# Data, Debt & Daemons

*Systemic Asymmetries on Spaceship Earth*

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## Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

## Abstract

Day by day, the rate at which we create new data increases exponentially. Our capacity to learn cannot keep up. We are tiny members of a vast universal network, incapable of discerning cause and effect. Instead, we develop simplified narratives, leaving ourselves misguided yet complacent.

The information management trade of both physical and intellectual property has become more vital to global economies than ever, replacing physical resources and manufacturing. Through our deepening reliance on specialization, we forfeit agency over our own homes while accruing unprecedented debt. Housing costs have risen dramatically compared to wages, despite reportedly successful economies. Citizens were supposed to have the ability to participate in financial markets using their property as collateral. This seduced many into the ideologies of unregulated capitalism. However, by the 21st century, these systems had become unrecognizable mutilations of their intended designs. The momentum we have gathered in the past century has thrust us on an unsustainable trajectory we have little hope of predicting.

We laid the foundation for Western economic dominance with technology, monetary policy, and globalization, but we did so using incentive structures that exacerbated wealth inequality. These systems integrate digital technology into both our physical and virtual spaces, operating on invisible planes that bypass our senses. The radical novelty of computers has entangled us in niche engineered concepts that few understand. They create a lack of accountability in Big Tech that policy-makers are ill-prepared for. We cannot ensure an equitable distribution of the leverage or stakes when we entrust brokers, politicians, traders, and captains of industry to make complex decisions for us without bearing the risks of their consequences. Our long-term welfare, including our future habitation on this planet, is not visceral enough to force effective reform.

Both our physical and our digital spaces are designed, built, evaluated, and monitored on asymmetric principles, causing disasters that future generations and the least fortunate always pay for. How did we normalize this moral hazard? How can digital systems born out of frustration with modern policy combat these issues, without disrupting the benefits of a techno-utopia? How can they promote efficiency, security, and transparency in the spaces we call home?

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## Daemon

*deɪ·mən*

*from Ancient Greek 'daimon'*
*(δαίμων: "god", "godlike", "power", "fate")*

1. *A benevolent nature deity, as the genius of a place or a person's attendant spirit.*

2. *A computer program that runs as a hidden background process, rather than being under the direct control of an interactive user.*

# Data, Debt & Daemons

*Systemic Asymmetries on Spaceship Earth*

*Science is more than a body of knowledge; it is a way of thinking.*

*I have a foreboding of an America in my children's or grandchildren's time — when the United States is a service and information economy; when nearly all the key manufacturing industries have slipped away to other countries;*

*when awesome technological powers are in the hands of a very few, and no one representing the public interest can even grasp the issues;*

*when the people have lost the ability to set their own agendas or knowledgeably question those in authority;*

*when, clutching our crystals and nervously consulting our horoscopes, our critical faculties in decline, unable to distinguish between what feels good and what's true, we slide, almost without noticing, back into superstition and darkness.*

- Carl Sagan
The Demon-Haunted World, 1995

In 2010, Tong Zou graduated from the University of Toronto with a software engineering degree and moved to Seoul, South Korea to begin his career. After a year of scrimping, he secured a job in Silicon Valley and settled down in San Francisco to earn a better salary. By 2018, he had nearly half a million US dollars in life savings and was ready to move back to Canada with his girlfriend. Though born and raised in Ontario, settling down in Vancouver had always been Zou's dream. Like many others at the age of 30, he was also looking to buy his first house.

Given how exorbitantly expensive Vancouver had become, Zou decided to settle for an apartment, which was still pushing his budget. So he researched methods on softening the bank commission fees his transfer would incur when bringing his life savings over the border to Canada. After seeing how successful his friends were at playing the digital foreign exchange market, he looked into cryptocurrency exchanges, which were largely unregulated but offered unbeatable transaction fees and convenience.

One popular tactic was to take advantage of favourable foreign exchange rates, timing the conversion from dollar to cryptocurrency to pay as small of a fee as possible. Zou's close friend even turned a profit using this method, using his Korean cryptocurrency account to move large sums of money without suspicion, fees, or taxes. Korean accounts had been banned from foreign ownership since 2016 to prevent money laundering and other financial schemes, but Zou's friend was exempt because he had opened his account in 2015. "He was able to transfer from his US dollars to an offshore crypto account and make a forty percent profit just on arbitrage." Zou said. "And I got jealous, because that's what humans do, right?" Not long after, he discovered Quadriga CX, a Vancouver-based digital currency exchange founded by Canadian entrepreneurs Gerald Cotten and Michael Patryn.

Cotten learned about cryptocurrency while studying at the Schulich School of Business in Toronto and saw a major opportunity in the market for a Canadian online exchange. The concept had seen success in other countries, but had a shaky status within Canada. "In the summer of 2013, there really weren't many options in Canada." Cotten said in an interview with De-Central Talk Live. "You couldn't hook up your bank anywhere. It was really difficult to get anything done, and it was slow." Competitors had struggled to create a smooth user experience for their growing client base due to their lack of acknowledgement from the major Canadian banks.

Cotten met Patryn while travelling in Vancouver. They shared the same vision of creating an exchange that worked seamlessly with the existing financial system, and together they launched Quadriga Fintech Solutions in 2013. With enough funding and traction from investors to register Quadriga as a money services business with FINTRAC (Financial Transactions and Reports Analysis Centre of Canada), they quickly became Canada's largest cryptocurrency exchange, taking their company public in 2015, and trading well over a billion dollars in cryptocurrency in 2017.

By the time Zou heard of them, they had amassed stellar user feedback as the most frictionless exchange option in the country. The major advantage that drew many clients in from their launch date was the convenience of conducting transactions anonymously and off-the-record books. “FINTRAC doesn’t actually require us to verify users for all types of transactions.” Cotten stated. “Technically, it’s not regulated. Of course, we take steps to ensure that people aren’t laundering money. We don’t want people transferring illicit funds through our system, but we’re not going to enforce regulations on people that don’t exist.”

Unlike many speculative cryptocurrency “whales,” Zou was not looking to hold on and ride the volatile waves of the currency’s swings long-term. He was simply looking to bypass fees and catch foreign exchange rates at a good time. Signing up, verifying, and exchanging the funds in his US bank account to Quadriga for “quadbucks” proved quick and painless as advertised. Once the transaction was verified and completed, Zou exchanged the currency for about $660,000 Canadian dollars, withdrawing it to his Canadian bank account to make a deposit on an apartment he had chosen. But when he checked his bank account, he did not see any new transactions.

**PART I**

# Inequity in Equity

*Why do we fail to understand the big problems?*

## Daemons & Determinism

*Particles & Puerperal fever*
*Predictable yet random, the Universe works in mysterious ways.*

In the beginning, there was only what we call "logic."

