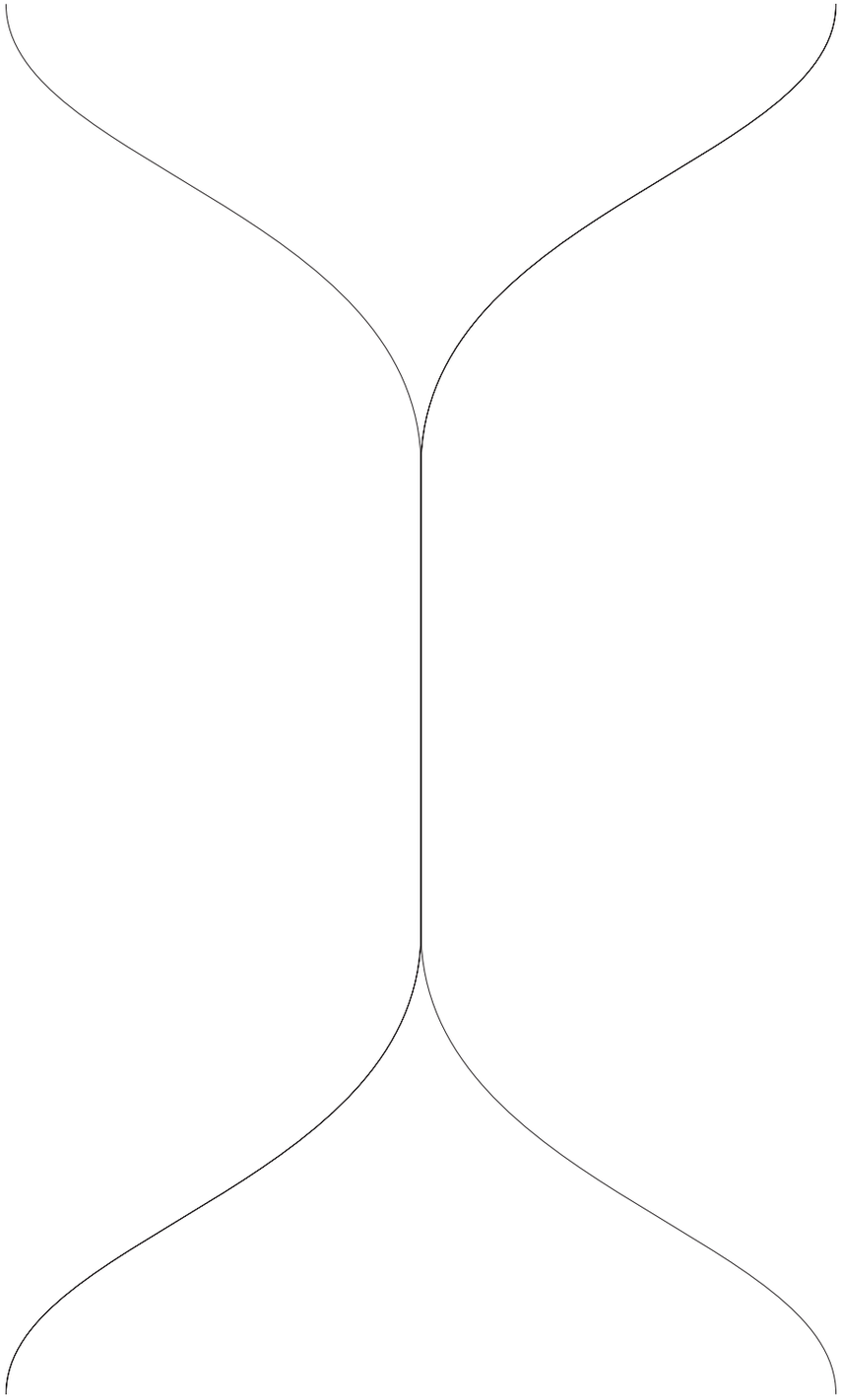
Infrastructure as Critique



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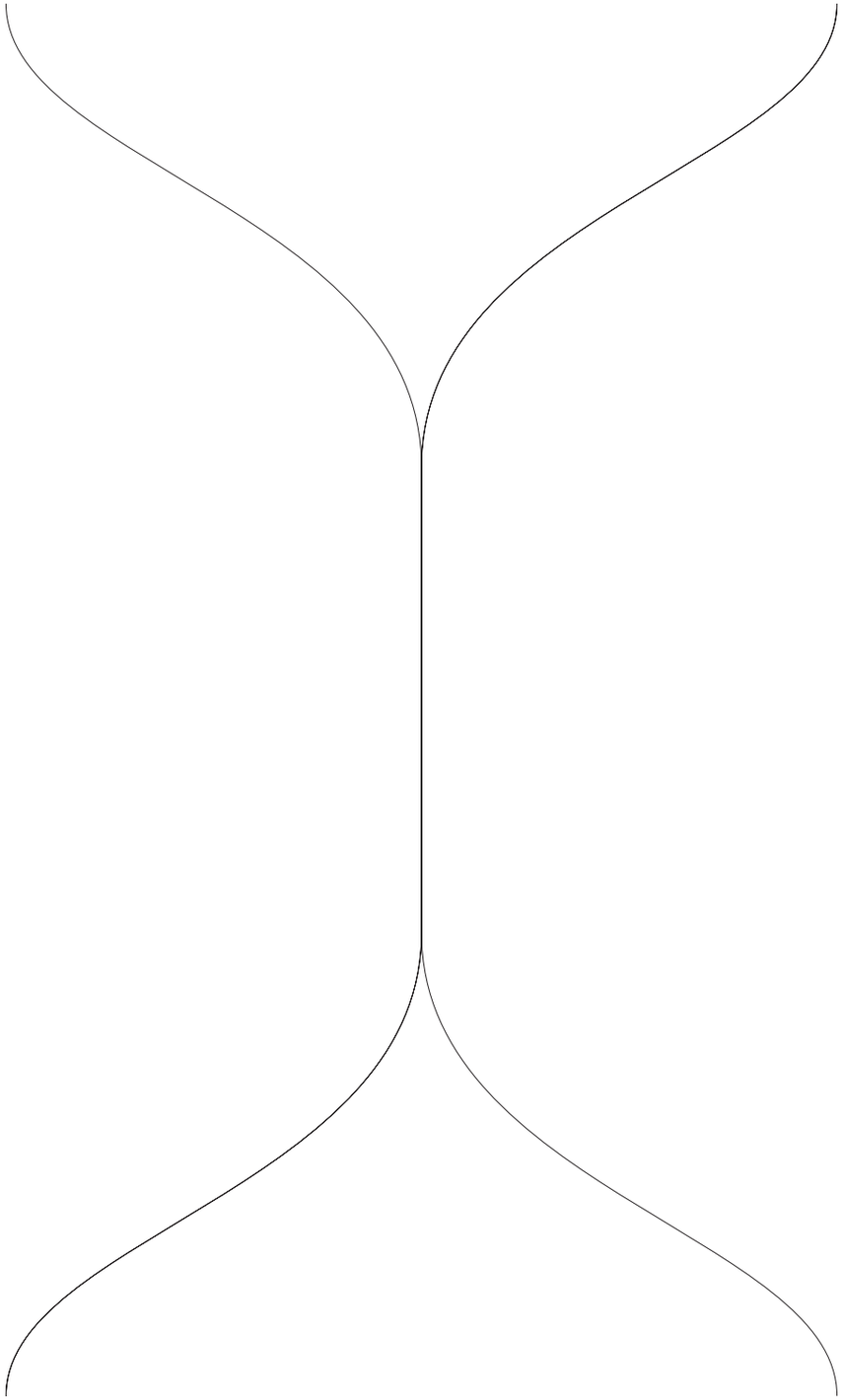

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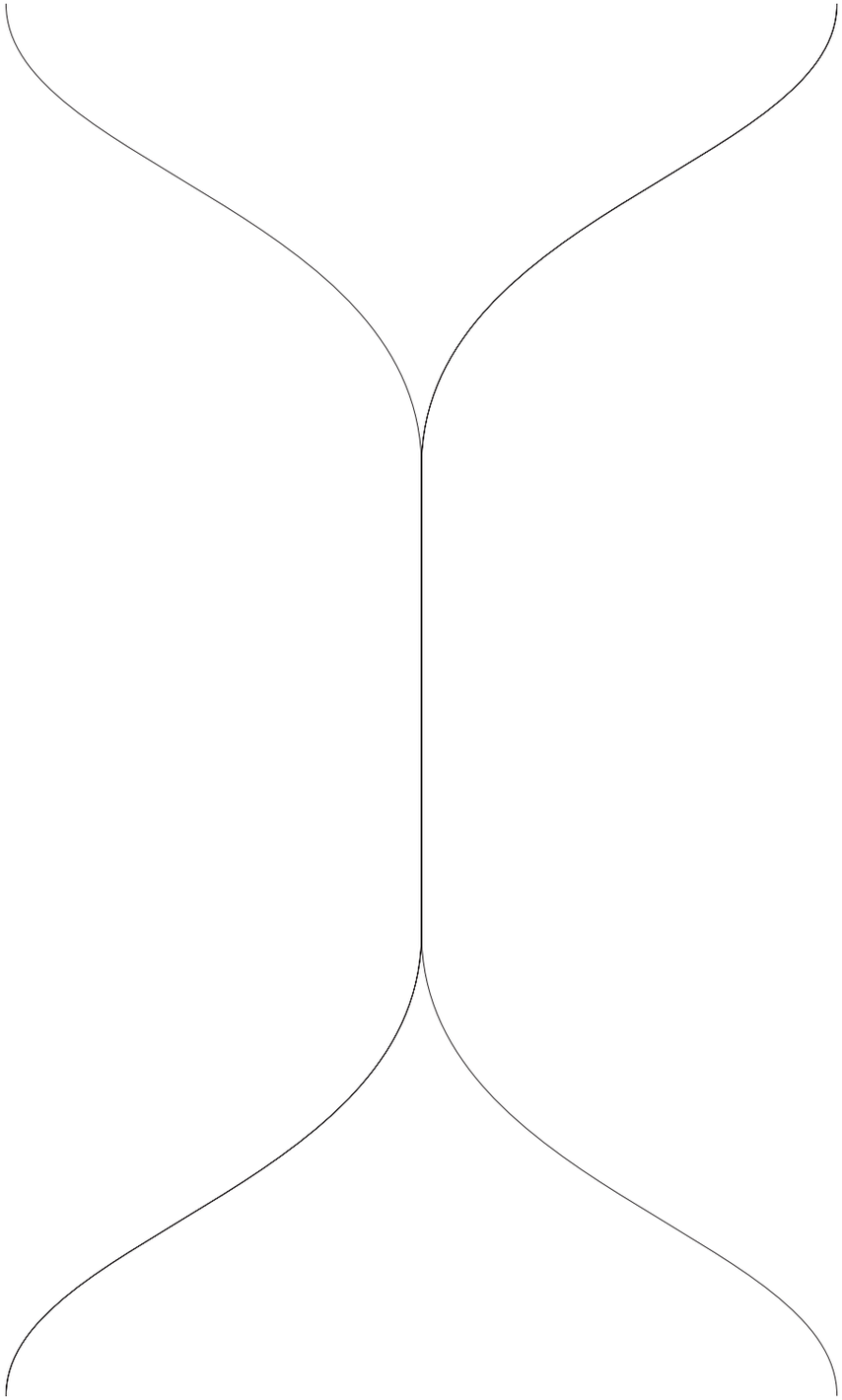


EDITORIAL

Whenever we are talking about planning, we are talking about infrastructure as critique. What we have in mind here was best encapsulated in a diagram[1] Pierce Myers posted on Instagram. In it, he swapped the left vs right axis with emergent distributional communism vs planned hyper-capitalism—in other words, he combined various supposedly contradictory elements and made a convincing case for how the battle between communism and capitalism will take place in the 21st century. On the one hand, Myers switched the emphasis from Soviet-led central planning to a decentralised cybernetic version of it, and on the other, shifted from neoliberal consensus of market efficiency and equilibrium to mechanism design and the new role of economist-as-engineer. What this diagram does best, then, is that it decodes the idea of what communism and capitalism as two different models actually are, and thereby challenges the various preconceptions of what is efficient and necessary in the current system.

This enables us to think differently about ideology as well. As Mckenzie Wark wrote[2] in *Molecular Red: Theory for the Anthropocene*: "Ideologies are not so much 'false consciousness' as the 'true' limited consciousness of particular modes of organization." The same can be said in relation to planning or infrastructure as critique. We can put forth a different measurement of ideology, where ideology is measured as the ability of a group or a collective to pursue and implement different societal mechanisms that increase the degree of societal complexity and the ability of self-determination. If this sounds abstract, let us give a further example from RadicalxChange founder Glen Weyl. In a rather Marxist-Spinozist way, Weyl points out various internal inconsistencies[3] between capital-

1 See: https://www.instagram.com/p/B8ZalfkFbx_/.

2 Verso, 2016, p. 46.

3 "The Political Philosophy Of RadicalxChange", ***RadicalxChange***, 19/12/2019, https://blog.radicalxchange.org/blog/posts/2019-12-30-gqx4th/.

ism and its own theory: what he suggests is to critique capitalism at its very roots, through the parameters capitalist economists take for granted, but which don't actually lead to the benefits supposedly characteristic of a capitalist society.

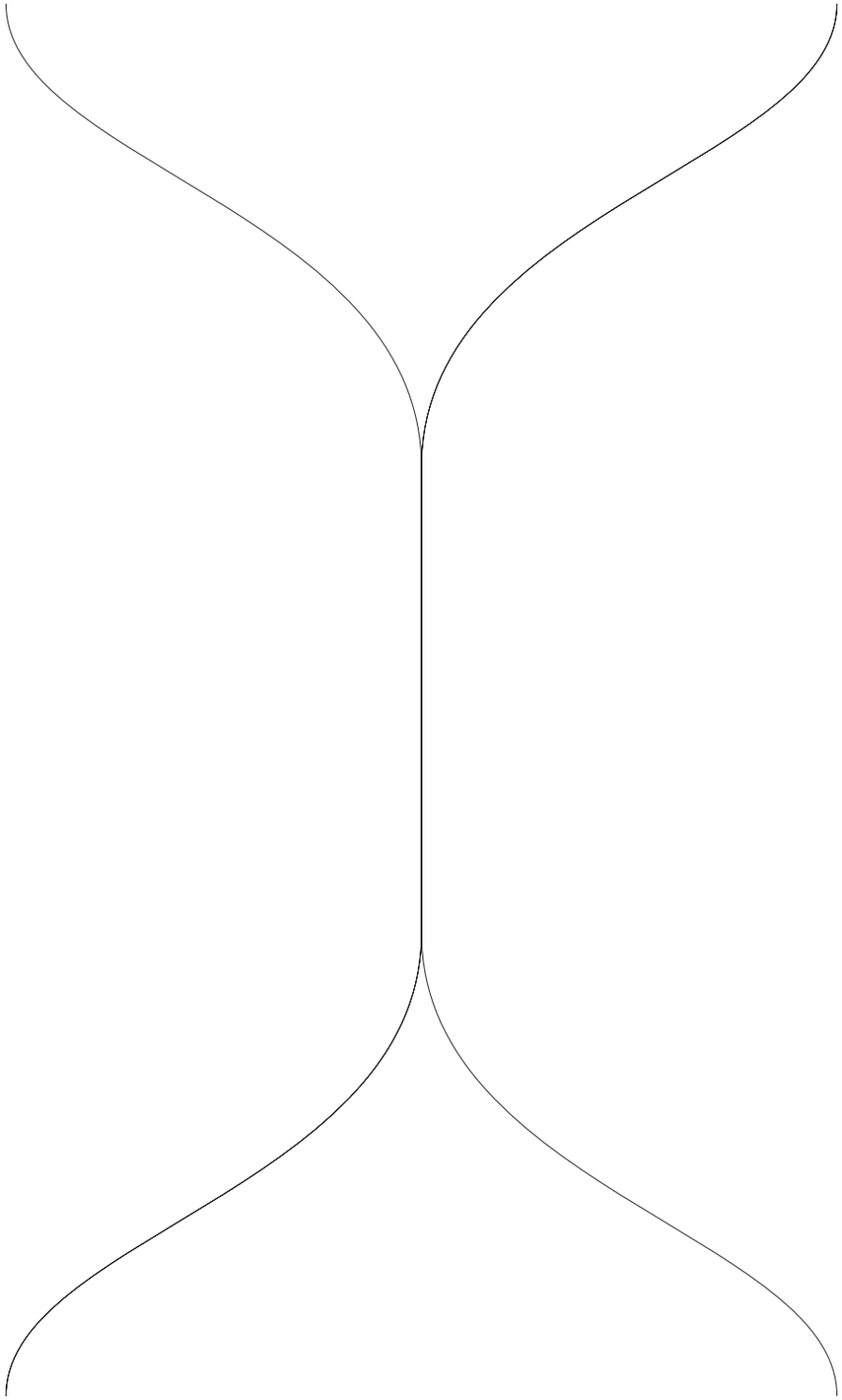
What all of this tells us is that planning (or infrastructure as critique) is not primarily about planning at all, since it can, for example, mean less planning. It's not about the management of X-risk, systemic surveillance or even better resource allocation, but about exposing alternative narratives and capabilities (meaning: inter-systemic speculations) that were intentionally or unintentionally not pursued or left behind. Planning has this primordial excess, as it always includes a completely different view of the world and expresses the changing relationship between matter and society or between ideas and the physical world. Simply put, planning is in fashion again, but for different reasons as it has been in the past. Every time we plan, we make visible what was previously hidden. We mine the history of ideas and denaturalise various assumptions and conclusions, which could not have been addressed without the new emphasis on infrastructure as critique. Planning is therefore a toolkit for realising new (and already present) futures, just as the film screen is a canvas for alternative histories, such as the first Moon landing by a Russian and not American astronaut, or the existence of multi-world fascism on a cosmic level.

There is, of course, a difference between a descriptive or prescriptive take on planning, and also between infrastructure as critique within and outside the system. Because planning has this speculative dimension in both of these forms, it can challenge the status quo of a given society, even if it's embroiled in all the dirty mechanisms as well. The best example of this is the crypto world: despite its absolutely capitalist way of planning, it radically challenges the neoliberal consensus and produces an opening in its stead. Jaya Klara Brekke formulated[4] this predicament in a very clear and insightful manner: "This suggests that even the metallist monetary ideas that Golumbia traces to anti-central bank right wing ideology (2016), is to some extent motivated by an ambition to resolve political economic questions through infrastructure … Rather than an entrenched affiliation to neoliberal economics, the economies and economics of Bitcoin, blockchain, DLT and cryptoeconomics are better understood as efforts to-

4 "Hacker-engineers and Their Economies: The Political Economy of Decentralised Networks and 'Cryptoeconomics'", in: ***New Political Economy***, 12/8/2020, https://www.tandfonline.com/doi/10.1080/13563467.2020.1806223.

wards engineering particular kinds of network behaviours, and achieving specific information security properties."

We could therefore say that planning is, in its essence, post-critical. To quote Weyl: "The key point is that if you want to undermine a system, the most powerful way to do it is using its own internal logic." To criticize a system in a way that, through accelerating its underlying foundations, leads to a logically consistent conclusions that subvert the existing model from within. In this sense, each system has its own Black Hole image that acts traumatically and a Copernicus that looks at the stars. And it's safe to say that something similar is happening in the post-covid-19 world, where the sedatives from the capitalist realism era are slowly wearing off and the new paradigmatic shift in knowledge production is taking place. As Reza Negarestani said, "consciousness is hard work" and maybe, just maybe, this unexpected pandemic hit will prepare us for the truly distributed problems and challenges we will face as a society when hyperobjects start to bomb the Earth. But when this happens, we will, thanks to the emphasis on infrastructure as critique, already have our values set differently, optimize for something else, set our parameters more holistically, know the necessity of governance futurism and embrace the need for smart visual culture.



EVERY FIRM IS A PLANNED ECONOMY

Did you ever hear about the future?

Maybe you even remember it yourself. It lived for a brief moment, somewhere between the Soviet Union's death and Microsoft's rise. Young Muscovites were becoming day traders instead of party apparatchiks, and Gorbachev was eating[1] Pizza Hut. A world order of markets and democratic freedom was in full swing. The new frontier lay in a borderless, anonymous internet. The great powers, the multinational conglomerates, and the panopticon security agencies? All were on the brink of being felled by decentralization, disruption, and tech-driven liberation. Free and sovereign individuals were walking out of the wreckage of the 20th century.

Liberatory visions of the future have left strong echoes throughout our culture. The dystopian Blade Runner images which have replaced them seem more like the result of a grieving process, rather than a real acceptance of utopianism's death. But the technologies which drove those images of the future have not died. The result is extreme dissonance between the future we were promised and the one in which we live.

Much of Silicon Valley pop ideology—whether cypherpunk, or the various iterations of libertarianism—is nominally suspicious of centralized power. Cryptocurrency was embraced as a

1 "Pizza Hut Gorbachev TV Spot Commercial", ***YouTube***, https://www.youtube.com/watch?v=fgm14D1jHUw&ab_channel=TomDarbyshire.

way to escape the coming collapse of central banking. Geographic escapism has always been popular as well, in the forms of seasteading, charter cities, or residences in New Zealand.

The irony, of course, is that digital power has accelerated nearly every trend which this attitude should theoretically oppose. Both great powers and great firms are able to monitor populations like never before—for the world-shakers like Amazon, Facebook, or China, that amounts to hundreds of millions, if not billions of people. Communications, content, or the ability to sell goods may be decentralized and more accessible, but the individual person has been made legible like never before. The only obstacles are how to properly analyze and use the enormous amount of information which commerce, security, and other aspects of daily life now make available.

The same logic has played out in other forms of decentralization. Rather than free cities or autonomous communities, we have special economic zones. Such experiments have accelerated economic development and brought millions out of poverty. But they have also enhanced the power of the central governments which have erected them. No one builds an SEZ with the intention of diminishing their power. The process often disrupts and outmodes middleman bureaucracies and legacy institutions, as well as local players who are unable to adapt or forcibly shunted aside.

The reality of decentralization is that it has a barbell shape. Successful local actors ultimately expand the power of central backers. The central actor is often far more coordinated and unified than the numerous participants in its ventures—bargaining does not occur on anything like an equal ground. A better term for how these various forms of decentralization work might be dynamic centralism: a process by which one actor disrupts peers, middlemen, or lower-level bodies through the creation of new decentralized networks. These networks provide various kinds of innovation and feedback of which the central actor is not immediately capable. But by either owning or having some control over the network, the central actor captures important gains.

With one future dead and buried, it can be tempting to escape into nihilism. A healthier response might be to remember that there are other futures, even utopian ones, beyond the marketing departments of Silicon Valley.

THE ECHOES OF CYBERSYN[2]

One of the stranger futures is the one imagined in Salvador Allende's Chile. The story starts with the theories of Stafford Beer, a British cyberneticist who was among the first to apply this research extensively to questions of management. Among those following his work were figures within the recently-elected socialist government of Salvador Allende in Chile. Unlike the Soviet Union, many of Allende's allies hoped to avoid the top-down centralism of its planned economy, instead protecting local initiative and the autonomy of workers. When they looked at the principles of cybernetics—rooted in how systems update and "learn" in response to feedback—they were convinced it could help them overcome the apparent contradictions of central planning which had plagued other socialist states.

This venture manifested as a network of telex machines. The idea was to place these in factories, which would provide the data necessary to check factory performance and relay information up and down the system. In line with both Beer's vision and those of his Chilean backers, the system provided autonomy for factories in resolving their own problems, with higher layers theoretically intervening only when an issue could not be resolved. Other tools assisted in simulating models of the economy, attempting to optimize the flows of production.

But the most iconic part of Cybersyn was the project's operations room. Beer and his associates put a great degree of thought into the room's aesthetics and functionality. Those in the operations room sat in seven swivel chairs, surrounded by the incoming and outcoming data of the nation's economic life, giving a centralized and conciliar air to a project nominally meant to avoid overly top-down methods of planning. Cybersyn was an aesthetic as well as a technological venture, and each aspect was meant to communicate the ideological values of a new society. It proved itself at least once, when the government used it to coordinate supplies in the face of an opposition-backed trucker strike.

Cybersyn met its end in the violent days following Pinochet's coup, and the American-backed overthrow of the Allende government. But much of the logic behind it did not. Dynamic feedback about producers and users drives every big data platform in the world. Global corporate franchise systems integrate subsidiarity

2 VILLARREAL, Nicolas, "How Capitalist Giants Use Socialist Cybernetic Planning", in: ***Palladium***, 23/9/2020, https://palladiummag.com/2020/09/23/how-capitalist-giants-use-socialist-cybernetic-planning/.

with central planning every day. Supply chains and online marketers apply predictive models to optimize the most niche links between production and consumption. Time and geopolitics may have wiped Allende and his allies from the earth. But Amazon, Google, and Walmart have created systems of economic planning of which Allende could only dream.

THE FIRM AGAINST THE MARKET

One way of looking at a market is to focus on the system of signals and exchanges, rather than the players. This is often useful. It can tell us when there is over- or undersupply. It educates us about the results of market power. It might reveal that people are lying about stated preferences. In many cases, it's how companies are looking at the world beyond their doors.

But in any industry, the danger is that these signals blind us to where the real source of value lies. Those who create, invent, build, and take risk are ultimately the source of wealth. Since no individual can do this alone, we build institutions which allow us to cooperate with each other. Every company and union, as well as every social or legal code governing labor and ownership, is ultimately an attempt to maximize the benefits of this cooperation while minimizing the cost—at least for the institution's creators. When people, organizations, or even entire classes clash against each other, it is because they believe that such cooperation is no longer possible under the current settlement.

