53, no. 2 (2020): 207–227, here 221f.

17 See Perrin Selcer, *The Postwar Origins of the Global Environment: How the United Nations Built Spaceship Earth* (New York: Columbia University Press, 2018). See also Paul Warde, Libby Robin, & Sverker Sörlin, *The Environment. A History of the Idea* (Baltimore: Johns Hopkins University Press, 2018), 53ff.

18 Warde et al., *The Environment*, 20ff.

19 Jacob Darwin Hamblin, *Arming Mother Nature: The Birth of Catastrophic Environmentalism* (London: Oxford University Press, 2013).

20 A key paper for such understanding is George Evelyn Hutchinson's 1948 paper: "Circular Causal Systems in Ecology," *Annals of the New York Academy of Sciences* 50, no. 4 (1948), 221–246.

21 As the Australian historian Martin Thomas observes, the expedition is its own "*genre*…a distinctive and self-perpetuating mode of moving, acting, organizing and writing," Martin Thomas, "Expedition as Time Capsule: Introducing the American-Australian Scientific Expedition to Arnhem Land," *Exploring the Legacy of the 1948 Arnhem Land Expedition*, eds. Martin Thomas & Margo Neale (Canberra: ANU Press, 2011), 18.

22 Elizabeth Kolbert, "CRISPR and the Splice to Survive," *The New Yorker*, January 11, 2021, URL: https://www.newyorker.com/magazine/2021/01/18/crispr-and-the-splice-to-survive

23 The residues from nuclear weapons testings serve as prime markers in identifying a distinct stratigraphic boundary for the start of the Anthropocene. See, for instance, several contributions in the "Nuclear Anthropocene" dossier at *Anthropogenic Markers: Stratigraphy and Context*, eds. Christoph Rosol and Giulia Rispoli (online at Anthropocene Curriculum, 2022), URL: https://www.anthropocene-curriculum.org/anthropogenic-markers/nuclear-anthropocene

24 See Jan Zalasiewicz et al., "When Did the Anthropocene Begin? A Mid-Twentieth Century Boundary Level Is Stratigraphically Optimal," *Quaternary International* 383 (2015): 196–203.

25 The metaphor of modernity as a heavy, unstoppable juggernaut derives from Anthony Giddens, *The Consequences of Modernity* (Stanford: Stanford University Press, 1990).

26 See ibid. and Will Steffen et al., "The Trajectory of the Anthropocene: The Great Acceleration," *The Anthropocene Review* 2, no. 1 (2015): 81–98.

27 Cf. Christoph Rosol, "Which Design for a Weather Predictor? Speculating on the Future of Electronic Forecasting in Post-War America," *Cultures of Prediction in Atmospheric and Climate Science. Epistemic and Cultural Shifts in Computer-based Modelling and Simulation*, eds. Matthias Heymann, Gabriele Gramelsberger & Martin Mahony (London: Routledge, 2017), 68–84; Christoph Rosol, "Data, Models and Earth History in Deep Convolution. Paleoclimate Simulations and Their Epistemological Unrest," *Berichte zur Wissenschaftsgeschichte* 40, no. 2 (2017): 120–139.

28 On October 22, 1948, the Haloid Company revealed its xerography technology. One year later, it rolled out the world's first commercial photocopier, the XeroX Model A.

29 Benjamin Steininger, "Petromoderne Petromonströs," *Technology and the Sublime*, eds. Giulia Rispoli & Christoph Rosol, special issue, *Azimuth* 12, no. 2 (2018), 23.

30 Yergin, *The Prize*, 541.

31 No wonder that even the famous "αβγ-paper," explaining the origin of the building blocks of the universe through big-bang nucleo-synthesis, was published in 1948: Ralph A. Alpher, Hans Bethe, & George Gamow: "The Origin of Chemical Elements," *Physical Review* 73, no. 803 (1948).

32 For more on the concept of technological autopoiesis, see Bronislaw Szerszynski: "Vom Werkzeug zur Technosphäre," *Technosphäre*, eds. Katrin Klingan & Christoph Rosol (Berlin: Matthes & Seitz, 2019), 48–63.

33 See, for instance, Robert Jungk's travel reports from the farms, laboratories, and offices of the American model in *Tomorrow Is Already Here* (New York: Simon & Schuster, 1954).

34 Indeed, the Hotel Commodore is itself a symbol of hypercapitalist continuity. Opened in 1919 and located next to the Grand Central Station, the hotel was named after "Commodore" Cornelius Vanderbilt, the founder of the New York Central Railroad. Donald Trump acquired the run-down hotel in the late 1970s under dubious circumstances. It was his first major project as a developer and the start of his real-estate empire. However, his business partner in the deal, Hyatt Hotels, would later outmaneuver him, buying his stake in the hotel in 1996.

35 For more on that topic cf. Christoph Rosol et al., "On the Age of Computation in the Epoch of Humankind," *Nature Outlook* 563, no. 7733 (2018): 1–5.

36 Will Steffen, "The Planetary Boundaries Framework: Defining a Safe Operating Space for Humanity," *The Safe Operating Space Treaty. A New Approach to Managing Our Use of the Earth System*, eds. Paulo Magalhães, Will Steffen, Klaus Bosselmann, Alexandra Aragão, & Viriato Soromenho-Marques (Cambridge: Cambridge Scholars Publishing, 2016), 23–46.

37 The Hungarian-American engineer Peter Carl Goldmark and his team at Columbia Records developed a 33 1/3 rpm long-playing disc made of polyvinyl chloride (PVC). Its introduction in 1948 marked the end of shellac records and the advent of the vinyl era.

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