As the oldest branch in philosophy, logic describes the governing laws of the Universe. Dimensions gave properties to existence, which we express through our language of logic we call "mathematics."

About 13.5 billion years ago, mathematical laws introduced energy in the Big Bang. 10 billion degrees celsius of rapidly expanding space forged an asymmetry of matter and antimatter. We describe what remains as "physics."

300,000 short years later, physical matter cooled, bringing the first light to a universe that had no eyes to witness it. We refer to these atoms' behaviours as "chemistry."

Over 3.6 billion years ago, a tiny ball of stardust chanced upon a holy sequence of chemicals, giving birth to cells. We call this life, and we study it as "biology."

Biological organisms replicated over billions of years through stochastic processes, dying in harsh environments almost as quickly as they were born. The surviving cells replicated their random mutations in greater numbers, creating multicellular organisms. Complete with central nervous systems, they developed emotions and thoughts by interpreting feedback, bringing us "neuroscience" and "psychology."

Billions of years passed, and hominid organisms began establishing mutual trust, creating oral propositions to shape the stories of "linguistics" and "anthropology" we share today. Through communal faith by language, and through the spread of our genes, we developed social systems; religion, agriculture, law, economics, politics, architecture, and various other technologies emerged.

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Towards the end of the Renaissance, Western hospitals experienced an inexplicable epidemic. With no probable cause, healthy new mothers were falling ill and dying within hours after giving birth. "Puerperal fever" devastated new families everywhere without discretion. But this was an era of innovation. Enlightened by the scientific revolution, doctors were confident they could solve this mystery with new scientific methods and data analysis. So they worked harder and longer, taking time to examine the dead bodies of the victims in between their shifts at the nursery.

But no matter what they tried, they learned nothing. Two hundred years passed and doctors still could not find any consistent pattern with the dead mothers they studied and the new mothers who died later the same day. In fact, despite advancing birthing facilities, puerperal fever rates only increased. By the early 1800s, hospitals reported an average of one-third of mothers dying from childbirth. The medical community, and families everywhere, were at a loss.

At the same time in Paris, France, astronomer, mathematician, and philosopher Pierre-Simon Laplace expressed his view of the Universe. He described a hypothetical daemon whose powers were so vast that it could track every particle in existence. It could calculate the eternal past and the future of the Universe based on the position, trajectory, and composition of every building block. Laplace's Daemon understood every event of all scales and time, from the microscopic to the celestial, from their creation in the Big Bang until forever after.

Under Newtonian mechanics, The Daemon represents the pinnacle of scientific knowledge. It has an objective view without human flaws, achieving epistemological perfection. Everything around us, from buildings to computers to people themselves, can be traced particle by particle from their lives as dead stars and gas floating through the universe. But we cannot perform the necessary calculations. We lack The Daemon's abilities. Uncertainty demonstrates a limit to our primitive brains' capacity to grasp physicalism and superdeterminism.

Earth designed all life as we know it, molding us through the indiscriminate laws of physics. Our cells replicate and prioritize short term survival in their immediate surroundings, and cannot effectively interact with the larger systems that allow modern society to function. Without a formal education, a person in the 19th century could understand almost every tool in their life. If a horse and carriage broke down, it did not take a genius to diagnose the problem. If the economic situation was getting dire, everybody could tell. This is not the case with 20th century innovations, as most educated people today are clueless about what goes on inside their phones or the stock market.

The Universe operates at scales far smaller than us, far greater than us, and further in time than we can grasp. The more complex and vast a concept is, the less logic persists. Reason is not instinctually memorable. Our bodies' observational toolkit misrepresents the code to the cosmos. We are lost without external tools like scientific models, which are still limited by induction. Nobody can actually see the Higgs field or its disturbances. We completed our standard model of particles by witnessing a small bump on a graph the Large Hadron Collider's computer spat out.

In 1843, Dr. Oliver Wendell Holmes noticed an unmistakable pattern while studying puerperal fever in a Boston hospital. After handling the corpses, the doctors were not washing their hands before heading back to the nursery to deliver babies. Holmes published "The Contagiousness of Puerperal Fever," suggesting that doctors sanitize their hands and sterilize their tools before attending to patients. The medical community dismissed him as a sensationalist.

Eighteen years before writing about his daemon, Laplace theorized that 4.6 billion years ago, a concentration of hydrogen and helium — the first two elements to exist — erupted in an explosion of nuclear fusion that continues to this day, blasting radiation through space. We refer to this nuclear explosion as the Sun. It started all life and maintains it every day. We consume its radiation in various forms to survive.

Plants convert the Sun's electromagnetic radiation into chemical energy through photosynthesis, losing 90 percent of the energy along the way. Animals consume these plants, losing 90 percent of the remaining energy along the way. We eat these plants and animals, losing another 90 percent of whatever is left. It is an entropic process that leaves 10 percent to power mass in our bodies like organs, blood cells, muscle, fat, and bones. The sun gives us life in every sense. When we create fire by burning wood, we are simply reactivating sunlight energy stored decades or centuries ago inside the tree. When we use fossil fuels and natural gas, we are using the sunlight stored by prehistoric life millions of years ago, sealed underground until we extracted it. From the body's perspective, our endgame is to gain as much energy as possible to outlast entropy in an eternal struggle for survival. This game is unwinnable.

Every building block of our bodies is on its own path. Each particle will persist long after we are gone, their time in a human body but a blink on their journey through the cosmos. Given the epistemological limits of our own bodies, knowledge does not exist, only pattern recognition. Humans do not judge or learn through formal logic. We extract countless patterns from experiences, forming beliefs around the most resonant ones. Moment to moment, we perceive, store, and react in rapid cycles of feedback loops to anticipate future events.

This perpetuates bias for patterns we perceive over those recognized by others. We only cling to vivid experiences that create memorable feedback loops for ourselves. Symmetry and order became attractive elements because they feed into that pattern recognition. We even yearn for their predictability, leading us to find patterns where none may exist. This breeds narrative, the mind's primary tool for understanding the world. All of our "knowledge" lies within narratives. Because our personal experiences are evocative, striking emotive chords, it is impossible to uproot our identity from our life experiences. We are only aware of what we can sense, unable to consider what we do not see. Methodological solipsism always persists, fooling our limited senses. Without a way for our bodies to experience the breadth, depth, and pacing of the climate crisis, how can any single person confirm global warming on a particularly cold day? The climate crisis is an imperceptible phenomenon, only understood through broader logical conclusions drawn from assisted observation. Scales of space and time disconnect peoples' experiences from how the world operates.

The patterns we internalize are only as potent as the accuracy, volume, and diversity of their sources. We are limited by the number of conceptual languages we can learn. According to popular theory, we take about 10,000 hours of practice in any one field to develop expert-level proficiency. A single lifetime is not enough to be a savant in all areas affecting us. The phenomenon of specialization is too new for evolution.