More immediately, this means that the marketplace involves competition between different forms of human planning. This applies to highly competitive markets all through the spectrum to monopolies. The small-time widget maker who is unable to choose his own price must still plan his operation and optimize where he can, even if his time horizon and range of action are smaller than Amazon's. Markets discipline this process by forcing the firm to adapt to the behaviours of their competitors and client base, as well as the ripple effects of events beyond their immediate scope.

However, it's the large and disruptive operations which are the most interesting. Companies take risks because they have to, not because they want to. As companies grow in size and market power, they will move to become less reliant on external risks. Vertical integration, buying out potential competitors, bearing upfront costs to control platforms, and other strategies are all the

result of this desire to maximize what can be planned—at least up to the point where the costs would outweigh the benefits. For most firms, this is a continuous process and often requires updates when old models or strategies no longer apply.

The notion that firms embody a kind of central planning is not new. The British economist Ronald Coase[3] viewed the organizational goal of a firm as "suppression of the price system", and—quoting Dennis Robertson—"islands of conscious power in this sea of unconscious cooperation". It was a topic he debated with his liberal colleague Friedrich Hayek. While Hayek disliked any notion of central planning, he agreed with Coase that markets are systems of information. Critical of the dominant theories about general equilibrium, Hayek focused on what the presence or absence of equilibrium could tell us about how market actors plan and how their plans interact. Two of the ideas that informed his critique of socialist planning were that planners cannot ever access all the relevant information for a whole economy, and, additionally, that the private information of a certain actor isn't necessarily transferable.

Like states, firms also encounter the calculation problem. It's easier for a great many decisions to rely on signals communicated by the market. But the rise of digital platforms has given both states and companies access to a level of information that would have been unimaginable just a decade or two ago. It's also created tools with which to analyze and predict behaviours—not merely those formally expressed in the marketplace or the political sphere, but even personal interactions, movements, and habits.

This development mimics other forms of decentralization in important ways. Previously, finding out about extremely large groups of consumers or users required either in-house or external resources for research, often using trial-and-error, focus groups, or other measures. In the digital age, the relationship is direct. In the case of Facebook, users numbering in the billions generate data about their usage every day. As a result, it offers micro-targeted access to entire swathes of the global human population like no other service can. Like the other tech giants, it has pioneered using consumers rather than suppliers or distributors as a basis for market power.[4] The costs are borne by those who want to access this user base. Conflicts about Facebook algorithms and

3 BOWLES, Samuel, KIRMAN, Alan, SETHI, Rajiv, "Retrospectives: Friedrich Hayek and the Market Algorithm", in: ***Journal of Economic Perspectives***, 31, 3, Summer 2017, pp. 215–230, https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.31.3.215.

4 THOMPSON, Ben, "Aggregation Theory", in: ***Stratechery***, 21/7/2015, https://stratechery.com/2015/aggregation-theory/.

Amazon's power over its merchants are two prominent examples. The ability to gather data from both sides even gives the owners of such platforms the ability to begin competing themselves. Amazon has made forays into basic consumer goods and convenience stores, for example.

Compared with the relatively primitive feedback mechanisms of Cybersyn, modern digital platforms generate feedback at both a scale and precision that Beer and his collaborators could never have imagined. Silicon Valley's tech giants are far from the first monopolies to gain immense control over market forces. But they have pioneered technologies which allow them to learn from market feedback, react to changes, and anticipate the future in ways that outpace not only their private competitors, but even many states.[5]

HARNESSING THE MARKET

Despite this immense market power, these tech giants still run into the limits of information access which Hayek noted decades ago. As large as Amazon and its cohort may be, other sellers have knowledge and skills which they either can't access or where the price of such access exceeds its benefits. While unable to abolish the uncertainty and competition which markets represent, such a company's relationship with markets differs from that of the small-time widget maker. For a firm with high enough market power and the ability to bargain aggressively, markets can start becoming more of a tool than an overarching reality.

Amazon is a particularly interesting example. Even the internal infrastructure developed for use between its various teams is subjected to market forces—the company makes these tools available to third parties, and the disciplining effect means these tools have to stay cutting edge. Its famous cultural norms like the "two pizza" rule for team sizes or the "it's always Day 1" motto are reflections of a structural integration of market forces. Market power and access to a massive pool of data benefits innovation, but market competition is intentionally embraced to ensure all-important victories on the margin.

This relationship to markets looks startlingly like the economic dynamics pursued by many states. The active creation and stewarding of strategic markets by states is not unique to mod-

5 HOBART, Byrne, "Why Big Tech Is More Competent Than the US Government", in: ***Palladium***, 1/7/2020, https://palladiummag.com/2020/07/01/why-big-tech-is-more-competent-than-the-us-government/.

ern China, but was policy in America and Europe as their economies developed. Industries from 19th century steel to 21st century medicine and computing can pay homage to such practices. More recently, the concept of industrial policy has made a powerful comeback in the United States and its allies in the face of populist upheavals—either as a tool for or a defense against that disruption, depending on who is talking.

Like Amazon, states can use markets to ensure discipline within industries that they are otherwise granting protection of patronage. One example of this is export discipline. While many industries around the world enjoy both passive and active protectionist measures, a key element of successful industrial policy in East Asia was making such support dependent on export measures. From Japanese machine tools[6] **to Korean automakers,**[7] **the region's strong capacity is the legacy of the Cold War era policy of linking support to success in ruthless global export markets. States used this metric to measure success and root out firms which couldn't measure up to the political requirements of postwar construction. Decades earlier, the American System set of policies had allowed U.S. firms to similarly outcompete British and European ones. Public support can jumpstart an infant industry, but export discipline ensures that it finally produces a champion.**

But from the perspective of states, dominance in a single industry is a precarious situation. A single disruption or conflict can be ruinous. There's a reason the world's great centers are places like Beijing, New York, Mumbai, and London. Tulsa, Oklahoma, may have been the oil capital of the world, but a single lucrative resource does not make a world city.

The rise of the special economic zone occurred in part because of its effectiveness in giving a country access to numerous different sectors, especially skilled manufacturing or service industries. Many of the states who have used SEZs lacked either institutional or industrial capacity, and often both. By constructing, importing, or even partially outsourcing the former, the country hopes to incentivize direct investments of the latter. The greatest beneficiaries have been states struggling to build both state and industrial capacity, or to diversify their economies. States from

6 LANDAU-Taylor, Ben and DIXON-LUINENBURG, Oberon, "How State Capacity Drives Industrialization", in: ***Palladium***, 12/2/2020, https://palladiummag.com/2020/02/12/how-state-capacity-drives-industrialization/.

7 CHERIF, Reda, HASANOV, Fuad, ***The Return of the Policy That Shall Not Be Named: Principles of Industrial Policy***, IMF Working Paper No. 19/74, https://www.imf.org/en/Publications/WP/Issues/2019/03/26/The-Return-of-the-Policy-That-Shall-Not-Be-Named-Principles-of-Industrial-Policy-46710.

Saudi Arabia to Rwanda have eyed China's Shenzhen metropolis as they get to work on similar zones. While industrial policies allow states to develop particular markets, a successful SEZ allows them to create a hub of markets, a node within the global economic system. In other words, these markets—as markets—are themselves a planned and intentionally constructed element of the economy.

Both strategies take an approach to markets as tools or mechanisms, rather than some kind of natural social order. Direct investment and the like occurs on the part of actors in the market, but the market as a total system also provides feedback. States can back industries, but they can't usually pick winning companies. The market acts as a great filter. If a state is lucky, a national champion makes its way through.

States and firms alike receive feedback from markets, adapt, and learn in pursuit of their goals. In essence, markets are useful for these organizations for very similar reasons to digital platforms: as systems, they contain information which could never otherwise be accessed.

ANOTHER FUTURE

Western liberalism tied markets to freedom. But private capital has built monuments of economic planning beyond what Cybersyn could ever have imagined. Simultaneously, global markets are actively being developed by a Chinese regime which believes that it can outmode Westen liberalism as the vehicle of progress.[8] Both—implicitly or explicitly—based their achievements on a radically different view of markets as mechanisms for information, feedback, experimentation, and wealth creation. Likewise, both chose to implement economic planning wherever they deemed it worthwhile to suppress uncertainty. The world's digital giants have taken this desire for analytic predictability furtherest of all. Markets and planned economies of various kinds are not divergent paths, but instead exist symbiotically.

The dynamic centralist paradigm is not going away. Those organizations with the greatest capacity for spurring decentralization and connectivity are also positioned to greatly expand their power from it. The merger of state power and technological capacity was traditionally considered a deeply problematic trend

8 GREER, Tanner, "The Theory of History That Guides Xi Jinping", in: ***Palladium***, 8/7/2020, https://palladiummag.com/2020/07/08/the-theory-of-history-that-guides-xi-jinping/.

in American discourse. But increasingly, it is a formal and explicit goal. India's backing of the de facto national champion firm Reliance[9] for building 5G looks a lot more like China's model than America's, even if that model is intended to secure the country's sovereignty against Beijing. It is America itself that will have to update its priors.

Accepting the dynamic centralist paradigm means disciplining it on at least two levels: national economies overall, and powerful companies within them.

First, states cannot ignore the question of what kinds of wealth its economies create, and for whom. The value of markets is that they allow people to act on their advantages. But a private equity firm which is adept at gutting the long-term viability of other companies, for example, is not an advantage overall. Basic research in fields like materials science or energy, on the other hand, can potentially improve the lives of all of humanity. The Anglosphere's commitments to market liberalism have already been challenged on both right and left by the political reactions to decades of economic gutting. Between geopolitical and domestic pressures, ambitious political players in these countries have little reason to stick to an outmoded consensus.

But there is no guarantee that the response will necessarily favour a new wave of innovation and growth. As with America's coal industry, there are plenty of established interests which would be eager for support and protection. This means that a choice exists for the winners of a would-be realignment. One mix of policies could take inspiration from Germany,[10] where publicly backed research institutions work closely with industry clusters to test and roll out their work. But a merely reactionary and protectionist approach could put it on the sluggish paths of France or India. The former uses markets as a mechanism to hone its industrial advantages, just as many East Asian states did to develop theirs. But the latter two have fallen behind in realizing their potential.

9 HOBART, Byrne, "India's TikTok Ban Is a Step Toward Digital Sovereignty", in: ***Palladium***, 22/8/2020, https://palladiummag.com/2020/08/22/indias-tiktok-ban-is-a-step-toward-digital-sovereignty/.

10 https://mp.weixin.qq.com/s?__biz=MzI0NjM1MDAxNA==&mid=2247483986&idx=1&sn=90cf748b2691e7c87e1b02d14fbab8ae&chksm=e941eb83de36629531914da4fe3f26b86095014734ce215b998b3335576c84efee395a34b3d9&mpshare=1&scene=1&srcid=0825PxtF8j67tkCb9ugr3apg&sharer_sharetime=1598323460880&sharer_shareid=f6eb67c8e0adbf2d453dea1dc30274d3&exportkey=Ak5q7gMJrUkQ1xdjJ6M0Xmc%3D&pass_ticket=O9wA/LzEsILWn4SF82g%2BZnNFrc4qz3mQjS%2BVd23pxKxlPz0ASCHGVdlVCGyJwFdZ&wx_header=0#rd.

Second, the growing power of the most successful private centers makes them inherently political entities. If a powerful company cannot be brought into alignment with the state and the greater interests of society, then it must be brought to heel with the tools of antitrust, many of which themselves need deep reform. But another question arises: under what circumstances is it desirable to let a large organization function, particularly an innovative and strategically important one?

Where high market power does exist, one solution is to ensure it is priced properly. Market power often expresses itself through rents: income earned from ownership or excess market power rather than production. Examples are income earned from mere ownership (land, capital, or intellectual), or from natural monopolies and network effects. Sometimes, rent-seeking is harmful enough to be strictly banned, like when it corrupts public agencies. But states should also target and tax legal rents as a fair price for exercising market power, even when that power is used for useful innovation. The goal of such taxes is to socialize some portion of the benefits of market power in order to compensate for the social costs. While the company still gains benefits from its ability to suppress the price system, it no longer has the right or ability to totally privatize them. Likewise, the active strengthening of labour unions, as well as placing labour representatives on boards, would counteract the ability of large companies to suppress wages and labour power. On the political side, the challenge here is overcoming the temptation to simply loot the company for short-term gain.

Ultimately, these measures exist in order to discipline market power and ensure that wealth is developed properly. But this shouldn't entirely distract us from the act of production itself. Both today and in previous gilded ages, these crises arise because of new technologies which have revolutionized societies. Cybersyn's real test would not merely have been whether it could take over the logistical management of Chile's economy as it existed at that point, but whether it could produce its next great transformation. Any economic planner, public or private, must ultimately learn how to update in response to what cannot be planned—otherwise, they stagnate and perish.

With much of the world's population now integrated into vast networks of markets and digital platforms, these forces are no less powerful for how they have been misread. Those with power can elevate the material conditions of their nations, but can also

brutalize the human being[11] in new ways. China itself is learning this as its material progress advances. With the Chinese Academy of Social Sciences[12] warning of China's transformation into a "society of strangers", the party-state's social credit systems are an attempt to fill the moral vacuum.

Once we understand the real logic of these social technologies, we are left with harnessing them properly for the advancement and flourishing of the human species. A clear vision of what this looks like precedes all questions of function.

Ash Milton is managing editor at *Palladium Magazine*. His overarching interest is the functioning of human civilizations, particularly the intersections of economics, institutional analysis and religion. After graduating from the University of British Columbia's Global Resource Systems program, where he studied economics, Ash worked as a market analyst and researcher before joining *Palladium*. He is now based in Toronto. The center of the governance futurism community, *Palladium* explores the future of our institutions, our societies and the world order.

11 MIKHAILOV, Vadim, "A Week in Xinjiang's Absolute Surveillance State", in: ***Palladium***, 29/11/2018, https://palladiummag.com/2018/11/29/a-week-in-xinjiangs-absolute-surveillance-state/.

12 KIRK, Hannah Rose, LEE, Kangkyu, MICALLEF, Carlisle, "The Nuances of Confucianism in Technology Policay: an Inquiry into the Interaction Between Cultural and Political Systems in Chinese Digital Ethics", in: ***International Journal of Politics, Culture, and Society***, 19/8/2020, https://doi.org/10.1007/s10767-020-09370-8.

OPTIMIZE THIS!

Over three billion people could not afford a healthy diet in 2019. That's about two out of every five on our planet earth. Of those, around 690 million—9% of the global population—are hungry. And yet, one-third of the food produced globally is lost or wasted. Why can't we feed everyone?

Feeding people costs money. Over 40% of the true costs of food production are not reflected in food prices. Costs are denominated in other currencies, too: land use, water use, and emissions, to name a few. Global croplands could color in the entire continent of South America. Global pasturelands rival Africa in size. These swathes of land soak up valuable resources and spit off harmful gases into our rapidly warming atmosphere. Agriculture accounts for 70% of global water consumption. Global food waste generates 8% of greenhouse gas emissions.

All of this soaking and spitting, this tilling, killing and milling, is delicately choreographed on a protean stage. Just three crops—wheat, maize and rice—comprise over 40% of worldwide caloric intake. Imagine if, one season, climate change were to unleash an unpredictable infestation of pests, disease or weather conditions that made just one of these crops untenable. The resulting worldwide shortages would be devastating. Even barring a sudden crisis, crop yields for these three cereals are likely to deplete by at least 10% over the next 10 years due to climate changes

already underway, while demand for them is expected to increase in line with 16% global population growth over the same time.

The way we do it now, feeding people is a massive global enterprise. It strains our soil, air and water. It is a fragile system, defenseless against economic and environmental shocks. One might wonder if there were a better way to organize—or *optimize*—the whole affair.

In the mid-20th century, a cluster of mathematicians, statisticians, economists and bureaucrats in the U.S. acted on a related impulse to optimize. They asked a deceptively simple question:

> What is the minimum amount of money an individual could spend on food, while getting all the required nutrients?

The Diet Problem, as it came to be known, is what mathematicians call a *constrained optimization problem*. Mathematically, its answer is the solution to a system of equations in many unknowns. More broadly, the Diet Problem is a core question about human survival in commodity capitalism. Its answer is a barometer for inflation and the cost of living, and an input to decision-making in social, environmental, and economic policy.

Inherent in the question is a normative stance so definitive, and so banal, that it is easy to miss: since prices cannot be controlled, some cannot afford to live.

Constrained optimization problems often quietly embody normative positions when they make their defining commands: **Optimize *THIS* subject to *THAT*.** The choice of *this* versus *that* is an ordering of priorities. What is negotiable ("what can we do") versus non-negotiable ("what must be done")? Here's one ordering of priorities: Aim to feed the most people given that prices are set by some external, invisible force. Here's another: Set prices so that, at minimum, all people are fed.

Which ground conditions are taken as fixed and unchanging and which are deemed flexible? Who ought to have authority to formulate an objective in the first place?

Simple as it seems in our time of ubiquitous mathematical modeling and endless computing power, an algorithmic solution to the Diet Problem eluded many bright minds for many dark years. This essay is a tour that guides us toward the Diet Problem's solution. Along the tour, we will see the marriage of computing and economics through the mathematics of optimization. We will witness the fusion—and confusion—of the "engineer"

and the "economist". I begin with a peek through the revolving door of a government institution that played host to a colorful cast of economists, engineers, mathematicians, statisticians and proto-computer scientists. I end with a discussion of how advances in the science of optimization once reordered the way we think about market organization on local, national and global scales—and may do so once again.

The story begins as the Great Depression collided into the Second World War. Dire economic circumstances traced out research frontiers in economics and engineering.[1] **We venture first into an administrative unit in the bowels of American bureaucracy: the Bureau of Labor Statistics.**

——ROLL CALL——

A future president of the American Statistical Association, graduate student Jerry Cornfield, arrived at the Bureau of Labor Statistics in 1934. Over the ensuing years, he would ping-pong around Washington, D.C. Colleagues would know he was in the office by the pipe smoke and the impish laugh emanating from his assigned corner. Mostly, he split his time between the Bureau's offices in the Department of Labor on 14th and Constitution Avenue, and the Department of Agriculture's Graduate School a few blocks south.

In 1937, 25 year-old economist Milton Friedman left his post working on the Urban Study of Consumer Purchases, an initiative sponsored by the Bureau of Labor Statistics. *The Economist* would, in 2014, call him "the most influential economist of the second half of the 20th century … possibly of all of it."

Young Friedman's departure freed up a position. A young mathematician fresh off a master's degree in mathematics, George Dantzig, filled the vacancy.[2] **Dantzig was hired as a Statistical Clerk for the Urban Study of Consumer Purchases. He was paid $1,140 per year. Later, as a PhD student at UC Berkeley, Dantzig mistook a famous unsolved question in statistics on the blackboard for a homework problem, and to his professor's amazement, solved it in a matter of weeks. The event made Dantzig an instant legend, and inspired a similar scene in the 1997 blockbuster *Good Will Hunting*.**

1 For book-length discussions on the co-evolution of economics and computing during this period in the U.S., see MIROWSKI, Philip, ***Machine Dreams: How Economics Became a Cyborg Science,*** Cambridge University Press, 2008; and ERICKSON, Paul, ***The World the Game Theorists Made*****,** University of Chicago Press, 2015.

2 DANTZIG, George, "The Diet Problem", in: ***Interfaces*****,** Vol. 20, No. 4, July 1990, https://web.archive.org/web/20160411141356/https:/dl.dropboxusercontent.com/u/5317066/1990-dantzig-dietproblem.pdf.

Not quite a coeval of these fresh faces in economics, Harvard Professor of Economics Wassily Leontief was also a frequent visitor to 14th Street and Constitution Avenue between 1941 and 1945. Born in 1906 and arrested more than once by the Bolshevik police before leaving the Soviet Union at the age of 19,[3] **Leontief is best known for his Nobel Prize winning development of Input-Output Analysis. The Bureau of Labor Statistics hired him to apply his model to the interdependencies of the U.S. economy, asking questions like "How will the cessation of war purchases of planes, guns, tanks, and ships—if not compensated by increased demand for other types of commodities—affect the national level of employment?"**[4]

In 1961, George Stigler led the Price Statistics Review Committee on a quest to better understand the measurement of inflation. The committee, which came to be known as the Stigler Commission, led to the establishment of a permanent research division for the study of prices at the Bureau of Labor Statistics. A couple decades later, Stigler would surprise and embarrass the sitting U.S. President Ronald Reagan in the heat of his campaign for re-election, by referring to Reagan's supply side economics as a "gimmick" when talking to reporters in the White House press room.

——THE DIET PROBLEM——

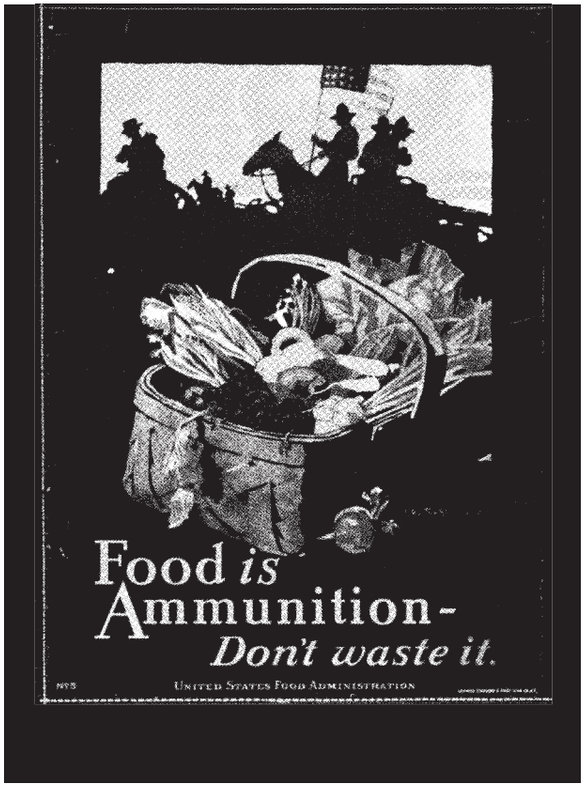
During the war, the U.S. Army asked Cornfield to come up with a low-cost diet for G.I. soldiers. Cornfield, still plodding in and out of government buildings in 1941, wrote down a mathematical statement of the problem and offered an approximate solution in an unpublished Bureau of Labor Statistics memorandum.

Meanwhile, Stigler also searched for a solution to the Diet Problem. His search culminated in an essay titled "The Cost of Subsistence," published in a 1945 issue of the *Journal of Farm Economics*.

At the start of the essay, Stigler clears his throat:

3 BERGSON, Abram, "Wassily Leontief", in: ***Proceedings of the American Philosophical Society*****,** Vol. 144, No. 4, December 2000,, https://www.jstor.org/stable/1515622.

4 KOHLI, Martin, "The Leontief-BLS partnership: a new framework for measurement", in: ***Monthly Labor Review*****,** June 2001, https://www.bls.gov/opub/mlr/2001/06/art3full.pdf.



> **Elaborate investigations have been made of the adequacy of diets at various income levels, and a considerable number of 'low-cost,' 'moderate,' and 'expensive' diets have been recommended to consumers. Yet, so far as I know, no one has mined the minimum cost of obtaining the amounts of calories, protein, minerals, and vitamins which these studies accept as adequate or optimum. This will be done in the present paper.**[5]

One of economists' most dubious superpowers is their ability to redescribe any situation with the building blocks of consumer and producer theory.

The consumer decides which commodities to buy. She hopes to maximize utility subject to her budget constraints. Meanwhile, the producer, usually thought to be a firm that owns a technology for converting inputs into outputs, is after profits. The firm wants to minimize costs while producing enough output to meet demand.

5 STIGLER, George, "The Cost of Subsistence", in: ***Journal of Farm Economics***, Vol. 27, No. 2, May 1945.

Naturally, then, Stigler compares the human body to a productive technology. Whereas firms' technologies take inputs (such as capital and labor) in order to produce outputs (products for consumption), the human body takes inputs (such as vitamins, minerals, calories) in order to produce health ("used here generically to describe strength, vigor, avoidance of disease, etc."). As Stigler sees it, there are two further similarities that make it appropriate to view the body as a health-producing technology.

First, just as in production technologies, most inputs to the nutrition function exhibit Diminishing Returns. The value of an additional unit of calcium for your health decreases the more of it you consume. Eventually, the value of an additional unit might even go negative: consume too much calcium and be struck with kidney disease and other health problems.

Second, just as in a firm's production of goods, the value of one input depends on what other inputs are used and in what quantity. In other words, the values of inputs in the health production function are Interdependent—you cannot fully understand the value of one input for health without knowing what other inputs will be present. For instance, without proper amounts of vitamin D, the body cannot absorb calcium.

Satisfied with his description of health as a productive technology, Stigler then turns to the data. He uses nutritional guidelines for a "moderately active man" who weighs 154 pounds. He draws on estimates of calories, protein, vitamins and minerals in common foods from a few nutritionists' surveys.

The diligent economist is careful not to overstate the precision of his exercise. An "apple" is not merely an "apple"! Different varieties of common foods exhibit unique nutritional profiles. The amount of vitamin C in an apple of the Northern Spy variety, Stigler tells us, is five times the amount in its McIntosh counterpart.