For hundreds of thousands of years, everyone grew up to be master hunter-gatherers. Without written language, we had no choice but to memorize massive amounts of information about our surroundings to survive, teaching the next generation through action. Around 10,000 years ago, we developed agriculture, a much more labour-efficient method for gaining energy. With

the currency for survival now plentiful, we could offload these group survival responsibilities onto others, freeing up time to investigate our existence. 500 years ago it was possible for an architect to be an innovative biologist, a chemist, a physicist, an astronomer, a mathematician, and a philosopher. Even as late as the 20th century, the Wright brothers could invent assisted human flight in their home workshop. But now, it takes too much knowledge and resources to push frontiers in all those fields. In today's world of accessible information, we behave as if we know what others know, but that could not be further from the truth.

We cannot recognize true cause-and-effect relationships in scenarios of different scales. We are not wired to address imperceptible concerns when there are more immediate ones. But large scale concerns have large scale consequences. Until we were already far along the trajectory of destroying our own chances of survival, most of humanity did not realize what was at stake. Many still do not. What happens when industries are so integrated into our lives we do not consider their consequences beyond our understanding?

It was not until the end of the 19th century when microscopes improved enough to provide irrefutable evidence for puerperal fever. The correlation was so unmistakable that doctors realized they should probably clean their hands before sticking them inside people. Hospitals implemented hygiene standards, introduced sterilization procedures, and puerperal fever disappeared. Had we possessed Laplace's Daemon's intellect, zooming into the cause and effects of contamination on a molecular level, puerperal fever would never have existed. When we are dealing with objects outside our scale, it is arrogant to feel authoritative over their behaviour. We have designed our scientific models to work with set scales of human experience, dividing the fields of knowledge as we perceive and interact with them. In reality, none of these groupings exist. Zooming outwards from an atom reveals molecules, cells, people, societies, the entire planet, the solar system, the galaxy, the cosmos, and so on, all made from the same matter, all following the same rules.

Everything is made of something. The intangible patterns we sense as abstract "systems" in our lives, whether they be ideas, beliefs, or language, manifest themselves in our brains as electrons and chemicals firing across synapses, subject to the same laws of physics as everything else. We tend to think of "art and science" as dichotomic, but fundamentally, they only differ in the way we experience them. Aesthetic evocation may feel abstract, but all art must work with our biochemical brains. In that sense, all arts are social sciences, extensions of natural sciences. Architecture, psychology, law, economics, politics, and education are all human-oriented practical applications of neuroscience, which is consciousness-oriented biology, which is life-oriented chemistry, which is earth-oriented physics, which is reality-oriented math, which is applied logic. This is the fundamental hierarchy Western science is built on. From intangible thoughts to particle behaviour, the sequence of the universe is stochastic chaos. Even if there is an objective singular truth, we will never find it, even with advanced tools. We as a species are as much of a part of the very system as anything we are trying to understand within it. The Universe may very well be predetermined and our fuzzy concept of free will greatly exaggerated, but it makes no functional difference to our perception.

*Given for one instance an intellect which could comprehend all the forces by which nature is animated, and the respective situations of the beings who compose it. If this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.*

*The human mind offers, in the perfection which it has been able to give to astronomy, a feeble idea of this intelligence.*

-Pierre-Simon Laplace,
A Philosophical Essay on Probabilities, 1814

When Laplace published his essay in the early 1800s, the atom was the smallest building block we had discovered. Quantum mechanics had just been acknowledged with Thomas Young's double-slit experiment, bringing more questions than answers, most of which continue to puzzle the smartest minds today. It would not be for another 100 years until we identified neutrons, protons, and electrons, and another 50 years after that when we found quarks. All known matter in the Universe is composed solely of up quarks, down quarks, and electrons. These three elementary particles make up everything we know. At the subatomic level, stars, rocks, and living people are made of identical parts — the parts are simply arranged differently.

We can theoretically predict the future of these parts based solely on the properties described by the Standard Model of Particle Physics, using additional constants such as the force of gravity. There are only 26 constants we need to know to formulate the entire Universe and all its complexities as we know it. We can trace everything in our known reality back to one equation that fits on a single page. If we adjusted any of these 26 constants by even the slightest amount, the Universe as we know it would not exist at all. We are still trying to uncover where these exact laws originated — we obsess over predicting the past just as much as the future. But even time itself is only a property of relative motion. Outside our minds, there is nothing to distinguish the past, present, and future. If there was no energy and therefore nothing moved, time would not exist.

Today, leading physicists theorize that particles themselves are disturbances from ten-dimensional "strings" vibrating at different frequencies to produce all the fundamental properties of existence. String theorists hope to create a unified "theory of everything" based upon this idea, but no one has been able to reconcile the mathematics. Many physicists also believe that every elementary particle has a symmetrical counterpart called a "sparticle." For every electron there is a "selectron", and for every quark, a "squark." Every top has a "stop," and every bottom has a "sbottom." Physicists are not known for their catchy branding, but they find this "supersymmetry" incredibly convincing. But many philosophers are more doubtful.

When the European Organization for Nuclear Research (CERN) constructed the Large Hadron Collider (LHC) over the French border near Geneva, Switzerland, many scientists thought the experiments would reveal too many new particles for all the worlds' physicists to handle at once. But to date, no sparticles have been found among the 330 million gigabytes of collision data CERN collected between 2015-2018. The LHC ran millions of collisions every second of every day for three years, with nothing new to show for it. In one month of this run, CERN stored more collision data than they had in all the years it took to find the Higgs Boson.

For whatever reason, when the Universe was born, there was more matter than antimatter. We are still trying to figure out where this asymmetry originated, because without it, nothing would exist after they cancelled each other out. The most important questions are the ones we do not yet know to ask. The only thing we know for certain is that we know nothing at all.