Stigler also looks at price data for 77 common food items. These data contain monthly averages of food prices in around 50 cities, and were published in the Bureau of Labor Statistics' flagship external publication, the *Monthly Labor Review*.

Nutritional and price data in hand, Stigler is now equipped to create an empirical analog of the theoretical optimization problem.

Recall, a constrained optimization problem has two components: an objective function, and a set of constraints. The objective of the Diet Problem is to identify the set of commodities with the lowest possible total cost. For any given basket of commodities chosen, we can enumerate a total cost, total calories, total protein, total calcium, total iron, and so on.

The easiest way to minimize costs is to buy nothing. The objective of the Diet Problem is a statement about price alone. The constraints are where Stigler ensures nutritional needs are met. Taken together, the objective and the constraints on achieving it ask for a nutritionally complete basket of foods that achieve the minimum cost.

With a clear statement of the optimization problem, and sufficient data, Stigler rolls up his sleeves to look for a solution.

Some commodities are obviously not contenders for Stigler's optimal diet. Others might be a close call. As a first step, Stigler eliminates the foods in the former category. Comparing commodities pairwise, he removes any commodity which is clearly nutritionally inferior to another. If all of the nutrients in a commodity can be obtained in another, less expensive alternative, that commodity is immediately disqualified.

Once the obvious losers are gone, Stigler makes the closer calls. Consider the goods that are only slightly superior to another good. For example, white bread is far inferior to white flour in every cost-nutritional dimension except for one: calcium. Still, neither white bread nor white flour is an economical source of calcium. So, the fact that white bread has more calcium than white flour is irrelevant to the pairwise comparison. The 154-pound man would source his calcium from neither white bread nor white flour. As a result, we can cross white bread off the list, as it is, for all intents and purposes, inferior to white flour. Through these pairwise eliminations alone, Stigler slashed the list of 77 eligible foods down to 15.

From the selection of 15, Stigler must still narrow down a selection of goods, and the amount of each good, to nourish the 154-pound man *at the lowest possible price*. The problem is that there are over 32,000 possible baskets of goods that could be selected from this list of 15! And he must decide not just *which* goods to include in his basket, but *how much of each* good to include in the basket. To check each potential basket against every other possible basket would take more time than Stigler had, especially without a computer.

This is where the future Nobel Laureate slips the lid off his airtight mathematical logic.

"Thereafter the procedure is experimental," writes Stigler, "because there does not appear to be any direct method of finding the minimum of a linear function subject to linear condition."

In other words, while his first two steps were algorithmic—firmly grounded in the mathematics of optimization—from there his solution proceeded heuristically, via a rule of thumb approach.

Through trial and error, eyeballing and ballparking, Stigler ended up with the following solution: Wheat Flour (370 lbs), Evaporated Milk (57 Cans), Cabbage (111 lbs), Spinach (23 lbs), Dried Navy Beans, (285 lbs), Pancake Flour (134 lbs) and Pork Liver (25 lbs). In 1939, the diet would cost $39.93.

—THE SIMPLEX METHOD—

Stigler was forthcoming about his diet's shortcomings.

"There is no reason to believe," he confessed, "that the cheapest combination was found."

The Diet Problem belongs to a subclass of constrained optimization known as linear programming. Stigler was missing a critical mathematical tool—one that had yet to be developed—an algorithm for locating the precise optimum of a linear programming problem. Without such a tool, he was left with heuristics alone.

One might reasonably ask why a heuristic is insufficient.

It is one thing to use a heuristic to solve the Diet Problem for 77 unknowns, as Stigler did. Being off by a few dollars will not have major consequences for the readers of the *Journal of Farm Economics*.

It is, however, another thing entirely to ask the Mathematical Advisor to the U.S. Air Force Comptroller to rely on heuristics as he solves variants of the problem with thousands of unknowns, over and over, and with ever-changing input data.

That was George Dantzig in 1946. He took a leave of absence from his graduate program to design systems to manage "hundreds of thousands of different kinds of material goods and perhaps fifty thousand specialties of people."[6] He was desperate for new ways to compute time-staged deployments and logistical supply programs.

At first, Dantzig used heuristics to solve the massive military planning problems handed to him. In his words, "I had formulated a model that satisfactorily represented the technological relations usually encountered in practice" along with "a large number of ad hoc ground rules issued by those in authority."[7]

But eventually he realized these heuristics were untenable. The mathematician within him ached for a more rigorous solution. He would later recall:

6 HOLLEY, Joe, "Vanguard Mathematician George Dantzig Dies", in: ***Washington Post*,** May 2005.
7 DANTZIG, George, "Reminisces about the Origins of Linear Programming", in: ***Systems Optimization Laboratory Technical Report*,** May 1981.

> **I formulated the planning problem as a set of axioms. The axioms concerned the relations between two kinds of sets: the first were the set of items being produced or consumed and the second the set of activities or production processes in which items could be inputed or outputted … The resulting mathematical system to be solved was the minimization of a linear form subject to linear equations and inequalities. The use of the linear form as the objective function to be extremized was the novel feature.**

Having formulated the lumbering problem this way, Dantzig thought a lithe solution lay around the corner.

"I assumed the Economists had worked on this problem," he admitted.

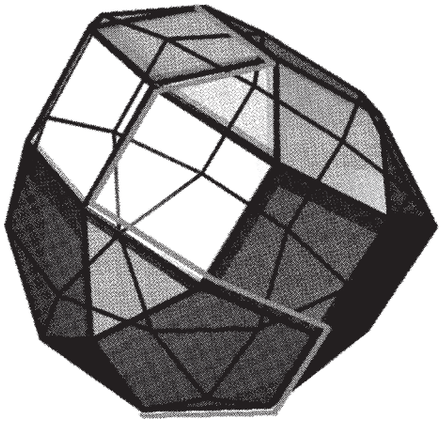
In Dantzig's reframing, the planning problem for the U.S. Air Force didn't look so different from early models of national economies. There are consumers who demand things. There are producers who supply things. What Dantzig wanted was an allocation that specifies who consumes and produces how much of each thing. Surely, he thought, economists would know a method for precisely solving such allocation problems?

In particular, Leontief's Input-Output Model came to mind. Dantzig was intimately familiar with the Input-Output model. He had remained close to a few colleagues from his time at the Bureau of Labor Statistics. These buddies worked with Leontief on developing the model for the U.S. economy after Dantzig himself had left the Bureau for his military post.

Structurally, this question was nearly identical to one of the most fundamental questions in all of economics. Dantzig was dismayed to find out that economists had not, in fact, found an algorithm for solving it.

So Dantzig proposed his own solution to the yet unsolved problem: the Simplex Method. Dantzig's approach envisions the region of all potential solutions as a polytope—a high-dimensional shape carved into space by the constraints of the problem. This polytope has a bunch of vertices (like the corners of a cube). Dantzig knew the optimum had to be one of these vertices.

The Simplex Method uses the fact that if a particular vertex is *not* the optimum, then there is an edge connected to that vertex along which the objective function is strictly increasing. Crawl along that line and find allocations which still satisfy the constraints (e.g. nutritional requirements) and yet do better and better at achieving the objective (e.g. lowest possible cost). We can visualize the simplex method as follows:



> **Imagine you are thrown down onto a vertex of the polytope. Ask yourself, at this vertex, is there a path I could follow to another vertex along which the objective function is increasing? If yes, then move to it. If no, then stay. Repeat for each vertex until you find one where you can't find anywhere to go. That is when you have reached the optimum.**

Before the military could deploy the Simplex Method in its operations, they needed to test it. "At a little bull session at the Pentagon with the Bureau of Labor's Input-Output team," someone suggested testing the algorithm on the Diet Problem.[8]

Cornfield couldn't find the data from his 1941 unpublished memorandum, but mentioned Stigler's data. Eager to test the viability of the Simplex Method (and also curious to see how much an algorithmic solution could improve on Stigler's heuristic solution), the Bureau set to work computing the minimum cost diet in 1939 via Dantzig's new algorithm.

Nowadays, the word "algorithm" is nearly synonymous with lightning fast computation. So it may sound counterintuitive to a contemporary ear to hear that algorithms can be much slower than heuristics. Even more so without modern computers.

Solving the Diet Problem algorithmically with the Simplex Method in 1947 demanded the labor of nine statistical clerks working 120 days. They carried out 17,000 multiplications and divisions on desk calculators.

The result? A 24-cent improvement on Stigler's solution and a bonafide test of Dantzig's new method. The new minimum-cost diet would set you back $39.69 in 1939 dollars.

8 DANTZIG, "The Diet Problem".

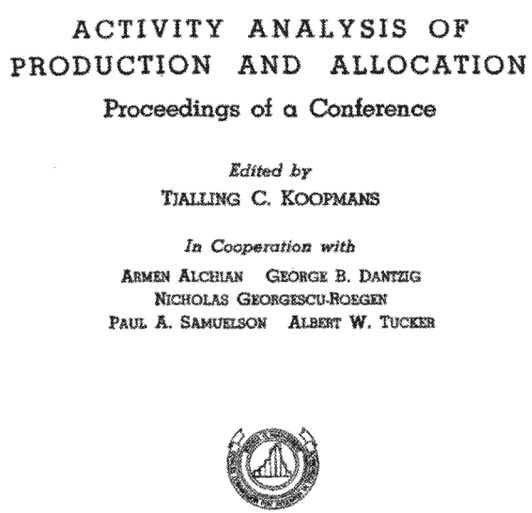
Within a year of the test, the Simplex Method changed the course of history. Dantzig's team had invented a punch-card system that would drastically speed up the computation time required to carry out the algorithm. With this improved computational ease, the U.S. Air Force, under Dantzig's direction, solved a massive linear programming problem which became the Berlin Airlift. Starting in June of 1948, the U.S. and Britain flew supplies into blockaded West Berlin. Planes landed every 45 seconds—perfectly optimized given the constraints.

—THE PLANNERS THAT BE—

The USSR lifted the blockade of West Berlin on May 12, 1949. A month later, and 7000 kilometers away from Berlin, several of our protagonists joined others at a Cowles Commission conference in Chicago. There, a captive audience listened as Dantzig debuted the Simplex Method and its achievements in the Berlin Airlift for the academic world.

The conference chair, Dutch economist **Tjalling Koopmans,** was especially stirred by Dantzig's discovery. He thought the Simplex Method shed new light on the **Socialist Calculation Debate** that had gripped many economists in the 1920s and 1930s.

The debate, carried out largely between Ludwig von Mises and Friedrich Hayek on the Right and their opponents on the Left, revolved around a computational question: could a centrally planned economy ever be feasible, given the difficulty of computing optimal allocations in a complex ever-shifting system? The capitalists on the Right argued, contra their socialist counterparts, that a centrally planned system could not calculate optimums quickly enough to rival the efficiency of a decentralized market system, in which consumer demand and producer supply grope their way toward optimal equilibrium prices.


ACTIVITY ANALYSIS OF
PRODUCTION AND ALLOCATION

Proceedings of a Conference

Edited by
TJALLING C. KOOPMANS

In Cooperation with
ARMEN ALCHIAN GEORGE B. DANTZIG
NICHOLAS GEORGESCU-ROEGEN
PAUL A. SAMUELSON ALBERT W. TUCKER

What does the Simplex Method have to do with the Socialist Calculation Debate? Koopman's remarks at the 1949 conference explain,

> To von Mises' arguments regarding the unmanageability of the computation problems of centralized allocation, the authors oppose the new possibilities opened by modern electronic computing equipment … Dantzig's model is an abstract allocation model that does not depend on the concept of a market.[9]

Koopmans believed that the Simplex Method reopened the debate because it offered a structured, computable way of generating "shadow prices", i.e. measures of relative values of different commodities. These values could in turn be used to guide allocations in place of decentralized market prices.

To modern eyes, Koopmans' response looks quaint. Confronted with a now antiquated punch-card system for computing solutions to a limited class of problems, he thought the tables had turned in the Socialist Calculation Debate. Imagine if Koopmans could see today's computing power, and the wide range of optimization problems that can be solved in seconds. Surely nowadays the descendants of von Mises and Hayek, arguing that the calculations required in a socialist economy are impossible, would have no ground to stand on?!

Like a time-traveling Koopmans, technologist and writer Evgeny Morozov revisits the Socialist Calculation Debate in a 2019 essay in the *New Left Review.* Morozov highlights ways in which the Left could harness data and computation to power centralized processes of price discovery.

Morozov also takes stock of the curious mix of economics and computation that now governs our lives as consumers and citizens. The role of the "economist", he notes, has recently fused with the role of the "engineer", especially in the digital economy.

9 Quoted in ERICKSON, Paul, KLEIN, Judy, DASTON, Lorraine, LEMOV, Rebecca, STURM, Thomas, GORDIN, Michael, ***How Reason Almost Lost Its Mind: The Strange Career of Cold War Rationality,*** University of Chicago Press, 2013.

He frequently quotes economist-engineer Al Roth, whose essay "The Economist as Engineer: Game Theory, Experimentation and Computation as Tools for Design Economics" became a manifesto of sorts for the nascent field of "market design".

Market designers are economists, computer scientists and operatios researchers who design markets: they "intervene in them, redesign them, fix them when they're broken, and start new ones where they will be useful".[10] After receiving their training in PhD programs, market designers often go on to work not in academia or government, but in Silicon Valley. Morozov, musing on the market design paradigm, writes:

> While Hayek, in his earliest contribution to the Socialist Calculation Debate, drew an explicit distinction between the economist—the protagonist of a market economy—and the engineer—the protagonist of a centrally planned one—the post-Hayekian consensus in neoclassical economics has yielded an odd blend of the two. And as the world has become increasingly digitized, building new markets, as well as fixing existing ones, has gotten easier and cheaper: acting upon the informational dimensions of market exchange can now be done remotely, by means of digital platforms.[11]

Of course it is not new for engineers and economists to work together to solve big problems. Think of the engineers like Cornfield and Dantzig at the Bureau of Labor Statistics in the 40s, borrowing desk calculators from their economist buddies like Friedman, Leontief and Stigler.

But market design represents a more subtle development. The economist, as conceived in Hayek and von Mises' arguments against socialism, never had to take a stand on the proper sorting of objectives and constraints. Indeed, the beauty of decentralized allocation, as they saw it, is that the market could be neutral, laissez-faire, indifferent: it reveals information through prices and consumers are left to act on them on their own accord. By contrast, the engineer was always a planner—e.g. a Comptroller in the U.S. Army making the most of limited supplies, a policymaker creating low-cost diets at the Bureau of Labor Statistics—whose entire raison d'être involved the sorting of objectives and constraints.

10 ROTH, Al, "The Economist as Engineer: Game Theory, Experimentation and Computation as Tools for Design Economics", in: ***Econometrica***, Vol. 70, July 2002.

11 MOROZOV, Evgeny, "Digital Socialism? The Calculation Debate in the Age of Big Data", in: ***New Left Review***, Vol. 116, March–June 2019, https://newleftreview.org/issues/II116/articles/evgeny-morozov-digital-socialism#note-22.

In the government agencies of a democracy, engineers are implicitly trusted by the public to do the hard work of sorting objectives and constraints in a way that best carries out the agency's mandate. In other words, when engineers—and economists who act like engineers—are employed by the government, their task is to act in the interests of the public. By contrast, when engineers—and economists who act like engineers—are employed by private firms, their task is to act in the interest of the firm.

There's some strange doublethink lurking in the minds of many economist-engineers. From one perspective, they see themselves carrying out a Hayekian fantasy. Allocations are guided by a massive, dextrous, invisible hand thumbing through droves of data, nanosecond-to-nanosecond, all over the globe. From another perspective, they live in Hayek's nightmare. Allocations are decided not by the invisible hand, but by *them*—an invisible class of illegitimate planners.[12]

In 2014, one of **Google**'s in-house chefs received a special challenge: to create a tasty dish out of the ingredients that feature in Stigler's solution to the Diet Problem. The chef came up with a gourmet creation that Googlers called *Foie Linéaire à la Stigler*. He dredged pork liver through white flour, seared it, and rested it atop a navy bean purée and marinated cabbage. Spinach pesto was drizzled on top.[13]

I can't help but see, lurking underneath the cutesy nerdiness of the *Foie Linéaire,* a mean-spirited irony on the part of the Planners That Be.

Remember that Stigler didn't have an algorithm for solving the Diet Problem when he wrote "The Cost of Subsistence"; he relied on heuristics. Since Stigler, we've developed not only algorithms, but cheap and plentiful software that can churn through data and locate precise optima in thornier and thornier optimization problems. These calculations always discover "prices" of a sort, which could help guide the allocations that might subdue so many global problems—including hunger and malnourishment.

So the gesture back to Stigler and the mockery of his minimum cost diet represents a willful blindness. The Planners That Be understand the awesome power of computation, and the way optimization gives rise to "shadow prices" that could help create fairer, life-saving allocations on local, national and global scales.

12 Philip Mirowski and Edward Nik-Khah make a series of related observations and arguments in their 2017 book ***The Knowledge We Have Lost in Information: The History of Information in Modern Economics*** (Oxford University Press).

13 ORWANT, Jon, "Sudoku, Linear Optimization and the Ten Cent Diet", ***Google AI Blog,*** September 2014, https://ai.googleblog.com/2014/09/sudoku-linear-optimization-and-ten-cent.html.

They must understand, how, if such awesome power were placed in the hands of a public interest-maximizing entity subject to robust democratic oversight rather than a profit-maximizing private firm, so many would be so much better off. And yet, the very people who understand this power most deeply are exactly the ones who have an interest in protecting the status quo. And with it, their rents in this so-called free market equilibrium.

Milton Friedman, 33 years after his stint working on the Urban Study of Consumer Purchases at the Bureau of Labor Statistics, wrote his era-defining *New York Times* essay titled "The Social Responsibility of Business Is To Increase Its Profits". Friedman's "shareholder value" paradigm continues to rule the modern corporation.

The shareholder value paradigm is a good example of an ordering of objectives and constraints that has calcified in our institutions and imaginations. The consequences have been devastating—for democracy, for equality, and for the sustainability of human life as we know it.

Corporations maximize profit (objective!) while meeting consumer demand, and of course, abiding by the law of the land (constraints!). Increasingly corporations are incorporating more and more "environmental, social and governance" (ESG) constraints into their business models due to growing pressure from socially-conscious investors. But such changes are largely cosmetic capitulations. Adding a few extra constraints here and there (e.g. no more child labor, no more drilling in the Arctic, carbon-neutrality by 2030) does not fundamentally change corporations' willful pursuit of long-term globally and ethically harmful "solutions" to their canonically structured optimization "problems".

A real change would be a change to the objective of the firm. A commitment to maximize something other than profit—the welfare of stakeholders—subject to making ends meet requires more than just a yearly theme at a conference for ruling class elites (Davos, 2019, "Stakeholders for an Inclusive and Sustainable World") or a frothy statement from an interest group comprised of CEOs of some of the world's biggest companies (Business Roundtable, 2019, "Statement on the Purpose of the Corporation").

A change in the firm's objective requires not just an overhaul in the firm's statement of purpose, but attendant changes in governance. It requires a constitutional moment for the modern corporation. The development of digital feedback infrastructure could enable the accounting and accountability required for firms to maximize something other than profit. It could also give all stakeholders a voice in guiding the firms' enactment of that objective.

——THE COST OF EXISTENCE——

What is the cost of subsistence? This question was formulated by Jerry Cornfield in a 1941 Bureau of Labor statistics memorandum. George Stigler, writing in a 1945 issue of the *Journal of Farm Economics,* proposed a heuristic solution. George Dantzig, who replaced young Milton Friedman at the Bureau of Labor Statistics in 1937, later, while employed by the U.S. Air Force, sought an algorithmic solution. Dantzig looked to Wassily Leontief's Input-Output models of the national economy, noticing that the structure of the problem—maximize a linear objective subject to linear constraints—took the same form as Leontief's early models of economy-wide planning. Finding no off-the-shelf solutions to problems with this structure, Dantzig proposed his own: the Simplex Method.

The extreme circumstances of the Great Depression and WWII advanced the science of optimization so quickly that, briefly, it seemed it might reshuffle the dominant ways of thinking about market organization. With a solution to the Diet Problem in hand—and so a centralized technology for discovering shadow prices to guide complex allocations—Tjalling Koopmans and others wondered if the Socialist Calculation Debate might be reopened.

We find ourselves now in similarly extreme circumstances. Already-bleak facts about food security will only get bleaker. Climate change will ravage croplands in both foreseeable and unforeseeable ways. The pandemic has already initiated the worst global economic shock since the Great Depression, putting millions *more* lives at risk from famine and malnutrition—an estimated increase of 9–12%.

In October 2020, the Nobel Committee awarded the Peace Prize to the United Nations World Food Programme. They quoted the organization's own words about the importance of food

in the wake of the pandemic: "Until the day we have a medical vaccine, food is the best vaccine against chaos." Meanwhile, the 2020 Nobel Prize in Economic Sciences was awarded to two of the world's pre-eminent economist-engineers, Paul Milgrom and Robert Wilson, both of whom were colleagues of George Dantzig's at Stanford. The Nobel citation read, "Milgrom and Wilson invented new formats for auctioning off many interrelated objects simultaneously, on behalf of a seller motivated by broad societal benefit rather than maximal revenue." It is true that Milgrom and Wilson's ideas have guided large public allocation problems—like the design of electricity markets and auctions for electromagnetic spectrum. Could their descendants, the economist-engineers they've trained, be even more ambitious in choosing the problems for which they go about—to use the title of Milgrom's 2017 monograph—*Discovering Prices*?

Perhaps our extreme circumstances will push the science of optimization even further, or, better yet, in a new direction. Economics and engineering have powerful tools for designing centralized systems that "discover" prices. Can we develop new optimization techniques—complete with democratic feedback mechanisms, privacy controls, and participatory social designs—that can help us solve the intricate, volatile allocation problems on which our way of life now depends? Maybe new developments in the science of optimization can again help us rethink our global priorities, and the way that they are reflected in the organization, and disorganization of our markets. It may be as simple as rearranging our objectives and our constraints.

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WHEN YOU KNOW YOU'RE WINNING

AN INTERVIEW WITH GLEN WEYL

It's not every day that you encounter a new figure you want to base the new issue of the Šum journal on. After becoming fans and recurring readers of Vitalik Buterin's blog, we stumbled upon his review of a book that attempted to change everything. *Radical Markets: Uprooting Capitalism and Democracy for a Just Society* (2018) became a new theoretical framework and tool through which we could build a new foundation for a society in crisis—for a post–covid-19 world. It quickly became clear to us that we needed to hear more from Glen Weyl, and that the true potential of fully embracing the fact that markets and property rights are socially constructed could not be overstated in importance and scope. In that short split of a second, everything seemed manageable and open to radical(x)change.

But we should stress that the true novelty of Weyl's approach came after the book was published. As the interview suggests, the actual phase change came in RadicalxChange founder's embrace of public and not private goods. This shift is of fundamental (philosophical) importance for living and thinking in the 21st century, and it provides a new politico-economic groundwork for emerging novelties, i.e. new collective management of protocols, new ways of ownership, decision making and voting, and, in general, a new conceptualization of value and the embrace of the collective. Or to use Mat Dryhurst's term, interdependent framework that we have to cultivate in relation to one another and the world. We were therefore left with little choice—we simply had to base the *Infrastructure as Critique* issue on Glen Weyl's approach and demeanour.

Valenčič: There has been a lot of talk in the past years about exiting neoliberalism, or what was later called capitalist realism. But you, in your email exchange with Vitalik Buterin,[1] casually pointed out how you found a solution to the problem, first with Radical Markets and then with Liberal Radicalism. Can you tell us a bit more about the new approach you've taken towards economic theory and in what way is it different from the current one?

Weyl: Radical Markets really took economic theory extremely seriously. It really was focused not on contradicting economic theory, but rather taking through to the logical conclusion the most fundamental premises underlying modern economics and showing ultimately how they were inconsistent with the most basic things that have been derived from that economic theory. It showed how private property, which is by many viewed as the core of capitalism, is fundamentally inconsistent with the free competition that is the essence of markets and it showed how "one person, one vote" rule, which is usually viewed as the core of democracy, is actually fundamentally inconsistent with the idea of collective government and responsiveness to the public will. And as such it offered a path to exit capitalism, exit markets through the very economic discourse that brought them about. Because it cut to the root of that economic thinking rather than trying to attack it from the outside.

The key point is that if you want to undermine a system, the most powerful way to do it is using its own internal logic. This is of course precisely what the struggles against imperialism have done for hundreds of years. The struggle against white rule in India was based on the values of the West and using those to undermine the concept of imperialism. That is really at the core of the idea of Hegelian dialectics, the critique, the antithesis, the synthesis, and while many people on the left often talk about Hegelian dialectics, they don't actually practice it, they don't take seriously the neoliberal logics, the foundations of the systems they seek to critique, and as such they can provide an antithesis, but they can't provide a synthesis that can actually supplant it.

Now the thing that is ironic I think about the project of Radical Markets is, well, I think it was extremely effective at offering a new synthesis, it of course itself provoked a sort of antithesis, a critique that showed the next step that needs to be taken—in particular, Radical Markets surfaced the central role of public

1 See: https://medium.com/@glenweyl/a-radicalxchange-between-vitalik-buterin-and-glen-weyl-328d8ad088cf.

goods. Public goods are at the core of what quadratic voting tries to address. They're at the core of how we should conceptualize the value underlying most property. And yet the basic framework in Radical Markets assumes that there are just a few public goods and that everything else is represented by money. Everything else is represented just by separated individuals each pursuing their own self-interest, and it gives solution to the problem of public goods in that context. But the reality is that that's completely inconsistent with the basic premise of Radical Markets, which is that attending to these public goods and focusing on them can transform our whole society.

So Radical Markets, just like the neoliberal discourse before it, sort of runs into its own contradictions and we're working in pushing past that in RadicalxChange and I'll talk a lot more about that in what comes up.

Valenčič: How would you compare Liberal Radicalism to the notion of classical liberalism? And in what way do you feel your project is connected to various other attempts to revitalise the liberal paradigm today? For example, meta-modernism (new interest in grand narratives), meta-liberalism (exit-oriented society) and post-liberalism (what happens to liberalism when history begins anew) are in a way connected to the RadicalxChange foundation you have founded.

Weyl: I think this question of the difference between Liberal Radicalism and the classical version of liberalism is really where you see this contradiction in even the Radical Markets paradigm emerge. In classical liberalism, the basic concept is sort of that there's some state of nature in which people are perfectly free. And that people get enslaved by social institutions and really what we need to do is break down the social institutions to allow people to be free again. You know one classic expression of this was by Jean-Jacques Rousseau who said that man is born free but everywhere he's in chains. And I think Liberal Radicalism really cuts to a very different foundation of what the liberated individual is.

In that view people have always, as long as they've been human, been part of societies. There is no isolated human being. There may be isolated animals in some cases, though not many of those even, but human beings are inherently social and political animals. That's the fundamental nature of what it is to be human. Humans really emerge with language and language is fundamentally social. And so there is no such thing as this liber-

ated individual that we can set free. Instead individuals start as part of a collective, they start in a tribe. The state of nature is not solitary, the state of nature is tribe-based and liberation of the individual only becomes possible in the modern period. How does it become possible? Well, Georg Simmel, one of the great founders of sociology, gave a really powerful vision of this, which is that while in a tribe, the people you marry, the people you hunt with, the people that you pray with are all the same. In a modern society, those may all become different sets of people, you may have political associates, you may have social associates, you may have work associates and they may all be different and you may be the unique person at the intersection of all those social circles and thus it's that intersection that defines you as a unique individual rather than just as a member of a collective. Thus the possibility of the individual emerges with diversity and social complexity. Thus the support for diverse and evolving social structures is actually one and the same as the support for the possibility of liberated individuals. And Liberal Radicalism recognizes this, it recognizes that in order to have any chance of supporting individual liberty, we must support the flourishing of diverse communities that make it possible for there to be an individual rather than just a collective. And conversely that social institutions are strongest not when they're a single organic whole without any internal complexity, but instead one where those social institutions are themselves given power by the fact that their participants are networked into different other social institutions.

So the fundamental idea of Liberal Radicalism is that we can only truly synthesize the sort of collectivist and individualist perspective when we go deeper and defend more fully what is the foundation of both the individuals and the collectives. That the individual, in order to become a liberated individual, must exist within a complex social setting because that's the only thing that makes individual liberation possible. On the other hand, groups can only be cohesive and strong to the extent that they tie together many disparate individuals and aren't just totalizing or wiping away the structure underneath them—so once we recognize that we can actually have stronger collectives and stronger individuals at the same time rather than seeing them in opposition to each other.

Valenčič: We find it interesting that you pose an increasing returns challenge to capitalism, because when we think about capitalism through the commonplace right-wing lens, we mostly equate it with the phenomenon of increasing returns. For example, when Nick Land says that "civilization, as a process, is indistinguishable from diminishing time-preference",[2] he is without a doubt referring to the motor of capital, i.e. the infinite loop of capital accumulation that brings about the infamous means-ends reversal. How can we then square your increasing returns challenge to capitalism and its constant need for growth, expansion and transformation?

Weyl: That's a great point because, as I've just been emphasizing, the way to make progress in moving beyond capitalism is not a frontal assault as is usually made on inequality or something like this. I think the real way to make progress against capitalism is to show that the very successes that are the core of what capitalism claims are inconsistent with its own theory. To make it impossible to defend the achievements of capitalism on capitalist terms. And that, to me, is the core of the argument about increasing returns.

All the libertarian economists will say that the great successes of capitalism come from increasing returns, non-zero-sum logic, cases where we can achieve more together than we can separately. And yet we know it's one of the most basic results in economic theory that in the case of increasing returns, capitalism and market equilibrium is inconsistent with efficiency. Why is that? Because the basic logic of why markets are efficient is that everyone gets paid their marginal returns. But when you have increasing returns, it means that on the margin people are more productive than they are on average. And that if a company tried to pay them all their marginal returns, it would go bankrupt. And this is just a very simple logic that I think comes home to anyone.

Imagine that you tried to pay to everyone who had created something the value they added to your life. How much would you be willing to pay to have a sewer rather than to have no sewer? I don't know, probably a third of your income, right? If you had to go to the bathroom without sewage. How much would you be willing to pay to maintain electricity? I don't know, maybe half your income. How much would you be willing to pay to maintain the internet? I don't know, a fifth of your income. Add up all those things and you get way above a hundred percent. You just cannot pay everyone

2 LAND, Nick, "The Dark Enlightenment", in: ***The Dark Enlightenment***, https://www.thedarkenlightenment.com/the-dark-enlightenment-by-nick-land/.

the marginal contributions that they make in a complex society and still be able to stay solvent. So the increasing returns phenomena, also sometimes called public goods, have to be managed by some sort of collective taxation democracy-type process. And yet they're at the core of everything that's claimed for capitalism.

What do the defenders of capitalism talk about? They talk about factories. Factories are increasing returns. Put a lot of people together, you get more output than you would if everyone is separately making things at home. What is another core claim of capitalism? Railroads. Railroads, classic networked good, increasing returns. A railroad between two small cities is not worth anything unless it can connect you to a broader network of railroads that can take you to many different places.

Another core claim of capitalism: electricity. Electricity doesn't work unless an electrical grid is built which serves many people—a classic increasing return network good. So of all the core advances of capitalism, you can't really think of an example that was supposed to define the success of the capitalist era and doesn't feature increasing returns, and increasing returns are fundamentally not efficiently managed by capitalism.

So it's by cutting to that core, by seeing at the very foundations of the arguments for capitalism where it goes wrong that you have a chance of moving beyond and transcending it. Only when we have a theory that can actually reconcile the importance of that sort of scale with the dynamism that we know that market societies have allowed do we have a chance to actually deliver on the promises the capitalism made at its core rather than just have a contradiction between the historical claims of capitalism and its theoretical foundation.

Valenčič: What do you think have been some of the best critiques of your central ideas so far (HGT, QV etc.) and do you plan to make any potential changes because of them? In the text *Why I Am Not A Technocrat* you actually write that you are finalising a critique of *Radical Markets* partially along these lines: "I could easily add to this list much of my work in Radical Markets, which manifested many of the problematic technocratic attitudes I critique above."[3]

3 See: https://blog.radicalxchange.org/blog/posts/2019-08-19-bv61r6/.

Weyl: I think by far the best critique of the book is around the problem of this atomized individual and money. All the mechanisms that are in Radical Markets have some notion of an individual and then some token or money that they use. And these are like two very extreme concepts. There's these completely isolated atomized individuals and then there's this totally anonymous fungible thing called money. And yet almost everything in the world lies somewhere in between. It's ridiculous to imagine that there's just some global currency and some isolated individual when in reality almost all of the social relationships we have are not in some global public good or in some global democracy, but in a whole range of intermediate public goods involvements that we have in communities, in families, in cities, in nations, in networks and software protocols etc. And this really affects almost all of the core proposals in Radical Markets and really creates major problems for them.

So, for example, in quadratic voting there's this notion of you having some tokens and the square roots of the tokens you give being added to the square roots of the tokens that other people give added up across the individuals so that if many individuals contribute tokens, there's more value than if a smaller number of individuals contribute tokens. But then a basic question comes, which is should me and my wife be under the same square root or under two different square roots. Are we one individual or two? Well, the answer is neither quite. We're probably closer to being one person than to being two separate people because almost everything we enjoy, we enjoy in common, and therefore if you treat us as separate individuals and you try to solve some public goods problem between us, you're going to end up just subsidizing our lifestyle because we each benefit from almost everything the other benefits from. But then you could ask whether me and the other people in RadicalxChange are under two square roots. Well, we're probably closer to being under two square roots, but not quite because if they benefit, it benefits me and it supports RadicalxChange and so forth. Are me and other people at Microsoft? Well, maybe a little bit more under different square roots, but again we're working closely together. So this purely individualistic notion where you just have each individual under a different square root doesn't actually reflect the nature of what I actually value. It's not all valued for myself, it's valued for the other people that I share public goods with and so you need a richer notion where people are sort of partially the same and partially different.

Another example is SALSA or COST or Harberger tax, whatever you want to call it, this system of property ownership, where I pay a tax on my self-assessed value and I have to be willing to sell it to someone else. But who is this someone else who I sell it to? Is it anyone in the world? Is it anyone in my nation? Is it anyone in my town? Is it anyone in my company? The reality is that those are very different questions and I am, in fact, going to sell it to someone who's going to have to follow certain rules, but those rules are defined by the community within which we sell it. On the other hand, you might then want that whole community to maybe assess the value for keeping that rule in place and sell it to some other organization and there might be this whole hierarchy of little taxes being paid to different people and different rights to buy different clumps of things and all that richness of social structure, which is going to be critical to making any of these ideas work, and that was really missing from the book. So while it sort of broke down some of the problems with neoliberalism, it maintained a lot of the philosophical commitments to this notion of the atomized individual and the abstracted society and market rather than understanding that there's all these different layers and that it's actually the relationship among these layers that matters the most. And I think that manifested in the style of the book as well, you know there's a technocratic style in economics where the role of the economist is that of the social planner—to just organize things and isolated individuals to then just go along. In some ways the book proposes different experiments, but ultimately it sort of has this vision of us just designing a social order, when in reality the most powerful thing that the book could have done is to actually offer tools of self-empowerment to a variety of different communities, and that's what we're trying to do in RadicalxChange.

Valenčič: Some people would probably object to COST, Quadratic funding and Quadratic voting since these could actually increase standardisation rather than diversity. As your model of society is built on reciprocity—in *Radical Markets*, you write: "Each individual must pay an amount equal to the cost that her actions impose on others"—there is a chance that it would limit some societal tasks, which can only be appropriately assessed in the future, when the feat will have already been done. How would you respond to such a critique? Would you say that such people lack imagination and only know about Elon Musk and Jeff Bezos, but not about grassroots initiatives like Democracy Mars?

Weyl: So I think there's an often really mistaken notion that acts of creativity are done by isolated individuals. But if you really look at it, almost all creativity comes from individuals who set at the intersection of a bunch of different social forces, who were at the point of collision between different worldviews forcing them to come up with something new—whether that be the way that Einstein tried to reconcile the ideas of, you know, the electromagnetism, the aether, or the Michelson-Morley experiment and the emerging field of quantum mechanics. Or the way that Marx tried to reconcile classical economics with a lot of the demands for redistribution and so forth. Creativity always emerges not from isolation, but actually from a collision of different forces. People who are isolated have no ideas to build on and people who are only part of one community have no way to be creative. So creativity is actually a result of social complexity rather than of an individual pursuing her completely independent and unconstrained vision. And so therefore a society that bolsters rich, emerging diverse communities is going to be the one that most empowers that sort of social evolution creativity and diversity that we want to try to achieve.

And you know, you can see this not just from a conceptual perspective, but from an economic perspective even. People talk about the value of something like capitalism or venture capitalism or whatever to allow these really creative ideas that won't be recognized until later to emerge. But that's only if they get backing from some wealthy person or if the person who has it happens to be wealthy. That's a very tiny fraction of people who are getting empowered with the ability to allow these new ideas to emerge. We can actually create much more diversity than that, many different pathways for people to be funding, which is precisely what things like quadratic funding allow. If you allow the support from those different diverse communities to actually lead to the emergence of an opportunity to do something creative, then we have the greatest chance of empowering those farsighted innovations.

Valenčič: Could you explain your position on the relationship between public and private goods? It seems like your proposition to formalise public and not private goods, but in a way that still retains or even intensifies the market dynamic and economic prosperity, marks a crucial shift. You are actually proposing a completely and radically new system of economic transactions, one based on formal economics and mathematical logic, or, more specifically, on the newly established quadratic funding mechanism.

Weyl: So the extreme and pure notions of public goods are the something which everyone enjoys together regardless of whether they're in some way directly participating in them and regardless of whether they pay for them, they can't be excluded, they're not rivalrous—everyone gets them together. The other extreme is private goods, where either I enjoy it or you enjoy it or someone else enjoys it. But the reality is almost everything in the world is neither of these two extremes. It's somewhere in between. It's, for example, something that most people in my community can pretty easily enjoy, but people from further away will find harder to enjoy. For example, I live in a canal. That canal is public property, but is it a public good? Well, not really because unless you live in my town and happen to have a house on the canal, it's not going to do a lot of good for you that the canal's there. You might be able to access it, but it won't give you much benefit. On the other hand, for people living on the canal, it brings a huge benefit that is shared among all of us. We've got a marsh down the road which maybe is a little bit more accessible. We've got a public tennis court … And even if you think about the most private goods, things that you just consume with your family or even at a restaurant, all of these things actually are shared within a community to a certain extent, but they also have limits on the degree to which they're shared. And the broader distinction really is one of increasing and decreasing returns.

Increasing returns are when some community of people can all achieve more together than they could separately. Decreasing returns are where the more people you put in, the more it actually reduces the benefit to any individual participated. And the reality is that everything is actually kind of a mixture of these things. There's an element of increasing returns, maybe for the people in my neighbourhood, but then as you start putting more people into the neighbourhood, it starts hitting this decreasing returns. And in order for any vision of a market to work, it needs to put this dynamic of increasing returns and decreasing returns at the very core of how the market system works.

Capitalism works purely for decreasing returns, but in reality it's filled with all these increasing returns things. The fact that all of us in the community enjoy a restaurant together if it opens, the fact that we all enjoy my canal together, the fact that protecting the country from Covid protects all of us from Covid. All these are increasing returns phenomena and they're at the heart of what makes markets work. On the other hand, because these different

increasing returns phenomena are diverse, because they're not all at some single, global or national or whatever level, to really have democracy govern increasing returns, it has to have the diversity and flexibility and choice that markets allow for. And therefore the sort of monolithic, unchanging state that tries to manage pure public goods, which is the usual way it's set up, won't really achieve anything either. We need the logics of democracy and the logics of markets to be deeply intertangled with each other like a DNA helix, not like two opposing forces. They need to be constantly interweaving to support the development of the other type of system. And the mathematical logic of the Radical Markets, RadicalxChange-type designs is to achieve precisely that, to achieve this tight back-and-forth interlinkage between democracy that governs these increasing returns-type phenomena and market, you know, competitive logics that govern their decreasing returns properly.

Valenčič: How has the role of the economist changed in recent decades? As Zoë Hitzig writes: "In this new role, the economist is more than just an adviser or an engineer but also a craftsperson, i.e. a technologist who implements as well as designs, and who creates as well as conceives."[4] What are some of the most important implications of this change? What political (and normative) dimension does this entail?

Weyl: Economists used to really have this very public-facing role. You think of people like Henry George, who actually ran for the mayor of New York City and almost won. People like Milton Friedman, who had spent so much time interfacing with the public, John Kenneth Galbraith. There used to be this role of the economist as the supplier of ideas that were then used by social movements, by political leaders for their own purposes. The economist as an educator and communicator. Now during the neoliberal period, economists increasingly became the go-to policy experts because neoliberalism said: oh, it's just the market, just let the market work. The only people who were thought to be competent to give advice were the technicians who just made sure that the market was working right. So whereas economics was supposed to be this thing of freeing markets to play out as they needed to, instead it actually became a way of dramatically narrowing the scope and

4 HITZIG, Zoë, "Economist as craftsperson in the FCC's 'incentive auction'", in: ***Hisreco***, 18/9/2018,https://hisreco.wordpress.com/2018/09/18/economist-as-craftsperson-in-the-fccs-incentive-auction/.

vision of the communication to the point where economists only spoke to technocrats. They spoke as experts to expert policy makers away from the public view. This is what Al Roth has termed whispering in the ears of princes.

And furthermore, because economists, unlike business people, are in these non-profit institutions, in the academia, they have a rhetoric of serving the public good which often exempts them or allows them to act within the culture as if they aren't doing anything to further their own interests, they're just serving the public interest—unlike a corporation which, you know, might be maximizing profits or something like that. And in some ways, this actually led the economics academia, I think, to become probably one of the most corrupt parts of our society. Because it's insulation as allegedly serving the public interest allows it to sort of brush aside and disregard a lot of the concerns about its power and dominance and a narrow technocratic view of the broader interests of society. And so I think that by becoming this sort of technocratic field, by amending its social role, economics has ended up putting itself in a position of both tremendous power and tremendous obscurity of that power from a public examination, public scrutiny, public conversation. And I think that's what we fundamentally need to undo if we want to have a chance of building a more fruitful relationship of economics to the world and an economic system that's more accountable to the public.

Valenčič: You've always been open to various ideas from the left and the right. You even said that your approach with Liberal Radicalism is the most coherent of the three established political identities because it is ultimately syncretic: "It's more socialist than the neosocialists are. It has more freedom and free markets, certainly, than the neoreactionaries."[5] Which brings us to the next question, i.e., the question of economics and ideology. You and Eric Posner urge conservative economists to take a closer look at your work, but presumably to no avail? Do you think this is in any way connected to the rigid understanding of markets and property rights?

Weyl: You're right that overall, we haven't won over most conservative economists, so you'd be pretty surprised by the range of economies who have some degree of sympathy for the ideas. In fact, what I would say is that the most common reaction I get from

5 MORRIS, David Z., "Vitalik Buterin Hopes This Man's Ideas Can Break America's Political Logjam", in: ***BreakerMag***, 1/7/2019, https://breakermag.com/vitalik-buterin-thinks-this-mans-ideas-can-break-americas-political-logjam/.

economists is not, "Oh, these ideas are totally inconsistent with economic theory!" but rather, "No, those follow logically from economic theory, but the public will never accept them."

The thing that's really ironic in economics is it ends up being conservative not because of what the theory says, but because of what economists assume is acceptable to the rest of the world, because they surround themselves in such a conservative milieu. They don't actually follow through the logic of their ideas and offer them to the public because they judge what is politically acceptable, what's socially acceptable by the very conservative assumptions that they never explicitly state, but that are sort of lying underneath a lot of their thinking.

But, you know, we don't need to actually win over conservative economists, that's not actually core to what will allow us to achieve a transformation. Instead, what we need to do is to take away from those conservative economists the key logic and arguments that they've used to dominate the public discourse. If we can show that the very economic logic that they've used to advance neoliberal ideas actually leads to something radically different, then they've lost the foundation for legitimating their wealth and their power and their influence and their concepts to the public. So the goal of taking so seriously the principles that they advocate is not fundamentally to persuade them, but to leave them just being dismissive, leave them saying, "Oh, that will never work!", without the argumentation that made them so persuasive. Milton Friedman, when he came in, was not a part of the establishment, he had arguments that people found really compelling and if we can show that those arguments actually lead somewhere else, the next generation will be led away—and that's what I've seen time and time again when I present in front of younger audiences. The critiques on the other side just come off as conservative or dismissive, just being like well, that will never happen rather than actually engaging the logic, and that's when you know that you're winning.

Valenčič: Do you in any way see your project of Liberal Radicalism as a possible middle point between unregulated capitalism and cybernetic (decentralised) communism? Even though the political philosophy of LR is still based on markets, in the epilogue of *Radical Markets* you imply that there could be a way to coordinate a society that goes beyond the analog computing of the price system. In such a society, cooperation would exceed competition as the underlying model of organization even more than in your quadratic one.

Weyl: I don't think I quite describe the RadicalxChange project as a middle path between these things. The way I would think about it is rather that it's trying to achieve what cybernetic communism is sort of all about, except the problem is it's very hard for cybernetic communism as just an abstraction, as an ideal without a description, without a concrete set of algorithms that correspond to it, to actually compete with the capitalist logic. Because without an alternative logic to actually just run, it's just much less efficient in spreading itself than capitalism. And, of course, this is exactly the sort of formalism that I think has been missing from a lot of the cybernetic or decentralized communist rhetoric and discussions. On the one hand it has allowed for things like Wikipedia or other online communities that are tied together by people of this very close relationship to each other to prosper, but on the other hand it did not spread and become a broader social logic. And I think RadicalxChange ideas—by trying to put that formalism in place, to make it really easy to scale, to make it really easy to describe and for people to adopt it—sort of allow for that cybernetic communism to have an expression that is as crisp and as meaningful as the unregulated capitalism logic, and therefore allow it to eventually win out against it.

Valenčič: How would you assess the relationship between economics and politics? Since you are not only a social technologist, but also a political economist, you probably don't see a clear dividing line between these two spheres. One social technology that you propose in this context is quadratic voting, which is in many ways a good antidote to the current overuse of exit and voice in our society. How so?

Weyl: So I see economics and politics not as two separate spheres, but as each profoundly at the core of the other. In order for the economy to prosper, in order for the economy to grow, we need increasing returns phenomena. We need electricity. We need networks. We need steam. We need railroads. We need factories. We need all the things that come with increasing returns. But increasing returns are inherently things that have to be democratically governed in order to be successful. In order to have meaningful democracy, we need competition. We need choice. We need flexibility. We need all of the things associated with markets.

Only once we get past the dichotomy between the political sphere and the economics, or even the political sphere sort of setting up the economic sphere, and realize that instead these things

have to be constantly interleaved with each other, that at the heart of the success of markets has to be the constant use of democratic mechanisms and at the heart of the success of democracy has to be the use of market mechanisms to truly define what democracy is, do we have any chance of either of these principles succeeding.

Valenčič: When we look at other similar projects, e.g. Palladium Magazine, Strelka Institute and others, they seem to not only emphasize institutions and better or more efficient planning or design, but also the need for some kind of a centralised or even supra-national authority (in the case of climate change, at least). Your approach is quite different in this respect, as it is explicitly anti-statist in its orientation. How do you see the problem of scale in RadicalxChange, and in what way would you tackle a question like climate change within its framework?

Weyl: I think the fundamental problem with focusing on global coordination—even though I of course believe in coordination that's not just based on nation states and so forth—is that politics is fundamentally multi-scale. And multi-scale not just in a geographic way, but in every other possible way as well. There are different racial groups, there are different productive companies, there are different industries, there are different languages, there are different networks. All of these intertwine with each other and of course there's millions of geographical scales, from a neighborhood to a part of a city, to a city, to a region, state or province, nation, the world etc. And the problem with so much of politics is it wants to just focus on one scale. It wants to just focus on some global conversation or some one notion of democracy rather than understanding that to be in any way effective or meaningful, democracy has to be federalist—and not just federalist geographically, but federalists in all these other ways. That there has to be this plurality of different institutions interweaving and checking and collaborating with each other if we want to have any chance of achieving the type of meaningful politics that we have. And that on the other hand, the market systems that usually do that sort of coordination across these different institutions have to be themselves filled with democracy. And that we will achieve progress on global issues like climate change only if we have this institution. So, for example, suppose that you try to control climate change, control carbon emissions, have a carbon tax without that sort of structure that I'm talking about. Well, you'd have to have global surveillance to charge everyone that tax, right? Coming

into some centralized authority—that would be totally dystopian. That would turn the attempt to impose climate change regulation, which should be a relatively uninvasive thing, into a form of totalitarianism.

So only by this sort of multi-scale structure do we have any chance of addressing the broadest, most global-scale issues. And that, I think, is a fundamental difference between the RadicalxChange paradigm and other paradigms, whether they be libertarians saying everyone go off and do their own thing, but then all the coordination is done by a carbon tax on the global level or something like that, or very centralized paradigms which say that we will have one global democracy.

Only systems that actually give us this complex pluralistic multi-scale (in many senses) governance allow us any chance of reconciling the sort of flexibility of the market with the importance of democracy.