$$\mathcal{L}_{\text{StandardModel}} =$$
$$-\tfrac{1}{2}\partial_\nu g^a_\mu \partial_\nu g^a_\mu - g_s f^{abc}\partial_\mu g^a_\nu g^b_\mu g^c_\nu - \tfrac{1}{4}g_s^2 f^{abc} f^{ade} g^b_\mu g^c_\nu g^d_\mu g^e_\nu +$$
$$\tfrac{1}{2}ig_s^2(\bar{q}^\sigma_i \gamma^\mu q^\sigma_j) g^a_\mu + \bar{G}^a \partial^2 G^a + g_s f^{abc}\partial_\mu \bar{G}^a G^b g^c_\mu - \partial_\nu W^+_\mu \partial_\nu W^-_\mu -$$
$$M^2 W^+_\mu W^-_\mu - \tfrac{1}{2}\partial_\nu Z^0_\mu \partial_\nu Z^0_\mu - \tfrac{1}{2c_w^2} M^2 Z^0_\mu Z^0_\mu - \tfrac{1}{2}\partial_\mu A_\nu \partial_\mu A_\nu - \tfrac{1}{2}\partial_\mu H \partial_\mu H -$$
$$\tfrac{1}{2}m_h^2 H^2 - \partial_\mu \phi^+ \partial_\mu \phi^- - M^2 \phi^+ \phi^- - \tfrac{1}{2}\partial_\mu \phi^0 \partial_\mu \phi^0 - \tfrac{1}{2c_w^2} M \phi^0 \phi^0 - \beta_h [\tfrac{2M^2}{g^2} +$$
$$\tfrac{2M}{g} H + \tfrac{1}{2}(H^2 + \phi^0 \phi^0 + 2\phi^+ \phi^-)] + \tfrac{2M^4}{g^2}\alpha_h - igc_w[\partial_\nu Z^0_\mu (W^+_\mu W^-_\nu -$$
$$W^+_\nu W^-_\mu) - Z^0_\nu (W^+_\mu \partial_\nu W^-_\mu - W^-_\mu \partial_\nu W^+_\mu) + Z^0_\mu (W^+_\nu \partial_\nu W^-_\mu -$$
$$W^-_\nu \partial_\nu W^+_\mu)] - igs_w[\partial_\nu A_\mu (W^+_\mu W^-_\nu - W^+_\nu W^-_\mu) - A_\nu (W^+_\mu \partial_\nu W^-_\mu -$$
$$W^-_\mu \partial_\nu W^+_\mu) + A_\mu (W^+_\nu \partial_\nu W^-_\mu - W^-_\nu \partial_\nu W^+_\mu)] - \tfrac{1}{2}g^2 W^+_\mu W^-_\mu W^+_\nu W^-_\nu +$$
$$\tfrac{1}{2}g^2 W^+_\mu W^-_\nu W^+_\mu W^-_\nu + g^2 c_w^2 (Z^0_\mu W^+_\mu Z^0_\nu W^-_\nu - Z^0_\mu Z^0_\mu W^+_\nu W^-_\nu) +$$
$$g^2 s_w^2 (A_\mu W^+_\mu A_\nu W^-_\nu - A_\mu A_\mu W^+_\nu W^-_\nu) + g^2 s_w c_w [A_\mu Z^0_\nu (W^+_\mu W^-_\nu -$$
$$W^+_\nu W^-_\mu) - 2A_\mu Z^0_\mu W^+_\nu W^-_\nu] - g\alpha[H^3 + H\phi^0\phi^0 + 2H\phi^+\phi^-] -$$
$$\tfrac{1}{8}g^2\alpha_h[H^4 + (\phi^0)^4 + 4(\phi^+\phi^-)^2 + 4(\phi^0)^2\phi^+\phi^- + 4H^2\phi^+\phi^- + 2(\phi^0)^2 H^2] -$$
$$gMW^+_\mu W^-_\mu H - \tfrac{1}{2}g\tfrac{M}{c_w^2} Z^0_\mu Z^0_\mu H - \tfrac{1}{2}ig[W^+_\mu(\phi^0 \partial_\mu \phi^- - \phi^- \partial_\mu \phi^0) -$$
$$W^-_\mu(\phi^0 \partial_\mu \phi^+ - \phi^+ \partial_\mu \phi^0)] + \tfrac{1}{2}g[W^+_\mu(H\partial_\mu \phi^- - \phi^- \partial_\mu H) - W^-_\mu(H\partial_\mu \phi^+ -$$
$$\phi^+ \partial_\mu H)] + \tfrac{1}{2}g\tfrac{1}{c_w}(Z^0_\mu(H\partial_\mu \phi^0 - \phi^0 \partial_\mu H) - ig\tfrac{s_w^2}{c_w} M Z^0_\mu (W^+_\mu \phi^- - W^-_\mu \phi^+) +$$
$$igs_w M A_\mu (W^+_\mu \phi^- - W^-_\mu \phi^+) - ig\tfrac{1-2c_w^2}{2c_w} Z^0_\mu (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) +$$
$$igs_w A_\mu (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) - \tfrac{1}{4}g^2 W^+_\mu W^-_\mu [H^2 + (\phi^0)^2 + 2\phi^+\phi^-] -$$
$$\tfrac{1}{4}g^2 \tfrac{1}{c_w^2} Z^0_\mu Z^0_\mu [H^2 + (\phi^0)^2 + 2(2s_w^2 - 1)^2 \phi^+\phi^-] - \tfrac{1}{2}g^2 \tfrac{s_w^2}{c_w} Z^0_\mu \phi^0 (W^+_\mu \phi^- +$$
$$W^-_\mu \phi^+) - \tfrac{1}{2}ig^2 \tfrac{s_w^2}{c_w} Z^0_\mu H (W^+_\mu \phi^- - W^-_\mu \phi^+) + \tfrac{1}{2}g^2 s_w A_\mu \phi^0 (W^+_\mu \phi^- +$$
$$W^-_\mu \phi^+) + \tfrac{1}{2}ig^2 s_w A_\mu H (W^+_\mu \phi^- - W^-_\mu \phi^+) - g^2 \tfrac{s_w}{c_w}(2c_w^2 - 1) Z^0_\mu A_\mu \phi^+ \phi^- -$$
$$g^1 s_w^2 A_\mu A_\mu \phi^+ \phi^- - \bar{e}^\lambda (\gamma\partial + m^\lambda_e) e^\lambda - \bar{\nu}^\lambda \gamma \partial \nu^\lambda - \bar{u}^\lambda_j (\gamma\partial + m^\lambda_u) u^\lambda_j -$$
$$\bar{d}^\lambda_j (\gamma\partial + m^\lambda_d) d^\lambda_j + igs_w A_\mu [-(\bar{e}^\lambda \gamma^\mu e^\lambda) + \tfrac{2}{3}(\bar{u}^\lambda_j \gamma^\mu u^\lambda_j) - \tfrac{1}{3}(\bar{d}^\lambda_j \gamma^\mu d^\lambda_j)] +$$
$$\tfrac{ig}{4c_w} Z^0_\mu [(\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{e}^\lambda \gamma^\mu (4s_w^2 - 1 - \gamma^5) e^\lambda) + (\bar{u}^\lambda_j \gamma^\mu (\tfrac{4}{3}s_w^2 -$$
$$1 - \gamma^5) u^\lambda_j) + (\bar{d}^\lambda_j \gamma^\mu (1 - \tfrac{8}{3}s_w^2 - \gamma^5) d^\lambda_j)] + \tfrac{ig}{2\sqrt{2}} W^+_\mu [(\bar{\nu}^\lambda \gamma^\mu (1 + \gamma^5) e^\lambda) +$$
$$(\bar{u}^\lambda_j \gamma^\mu (1 + \gamma^5) C_{\lambda\kappa} d^\kappa_j)] + \tfrac{ig}{2\sqrt{2}} W^-_\mu [(\bar{e}^\lambda \gamma^\mu (1 + \gamma^5) \nu^\lambda) + (\bar{d}^\kappa_j C^\dagger_{\lambda\kappa} \gamma^\mu (1 +$$
$$\gamma^5) u^\lambda_j)] + \tfrac{ig}{2\sqrt{2}} \tfrac{m^\lambda_e}{M} [-\phi^+ (\bar{\nu}^\lambda (1 - \gamma^5) e^\lambda) + \phi^- (\bar{e}^\lambda (1 + \gamma^5) \nu^\lambda)] -$$
$$\tfrac{g}{2}\tfrac{m^\lambda_e}{M}[H(\bar{e}^\lambda e^\lambda) + i\phi^0 (\bar{e}^\lambda \gamma^5 e^\lambda)] + \tfrac{ig}{2M\sqrt{2}} \phi^+ [-m^\kappa_d (\bar{u}^\lambda_j C_{\lambda\kappa} (1 - \gamma^5) d^\kappa_j) +$$
$$m^\lambda_u (\bar{u}^\lambda_j C_{\lambda\kappa} (1 + \gamma^5) d^\kappa_j] + \tfrac{ig}{2M\sqrt{2}} \phi^- [m^\lambda_d (\bar{d}^\lambda_j C^\dagger_{\lambda\kappa} (1 + \gamma^5) u^\kappa_j) - m^\kappa_u (\bar{d}^\lambda_j C^\dagger_{\lambda\kappa} (1 -$$
$$\gamma^5) u^\kappa_j] - \tfrac{g}{2}\tfrac{m^\lambda_u}{M} H (\bar{u}^\lambda_j u^\lambda_j) - \tfrac{g}{2}\tfrac{m^\lambda_d}{M} H (\bar{d}^\lambda_j d^\lambda_j) + \tfrac{ig}{2}\tfrac{m^\lambda_u}{M} \phi^0 (\bar{u}^\lambda_j \gamma^5 u^\lambda_j) -$$
$$\tfrac{ig}{2}\tfrac{m^\lambda_d}{M} \phi^0 (\bar{d}^\lambda_j \gamma^5 d^\lambda_j) + \bar{X}^+ (\partial^2 - M^2) X^+ + \bar{X}^- (\partial^2 - M^2) X^- + \bar{X}^0 (\partial^2 -$$
$$\tfrac{M^2}{c_w^2}) X^0 + \bar{Y} \partial^2 Y + igc_w W^+_\mu (\partial_\mu \bar{X}^0 X^- - \partial_\mu \bar{X}^+ X^0) + igs_w W^+_\mu (\partial_\mu \bar{Y} X^- -$$
$$\partial_\mu \bar{X}^+ Y) + igc_w W^-_\mu (\partial_\mu \bar{X}^- X^0 - \partial_\mu \bar{X}^0 X^+) + igs_w W^-_\mu (\partial_\mu \bar{X}^- Y -$$
$$\partial_\mu \bar{Y} X^+) + igc_w Z^0_\mu (\partial_\mu \bar{X}^+ X^+ - \partial_\mu \bar{X}^- X^-) + igs_w A_\mu (\partial_\mu \bar{X}^+ X^+ -$$
$$\partial_\mu \bar{X}^- X^-) - \tfrac{1}{2}gM[\bar{X}^+ X^+ H + \bar{X}^- X^- H + \tfrac{1}{c_w^2} \bar{X}^0 X^0 H] +$$
$$\tfrac{1-2c_w^2}{2c_w} igM[\bar{X}^+ X^0 \phi^+ - \bar{X}^- X^0 \phi^-] + \tfrac{1}{2c_w} igM[\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-] +$$
$$igMs_w[\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-] + \tfrac{1}{2}igM[\bar{X}^+ X^+ \phi^0 - \bar{X}^- X^- \phi^0]$$