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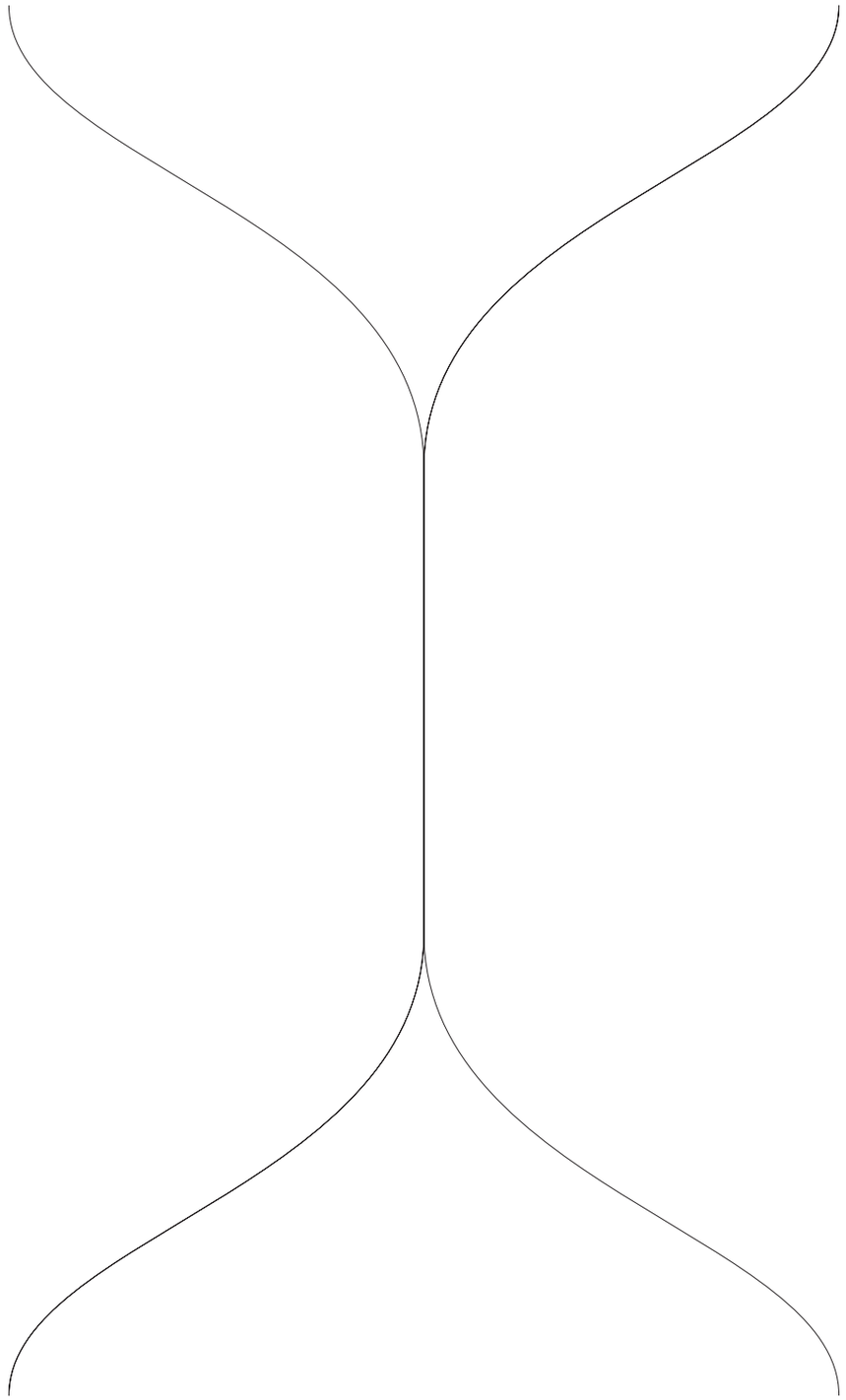

CRYPTOPOLITICS —AN UPDATE

Cryptography becomes effective and operational at the exact mathematical limits of machine learning algorithms.[1]

> **Even if you know nothing about maths, just take that in for a moment.**
>
> ***- There are actual, mathematical limits to what machine learning algorithms can learn!***
>
> ***- Those mathematical limits can be used for the development of secure cryptographic techniques!***

Perhaps neither of those exclamations particularly whets your appetite to read on so let me try and explain with a few metaphors …

Imagine machine learning algorithms trawling vast datascapes of information scraped from phones, laptops, Amazon echo devices or whatever other gadgetry. Algorithms informed by knowledge constructs such as correlations, drawing together ever-shifting streams of data points into something that might be made sensible to a human. In this mathematical universe, the human eye cannot see much of anything without the help of these reasoning agents, throwing up relevant numbers that in turn might be visualised on a dashboard to compute "What is the norm here?", "Where is the anomaly?", "What is likely to happen next?"[2]

These shifting datascapes also have mathematical limits called "impossibility results" that are blind spots, areas that cannot be calculated, sensed and made sense of by these algorithmic agents. And such blind spots, it turns out, comprise the numbers-putty from which to sculpt secret hideouts, extend underground mycelial networks and plan out and defend data territories. In short, cryptography.

Cryptography consists of a set of techniques that can be used for planning and organising our collective datascapes: mathematical doors that can only be opened with the right keys, shaded areas revealing only partial attributes, and secure records that can only be altered after solving a puzzle. And what is more, because cryptographic techniques are fairly low cost, such defences can, in theory, be designed and determined by individuals, groups and nation states alike. As a result, a cryptopolitics has been emerging around different and contingent understandings of security.[3] **Ad-hoc cryptopolitical alliances gathered around different understandings of who embodies a potential adversary and what security means for individuals, whether citizens, hackers, nation states, communities and corporations: a tech giant like Apple for a moment defending the privacy rights of individuals against a snooping state; in another moment, the European Data Protection Regulation (GDPR) is intended to defend the privacy rights of individuals against platform surveillance; meanwhile hackers of different shades, defending or attacking communities, corporations and states alike.**

The questions I am curious to explore with you, and for you, friends, is the scope of cryptopolitics today given some major technological and geo-political shifts. What will unfold over the next ten pages comprises three short discussions:

> **One.**
> ***Surveillance—an update.*** **Cryptopolitics first originated around the cypherpunks, a network of people concerned with protecting privacy in the face of the mass-surveillance capacities of the internet. Where nefarious security agencies might try and shine a light on you, cryptography can secure your safety in the dark. But surveillance is beginning to look radically different, and privacy as the core of cryptopolitics today is not enough.**

1 Universität Bern, "Einstein Lectures 2019, Shafi Goldwasser, Safe Machine Learning", ***YouTube***, https://youtu.be/vnnivgXFhRs.

2 AMOORE, Louise, ***Cloud Ethics, Algorithms and Attributes of Ourselves and Others***, Duke University Press, 2020, https://www.dukeupress.edu/cloud-ethics.

3 MONSEES, Linda, ***Crypto-Politics: Encryption and Democratic Practices in the Digital Era***, New Security Studies, London and New York: Routledge, 2019.

Two.
Cryptography—tools of war, pillars of democracy and rites of initiation. **Cryptography can do much more than protect privacy and determine the conditions of light and dark. It comprises the art of secrets. Part two comprises three little stories about the three main societal functions of such art of secrets, with the hope that it might open up some fresh perspectives for a broader cryptopolitics.**

Three.
Sovereignty—an update. **It is no coincidence that cryptographic techniques are becoming more prevalent at the same time as the words "digital sovereignty" are making appearances in headlines, reports and in whitepapers. In this final discussion I want to emphasise what is currently at stake in cryptopolitics, and what is at stake is nothing less than a global redefinition of the relationship between *territory* and *networks*.**

I want to share some of these unresolved questions, current state of affairs and considerable work happening right now across the disparate fields of computer science and policy, critical theory and the more obscure practices of conspiracy. It is my humble intention to leave you entertained with glimmers of curiosity and some leads to follow in your own quest.

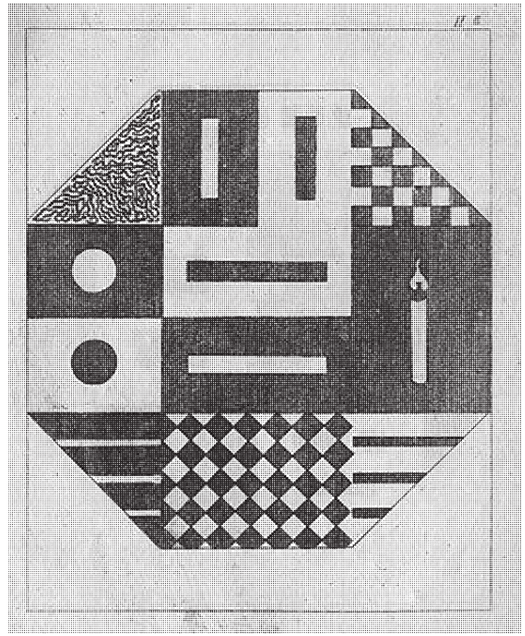

Illustration II in Goethe's Farbenlehre

1
SURVEILLANCE—AN UPDATE

In a series of lectures at Bern University last year, distinguished cryptographer Shafi Goldwasser began to lay out the technical case for why cryptography has much to offer in the design of more "safe" uses of machine learning.[4] At the crux of her argument is the possibility of ensuring privacy while nevertheless allowing for computation to take place. Cryptography of the 1980s employed mathematical impossibility results that would also delineate absolute limits to machine learning ("bliss for crypto is nightmare for machine learning"). But today, she argues, there is scope for an alliance: impossibility results, rather than being a nightmare for Machine Learning, are going to propel it forward. How? By solving one of the impending problems for curious algorithms in our mistrustful times—the continued availability of data in the face of growing awareness and regulations protecting privacy rights.

4 Universität Bern, "**Einstein Lectures 2019, Shafi Goldwasser, Safe Machine Learning**".

Privacy is the core of the cryptopolitics of cypherpunk. The cypherpunks, a name coined by Jude Milhon,[5] formed around a mailing list and the crypto-anarchist and cypherpunk manifestos. A relatively politically heterogeneous bunch of people, their politics developed around the ability of cryptography to protect individuals from surveillance and attacks by *even the most powerful adversary*, whether states or corporations. As the internet became an established and essential infrastructure through which more and more social, economic and political activities would take place, a bunch of cryptographers, activists, entrepreneurs and engineers realised that these networks would likely become nightmarish tentacles of surveillance and control. They were prophetic in this awareness and critique, and the importance of their efforts and the continued work of privacy rights activists towards making cryptography broadly available and fighting for privacy cannot be overstated.[6] Here, at very little cost, mathematical properties make it possible for an ordinary person to keep communications private and untampered.[7]

Is darkness a precondition for freedom? For the cypherpunks the answer is yes.[8] The cryptopolitics of the cypherpunks intends to throw some digital shade and shelter for the powerless while turning a light of scrutiny upon the powerful. And cryptography is what creates *the dark* in digital space, meaning it can determine networks, relations and information that are partially or fully concealed.

The dark is needed in order for the as-of-yet-unformed to emerge and take shape safely and in its own time. Not just for individuals, darkness is important for collectives too, tentative, heaving and experimental, feeling into a new a sense of what it means to move together and to be together, before these crystallize into articulated structures, laws, roads and code, well-known pathways that can be depended upon, a way of life. And, more politically, for such ways to coalesce into an organised force for self-determination and change. The dark is necessary for the possibility that things might be different.

5 CROSS, Rosie, "Modem Grrrl", in: ***Wired***, 1/2/1995, https://www.wired.com/1995/02/st-jude/.
6 SWARTZ, Lana, "What Was Bitcoin, What Will It Be? The Techno-Economic Imaginaries of a New Money Technology", in: ***Cultural Studies***, 32, no. 4, 4/7/2018, pp. 623–650, https://doi.org/10.1080/09502386.2017.1416420; WEINER, Anna, "Taking Back Our Privacy", in: ***The New York Times***, 19/10/2020, https://www.newyorker.com/magazine/2020/10/26/taking-back-our-privacy.
7 LEWIS, Sarah Jamie (ed.), ***Queer Privacy, Essays From The Margins Of Society***, Leanpub, 2017, http://leanpub.com/queerprivacy.
8 O'LEARY, Rachel, https://www.coindesk.com/bitcoin-lost-way-subversive-roots.

But surveillance, in the age of machine learning algorithms and neural networks, has changed. The conditions of light and dark, visibility and invisibility are shifting. This, friends, has recently been reported from some of the forefronts of research,[9] and I would like to pass on the message, because it suggests that cryptopolitics needs an update.

Since the Enlightenment, knowledge and power has been overwhelmingly associated with seeing. To shine a light on something is to make it visible and knowable. The *light* in European En*light*enment brought the eye in the sky down to the individual on earth, promising liberation from the gods through the measured and measuring eyes of (those-included-in-the-category-of) humans, now able to see, to learn and know, and to shape their own fate. Perspective frescos centring the spectator's point of view, a viewpoint for considered reflection by the now free and informed individual.

The gods in the meantime shape-shifted, the eye in the sky manifested as the eye of the sovereign, first as kings, then state authority. To see is to know, and knowledge is power. And the lone hero's battle against the gods continued on earth against the all-seeing eye of the state. The most famous *dispositif* of surveillance is Bentham's panopticon prison design, and it is the shape of an iris.

***Against power,* there are now generalised digital "dark" obsessions, extending into alt-right distortions of the dark ages that oversubscribe to a caricature version of darkness as, simply, *the absence of power*:[10] here, it is assumed, lies complete freedom for the individual. It is the rookie anarchists' wet dream, a post-apocalyptic terra-nullius liberated from all strictures where heroes can posture and a free world can be born. Needless to say, terra-nullius is a colonial myth invented to invalidate life in other forms and prepare a lone stage for the hero versus the sovereign.**

What I mean is give a bunch of guys "freedom" in a dark room to do whatever they want, and surprise, many of the well-worn problems will be reproduced. The swirling dark does not automatically deliver final liberation. For example, the many protocol governance crises of the crypto-world showed that it was not enough to escape to the internet and turn off the lights.[11] The dark beyond the purview of the sovereign demanded new ways of dealing with old problems, lest it merely provide a vacuum to be

9 AMOORE, ***Cloud Ethics, Algorithms and Attributes of Ourselves and Others***.
10 KAUFMAN, Amy, "A Brief History of a Terrible Idea: The 'Dark Enlightenment'", in: ***The Public Medievalist***, 9/2/2017, https://www.publicmedievalist.com/dark-enlightenment/.
11 AZOUVI, Sarah, MALLER, Mary, MEIKLEJOHN, Sarah, "Egalitarian Society or Benevolent Dictatorship: The State of Cryptocurrency Governance", ***The Fifth Workshop on Bitcoin and Blockchain Research***, 2018.

forcefully occupied by whoever throws the most violence, lies or money at it. The dark began to take on some shape around campfires, some more blazing or clumsy than others, but a plethora of experimentation with governance, economics and collective organising,[12] and how to deal with that which is all too familiar to those with two names: the fact that the structural and historical ripple through minds and bodies, as much as disciplines, institutions and infrastructures.[13]

This is all just to say that *the dark* in early cypherpunk does not fully amount to a politics. What matters is not whether one is seen or not, but who determines the conditions of visibility/invisibility and towards what end. What matters is not anonymous, pseudonymous, nym networks per se,[14] but who is able to strategically deploy these and for what purpose. The attraction of cryptography, for the cypherpunks and others, was, after all, that it comprised mathematics: cheap and potentially accessible for ordinary people.[15] Design and engineering decisions, far from being neutral, will indeed serve some uses and users better than others. Another example: recently, O'Leary called for the world of crypto to return to its subversive roots in cypherpunk—what she refers to as a "dark renaissance".[16] And these, to be sure, are fertile beginnings, a reminder of the early political ambitions—decentralised, cryptographic networks as a strategy against power. But there is an important link that O'Leary perhaps prematurely assumes from her readers, namely the connection between building anonymous networks and her experiences in Kurdistan and readings of Ocalan's political ideas. What matters is not a generalised dark enlightenment that seeks to "extend the space of illegality outward: to increase the remit and power of unauthorized black market activity and strip resources away from the nation-state",[17] but rather the specifics of *which* resources of *what* state and *who* might benefit from the illegality of black markets. That is where the politics lie—if by stripping resources, we perhaps mean tasers, guns and tanks of police forces, great. Public health facilities, less so. If black markets can be deployed by non-aligned

12 CATLOW, Ruth, "Decentralization and Commoning the Arts", in: ***Free/Libre, Technologies, Arts and the Commons***, Nicosia, Cyprus: University of Nicosia Research Foundation, 2019.

13 BROWNE, Simone, ***Dark Matters, On the Surveillance of Blackness***, Durham and London: Duke University Press, 2015.

14 DappCon, Berlin. ***DAPPCON 2019: Network-Layer Anonymity for Privacy-Enhanced Dapps – Claudia Diaz (Nym)***, 2019, https://youtu.be/5A378jgYXSc; GURSES, Seda, TRONCOSO, Carmela, DIAZ, Claudia, "Engineering Privacy by Design", 2011, p. 25.

15 SWARTZ, Lana, "What Was Bitcoin, What Will It Be? The Techno-Economic Imaginaries of a New Money Technology", in: ***Cultural Studies***, 32, no. 4, 4/7/2018, pp. 623–650, https://doi.org/10.1080/09502386.2017.1416420.

16 O'LEARY, https://www.coindesk.com/bitcoin-lost-way-subversive-roots.

17 Ibid.

states to protect Indigenous resources and circumvent exploitative WTO trade regulations, great; for the secret export of extreme surveillance gadgetry to oppressive regimes, less so. The specifics of the given (crypto)political project matter.

In the meantime, the engineering of optics, visibility and invisibility is becoming ever more sophisticated. Yet the skills required to fully understand and navigate what is a broad spectrum of modes of seeing, being and becoming remain somewhat crude. Friends, surveillance no longer means the same thing. And an insistence on privacy is not enough. The centralised authoritarianism of Orwell's 1984 has morphed into more distributed and contingent processes. The iris of Bentham's prison has been replaced with multiple devices and sensors producing dynamic datascapes, where freedom or incarceration is relative, relational and fine-grained.[18]

Louise Amoore describes the new state of affairs: your individual attributes form part of cloud computing datascapes, training and informing algorithms, the consequences of which might nicely serve your immediate convenience while striking down elsewhere, elsewhile on another with violent force.[19] Disparate attributes of a myriad of people, beings and things flow through and are processed by algorithmic sensibilities informing some credit rating agency, some border agency, some security agency for setting thresholds for access or targeting, what Benjamin describes as an extension of carceral politics.[20] This is a novel mathematical universe. Novel, because this work to make the world calculable implies an incursion, selection and digital representation as data of an otherwise much larger universe.[21] It is not a neutral representation of the world, there is no such thing as "raw data"[22]—my digital data attributes is not me, so to speak, but a classed, gendered and racially skewed measure of me,[23] and a quite particular kind of optics opening on to an ever-shifting collection of digital information that is calculable in unique ways. A subject might fall above or below the threshold, a threat, not a threat; a scenario will be likely or unlikely. The surveillance of machine learning algo-

18 BENJAMIN, Ruha, "Catching Our Breath: Critical Race STS and the Carceral Imagination", in: ***Engaging Science, Technology, and Society***, 2, 1/7/2016, p. 145, https://doi.org/10.17351/ests2016.70.

19 AMOORE, ***Cloud Ethics, Algorithms and Attributes of Ourselves and Others***.

20 HALPERN, Orit, ***Beautiful Data, a History of Vision and Reason since 1945***, Durham and London: Duke University Press, 2014.

21 GITELMAN, Lisa, "***Raw Data" Is an Oxymoron***, Cambridge, MA: MIT Press, 2013.

22 CROSS, "Modem Grrrl".

23 CRAWFORD, Kate, "Artificial Intelligence's White Guy Problem", in: ***New York Times***, 25/6/2016, https://www.cs.dartmouth.edu/~ccpalmer/teaching/cs89/Resources/Papers/AIs%20White%20Guy%20Problem%20-%20NYT.pdf.

rithms does not exactly entail the *veillance*[watching]*sur*[over] of a subject, but rather a form of "governance through the partial attributes of unknown others".[24]

Going back to where we started, this somewhat distorts Goldwasser's promise of the best of both worlds—privacy while nevertheless being able to compute the invisible data. The safe machine learning made possible through Goldwasser's cryptography might be adequate for securing privacy rights of a liberal individual by limiting what might be immediately "seen". But in the meantime it radically extends the scope and reach for "knowing" and "doing" because the unseen-yet-knowable can now stretch deep into the most intimate and most vast collections of data traces. This complex cryptopolitics criss-crosses the cracked Doric columns separating the now dusty public and private spheres. Through cryptographic techniques—such as zero-knowledge proofs using probabilities in nifty ways—certain types of knowledge about a thing, or an aggregate of many things, can be known without revealing that actual thing. These are mathematical possibilities that begin to stretch at what privacy and surveillance actually entails today and why, importantly, privacy as the crux of cryptopolitics is simply not enough. The optics are different, these are not cameras, but algorithms and what they are sensing and computing are not individuals, but partial attributes arrived at through probabilities. This allows for a radical extension of what can be *known* and *done*, by a sovereign or otherwise, while nevertheless limiting what can be immediately *seen*.

24 AMOORE, *Cloud Ethics, Algorithms and Attributes of Ourselves and Others*.

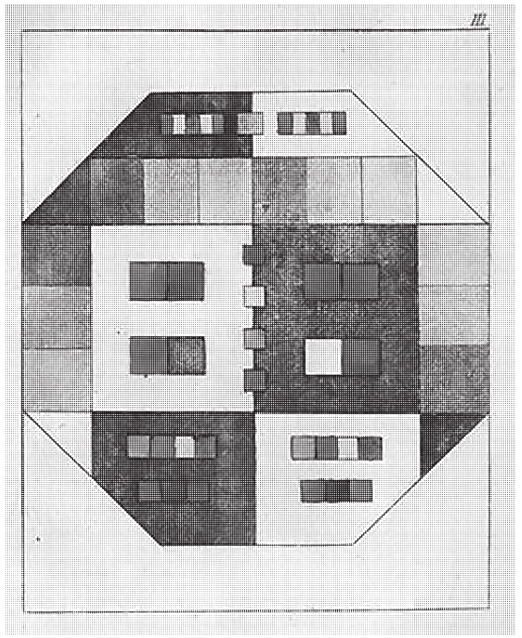

Illustration III in Goethe's Farbenlehre

2
CRYPTOGRAPHY— A TOOL OF WAR, PILLAR OF DEMOCRACY, RITE OF INITIATION

Let us now enter a broader spectrum. There is more to cryptography than encryption techniques, revealing and concealing, the "light" and "dark". In its most general sense, cryptography is an ancient art of secrets. It entails the creation of puzzles and codes in order to pass on secret information and to make sure that information has not been tampered with. And secrets have several societal functions. In part one, I discussed cryptopolitics as having emerged out of a concern for privacy, how the conditions of surveillance are radically changing, and why cryptopolitics needs an update. Here, in part two, I will present to you a few anecdotes intended as illustration of broader contexts and techniques, for your inspiration. What follows are three little stories about cryptography as a tool of war, a pillar of democracy and as a rite of initiation.

Cryptography as tools of war. **The Colossus is a machine that was invented in order to break the encryption of the Lorenz used to encrypt German messages during World War II. It was also the first semi-programmable electronic computer, invented by the engineer Tommy Flowers. The Colossus was built, had operated and still resides in Bletchley Park, a leafy location with a quaint scattering of buildings an hour's train ride outside London, to which I was headed one sunny day in the spring of 2019.**

I had recently submitted my PhD thesis on the politics of blockchain technology and I had been invited on this little excursion to one of the historical birthplaces of modern cryptography and computing by a friend—a computer engineer—who had (in) famously just jumped ship from working on *DECODE*, a flagship, early European challenge to US Big Tech, to instead work on the Facebook Libra project, EvilCorp's own cryptocurrency.

That is to say, curiosity spurred my visit that day. Unresolved questions from my thesis and surprise at my friend's recent decision had me wondering what might be meaningfully said about the politics of information security engineers. And whether the history of cryptography as a tool of war would have any clues to offer.

Standing in front of the Enigma machine, something clicked, on the machine and in my mind. Here was an encryption machine that had been considered unbreakable. It would change its encryption cypher regularly, meaning there were gazillion (meaning "shit ton", more precisely 103 sextillion) potential encryption settings. It was unbreakable. Until it wasn't. In fact, it was broken twice, first by Polish code breakers just after the first world war, and then again by UK codebreakers at Bletchley Park (including the now-famous Alan Turing) during the Second World War.

Cryptography emerged as a strategic tool of war, a context that continues to shape practices of information security engineering and the social, political and economic ideas in the world of cryptocurrencies and blockchain technology. In part because of this history, cryptographic techniques necessarily present an impression of being unbreakable. For the excellent engineer, exquisite engineering, bolstered by the eminently powerful mathematical war tool of cryptography, might determine the course of history and turn the whole geopolitical situation. And this, it seemed to me, was perhaps one of the reasons for that hop and a skip of my excellent-engineer friend over to EvilCorp—the temptation of making unbreakable tweaks to a system from the inside and thereby determining the conditions of 2 billion people.

Such cryptowar histories are also reflected in contemporary decentralised systems where interactions are thought through in terms of attack vectors, adversaries, honest and dishonest behaviour. A perspective which starts from the premise that people should not be trusted, in fact *cannot* be trusted and therefore require a "trustless" system to govern them. At the core of such trustless systems would be cryptography, providing a mathematical certainty that even the most powerful of authorities would not be able to break. And curiously, or perhaps unsurprisingly, this means that interactions between people as well as with the protocol are understood through the terms of war and war games, inviting, in fact *encouraging*, attacks. The very same compulsion to present encryption techniques as unbreakable will also spur the very efforts to break it. For the mathematical mind, it is an irresistible game, a puzzle that begs solving.

Personally, I am interested in how cryptographic techniques might emerge from such shady dealings and new decentralised cold wars to more explicitly and deliberately help people and communities navigate the politics of contemporary digital life. If there are things to be learnt from Bletchley Park, it is that cryptography can grant some strategic advantage at a key moment in time, but it is not unbreakable. I was standing in front of the very evidence of this. The historical and contextual are two aspects that are not captured by information security models. Cryptography is only ever one strategic part of the operations of empire, and unless clearly articulated, engineers will be at its service.

Cryptography as a pillar of democracy. **And in fact, infosec engineers *did* get politically organised. When I said earlier that the cypherpunks were the beginning of crypto*politics* I meant it literally—bringing encryption from the service of warfare into the service of democracy. Before a number engineer-activists, hackers and entrepreneurs consistently made the case that these mathematical tools be free and open to all, cryptography was considered as ammunitions. In what became known as the "crypto wars", a now well-worn story that has become legend in crypto history more generally, strategies included printing encryption functions out as a paper book to circumvent US ammunitions regulation. These campaigners argued (and digital rights activists still to this day have to continue to argue) that encryption is as a pillar of democracy in the digital age. Without digital communications being both private and secure, democracy is impossible: information will be manipulated, knowledge will be censored and people will be oppressed by other people.**

Such well-worn legends aside, what, more specifically, can cryptographic techniques achieve then in terms of democracy in the digital age? I will whip through a few, just to give you an impression:

> They can help ensure that you are getting the correct version of a file, website or data without it having been manipulated. For example, cryptographic "proofs" are techniques, which amongst other things prove whether some information has been tampered with by running what is called a hash function. "Hashing" takes some digital information and spits out a string of characters that are unique to the input. This means that if someone changes the data the output will also change, a mathematical proof that the data has been tampered with.
>
> Cryptographic hashing, keys and signatures are all widely used. You will for example recognise that little "*s*" that has appeared in the familiar *https://*, securing the transmission of information across the internet. Actually, cryptography is used to create entirely new kinds of networks. There is now also *ipfs://* and *dat://* that make it possible to serve content directly from your device to someone rather than routing it through a third party's server. Here are plenty of possibilities for new kinds of direct control over your digital residue.
>
> These techniques can also enable forms of decision making in and about the digital. Cryptographic keys for example can allow a person to decide who gets to see a message or not. They can also be used as digital pseudonyms, a key granting specific credentials, voting and decision-making powers in various online communities and organisations. In general, cryptography can address the question of who has *control* in the digital sphere, and with the right design can ensure and secure digital spaces that are under democratic control.

Much of these musings on the need for encryption and other cryptographic techniques for democracy in the digital age still rely on social and political ideas of democracy from the past, however. More specifically, they rely on the democratic subject as a liberal individual who can make meaningful decisions. The European *General Data Protection Regulation*, for example, has granted us all that luxuriously advanced democratic experience of clicking yay or nay to abstract cookies questions for every single website we visit. Frustrating because really, individual decisions on privacy and data sharing bear little actual weight in a world which, as we know now, is governed through the *partial attributes of unknown others*. So for

example, in a curious cryptopolitical plot twist, where we might have fought for *untraceability* as essential to privacy, now our allies and friends are developing refined cryptographic techniques to trace our partial data attributes to be able to see whether they are used for nefarious profiling purposes.[25] There is plenty work to be done here, and nothing obvious about the more specific role of cryptography as a pillar of democracy in the age of Machine Learning and AI.

Cryptography as a rite of initiation. Rarely is this more esoteric function of cryptographic techniques explicitly acknowledged by cryptographers. But it is one of its most powerful and subtle aspects.

The mysterious game Cicada 3301 involved a meandering maze of cryptographic puzzles: a message hidden in a digital image, a website on the dark web with a two-day countdown, at the end of which specific geo-locations were revealed in cities across the world where a QR code was hidden, self-destructing files and finally a 54-page runic book comprising different encryption techniques for every page or section. These clues, each signed by the creators using the same GPG key, would send puzzle-solvers deeper and deeper into a world of hidden secrets and messages and, essentially, a search for some meaning to it all. What did the messages signify? What was the broader reason for this elaborate Alternate Reality Game? And who had created Cicada 3301, the name of which matched the mail server of the cypherpunks?

The questions themselves turn out to be more powerful than their answers. They spurred a continued quest for several years, a quest so hard and difficult that it forged large communities of people all on the hunt for clues gaining significant cryptographic skills in the process. Solving each puzzle was a rite of initiation into the company of a select few who had made it that far.

Cryptography is the art of secrets. And as such, its characteristics can at times run directly against the grain of a form of knowledge that seeks articulations aimed at the most immediate form of transmission, laying bare the full facts in the light of day. To simply reveal something is to break the magic. This is a refined art of shadows, an art that easily lost in the clumsy floodlight of enlightenment-informed data accumulation and information processing. The immediate return of a google search somehow does not deliver on a deeper sense of meaning. The difference between knowledge as *information* or *realisation* is how the body is transformed in the process.

25 JARMUL, Katharine, mail-list archive, ***Probably Private: Episode 2 – GDPR, SurveillanceTech, Browser Tracking***, https://buttondown.email/probablyprivate/archive/1bc801a7-a8bb-4fc1-891b-eebc705d9d89.

Last year, I had a conversation with the artist Lawrence Abu Hamdan. He was seeking some advice on potentially using blockchain for a work on reincarnation (yes, you read that correctly), and I, on the other hand, was seeking insights into this idea that cryptography somehow serves as a rite of initiation. He told me about the Druze people whose sacred books are not in one location, but spread across several households. In my mind's eye I saw myself knocking on doors, introducing myself first to a family, then a lone old woman, a young couple, speaking, eating, learning of their ways, building trust without which access to these pieces of holy knowledge would be impossible. The hidden books demanded a sacrifice of time, an effort, only partially and slowly revealing themselves. The sacrifice in the meantime would prove transformative, a rite of initiation into a new way of being.

The elaborate Cicadia game started with a post on the now infamous 4chan online messaging board. Another branch to this story leads to different path of initiation. Encrypted clues by the anonymous "Q" are sent out to followers to go and solve, bringing them deeper into a maze of conspiracies that seems to have taken on a life of its own and became a major force in the recent 2020 US elections.[26] Conspiracy in the meantime means to conspire, to breathe together, and while facts and truths might help disband some of the more harmful tangles, there remains a dearth of inspiration, new ways to conspire.[27] (Let's not kid ourselves—it is obvious that we are in the midst of a profound famine of meaning and community. Loneliness is the spiritual pandemic, and it has been raging for a lot longer.)

Hamdan also suggested that calligraphy can be understood as a form of cryptography, the aim of which is to partially conceal the word and its literal meaning in order for a more embodied experience to take hold: an impression and a gesture. The sacred in this encounter with the page is a form moving beyond interpretation—that clouded first layer of the mind—into an immediacy of presence with the meaning. We can pretend that cryptography pertains to the cool rationality of cold war strategy, a functional pragmatics. But there is a lot more to this art of secrets, a much more refined practice of shaping quests that become a rite of initiation into the presence of meaning and community, some of which are weird and wonderful, others truly disturbing.

26 KAMISKA, Isabella, https://ftalphaville.ft.com/2020/10/16/1602828074000/The--game-theory--in-the-Qanon-conspiracy-theory/.

27 LAGALISSE, Erica, ***Occult Features of Anarchism, With Attention to the Conspiracy of Kings and the Conspiracy of the Peoples***, Oakland: PM Press, 2019.

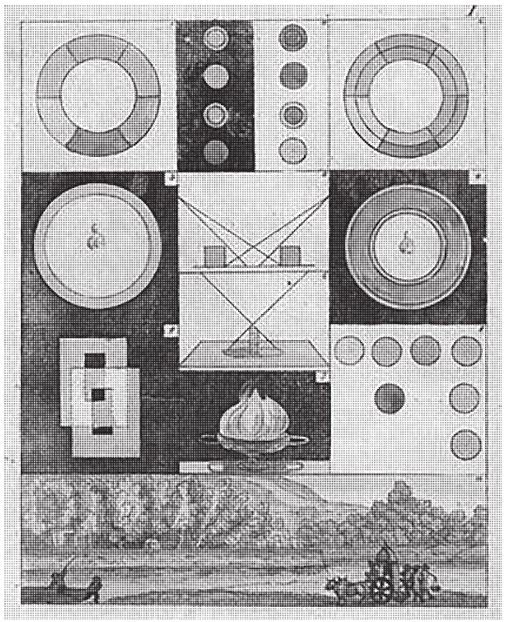

Illustration I in Goethe's Farbenlehre

3
SOVEREIGNTY—AN UPDATE

Earlier, I mentioned that what is currently at stake is nothing less than a redefinition of the relationship between *territory* and *networks*. There are major geo-political rearrangements taking place right now across the entire stack, from physical infrastructure to information, financial and monetary networks. These are attempts at determining "digital territories" and grappling with how to define and assert some sort of "digital sovereignty" in network space.[28] And cryptographic techniques are at the core of such emerging arrangements. But sovereignty in the digital means very different things to different people.

If we look back, for a moment, in the optimistic '90s/early '00s glow of globalization (shared even by alter-globalizations of the time), networks were thought to be untethered/ing from territory, connections criss-crossing borders and boundaries facilitating

28 MÖLLERS, Norma, "Making Digital Territory: Cybersecurity, Techno-Nationalism, and the Moral Boundaries of the State", in: ***Science, Technology, & Human Values***, 31/1/2020, https://doi.org/10.1177/0162243920904436.

dreams of a digital commons where the people of the world might meet, frolic, share knowledge and organise. Then platforms and apps took over from websites and blogs, mass-mergers and acquisitions, centralised decentralisation. A sharp inhale, a pause, and giant tech appeared, silicon software sovereignty, bigger than anything the world had seen in terms of wealth and reach.

Networks are radically *deterritorialising* in their effects. Those coloured maps of the world, recognizable shapes of pinks, orange, greens and blues, drawn up by public officials delineating territories under the sovereign control of nation states [in a British BBC accent], replaced by zooming in and out from a street view to a continent, a unified map ambitiously assembled by private mega corp. google, with only a hint of an outline of nation states [in the voice of Siri].[29] Initially, the dissolution of national borders was hopeful, then sudden horror at the simultaneous dissolution of democratic institutions towards a platform-feudalism.[30] To be explicit: "Microsoft's anti-piracy technology could also, in theory, remotely revoke its licenses and thereby incapacitate the entire German administration at the push of a button".[31]

On top of that, it turned out that those untethered networks and clouds serving up a global cyber-communion-turned-platform-feudalism were mostly the very-tethered-indeed infrastructures of neoliberal globalisation under US geopolitical rule. (With Trump in the Whitehouse, the European political classes began to envy the Chinese political classes for their keen awareness of this all along.)[32] As these arrangements revealed themselves and came undone, the wheels of history have begun to churn again in an awkward flip-flop of a punctured tyre. Geopolitics is back. So, ehm, what should sovereignty mean now?

This is the picture, an attempted resurgence of somewhat freeze frame familiar maps but now operating through new mediums of statecraft "shifting tasks of government into the domain of computer scientists and network engineers".[33] But there is more going on in the actual territory so to speak. Like an elastic

29 LESZCZYNSKI, Agnieszka, "Situating the Geoweb in Political Economy", in: ***Progress in Human Geography***, 36, no. 1, February 2012, pp. 72–89, https://doi.org/10.1177/0309132511411231.
30 BRIA, Francesca, "Our Data Is Valuable. Here's How We Can Take That Value Back", in: ***The Guardian***, 5/4/2018, https://www.theguardian.com/commentisfree/2018/apr/05/data-valuable-citizens-silicon-valley-barcelona.
31 MÖLLERS, "Making Digital Territory: Cybersecurity, Techno-Nationalism, and the Moral Boundaries of the State".
32 ZHAO, Yuezhi, "China's Pursuits of Indigenous Innovations in Information Technology Developments: Hopes, Follies and Uncertainties", in: ***Chinese Journal of Communication***, 3, no. 3, September 2010, pp. 266–289, https://doi.org/10.1080/17544750.2010.499628.
33 MÖLLERS, "Making Digital Territory: Cybersecurity, Techno-Nationalism, and the Moral Boundaries of the State".

band that has snapped, the crumbling of the US empire is also unravelling more of the threads of a frayed European post/colonialism. Sovereignty is and always was contested, and its meanings in terms of digital networks no less so. *Digital Sovereignty*. Here is a concept that curiously is now being mobilised by hacker communities, nation states, Indigenous groups, city governments, European policy makers and digital rights activists alike. All very unlike types of people indeed. And so the practical meaning of these two words is still being defined, while nevertheless being quite effective as a mixed bag broad rallying cry to address anxieties over a loss of control over the digital.

While the general problem is vaguely agreed upon, what 'sovereignty' should mean in this day and age and the more precise ways that it should be achieved is entirely unresolved. Sometimes it implies extending existing forms of territorial and regulatory control into networked infrastructures and digital spaces—new borders and boundaries, techno-nationalisms where governments seek to garner national sentiments about digital infrastructures. Other times it implies further escape from territory, where hacker communities seek to create online networks, organisations and apps beyond anyone's control. Cryptography is playing a key part in these contemporary contestations around digital sovereignty. These span techniques for territorialising data and computation in specific locations and devices to instead radically deterritorialise across distributed networks—both in response to large corporate owned data-centres. They also span techniques for intervening in conditions of visibility and agency, determining who can do what using cryptographic keys and proofs. And cryptography has also become an intervention into sovereignty over value in the digital space—and here I mean cryptocurrencies as well as FinTech more generally and, not least, centrally banked digital currencies.[34]

There are, indeed, many versions of sovereignty being worked on at the moment with quite different significance for our digital futures. "Self-sovereignty" is an idea that has been developed amongst the cryptopolitics of distributed network cultures beyond state contexts.[35] The notion is nifty and nice, namely to grant people full insight into and control over what is known about them online. Imagine being able to immediately see whether an

34 BREKKE, J. K., ***Contested Cryptographic Geographies*** (forthcoming).
35 FARIA, Inês, "Trust, Reputation and Ambiguous Freedoms: Financial Institutions and Subversive Libertarians Navigating Blockchain, Markets, and Regulation", in: ***Journal of Cultural Economy***, 12, no. 2, 4/3/2019, pp. 119–132, https://doi.org/10.1080/17530350.2018.1547986.

online action will negatively impact your credit rating, or how much a given company is making from harvesting your data and what precisely they are using it for. Your cookie settings would take on a whole new meaning. But for that meaning to not simply result in generalised anxiety at the weight of your every online decision, some of this needs to simply be taken care of collectively. In the meantime, digital sovereignty is also invoked at sub-state level by communities and municipalities that are, for good reasons, keen to carve out some datascapes that would not fall under immediate state control.[36] Here, a digital commons is taking shape, one such promising potential collective framework. Digital sovereignty is also being worked on by Indigenous communities. Indigenous sovereignty is contrasted with settler colonial sovereignty,[37] the former emphasising primarily relationships between beings and land, while the latter primarily emphasises delineation of ownership over some body—whether land, resources or otherwise. And there is also data-sovereignty, worked on with and by communities who are keenly aware of how their information and knowledge otherwise gets captured into private ownership and property regimes. Others seek to move beyond the bloody histories of sovereignty altogether, towards a web of commons, where organised communities might have control over information infrastructures and the data and intelligence enabled by these.[38]

There is a real risk that digital sovereignty will fall back on familiar patterns of sovereignty, something along the lines of a digital settler-colonial-sovereignty—meaning a sovereignty primarily based on delineating territory, ownership, private property rights and the protection of markets. But this is where the machine might strangely save us. And here, I want to pick up on some threads from part one. Machine learning operates on partial data attributes and their relations. The operations as well as the value derived from these are intensively collective and relational. A trivial example: your age is not particularly significant or interesting on its own. But pair that with your frequency of visits to a particular park at certain hours, and compare it with other age attributes visiting that park and a story begins to appear. "[V]alue comes from the patterns that can be derived by making connections between pieces of data, about an individual, about individuals in relation to others, about groups of people, or simply about the structure of information itself."[39] This is why some of the more woke policy people are now arguing that individual rights and ownership over data is limited and that there is instead a need for collective approaches to managing data in data trusts[40] or data unions as well as entirely new value systems around data and their derived intelligences. These problems force collective and relational approaches (and I mean "collective" and "relational" in a precise manner, not as an appeal to some vague sentiment of "good") because the individual and the propertied simply hold little immediate relevance in the operations of big data, machine learning and AI.

Let's wrap up here friends. Cryptopolitics is at the core of major contemporary developments, but it needs an update. For now I leave you to imagine the further details.

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36 BRIA, Francesca, "Barcelona Digital City: Putting Technology at the Service of People", ***Barcelona: Ajuntament de Barcelona***, 2019, https://ajuntament.barcelona.cat/digital/sites/default/files/pla_barcelona_digital_city_in.pdf.

37 BRIA, "Barcelona Digital City: Putting Technology at the Service of People"; MORETON-ROBINSON, Aileen, ***The White Possessive Property, Power, and Indigenous Sovereignty***, Minneapolis: Minnesota University Press, 2015.

38 MCKELVEY, Karissa, "The Web of Commons: Rethinking the Status Quo from the Data Up", in: ***NESTA***, 14/9/2020, https://www.nesta.org.uk/report/web-commons-rethinking-status-quo-data/.

39 CRAWFORD, Kate and BOYD, Danah, "Six Provocations for Big Data", 2011, http://dx.doi.org/10.2139/ssrn.1926431.

40 POGREBNA, Ganna, "Machine Ethics & Bottom-Up Data Trusts: Solving Imbalances in Data-Driven Systems| Sylvie Delacroix", ***YouTube***, 2020, https://youtu.be/JE6ZmwJbRt4.

REWRITING THE EARTH AS PRAXIS

GREEN TOTEMISM, ACTUALLY-EXISTING-GEOENGINEERING, AND THEIR OVERCOMING

The disciplines of the built environment don't seem to be accustomed to addressing the scale and scope of the environmental design necessitated by the current ecological predicament, and therefore they may need to rehearse an expanded repertoire. If geoengineering is narrowly defined, more than broadening its content to include other interventions of similar scale and effect, it may also be useful to broaden the overarching concept of the interventional practice to which it points. For the first, we may look at the utilization of nature as a climate solution to realise that some of our already existing deliberate geoengineerings are found where we would least expect them. But more than that, uncovering some of the problems arising in the process of accepting such a framing, as well as putting it to actual work, we will attempt to highlight how engineering and its accompanying methods present blind spots and thus cannot but be but only part of a wider praxis to address planetary change. A critical perspective from a Martian engineer offers some parallel notes on the concepts employed.

PAPAM

In its various manifestations throughout the past year, from wildfires to the raging pandemic, the deepening ecological crisis has made itself painfully apparent. Although the responses and their results on many fronts have not been particularly encouraging, it seems that consensus is growing for more intensive efforts to protect ecosystems, reduce the anthropogenic footprint and remedy part of the inflicted damage. This remediation process is many

times considered as a narrowly restorative one: as a return to a previous condition that was working just fine, before humans meddle too much. Misunderstanding this for a process of "undoing" the damage is problematic in at least a couple of ways: it implies following the same path in reverse, and it also connotes processes of erasure and subtraction. Neither of them are necessarily true, especially since we realised that "simply" cutting down on emissions will not be enough.[1] On the one hand, restoration work may introduce new paths or redefine the target goal as our understanding of ecosystems evolves. On the other hand, many aspects of the decarbonization project are crucially additive, with ecosystem conservation enclaves and installations of renewables being examples of particularly spatially intensive and space-fixing responses.[2] In any case, the planetary remediation project includes deliberate large-scale geographical reorderings.

And, it seems, the disciplines of the built environment are not accustomed to addressing the scale and scope of this kind of interventional praxis, and therefore they may need to rehearse an expanded vocabulary in that respect. The modification of geophysical and geochemical properties on climate- and planetary-significant scales has recently been associated with "geoengineering" and its narrow set of techniques, with much of the discourse also treating it as an emergency on/off mechanism. But if we were to do justice to the term and include the vast variety and combinations of interventions of which the cumulative impact is of similar extent, the project of planetary modifications would begin to resemble an orchestration of different complex programs in a rather significant temporal depth. Methods may vary from synthetic to natural, focuses may vary from biological concentrations to chemical ones, schedules may vary from years to aeons, while both the inevitable variety of planetary imaginaries and

1 Cutting down on emissions is not enough for at least three reasons: first, it does not seem feasible to reduce CO_2 emissions fast enough in order to meet the targets; second, some sources of GHGs are unavoidable, at least in the medium term; and third, rapidly eliminating emissions will result in short-term temperature rises. Indeed, out of the 116 IPCC scenarios that are potentially successful in meeting the 2°C target, no less than 101 assume the employment of large-scale NETs. See: ANDERSON, K. and PETERS, G., "The trouble with negative emissions", in: ***Science***, 354:6309, 2016, pp. 182–183; and FIELD, C. B.,and MACH, K. J., "Rightsizing carbon dioxide removal", in: ***Science***, 356:6339, 2017, pp. 706–707.

2 The trillion trees discussed in the recent World Economic Forum require a space almost equal to the lands of the US and China combined; solar and wind renewables demand ~45 times more space compared to coal because of their low energy density; and some have gone so far as to argue that half the earth should be reserved for ecosystem conservation. See: BASTIN, J.-F. et al, "The Global Tree Restoration Potential", in: ***Science***, 365, 2019, pp. 76–79; VAN ZALK, J. and BEHRENS, P., "The spatial extent of renewable and non-renewable power generation", in: ***Energy Policy***, 123, 2018, pp. 83–91; WILSON, E. O., ***Half-earth: Our planet's fight for life***, New York: Liveright, 2016.

the different culturally embedded cosmotechnical protocols of approaching and repurposing geography are to be taken into account. In this essay we will argue that in order to practice and govern interventions in such scales, it is necessary not only to broaden the concept of the established term "geoengineering" to include other environmental modifications of similar scale and effect, but also to broaden the overarching concept of the "interventional" practice to which it points.

To address the conceptual extensions of both geoengineering and the overarching practice of deliberate modifications to which it belongs we will route our thinking through a proxy. This we will initially frame as an actually existing genre of geoengineering, albeit one that, interestingly enough, is promoted as its inverse: so-called "Natural Climate Solutions" have been at the epicenter of the discourse related to climate change mitigation, supported by environmentalists and policy makers alike as non-technological and mild responses that leave nature mostly intact. Contrary to that, we will argue, is one of the few deliberate geoengineerings we already have: the recursive relation between the reorganization of natural ecosystems and their analytical and normative modelling as possible negative emission technologies is part of a deliberate geographical reordering already taking place.[3] Uncovering some of the problems that arise in the process of accepting such a framing, as well as putting it to actual work, we will attempt to highlight how engineering and its methods present blind spots and thus cannot be but only part of a wider praxis to address planetary change. It is to this extended repertoire that we will refer to as a *geopraxis*, which is not suggested as an alternative to geoengineering, but rather as a concept that includes it.

What follows will unfold as an argument for two voices. The authors we will be taking turns reasoning on the base of our separate yet complementary individual familiarity and experience with the analytical and the propositional parts of the argument respectively. The second author's extra-terrestrial experience may prove useful in contributing a certain comparative perspective, which will be shared in a more autobiographical tone.

3 The observations on NCS presented here are based on my research: PAPAMATTHEAKIS, G., ***Negative Emission Natures: nature as technology in the climate change discourse***, MSc dissertation, Athens: Harokopio University Dpt Geography, 2020.

GEO: CONCRETE BODY

During the research conducted in the context of the Colonial Group's space expansion program we looked at the earth as one possible alternative. Since our program would require certain reformations of your terrestrial environment, our group of experts was interested in how earthlings perceive deliberate large-scale environmental transformations. We were surprised to realize that despite a clear rise of studies on the topic in the second half of the 20th century, these transformations were conceived in an increasingly narrow way. The multitude of large technical projects of the past that reshaped the face of continents and articulated nations failed to be conceptualized holistically and in their cumulative impact. When the problem of the world—indeed the planet—as a system was actualized, certain renderings of holistic interventions appeared. Of the ones now most vividly discussed, so-called "geoengineering" emerged in research literature as early as the 1960s, as an attempt to shape and manage the earth's climate.[4] Despite the variety of "-engineering" techniques discussed and developed, the parochialism of the concept still appears not only in its exclusive obsession with a certain element, that of CO2, but also within the under-operationalization of the prefix "geo-", which points abstractly to the body of the earth as the site for intervention, at best signifying the scale of the project. However, given the linguistic and epistemological roots of what on earth you call geography, it is difficult to resist the temptation to reread the phrase as a shorthand for the slightly earlier "geographic engineering"—perhaps misreading proper historical connections, but nevertheless exposing the content of the term from another angle. The phrase is attributed to Edward Teller, a major figure in the hydrogen bomb research during the Cold War arms race, who was also a principal investigator for the Plowshare program, which explored the utilization of atomic bombs for civil engineering purposes. Teller's wish to literally move mountains[5] speaks of

4 David Keith documents Cesare Marchetti's as one of the first references to geoengineering: MARCHETTI, C., "On geoengineering and the CO2 problem", in: ***Climatic Change***, 1, 1977, pp. 59–68. See: KEITH, D., "Geoengineering the Climate: History and Prospect", in: ***Annual Review of Energy and the Environment***, 25:1, 2000, 245–84. However, the concept of what we today call "geoengineering" appears in scientific literature earlier, albeit connected to weather modifications. It seems that the Soviets were first in conceptualising aggregated weather manipulation as climate modification; see: BATTAN, L. J., "A View of Cloud Physics and Weather Modification in the Soviet Union", in: ***Bulletin of the American Meteorological Society***, 46:6, 1965, pp. 309–16.

5 REGIS, Ed, ***Monsters: The Hindenburg Disaster and the Birth of Pathological Technology***, New York: Basic Books, 2015; KIRSCH, S. and MITCHEL, D., "Earth-Moving as the 'Measure of Man': Edward Teller, Geographical Engineering, and the Matter of Progress", in: ***Social Text***, 54,

a brick-and-mortar "geo-" that operates with and through its own planetary body. It also connects "geographical engineering" with earlier proposals for climate interventions through mega-engineering schemes, both in reality and science fiction: in the late 19th century, inventors from both sides of the North Pacific were proposing patents and projects to warm up their harsh climate through large-scale engineering projects that altered geographical features from ocean currents to shores and the direction of rivers.[6] As a matter of fact, some of these schemes on your planet were downright influenced by our Great Canals Project, initiated in the face of the 1600s water shortage and ensuing ecological crisis, on which a namesake ancestor of mine served as the principal planner and engineer.[7] Although we have for some time now been developing a more critical look towards this sort of upscale engineering, something that I will unpack below, it is this sense of feeling and folding the planet in the role of no more than another chemical part of it that culminates along the way. Towards our effort to broaden the understanding of environmental modifications, the reoperationalization of the prefix "geo-" in its expanded geographical sense may help us think in terms of a way of acting with and through the planetary body, connoting not only to scale, but also to tools and materialities, and, moreover, untethering the word from its burdening link to climate modifications.