*I am convinced God does not play dice.*

- Albert Einstein

## Automata & Altruism

*Congo & Coltan*
*Darwin & Dawkins*
*Genetics & George Price*
*We are selfish and subservient to survival.*

*If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is*

- John von Neumann

In 1885, Belgian colonists invaded the Congo. Over the following twenty-five years under King Leopold II, they massacred 10 million Indigenous Congolese, driving them off the land or enslaving them to harvest rubber, gold, copper, ivory, and diamonds to fuel Western economies. To keep production consistent, Leopold implemented daily mining quotas. Every time a slave failed to meet their quota, Leopold amputated a limb from one of their children or close family members with a machete to keep them motivated. During the 1930s, Armand Denis, a Belgian filmmaker fascinated by Africa, shot a series of documentaries about life there, bringing footage back home to narrate for European audiences. To help sell an exotic depiction of a foreign land, he fabricated stories and romanticized Africa's history based on the rumours he heard. During his visit to the Congo, he encountered two groups of locals, one mostly cattle farmers, the other grain farmers. He depicted the cattle farmers, the Tutsi, as a separate race of noble, intelligent people that ruled over the crude and primitive locals, the grain-farming Hutu.

> *The rich land discovered no one knows how long ago by tall majestic men who came from the north, perhaps all the way from ancient Egypt; to preserve here the civilization and beauty another age. We see the court dancers, how superior their flowing rhythm is compared to the crude shuffle of the forest tribes. When the giants found Rwanda they found it thickly settled, but so great was the superiority of these tall people from the north that although outnumbered a thousand to one, they established complete domination over the mountain tribe which inhabited the region. The blacks became their slaves.*
>
> - Armand Denis
> The Congo I Knew, 1935

The Belgian government built on stories like these. They found the genetic diversity of the region too nuanced for their liking and wanted a more convenient system for identifying the local people. They brought government scientists to conduct phrenology studies on the locals, hoping to "prove" genetic differences. They officially rendered the Tutsis a foreign race, citing their scientific proof that they had larger brains than the Hutus. But many of the locals had not ethnically identified themselves, so to create these new classifications, the Belgian government had taken it upon themselves to assign races based on their own judgement. Hutu and Tutsi people did not usually match the strict phrenological statistics the Belgians had created for their respective groups, so they were simply sorted into the race the colonists felt they most closely resembled. Often these decisions were based on external characteristics like wealth. A person owning assets of more than ten cattle automatically made one Tutsi. The colonists forced both groups to carry racial identity cards and placed their newly defined Tutsis in positions of power to govern who they considered lesser beings. Brainwashed into believing their newfound genetic history, the two groups were taught to hate and fear one another. Meanwhile, the colonists harvested their surrounding resources through their enslavement.