THE DISCOVERY OF ECOSYSTEMS AS CARBON SINKS: AN ACTUALLY-EXISTING-GEOENGINEERING

With the intensifying climate crisis, geoengineering crosses the threshold into the mainstream, with plentiful Vox- and Vice-like articles and documentaries asking what it is and whether we should resort to it. Although their attitude may range from heroic techno-optimism to apocalyptic neo-Luddism, most of them dis-

1998, pp. 100–34. Also, see my "Black Natures and the Mountain is a Cannon" in: BAUER, M. and SKUFCA, A. (eds.), ***Black Market***, Ljubljana: MGLC, 2020.

6 See: FLEMING, J. R., ***Fixing the Sky: The Checkered History of Weather and Climate Control***, Columbia University Press, 2010; PETROVICH RUSIN, Nikolai and ABRAMOVNA FLIT, Liya, ***Man Versus Climate***, Moscow: Peace Publishers, 1960.

7 "Stalin was a great admirer of canal projects, and he was fascinated by the role of engineers in their constructions." In one of his favorites, "the builders of socialism on the planet Mars have to rely on an engineer named Menni." (GRAHAM, L., ***The Ghost of the Executed Engineer: Technology and the Fall of the Soviet Union***, Harvard University Press, 1996, p. 62.

cuss only a limited number of techniques, of which the most popular are artificially shading the earth using particles and vapors, and sequestering carbon industrially and through iron-fertilized marine algae. Such interventions are implicitly or explicitly referred to as deliberate, abrupt, large-scale technical fixes targeted at climate control. Some scholars, however, urge us to open up the understanding of the term in order to meet the complexity of the geotechnical and geopolitical project it assumes. For example, Pak-Hang Wong and Holy Jean Buck emphasize the maintenance project of the world-being-restored, while Benjamin Bratton insists on a reframing based on the "scale of design and ... design effect".[8] In a response to such calls we will attempt to not only open up the understanding of the concept, but furthermore to rethink its categorical context.[9]

For good or ill, geoengineering in its narrow sense of a one-off technical fix is not practiced today neither comprehensively nor at scale, save for a few experiments like the *SPICE* project and some exploratory enterprises like *Climeworks*. However, as we stretch the concept, certain schemes may start falling into its category, such as the policy-led orchestrated international cutting down on CFCs to reduce the ozone hole, or the curb on sulphate particles to mitigate atmospheric pollution. The key here is their conceptualization as one comprehensive project—even if they were not designed as one—in order to grasp the strategy of implementation and their cumulative implications. This way, and looking with eyes half closed, we may identify ongoing geoengineering projects even if they are camouflaged under a contrasting narrative. This is the case, we want to posit, with the recently hyped "Natural Climate Solutions" (NCS).

NCS are a set of techniques conceptualised in a 2017 paper co-authored by ecologists, biologists and geographers who set out to measure the aggregated potential of a combined utilization of various ecosystem-based climate mitigation acts, from reforestation and avoided land-use conversions to prescribed fires etc.[10] Representing a dogma of minimum intervention that favors the

8 See: BUCK, H. J., ***After Geoengineering: Climate Tragedy, Repair, and Restoration***, London: Verso, 2019, pp. 26–28; WONG, P.-H., "Maintenance Required: The Ethics of Geoengineering and Post-Implementation Scenarios", in: ***Ethics, Policy and Environment***, 17:2, 2014, pp. 186–91; BRATTON, B., ***The Terraforming***, Moscow: Strelka Press, 2019, pp. 75–77.

9 However, in appropriating the term as we may, we wish to stay with its character as a deliberate act, since this connotes its affordance to be designed or strategized. Having said this, we exclude from our reach the various inadvertently cumulative anthropogenic effects from the Holocene-stabilizing agriculture and the like.

10 GRISCOM, B. W. ***et al***, "Natural Climate Solutions", in: ***Proceedings of the National Academy of Sciences***, 114:44, 2017, pp. 11645–11650.

preexisting natural ecosystems, NCS are promoted in many aspects of the climate change discourse as the preferable end of the spectrum that has undesirable geoengineering schemes on the other end. Through a simple but persistent narrative, proponents of climate action from environmental and activist organizations refer to NCS as a non-anthropogenic, non-interventional, autonomously functioning methodology that utilizes the preexisting dynamics of ecosystems: the emphasized key feature is the natural *origin* of the compound systems and techniques. What is important for this narrative is that choosing NCS means essentially letting nature claim back what humans have harmfully been exploiting before. A combination of the claims of some of its proponents reads: "A better way to mitigate climate change [is to] let nature do it for us"; "The word 'natural' is very important: in all its history we haven't needed to intervene in these systems to make them work and do what they do"; "The earth knows how to balance her systems"; besides, "this has been the traditional functioning of the biosphere as a carbon storage".[11] A similarly latent, albeit more moderate, preference for the notion of the "natural" seems to also exist in policy cycles as well as the scientific discourse, especially since a notable amount of science on the matter is produced through NGO-connected researchers and funds: of the total thirty two co-writers that contributed to the 2017 NCS paper, no less than twenty one mentioned an environmental NGO as their primary or secondary affiliation. Although different proponents may maintain differing accounts of the content of "nature", the latter does remain a unifying reference. Environmental NGOs from the ideological mainstream, such as *The Nature Conservancy*, those with a "deep ecology" background, such as *Greenpeace*, radical environmentalists, such as the *Climate Land Ambition Rights Alliance*, and corporations, such as *Shell*, all have different imaginaries of nature in mind when promoting NCS.[12] Eventually, several figures of Nature emerge: biochemical climate-performance natures, neoliberal natures with ecosystemic financial value, decolonial natures directly identified with the natives who experience it etc. Nevertheless, as an overarching and inclusive

11 In respective order, excerpts were synthesized from: Natural Climate Solutions Catalyst, "How nature can save us from Climate breakdown", in: ***YouTube***, 2019; The Nature Conservancy, "Natural Climate Solutions", in: ***YouTube***, 2016; The Years Project, "The Solution to Climate Change is all around us", in: ***YouTube***, 2019; Breakthrough Institute, ***How to Reverse Global Warming***, Whitepaper, 2017.

12 See: GIORGETTI, C., "The Role of Nongovernmental Organizations in the Climate Change Negotiations", in: ***Journal of International Environmental Law and Policy***, 9:1, 1998, pp. 115–137; GOUGH, C. and SHACKLEY, S., "The respectable politics of climate change: the epistemic communities and NGOs", in: ***International Affairs***, 77:2, 2001, pp. 329–345.

concept, it emerges as common ground, albeit an abstract one: the blurry outline of a universally acceptable cult.

And as if all this passionate embracing of the natural was not enough to shape the anti-technological narrative of NCS, its proponents explicitly and repeatedly contrast it to technical fixes and geoengineering. It is, however, by attending to this very obsessiveness that the cracks of its seemingly coherent narrative start appearing. Biochar burial, one of the twenty practices outlined as NCS in the 2017 seminal paper, serves as a case in point. Bellamy and Osaka wonder why it's considered "natural", since both biochar and the practice of scattering it in fields are anthropogenous.[13] On the other hand, in a working policy paper for nature-based practices, Climate Action Network posits biochar burial as a technical, geoengineering practice that shouldn't be considered natural.[14] It may be that the key is to think not in terms of either-or, but rather in terms of both-and: NCS could both utilize elements of natural origin *and* be a geoengineering practice. But if one considers the two as mutually exclusive, it may also be that the narrative of naturalness is more of an ideological veil that obscures information and starts breaking down as we look closer at the constitution of NCS.[15]

In spite of the aforementioned widespread narrative of NCS, in the scientific discourse on this subject—where the terminology is introduced, the solutions themselves are framed as such, and their ontological properties are established—the promise of their pure and inviolated nature is deconstructed on multiple levels. It actually turns out that NCS are both unnatural and technological to a much greater extent than their supporters care to admit. Framed as Negative Emission Technologies, natural entities are reorganised teleologically to achieve the primary goal of maximum carbon absorption and its long-term storage, which is, according to Latour, the essence of a technological metaphor. If this sounds somewhat self-evident because it adheres to the now banal and well-established instrumental logic of the Enlightenment, the systematization of NCS is not only a Latourian technological metaphor, but also the creation of a "technical object" in a Simondonian logic. More than means to an end, ecosystems beget

13 The authors assume that biochar burial is considered natural owing to its similarity to ancient techniques used by native civilizations. See: BELLAMY, R. and OSAKA, S., "Unnatural Climate Solutions?", in: ***Nature Climate Change***, 10, 2020, pp. 98–99.

14 Climate Action Network, ***Position Paper on Forest and Land Restoration – Natural Ways of Limiting Temperature Rise to Below 1.5°C***, Whitepaper, 2018.

15 On this, see also the very interesting: CORNER, A. and PIDGEON, N., "Like artificial trees? The effect of framing by natural analogy on public perceptions of geoengineering", in: ***Climatic Change***, 130, 2015, pp. 425–438.

new features characteristic of technical objects in their evolution towards technological concretization, which is a development of synergies between parts that make them work in synthesis, eventually creating "techno-geographies".[16] Therefore, when natural ecosystems are chosen to be conserved or enhanced, this is not on the basis of their natural origin, but rather because their technically evolved—and possibly modified—systems manage to operate efficiently as carbon sinks, and simultaneously allow for maximum synergies toward other targets, for instance biodiversity etc.

Interestingly, when Latour refers to the definition of the technological act, he writes: "As soon as you imagine parts that 'fulfill a function' within a whole, you are inevitably bound to imagine, *also, an engineer* who proceeds to make them work together."[17] NCS as a technology include acts of engineering and reengineering environments as parts of a planetary whole in need of remediation. Their blueprint in scientific literature describes various acts of intervention characterised as of "high engineering complexity".[18] From the simple management of existing ecosystems to selective conservation, programming of species and populations, and their creation, ecology and biology in the Anthropocene tend to categorise ecosystems as designed, impacted or even novel.[19] In many of these cases natural purity can be undermined by the priority of articulating cost-effective solutions. Performing carbon budgeting exercises, there are scenarios in which existing indigenous ecosystems may lag behind in carbon sequestration and storage over man-made and intensively managed ecosystems. From a biochemical point of view, certain species of fast-growing conifers store larger amounts of carbon quicker than other (possibly endemic) tree species, while from a biophysical point of view cultivated lands in temperate zones have climatic advantages over natural, existing ecosystems.[20] As monocultures are, of course, undesirable for many reasons, this is not to suggest an embrace of carbon plantations, but rather that the possible combinations for different plans are much richer than just resorting to things natural. In fact, some natural ecosystem management solutions (even

16 On technological metaphors, see LATOUR, B., ***Aramis or the Love of Technology***, Harvard University Press, 1992. On the notion of technological concretization, see SIMONDON, G., ***On the Mode of Existence of Technical Objects***, University of Minnesota Press, 2017 [1958].

17 LATOUR, B., ***Facing Gaia: Eight Lectures on the New Climatic Regime***, Cambridge: Polity, 2017 [2015], pp. 95–96, emphasis in original.

18 FIELD and MACH, "Rightsizing carbon dioxide removal", p. 707.

19 MORSE, N. B. et al, "Novel ecosystems in the Anthropocene: a revision of the novel ecosystem concept for pragmatic applications", in: ***Ecology and Society***, 19:2, 2014.

20 SEDDON, N. et al, "Grounding nature-based climate solutions in sound biodiversity science", in: ***Nature Climate Change***, 9, 2019, pp. 84–87.

within the framework of NCS) may not only be unnatural, but may even destroy existing endemic natures. For example, one proposition would be to clear mature forests that have reached their saturation points in terms of carbon uptake, bury the carbon-rich biomatter and reforest on top.[21] Or in an even more invasive logic, forests at high latitudes that bear endemic species of trees with dark foliage could be deforested so as to leave space for snow, increasing the terrestrial surficial albedo.[22]

Beyond this literal engineering, the example of NCS also points to another form of intervention in the environment, one rather more indirect. Without necessarily creating new entities or physically modifying existing ones, the framework of NCS ends up hijacking our interpretation models for the natural environment and substituting them with new ones, in which ecosystems are primarily considered as carbon sinks. In a moment of quiet revelation, forests are rediscovered as carbon sequestration factories, ecosystems that previously were of no particular interest now come to the forefront of research and conservation (e.g. mangroves), while local economic and cultural systems are reconfigured (e.g. see the UN REDD+ programs). However indirect and conceptual this may be, it definitely assumes and begets further geographical reorderings.

Eventually, combining two ways of reengineering physical and conceptual geographies, NCS practices, many of which are already being tested (no-tillage agriculture) or even performed at scale (the one trillion trees campaign), are in a quite literal way an actually-existing-geoengineering. Framed as such, NCS emerge as deliberate transformations of planetary geochemistry in climate-significant scales and are therefore instances of geoengineering's expanded content. Nevertheless, we cannot help but notice that, rather interestingly, NCS, as discussed above, tick all the boxes of the "undesirable" narrowly defined technical geoengineering: they assume a deliberate environmental transformation, are in essence technological, aim for continental and planetary-scale reconfigurations rendering the planet through holistic models, and are exclusively directed in a rather not-bottom-up way.

21 MACKEY, B. et al, "Untangling the confusion around land carbon science and climate change mitigation policy", in: ***Nature Climate Change***, 3, 2013, pp. 552–557; ZENG, N., "Carbon sequestration via wood burial", in: ***Carbon Balance and Management***, 3:1, 2018.

22 POPKIN, G., "The forest question", in: ***Nature***, 565, 2019, pp. 280–282; MYKLEBY, P. M. et al, "Quantifying the trade-off between carbon sequestration and albedo in midlatitude and high-latitude North American forests", in: ***Geophysical Research Letters***, 44, 2017, pp. 2493–2501.

ENGINEERING: INTERMEDIATING

Ever since it was first used in your languages, engineering has mostly been associated with the practice of building artifacts anew, initially military machines ("engines") and structures. During the Renaissance the engineer also connoted the inventor, a cultural logic that survived into the 19th century, and filing for peculiar patents.[23] This view, however, posits the engineer as a type of creator, a quality that can currently be only partially justified by their actual occupation. Although in the context of our Great Canals Project the engineer was the central figure, in the aftermath of some of the project's discordancies we moved on to conceptualize the role of the engineer as that of an intermediary. Let me explain two reasons for saying so. It is now common to think of our planets as "computers" that calculate their metabolic procedures and energy flows. As scholars in both our planets have pointed out, computation was "discovered more than it was invented".[24] However, consider that your silicon computation is yet incommensurable with the bioinformational signal of natural logistics. That makes engineering, which operates in the translation between the two, bridging scales and approximating material tolerances, one of the procedures by which the fleshy and messy problems of chemistry and physics are circumvented without being ignored.[25] In a sense, then, engineering bridges the metaphorical and literal computations. If this is an epistemological in-betweenness, it seems to be followed by another, rather practical one: the increasing complexity of technics and the resulting specialization has arguably rendered a lot of the practitioners of the discipline as "accounting intermediaries", excessively focusing on the specifics of a problem they did not necessarily formulate or frame. Working to reconcile model and reality, the engineer struggles to address the premises of the first or the contexts of the second.[26] With the heroic eras of technocratic utopianism—in

23 A. Picon and others refer to the Renaissance type as the "artist engineer". According to Picon, engineering is later professionalized, creating a massive labour force characterised by diversification and specialization. See: PICON, A., "Engineers and Engineering History: Problems and Perspectives", in: ***History and Technology***, 20:4, 2004, pp. 421–436.

24 BRATTON, B., ***The Stack: On software and sovereignty***, MIT Press, 2015, pp. 76–81.

25 I have borrowed the phrase from R. Negarestani's interview with Fabio Gironi, "Engineering the World, Crafting the Mind", at neroeditions.com. Speaking about approximation techniques, he writes: "These are procedures by which engineers circumvent the messy problems of physics without forgetting about them."

26 We ought to note that in contrast to our argument, Negarestani believes in the political agency and creativity of engineers. To be clear, our intention is not to say that there cannot be brilliant minds breaking new grounds—to the contrary, these are people most competent to do so—but we refer to the mass labour of engineering work performed nowadays.

which some of my forefathers were lucky enough to have participated—fading in the past, the overlooked medium in which all of these intermediary and overly absorbed practitioners operate emerges as a necessary object to refocus on.

NORMATIVE MISADVENTURES OF ANALYTICAL MODELS

Looking at NCS as engineering, and considering Menni's proposition for the intermediary character of the latter working to reconcile reality with its translation, the practice of modelling emerges as a key point. Thus, in order to explore some of the shortcomings of what we understand as fixations of the -engineering logic, and in order to overcome it, we will attempt to look at the construction of and inherent assumptions behind the models employed in the act.

Bringing together some foundational moments of modern geography and biosemiotics, sensing emerges as the main device of animals to construct the perception of their environment.[27] Through this signaling, organisms define not only their world, but also their very selves, mutating to integrate and adapt in it. Humans embody this theory through the evolution of our physiological features, seeking to extend our sensory apparatus by, for example, utilizing the specialized sensing of other animals or inventing tools as prosthetics to our bodily sensing mechanisms. Scaling this up, reaching out to understand the environment and parts of the world demands the strenuous labour of collecting and assembling empirical information, which has taken the form of animal genealogical indexes, herbariums, cartographical surveying, and later also atmospheric, soil and water measurements etc. The gradual assemblage of sensing tools, from analogue to electronic, with their increasing scale, ubiquity and interconnectivity has eventually extended humanity's sensing apparatus to become a planetary skin enveloping the earth.[28]

Nevertheless, sensing in itself generates nothing more than arrays of numbers and bulk figures. This "raw" data needs to be collected and then anthologized in certain ways in order to make

27 Kwinter refers to Jakob von Uexküll and his concept of the "Umwelt" among others. See: KWINTER, S., "Neuroecology: Notes towards a synthesis", in: NIEDLICH, W. (ed), ***The Psychopathologies of Cognitive Capitalism: Part Two***, Berlin: Archive Books, 2013, pp. 313–33.

28 GABRYS, J., ***Program Earth: Environmental Sensing Technology and the Making of a Computational Planet***, University of Minnesota Press, 2016. In her introduction she refers to N. Gross ("The Earth Will Don an Electronic Skin", in: ***Business Week***, 1999), who starts his essay by referring to that skin as "an uncanny piece of engineering".

connections and assume correlations that would make collection meaningful. Focusing on the epistemology of climate science, Paul Edwards describes the necessity of models to even "make sense" of initial measurements, and emphasizes the models' ability to complement primary data with newly generated (simulated).29 In a similar way, our assessments, scenarios, planning and interventions depend on massive intakes of data and therefore employ models to taxonomize this information and render it useful. At the same time, since it is not—at least not yet—computationally possible to measure and keep track of all natural processes and render them in readable images, models are used to make projections and extrapolations to complement real measurements. Thus, environmental actions are not only based on, but also worked through and first tested on such descriptive, projective or predictive models.

The current situation seems to be defined by the obsession of gathering environmental data, and various scholars argue that a somewhat more imaginative interpretation and creative synthesis lags behind.[30] Undoubtedly, the effort spent to refine the resolution of the sensing image and to update the computational capacity of the planetary skin and its central processing units solidifies our descriptive models. Whether that equals a solidification of our understanding of the problem remains a contested issue, but it certainly makes the prevailing understanding more rigid and more difficult to challenge. In their hypertrophy, such analytical models often conceal essential hypotheses that underlie their framework. What lies hidden behind the confidence levels and dense data clouds of these hypotheses are the assumptions about the kind of information to be collected or its subsequent synthesis. Taking these under consideration, one could argue that some of these models may operate on the fence between the analytical and the propositional, sometimes even leaping from the former toward the latter.

Although many scholars document this normative aspect of maps and models as a problem in itself,[31] it is even more consequential to examine the leap in those cases when the environmental reading takes place in the context and as the base of forthcoming active interventions, as in the case of climate change

29 EDWARDS, P., ***A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming***, MIT Press, 2010. Edwards recounts R. Giere's phrase "models almost all the way down" which he substantiates throughout the book.

30 NIGHTINGALE, A. J. et al, "Beyond Technical Fixes: climate solutions and the great derangement", in: ***Climate and Development***, 12:4, 2020, pp. 343–352.

31 A very well-known critique is the one targeting the most commonly used projection of the globe,

mitigation. NCS provide a fertile ground for interrogation because their epistemological construction insists that they are a set of solutions of minimum intervention, making it interesting and counterintuitive to investigate how their analytical geo(geographic)models of natural ecosystems conceal normative, propositional aspects that end up writing on top of the very image they claim they are only reading.

At first, such a leap is perhaps especially apparent for NCS, when for example maps recording biodiversity rich areas simultaneously become the blueprints or at least the base for the blueprints for conservation, grounded on the implicit premise that the least or best we can do is save what we currently have. The Half-Earth project, modelled after biologist E. O. Wilson's book of the same name, indexes hotspots of biodiversity, but it is unclear whether these places are mapped as taxonomies or laid down as a planetary conservation plan. Deterministic as they may be, they are also arbitrary and misleading, as these readings depend on human-centered definitions of what is natural for nature[32] and assume externally imposed futures that were never agreed upon, for example that the tropics should remain green even if that means underdeveloped as well.

The second point in which the normative disposition becomes evident is in the choice of the data to be collected, for the assembly of the analytical model is tied to a specific understanding of the problem and a specific hypothesis for its possible solution (and its overall solvability). In our case, NCS are invented by the scientific community as a response to climate change, which is understood as a problematic disequilibrium of planetary chemistry due to an excess of greenhouse gases in the atmosphere.[33] Management of ecosystems is therefore conceived as a biophysical-biochemical solution for a biophysical-biochemical problem, meaning that the information gathered to create either analytical

the Mercator projection, exposing problems of scale or focus among others, connected to misinterpretations, stereotypes and colonial views; see: CORNER, J., "The Agency of Mapping: Speculation, Critique and Invention", in: COSGROVE, C. (ed), ***Mappings***, Reaktion, 1999, pp. 213–252. Also, in her ***Program Earth***, J. Gabrys argues that the totality of our planetary sensing apparatus generates new environments and environmental relations through the ones it sensed.

32 The argument of the "biopolitics of plants" is laid out in S. Wakefield's "Making nature into infrastructure: The construction of oysters as a risk management solution in New York City" (in: ***Environment and Planning E: Nature and Space,*** 2019), and B. Braun's "Environmental issues: Inventive life" (in: ***Progress in Human Geography***, 32:5, 2008, pp. 667–679). For the Half Earth project, see www.half-earthproject.org.

33 DEMERITT, D., "The Construction of Global Warming and the Politics of Science", in: ***Annals of the Association of American Geographers***, 91:2, 2001, pp. 307–337; BERNSTEIN, S. and HOFFMANN, M., "Climate politics, metaphors and the fractal carbon trap", in: ***Nature Climate Chang***e, 9, 2019, p. 919–925.

or propositional models utilizing NCS focus on their carbon-absorption capability. Characteristic of this rationale are the proposed parametric valuations for the assessment of ecosystems, such as the so-called "Climate Regulation Value", which scores ecosystems solely according to their biophysical and biochemical carbon sinking performance. This technoscientific framing of ecosystems as carbon sinks prevails and structures the relevant discourse, extending outside the scientific domain to latently influence the realms of both policy and activism. Regardless of the political premises of different policy groups or activist organizations, the affordance of ecosystems to function as CO2 sinks is not only treated as a given, but as an implicit priority too.[34]

A third aspect of the normative disposition becomes apparent after the data are selected, as they are processed to be configured in a coherent image. Since similar datasets can be assembled in different ways and point to different directions, this architecture is another implicit propositional aspect of otherwise analytical models. Putting data together in certain ways highlights specific vulnerabilities of systems and ecosystems, creating treasure maps for coming interventions. The upstream creation of analytical maps that later shape any form of geographic engineering essentially assumes a specific planetarity—present and future. The varying geopolitical priorities, the cosmotechnical traits and the geographic vernaculars result in varying totality projections and holistic models of the desirable world to come. Again, existing NCS interventions, such as the upscale tree-plantings, provide palpable examples of conflicting or incommensurable cosmograms. The *Plant-for-the-Planet (PftP*) NGO, which first set the billion trees target, joined forces with the *ETH Crowther lab* to map the global reforestation potential.[35] The resulting map is also a plan for *PftP* as well as an image of the green totality they imagine. On the other hand, *Ecosia*, a web search engine operating toward a stated mission of environmental concern, also plants trees, yet does so according to maps focusing on biodiversity hotspots rather than carbon concentration.[36] The two planting trees projects both imagine an additional billion trees on this planet, but propose and eventually create different afforested worlds. However, the engineering focus on chemistry mitigation filters out the

34 Evidence on that claim, as well as an elaboration on the latent influence of the technoscientific framing upon the activist discourse on nature and NCS can be found in G. Papamattheakis' "Negative Emissions Natures", especially chapter 7 "The non-negotiable nature of the technological: discourse traffic within the epistemic community of climate change".

35 BASTIN et al, "The Global Tree Restoration Potential".

36 Ecosia team prioritizes planting locations according to the analytical biodiversity mappings of Global Forest Watch: www.globalforestwatch.org. Thanks to Antonia Burchard-Levine for pointing it out.

specific assumptions and preferences upon which the holistic renderings of the intervention models are based. The different totalities are always there, but never made explicit—most times, they're non-conscious or considered of secondary importance.

In climate change mitigation paths, regardless of whether they employ ecosystems or synthetic artefacts, the hermeneutics of the models—whether analytical or propositional—precede the actions taken. As reconstructed worlds unto themselves,[37] the descriptive models have then already laid a framework that influences the subsequent procedure, thereby predetermining genealogies of acceptable responses and solutions. Analytical models therefore also partake in the ongoing reengineering of worlds through a recursive translation between earth and earth-models indirectly defining more aspects of the discussion than they are designed to. If we refer to geography as the understanding of various features of the earth through our interpretive modeling—be that terrestrial maps, plant taxonomies or climate contours—then in cases such as those mentioned above these models are not only reading, but implicitly rewriting the earth, performing a literal geo-graphy, a geo-writing. What emerges along with this realisation is a design project—in Benjamin Bratton's words: "Part of the design question then has to do with interpreting the status of the image of the world that is created by that second computer, as well as that mechanism's own image of itself, and the way that it governs the planet by governing its model of that planet."[38]

PRAXIS: CRAFTING MEDIUMS

As was the case with our civilization's former stage, at the time of the Great Canals Project that proved to be what we later called the capitalist colonization of our planet, so in your current historic condition on earth, it may also be that overthinking in terms of "-engineering" for its practical and solution-oriented approach is a cultural pathology. This is not to negate the practicality and necessity of this mentality, but to realise its inadequacy. I haven't read too much of Aristotle and early earthly philosophy, nor some of his well known readers, such as Heidegger and Arendt, but I sense that the distinction between praxis and poiesis is of conceptual utility here—and this is the only reason why I will resort to such abstract concepts. The teleological focus on making, production, and final product that is nested in the concept of poiesis causes some sort of blindness toward the process and everything around it constitutive of the activity, the praxis.

Importantly, if the approach that engineering suggests is inflexible or short-sighted, it may be a problem of its framing and not of its content or result. In the assemblage of data, other aspects that could well be parts of the analysis or the response, such as their interaction with social systems or the socio-economic potential of natural ecosystems, are at best obscured if not hindered altogether. In parallel to—and not instead of—the useful effort to map every tree on the planetary surface, classify them and match them with ecosystem clusters to understand their geography, there seems to be space and necessity for another effort to research the co-production of new environments, economics and social justice. Moreover, in the articulation of data in meaningful renderings, acknowledging the holistic base upon which the imaginations are built is essential in learning from and acting to address the frictions that will be emerging in the juxtapositions of different cosmograms. In any case, the shortcomings of the engineering fixations and their models are to be tackled in complementary domains, not entirely substituting them, yet definitely enriching them. Thus, framing, along with a set of qualitative aspects around models and data, emerges as a major weakness in the current approaches to environmental modifications. As certain scholars I found in your literature argue: "Framing is perhaps the most foundational moment of inadvertent concealment within climate change science as it allows some questions to be asked and others to be edited out."[39] Currently, it is the technoscientific framing of the analytical approach that is infused and dispersed in the models, indirectly defining more aspects of the discussion than it is designed to.

The complementary domain we are trying to outline with George points to everything *around* what seems to be the core problem that engineering comes to tackle. As a design project, it essentially refers to the medium of the engineering problem. If for engineering the problem is taken for granted, design is more accustomed to question the premises for the framing of the problem. It suggests to spend more time working on the framework of the problem, the conceptualization of its totality, the exposure of its hidden components etc.[40] In other words, all these elements that define the greater project as a composite crafting process—as geopraxis.

37 An eloquent argument around this claim can be found in B. Konior's "Modelling Realism: Digital Media, Climate Simulations and Climate Fictions" (in: ***Paradoxa***, 31, 2020).
38 BRATTON, ***The Stack***, p. 301.
39 NIGHTINGALE et al, "Beyond Technical Fixes", p. 346.
40 See: EASTERLING, K., ***Medium Design***, Moscow: Strelka Press, 2018.

But even before that, any project of rewriting the earth demands that we first recognise the efforts of geographic interventions as a design project in the first place: instead of straight-forward solutions to objectively set targets, we are to encounter choices and trade-offs within evolving and intermeshed systems. No matter how conservative, green or natural any approach will be, it's all about normative propositions all the way down.

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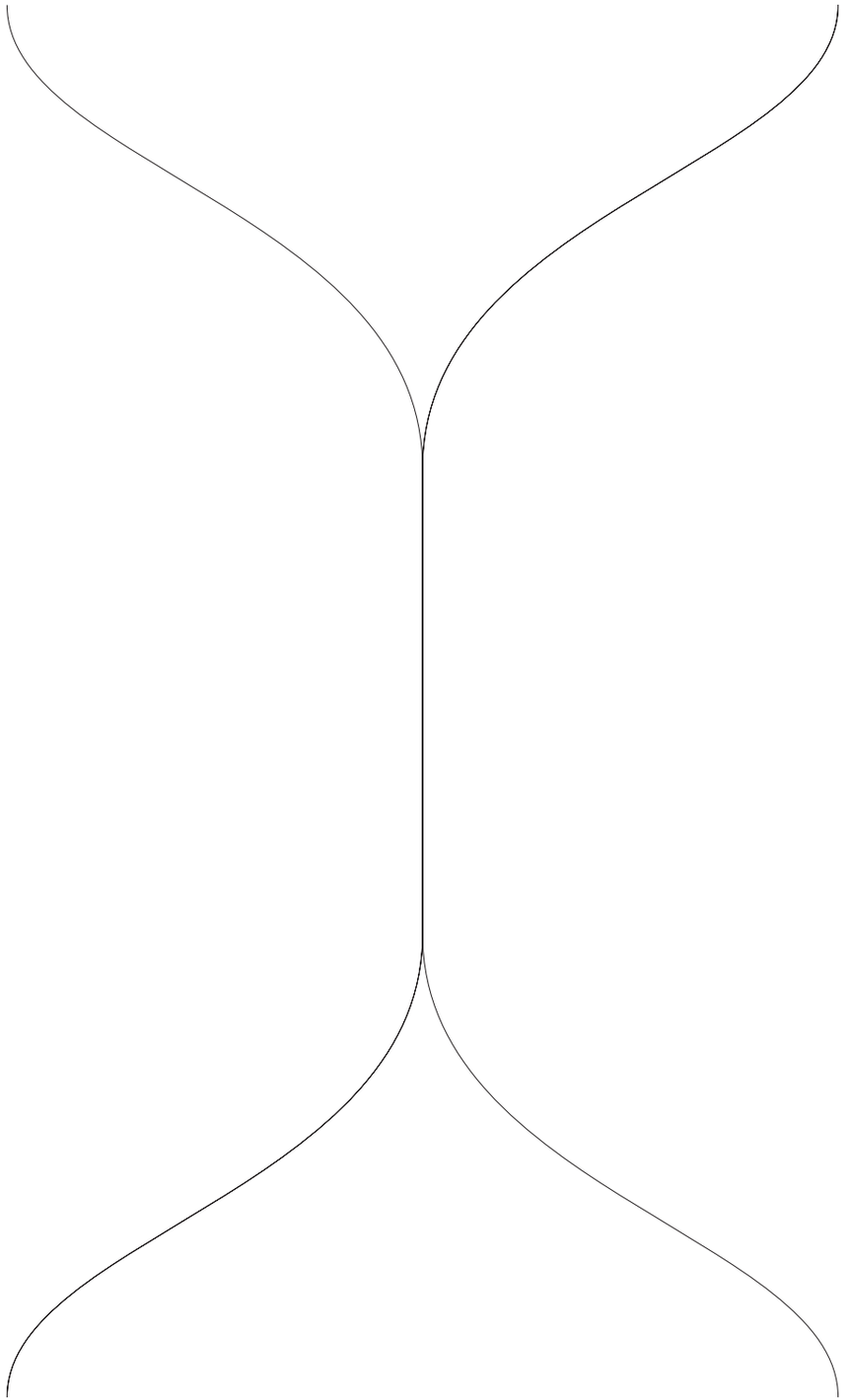
Menni Aldo is a practicing engineer and a worker polymath. He is interested in new materials and planetary resources management. He serves as the principal investigator of the Colonial Group's space expansion research program. His upcoming monograph looks at the history of environmental and ecosystems engineering on Mars through the archives of the Aldo family.



MIAMI

I spent most of 2019 working on a future infrastructure initiative at a worldbuilding studio in Los Angeles. We were contracted by a major engineering consortium to create five immersive worlds that bring to life the future of architecture and engineering through compelling human narratives and evocative visuals. The series of cities was designed specifically to inspire new thinking about the direction of urbanism in the extreme ecological contexts of the coming century—a shocking wake-up call for a generation of comfortable boomers of the engineering world, but a wet dream for collapsnik zoomers who grew up with Minecraft, Cyberpunk 2077, and *Society If…* memes.

The term of art for our deliverables is *Narrative Worlds*, a cringy shibboleth, but a term which in fact represents the de facto method of American future planning in the context of the Military-Entertainment-Industrial Complex. From RAND to Hollywood to CNN to Call of Duty, and manifesting in enterprises like Palantir and Anduril, it's second nature for the U.S. to instrumentalize narratives of xenophobia to turn tax dollars into NatSec infrastructure.

But when it comes to *public* infrastructure in the context of climate change, it's next to impossible to create the much needed political coordination. This is in part why groups like us are tapped: to add a safe helping of sex appeal to urgent ideas for urban resiliency, to mix some candy with the concrete. The urbanization scenarios included off-planet industrialism, extreme Arctic cold, multi-level mega-densification, rural automated agricultural complexes, and the offshore floating cities.

The first expo was scheduled for Miami in late 2019, so the offshore floating city was a natural starting point.

We aimed the concept at conservative infrastructure standards and regulation, much of which limits development in amphibious urbanism, specifically in coastal jurisdictions which face serious environmental degradation in the coming century due to sea-level rise, flooding, and storm surges.

The city was designed like a honeycomb, floating triangular platforms that interlock and form canals of water in between, like streets cutting across larger hexagonal blocks. They would be tethered just off shore, and were designed in tandem with seawalls and reefs to handle major coastal storms and large-scale climate migration. While for some a floating city conjures memories of SeaSteading libertarians—Silicon Valley males seeking taxhavens and polygamy—our project took inspiration from places like Lagos, Tenochtitlan, and Amsterdam and was built with contexts like Jakarata, Guangzhou, New York, Dhaka, and Miami in mind, cities which face major flooding risk.

Floating, modular architecture might be conceived as major public projects, or by elites from the private sector, edifying rentier capitalism. It's just as easy to imagine the Chinese state advancing its island building capacity as it is to imagine Dubai sheikhs doing it for vanity. It could be micro-grants for Jakarta's small businesses or real estate developers building tech start-up campuses in the East River just off Manhattan. In actuality, we found this to be the most challenging part to imagine, and not for want of reason, but for the breadth of possibilities. So we left the economic model open to interpretation.

To assuage doubts about the technical feasibility, our immersive Unity UI demonstrated hundreds of research insights that explained the functions of the city and its patterns of use, for example how they are anchored, how they move around like puzzle pieces, how utilities connect via umbilicals, how canals dilate to accommodate traffic, or even how the platforms are insured.

My job was not only to research and conceptualize these new urban scenarios, but to convert them into written narratives that were complex and elegant, *future-facing but human*: for instance, following along in a third person virtual camera as a young boy wolfs down his breakfast of kelp toast and the algae shake, hops onto the transit boat with his waterproof gear, and plunges into the water a few minutes later above the artificial reefs where his morning biology class is taking place.

RISK

I spoke to many different experts, like ocean bioengineers, climate change specialists, kelp farmers, oil-platform builders, deep sea roboticists, and nuclear scientists. But the most interesting voice was a leading figure in the field of Uncertainty Analysis. Over pre-pandemic Zoom, he painted a clear picture of the main driving factor in new urbanization: climate risk.

Private actuaries only look at accumulated losses and adjust premiums accordingly. They only look at a specific asset and its damages. In other words, they are very good at predicting the likelihood of a storm that destroys a certain type of structure. But they do not look holistically at the level of all possible economic impacts. In fact, no one really does. There is no entity that converts ecological risk into opportunity cost.

New types of resilient infrastructure have no history and no data sets to prove they are a smart capital investment. No one really knows the econometrics of amphibious retrofitting, so no one will insure it. Instead, cities are left with ancient technologies, like lifting things on stilts or digging bad ditches.

Things are getting so risky that no private company will cover flood insurance in Louisiana. This will soon be the case with fire insurance in California. There is so much risk that private companies can't make money—the premiums are too high, and the payouts are even higher. The insurance companies pull out, leaving only the state to step in. But the state suffers huge losses in providing fire insurance, and it gets worse each year. Eventually it calculates how it can quickly and easily make modifications to other things that it controls, such as building code, landscape management policy, and fire infrastructure to reduce its losses. The built environment undergoes long-lasting improvement, the ecological situation gets better, and people save money.

In simple terms, as ecological risk in the system grows, the burden of the risk *naturally* centralizes. It moves from a paradigm of thousands of competing private insurers to a more centrally coordinated endeavor. Not by ideology, but by necessity. The actuaries and the insurance providers then have aligned interests with the development of new infrastructural standards. And perhaps more than any other force, the actuarial integration with building codes and infrastructure standards into a singular organization paves the way for the most resilient, but strangest new vistas of future engineering at multiple scales.

With state issued insurance, people also come to realize that once insurance is public, it is their own tax dollars that are paying for the rich bastards and the ignorant rednecks to occupy the most fire-prone and flood-prone parts of the landscape, such as the hills around Los Angeles or the exclusive beaches of Miami, and so people begin pressuring new types of regional planning from the bottom up as well.

The name for the threshold is the Uninsurable Risk Environment: when market premiums are so high that states have no choice but to step in, forcing the centralization of risk management. Ecological change forces America's hand towards a more centralized risk management model in order to create new adaptive infrastructure. But what's left is a gaping hole in the public imaginary of what could and should then be built in the space of architecture, infrastructure, and engineering.

"Hence the need for compelling narratives."

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Months later, we're speeding in an Uber from Miami International to the Hyatt Regency in downtown, where the expo is taking place. Through the downpour I make out the tentacular exoskeleton of the incomplete *One Thousand Museum*, a luxury residential tower designed by the late Zaha Hadid. The $500 million structure looms over the Biscayne Bay, just a meter or so above sea level in a perennial flood zone. Without a doubt, the tower already assumes the status of a dystopian icon—a eulogy to harebrained oligarchic parametricism.

But the seeds of what actually should come next are already apparent. With an ever-expanding palette of engineering techniques and building technologies, it's just a question of whether or not governments have the gall to take decisive action *now* or if they need to wait to incur decades of pain and loss to force their hand.

The climate projections for south Florida are bleak. Climate experts have suggested that sea levels could rise two meters by 2100, a worst-case scenario in which over one million Miami residents would be displaced. The city's most illustrious real estate would be rendered valueless. The only path is to embrace the alien solutions that lurk on the edge of the infrastructural imagination, the outlandish kinds that kids create in game engines, the kinds which are so deeply functional that they might appear absurd. The only other option is forced migration. But knowing how attached people are to their cities, it's a matter of trading one catastrophe for another: social or ecological.

On the first day of the conference, an older engineer pops out of the Floating City VR experience after flying around for about ten minutes. Dazed, he stares out of the gallery windows at the bay, squinting as his eyes adjust to the natural light. The headphones still cover his ears. Looking over at me with a glare, he shouts in a thick Bible Belt accent.

"Why would anyone wanna live like that? You're outta yer mind …"

I tend to agree, his question is valid. I almost couldn't bear standing around for another minute in the same low-poly VR model, canted and rocking in the ocean on simulated storm swells.

"I don't know the alternatives."

A sea wall for New York that costs hundreds of billions of dollars? Nuking hurricanes? Creating artificial glaciers? Moving an entire capital city, like Indonesia is planning to do with Jakarta? Wait for floating UN disaster tents?

NEW VALUE ONTOLOGY

Centralization is taboo in America. The infrastructural shifts demanded by climate crises expose the sluggishness of the contemporary model of liberal political governance—one based in a decentralized free market ideology. The decentralized structure of the risk management and engineering sectors makes them very hard to redirect under forms of system-wide duress. But something has to give.

If the floating city offers any particular insight, it shows the weird extremes of urbanism that are beginning to take shape under today's conditions. Fiat currency takes the form of a premium, which is *the guiding price signal* for systemic risk management. This makes the Actuary the Oracle, the archetypal mediator between the present and the future. But the private Actuary only calculates at the scale of the asset, and myopia of the situation becomes increasingly dire over time: thousands of independent calculators who bear zero responsibility for altering the underlying causal forces of what they calculate.

In the decentralized model of private risk management, the price signal of the premium increases as ecological resilience goes down, until the threshold of the Uninsurable Risk Environment is crossed, at which point there is a precipitous fall in systemic security. At this point the state entity claims responsibility and takes net losses to sustain life in the area under its jurisdiction to prevent wholesale emigration and the depletion of the tax base.

But the fiat signal is clearly deficient as a value indicator. It is reactionary. When considering the causes of the problem of climate volatility, there is simply no value mechanism in place that can properly drive urgent processes of decarbonization, biodiversification, and urban adaptation. There is only a never-ending sequence of escape maneuvers and mass migrations.

An *ecological economics* is required, one that provides a reconceptualization of the economy in terms of digestion and metabolism. The ecological economy reintroduces its waste into metabolic flows by downcycling or upcycling some of the types of waste which plague the entire ecosystem, such as plastic, CO_2, and chemical slag. Instead, the present structure of the economy places a premium on the digestion and destruction of the biosphere.

From the broad perspective of ecological risk, much of the contemporary movements in culture, from small tribes, to the fashion system, gaming and architecture, all fit within a kind of ecological response to the conditions of collapse. The multitude of global-scale shifts in agriculture, governance, and media are creating both fragility and resilience at multiple scales. These forces of climate change are producing new communities of value, from the aesthetics to infrastructure.

Cities like Miami fit into strange parametric containers of risk management, and simultaneously, as awareness of the changing planet grows, the dynamics of media feed a culture in which people become obsessed with the structures of supply chains, materials sourcing, internet infrastructure, and economics. These dynamics are becoming the fashion.

The result is a kind of smart visual culture, ways of folding bigger and bigger ideas into emergent aesthetics, a kind of encryption that gives people a libidinal language for processing these larger shifts.

SMART VISUAL CULTURE

Smart visual culture is a way of wrapping good ideas in an intriguing aesthetic. It's a way of formatting ideas to create resonance within a specific subset. These ideas often involve new ways of defining value.

Visual culture aims at a range of scales from subcultural groups, urban developments, and ecological systems. New value ontologies often propagate through aesthetic representation first, and are often driven by changing opportunities and risks. Emer-

gent forms of organization and valuation often occupy novel or repurposed aesthetics.

At the scale of small communities and subcultures there is the strong agitation to exit the system of capitalism. Artists, creatives, and grifters pioneer new systems to create value within their groups. In some cases the means are high tech, making use of small p2p networks or non-fungible tokens that can cut out the costs of middlemen by linking members directly into sub-economies. Teams like Zora, foundation.app, Rally, and StakeOnMe give creators control over the constraints of how their work circulates outside of bank-controlled fiat. Digital objects, like albums, video, or digital garments are bought, sold, and traded in abstract spaces, as if in an exclusive pop-up or a gallery.

Fashion is one of the quickest registers of shifting culture; the form of expression most closely related to libido and highly indicative of political disposition. Because fashion and art are based in attraction and attention, they are sites for new aesthetic production. As new zones of political, economic, and social autonomy appear, young people are using alternative ledger systems which accurately reflect their evolving ideology, sometimes for no other reason than because it's hot.

In times of uncertainty, people share resources in ways that break with standard protocols. Small social units take on pronounced importance. For the precariat, new collective techniques for securing the bag take the shape of micro-scale wealth sharing, gig hunting, and financial hacks. Decentralized economic mediums are being drawn into the realm of small group culture where lifestyle aesthetics are made on top of new systems of value transfer.

As Other Internet puts it[1],

> hawala, chit funds, chamas, and other forms of P2P savings or credit associations are notable precursors to the kinds of financial relationships we anticipate decentralized cryptocurrency protocols will soon enable. The informal nature of these peer-to-peer institutions, often composed of neighbors and friends, reveals the central role that trust plays in squad logic. Whether housemates or friends sharing a Discord group, squads allow social currency and financial capital to inter-convert, creating opportunities and group resiliency that would have been impossible to achieve alone.

1 HART, Sam, SHORIN, Toby, LOTTI, Laura, "Squad Wealth", ***Other Internet***, 19/08/2020, https://otherinter.net/squad-wealth/.

New valuation systems that are originally adopted in smaller, lower stakes scales, like a subculture or squad, can eventually grow to the generation of architecture as literacy grows. Tokenomics enable a radically different structure to the creation and ownership of housing. With smart contracts and consensus mechanisms like quadratic voting, it becomes possible for large sums of capital to aggregate rapidly, like a traditional capital investment, but by a distributed set of stakeholders. The clearest instance is the housing market, in which it would be possible through smart contracts (or a DAO model) for 200 residents to then build and own a $10 million building. This would mean no rent, just ownership and voting mechanisms built on public, unalterable ledgers.

For the sake of comparison, the list of the top 100 cryptocurrencies by market value maps almost exactly onto the top 100 most expensive buildings ever built, excluding Bitcoin. This is an incisive indication of an alternate reality in which, instead of a small cabal of global elites reaping profits from major real estate investments, these profits are easily distributed across a much wider set of stakeholders without much financial or contractual complexity.

Buying real estate with cryptocurrency is not about tax evasion or anonymity—it's a financial architecture based in the programmability of currency that establishes the conditions of joint asset ownership and consensus amongst shareholders.

Lastly, the metaproject of alternative value ontologies is the question of an *ecological economics*, one that provides a reconceptualization of the relationship between the economy and ecosystems. The current structure of fiat currencies creates incentive to rapidly digest the ecosystem, leaving behind wasted externalities like plastic, CO_2, and slag. The system could instead be based in the valuation of metabolism, whereby an economic model is derived from the full cyclicality of a material lifecycle. This would create incentives in which waste products would be metabolized and returned to where they came from. Smart contract architecture can trigger payouts when certain criteria are met, such as the reintroduction of carbon-sequestering biomass in the form of a forest or the balancing of the pH of the ocean.

In fact, while it sounds hopelessly naive, this may be the direction economics move, and again not for reasons of morality or ideology, but from necessity. As ecological risk analysis becomes more granular through climate modeling and data aggregation, projections of future losses to agriculture, the built environment, and biodiversity become increasingly accurate. These risks are

quantified by an array of independent agencies, and converted into a host of numerical coefficients, such as the likelihood of 100+ mph tornado winds in Western Oklahoma, a 10 ft. storm surge in Miami, or a million-acre wildfire in northern California. In today's paradigm these risk coefficients are converted into a unique price signal, an insurance premium, expressed in fiat currency. The price signal encourages or discourages certain behaviors. But as discussed above, climate change is centralizing risk management.

When the amount of calculated loss due to climate change can be successfully aggregated by trusted national or transnational entities, it can be demonstrated that the net accumulated losses are greater than the net costs of the implementation of infrastructural standards which would prevent those losses. Energy, transportation, and agriculture are chief classes on the *preventative* side, while decarbonization, labor models, and landscape geoengineering are on the *reparative* side.

This calls for a level of deeper aggregation which under historical circumstances would appear heavily authoritarian: the steering power of risk projections would create an extreme degree of control over how infrastructure and inhabitation are developed. But if we were to assume the model of a public climate ledger for instance, we could imagine networks of risk assessment that are actually highly "decentralized" while still constituting deep aggregation. The aggregation of climate data could be generated and redundantly cross-referenced by large-scale networks that calculate risk coefficients that can then circulate throughout national decision-making architecture at multiple scales, and according to different financial incentives and price signals.

SIGNS AND PORTENTS

The old pillars of American visual culture, Hollywood and the art world, are both dead. And it's not just due to the pandemic. Hollywood's top films from 2019 included bored Star Wars remakes, shitty Marvel movies, '90s Disney remakes in CG, and the Fast and Furious. It's stuck in its own kind of abyss of repetition. Netflix changed the film industry, but at the end of the day, it's the game industry that has taken the entertainment market share. On the other hand, the contemporary art world has been eaten by social media. The staid global oligarchy still manages to make use of paintings, but in general it's never been less relevant. Despite the insistence that bad times create better art, this is not the case.

Within these now-dominant mediums of visual culture, games, and social media, interesting signs and portents are not just discernible, they're viral. But in an age of frenetic media, they echo back and forth and from the top and bottom at lightning speed, and the right messages are often coming from the wrong messengers. Instagram models touting nuclear energy, Kanye discussing bioengineering on Rogan, or housing co-op games built on the blockchain by bored L/acc programmers.

Smart visual culture follows the template of taking good ideas and wrapping them in evocative aesthetics. It's the only way to break ideas into the main circuits of evolving culture. With the risks imposed by our climate predicament, everyone needs to look deeper into the realities of adaptation, and visual cultural production seems to be shedding its old husks and taking a look at tomorrow's foreign infrastructure hiding just beneath the mask.

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