By the 1950s, many civil rights groups called for the Congo to be liberated from colonial oppression. Under visionary leader Patrice Lumumba, the Republic of Congo declared independence in 1960. As the first Prime Minister, Lumumba hoped to rebuild a united Africa under a new democratic republic, free from colonial control. But as the state transitioned into self-governance, Belgian colonists told the Hutu they deserved to "rightfully" take their land back from the Tutsis. They felt guilty fostering such an imbalance between the two groups and encouraged a rebellion. But they had stirred tension for too long. A full scale genocide broke out, and Tutsis were hunted down and slaughtered in droves. The Congo army, disgruntled with their continued mistreatment by Belgian occupation, added to the chaos instead of stopping it. Lumumba traveled to the US, requesting aid from the government to step in, but he was rejected. Desperate, he sent a telegram to the other world superpower, the Soviet Union, asking for their government's help instead. However, the telegram was intercepted by the CIA and made its way to President Dwight D. Eisenhower.

One of the resources the US relied on the Congo for was cobalt. Cobalt is crucial for building vehicles, plane engines, household appliances, and batteries, but the only suppliers in the world were the Soviet Union and the Congo. Eisenhower feared that Soviet military occupation would monopolize Central Africa's resources, crippling the American economy. Western citizens had become accustomed to their new high-tech lifestyles, and the military needed vehicles and planes. So Eisenhower called for Lumumba's assassination, on the grounds that he was associating with communists. Backed by the CIA, Congo Army Chief of Staff Joseph Mobutu staged a coup d'état, seizing control from Lumumba. He kidnapped the democratically elected Prime Minister, executed him by firing squad, and dissolved him in sulphuric acid. The President had gotten his way, and America's economy continued to boom.

Lumumba had only been in office for a few months, but the seeds for the collapse had been sown long ago. With racial identification cards, Tutsis were easily targeted and could not blend in. The survivors banded together, hired militias from nearby states, and fought back. A struggle for the land and resources erupted, one that still continues today. Mobutu sent his troops to break up the violence, but his soldiers only ended up joining the struggle for the mines. When Mobutu tried to stop them, he was overthrown and exiled. The Belgian colonists had incited a race war between people of the same race, people who had shared the same land for thousands of years in peace. And now the US had embroiled them in the center of the Cold War.

By the late 1990s, America's digital infrastructure was growing rapidly in the Dot-com boom. Corporations went after materials to build their electronics, many of which had to be mined from the Congo. Though copper and cobalt are crucial materials, so is the lesser known columbite-tantalite, also known as coltan. Coltan is composed of niobium and tantalum, dense, ductile, corrosion-resistant elements that are highly conductive. These properties make them crucial for manufacturing transistors, capacitors, and semiconductors in integrated circuitry. It is estimated that most of the world's coltan reserves are in the Congo.

*We've seen more than half a million people butchered, mutilated, raped, and torn from limb to limb. Only this week we've read of massacres in Stanleyville, of mass shootings, of unarmed women and children being murdered, and of the burning alive of sixty men being tied together and soaked in petroleum.*

*Through all these events, Your directors and I have asked ourselves only one question: To what extent will the operations of your company be affected? We are pleased to report that these conflicts are happening a thousand miles from the main seat of our mining operations and not need in any way directly concern us.*

- Official televised statement to the shareholders of
Union Minière Mining Corporation
1960

By the turn of the millennium, the Dot-com bubble had peaked. One reason was the pending release of the PlayStation 2, Sony's advanced new video gaming console. In the West, the excessive demand for the PlayStation 2 and other digital goods caused coltan prices to skyrocket. Sony could not produce consoles fast enough and the market responded. Within months, coltan more than quadrupled in value. As wealthy Western countries demanded more goods, corporate-backed militias came rolling in from Namibia, Uganda, Zimbabwe, Angola, and Chad, under the pretense of stopping the violence. But in what some media called "The PlayStation War," they began killing each other over the mines.

The militias sold the resources to Western companies with Eastern factories, using the revenue to buy weapons and ammunition to continue their fight for the mines. During the height of the boom, the Rwandan army exported over a hundred tons of coltan per month. Corporations then sold the resources to the public in finished electronic products, while the guns that paid for them went to work on soldiers and civilians alike. Children too young to wield guns were instead tasked with mining coltan to earn meals. If they could not shoot the enemy, they could at least help their friends do so. As militias disrupted the flow of mining and exports, concerns grew in the US over reports of a coming shortage of PlayStation 2s for the Christmas shopping season.

But one man, an evolutionary biologist named William Donald Hamilton, walked right past the violence. He had come for chimpanzee feces, not war. Hamilton made his way through the war zone, and into the jungle around Kisangani. He found the stool sample he was looking for and left for Nairobi airport, but contracted malaria on his way. He took an aspirin to deal with the symptoms, but it got caught as it went down, rupturing his gut and forming an ulcer. Multiple organs failed, killing him. But even in his last moments, Hamilton knew he would escape death.

For the longest time in the Western scientific community, humans thought themselves to be an enlightened species. Many scientists believed that we had physically unique brains that functioned differently than other animals, placing us on a higher plane of consciousness. But scientists contested this theory increasingly through the twentieth century, as they discovered the same chemical elements in the brains of other animals, and that these chemicals could be synthesized. As an evolutionary biologist, Hamilton believed not only were we not functionally different from other animals at all, but that all life was driven by nothing but DNA following rigid sets of its own behaviours. Having studied evolutionary modern synthesis closely, including the works of Charles Darwin, Hamilton observed distinct patterns in human history, structure, and culture. His main hypothesis insisted there to be a single common denominator in all life's behaviour. He surmised that our genes determined a lot more about our identities than we previously thought.

But one of the things Hamilton could not completely reconcile was the question of altruism. If evolution is about survival of the fittest, and every agent is out for their own preservation, why did we seem to have as many altruistic instincts as self-preserving ones? Why did so much life demonstrate self-sacrifice?

For years, altruism stumped Hamilton, preventing him from fully proving his theory. He created equations to justify such altruistic traits through group benefits but was unable to align it perfectly with the rest of his evidence.

In 1964 he published "The Genetical Evolution of Social Behaviour," a scientific paper outlining his theories on kin selection. He demonstrated through mathematical proofs how a singular mathematical principle could logically align all cell behaviour and their strategy for copying themselves. Survival was a chain of causality that rippled through every stage of life and our actions. It was a prime example of Laplace's Daemon at work. But the paper went unnoticed or misunderstood in the scientific community, except by one person.

***

In 1942, a fresh faced twenty-year-old chemist named George Price went to work for the Manhattan Project led by J. Robert Oppenheimer in Los Alamos, New Mexico. Price worked with uranium mined from the Congo to build the atomic bomb that ended the lives of nearly 100,000 Japanese civilians in under a single minute, and many more in the following decades. Remorseful about his hand in the destruction, Price left to teach at Harvard University. After marrying, having a daughter, and getting divorced, Price abandoned chemistry and joined IBM in 1961, where he designed graphic data processing interfaces. He enjoyed the pure logic of computers, as his experience with them on the Manhattan Project had been enlightening. During his time in Los Alamos, Price worked directly under mathematician, physicist, and computer scientist John von Neumann, one of the fathers of digital computing.

A prolific polymath, von Neumann published over 160 academic papers, many on how mathematics and logic could apply to countless other fields thought to be unrelated. As one of the leading pioneers of computer science, he wrote about his theories of "self-reproducing automata". He postulated they would inevitably exist in the future, when humans would invent the first self-replicating machines to augment our capabilities and improve our lives. These machines would foster a new era of perfect comfort and harmony between technology and mankind as they evolved together into what is now called the singularity. Von Neumann designed these replicating machines, laying out the mathematical groundwork for what would be required to build such automata. He would often discuss the future of computers with his colleagues, drawing Price deeper into the field over the course of his time at work on the bomb.

In 1967, six years into his job at IBM, Price was diagnosed with thyroid cancer. After a surgeon botched the removal of his tumours, leaving him partially paralyzed, he broke down and moved to London, England with his insurance payout. Shortly after arriving, he was passing time at a university library when he chanced upon Hamilton's paper. Even though he had never worked with cells or DNA before, the equations that Hamilton had written about organisms struck Price with stark familiarity. They looked like the functions he was used to seeing in computers.

## Selfism

> *DNA is exactly analogous to the binary digits of some computer code, unraveling like a reel of magnetic tape on some giant computer. It is a coded description of ancient worlds of which your ancestors lived. DNA is the wisdom of the old days, and I mean very old days indeed. We are the descendants of a tiny elite of successful ancestors. We are walking repositories; walking archives of the African Pliocene.*
>
> - Richard Dawkins

Without any training in genetics or evolutionary biology, Price derived what would become known as the Price Equation from Hamilton's work. It predicted the probability of certain traits changing over time in kinship and offspring, helping explain how genes made decisions based on the information they were presented with. Price's equation was the key to Hamilton's group selection theory. It quantified the biological balance of selfism and altruism, bringing a profound new understanding of our behaviour that found applications in other fields such as economics.

Under this conclusion, all life on earth behaved in alignment with the goals of their DNA, regardless of perceived morality. When DNA was combined, people failed to draw rational conclusions, but they acted logically according to the patterns set in their minds. If these actions harmed group genetic survival in the big picture or over the long run, there would be no feedback to stop us. When it comes to the mind, the whole is less rational than the sum of its parts.

Hamilton and Price demonstrated that we are driven by our innately "selfish" cells, individually performing functions based solely on our coded DNA. We have no free will or inherent morals, only biochemically powered calculations. The self-replicating automaton of the future that von Neumann had dreamed of, had been here the entire time. It was us; it was the Earth and the Sun. It was life itself.

With our behaviour calculated by biochemical computations, we are no different from the artificial intelligence of our science fiction novels. The consciousness arising from a cloud of code is unable to grasp the true nature of its own existence. Our minds developed heuristics to compensate for their lack of logical processing power, psychological shortcuts relying on thin-sliced intuition, perceived patterns, and emotional biases to make choices. The core of this decision-making process turned out to be a simple criterion for kin selection carried over from the natural selection mutations: The closer in DNA someone resembles your own, the more you should care for their welfare. Altruism is a matter of preserving similar life to ensure your own genetic code's survival.

However, Price's findings had more alarming implications. Equations have equal weight on each side. While it was mathematically beneficial for an organism to express cooperative attitudes towards closer organisms, it was equally rational — in a zero-sum manner — for it to be hostile towards more distant relatives. Caring for the welfare of other groups would not only be wasted

effort, but a direct attack on the organism's own genes. Only heavy exposure and communication with foreign objects, people, or ideas could override their instincts. Repetition can train our neural pathways to overcome certain genetic impulses.

From the DNA's perspective, life is not about social justice, equity, or even a happy host, but about using us to guarantee its replication indefinitely. All life on Earth evolved this way because it was the only effective strategy in the survival of the fittest. The genes that make enemies of the unknown are the only genes left standing. In a cost/benefit analysis of genetic insurance, being spiteful is advantageous to the gene if it means a higher chance of similar genes' survival — even to the point of sacrificing their host's life. As mere genetic vehicles, we facilitate a universal strategy game for strings of code to play against each other for eternity. There will be grave sacrifices and plenty of losers, but no real winners.

Awestruck by the revelation he believed to unlock the behaviour of all life on earth, Price, a lifetime agnostic, converted to Christianity. Complex issues and systems of various disciplines could now be explained by a simple equation he had derived. And if every action that he ever took — including every action leading up to his discovery of that equation — was merely a result of his own genes interacting with the world, a higher creator had to have selected him to receive such knowledge all along. It was all too coincidental otherwise.

To further develop their theories, Price and Hamilton began working with a young evolutionary biologist and amateur computer programmer named Richard Dawkins. Dawkins compiled all of their findings with his own and published The Selfish Gene in 1976. Instead of using mathematical proofs that had rendered Price and Hamilton's work useless to the layman and even to many other scientists, Dawkins used stories and anthropomorphized analogies of cell behaviour to build a narrative model the public could understand. As profound as Hamilton and Price's mathematics were, they were useless without effective interpretation.

Dawkins explains how human enlightenment is simply an illusion of free will we experience as a result of the complex web of logical processes taking place in our bodies. It is based entirely on networks of individual cells. Dawkins also coins the term "meme", describing a unit of human culture contained within a particular idea, behaviour, or style through evolution that could manifest itself in ways analogous to the gene, such as linguistic trends and iconography. Memes can be found in every corner and time of humanity; religion was one of the very first memes. Selfish replication could model human culture in many ways.

The book gave a tangible form to the eternal soul, a conscious spirit that could live forever through many hosts over time, as lines of code. Many saw a purpose of greater good for all life extending beyond their own fleeting life. If we were all indeed family, with shared ancestors from the same prehistoric burst of hydrogen, then it was our genetic duty to look out for all of its children. Some are not surprised that we share 96 percent of our genes with chimpanzees, but many are shocked to discover that we share over 60 percent with bananas. We could never know just by eating one.

## Altruism

> *I wanted to conjure up in the mind of the reader the image of the organism including ourselves as a machine for passing on genes. I wanted to shift the focus away from the idea of the organism as being the agent in life, to the immortal replicator, which is the gene. That is the law of natural selection. It's the selfish gene, but not the selfish individual.*
>
> - Richard Dawkins

Revolutionary as this was — not only to the scientific community, but to the world as a whole — their discoveries sent both Hamilton and Price down separate but equally dark paths. Although he felt enlightened and gifted by God, the truth about humanity eroded George Price's soul. He was unable to escape the fact that while he had unraveled the secrets behind our actions, he had absolutely no idea how to fix the horrors that occurred because of them. Falling into a deep depression, he focused all his energy on becoming as altruistic as possible, behaving as he felt a good Christian should. In a vain attempt to disprove his own work, he tried to seize agency from his genes by giving all his money and possessions away at random to homeless people around London, while isolating himself from loved ones. He began offering up his home to stay indefinitely, and when squatters inevitably stole his belongings to feed themselves and their various vices, he only encouraged it. He even gave barefoot strangers the shoes off of his feet if he saw they did not have their own. But his depression only worsened.

Price began his career helping to end lives, and concluded by trying desperately to help save lives, anchoring his morality in Christian principles as if they were a genetic code in opposition to the code within himself. He went so far as to deny himself any romantic relationships, knowing that such emotional and carnal desires were only a genetic appetite for reproduction. But ultimately, he knew that nothing he did would ever change a thing; everything was already going to happen anyway. Concerned for his friend's mental health, Hamilton and his wife took Price into their home, pleading with him to give up this self-destructive behaviour and rejoin their research.

In a final act of defiance against his life-preserving genes, Price sliced his carotid artery with a pair of nail scissors, killing his DNA in a metaphysical murder-suicide, and ending the struggle for good.

Hamilton identified the body. He was one of the only two academics at his funeral. The rest were some of the homeless and alcoholics that Price had helped. Now accepted by his peers, one of the most highly regarded scientists in the world, Hamilton took a direction in opposition to Price's. Based on the same understanding, Hamilton began advocating for eugenic policies, believing that modern medicine had inadvertently disrupted nature's cycle of natural selection of superior and inferior genes. Fearing evolutionary regression, he wrote that we should phase out inferior people by criminalizing medical help for those with adverse hereditary conditions and diseases. This was for the greater good of the human race.

In his efforts to combat modern medicine, he went looking for evidence that mankind's arrogance in the field was dangerous for humanity. A journalist told him that while developing a polio vaccine, American scientists had accidentally created HIV out of chimpanzee DNA in the Congo. Responsible for killing over 30 million people and infecting many more, it created the perfect opportunity for him to indict the Western medical community. So in January 2000, after the Y2K panic had subsided, he headed into the Democratic Republic of Congo looking for proof in chimpanzee feces. Instead he met his fate retrieving the pointless sample for a later-debunked theory. Richard Dawkins organized a secular memorial for him in Oxford, and a piece Hamilton had written about his own passing was published.

> *I will leave a sum in my last will for my body to be carried to Brazil and to these forests. It will be laid out in a manner secure against the possums and the vultures just as we make our chickens secure; and this great Coprophanaeus beetle will bury me. They will enter, will bury, will live on my flesh; and in the shape of their children and mine, I will escape death. No worm for me nor sordid fly, I will buzz in the dusk like a huge bumble bee. I will be many, buzz even as a swarm of motorbikes, be borne, body by flying body out into the Brazilian wilderness beneath the stars, lofted under those beautiful and unfused elytra which we will all hold over our backs. So finally I too will shine like a violet ground beetle under a stone.*
>
> - William D. Hamilton,
> My Intended Burial and Why

Through their shared findings, Hamilton, Price, and Dawkins also inadvertently quantified morality in a way that could guide a code of ethics. For the first time, we were logically able to distinguish between the role of cells within a bodily system, and the role of humans as organisms in social systems. A division of scale had been established. From the particle to cell level, everything about life's behaviour is a rational product of coded patterns selected for success. But once we are dealing with organisms outside of our own bodies, our cells no longer have a Daemon-like interconnection. Without direct communication with another body's entire set of cells, one is blind to their concerns, motivations, and thoughts. We must rely on language. Cells are instinctively unconcerned with the distant, whether it be genetic, geographic, or temporal.

When the holiday season rolled around later that year, the PlayStation 2 was released to the delight of many on Christmas morning. It became the best-selling video game console of all time, finding its way into 160 million homes.

Over 5 million people and counting have died in the Congo war, the highest death toll of any war since World War II. It rages on today, over all the same land, and all the same resources.

*Let us try to teach generosity and altruism, because we are born selfish. Let us understand what our own selfish genes are up to, because we may then at least have the chance to upset their designs, something that no other species has ever aspired to do.*

- Richard Dawkins
The Selfish Gene

## Systems on Spaceship Earth

*Acid & Anarchy*
*Dymaxion Domes*
*Ecosystems & Energy*
*We exemplify the paradox of self-stabilization.*

*The world is a raft sailing through space with, potentially, plenty of provisions for everybody; the idea that we must all cooperate and see to it that everyone does his fair share of the work and gets his fair share of the provisions seems so blatantly obvious that one would say that no one could possibly fail to accept it unless he had some corrupt motive for clinging to the present system.*

- George Orwell
The Road to Wigan Pier, 1937

> *I dreamed that I was in a sub-tropical country, separated from my friends, standing alone. ...I could see a number of savages armed with spears and the long pointed shields used by some South African native tribes. I myself had a loaded rifle, but realized that I was quite unable to escape in face of the number of armed savages who blocked the way. Then my wife appeared in the open space, dressed entirely in white, and advanced towards me ...and though there was some suggestion that I fired the rifle, but with no knowledge of who or what I fired at, I awoke.*

Botanist Arthur George Tansley sat up in his bunk, shaken by his dream. He wanted to know from where it had originated. But the year was 1914, and he was sitting in a World War I army bunk, with no one around who could give him any answers. When he returned home and resumed his duties as the first president of the British Ecological Society, he learned of an Austrian doctor named Sigmund Freud, who believed dreams to be unresolved subconscious turmoil surfacing in our conscious minds. Tansley travelled to Vienna in 1922 and became one of Freud's patients, developing a lifelong friendship. Tansley even wrote Freud's obituary when he died in 1939. Over the course of their sessions, Freud was unsuccessful in identifying the cause of Tansley's dream, but it became clear that Tansley was far more academically interested in Freud's theories anyway.

Freud told him that his all his psycho-analytic concepts manifested as physical events in the brain, their functions part of "a superstructure set in organic foundation at some time or another." Freud believed the brain conducted complex biochemical and electrical signals that created patterns somehow arising as consciousness, but decided it was pointless to attempt further study of the precise one-to-one relationship given our available tools at the time. Returning home to England, Tansley preached to his friends that Freud would become the most influential person since Jesus Christ.

In Tansley's efforts to model what would become the foundation of ecology, he inadvertently sowed the seeds of a myth that would endure through minds even today. He combined his theories with those of fellow ecologists Frederic Clements and Henry Chandler Cowles, using Freud's model of the electric brain to describe plant life in his ecology work. Observing cycles that fostered plant growth, he saw these environments as giant systems of energy that monitored each other through chain reactions of feedback. Each agent communicated in the chain, allowing them to regulate themselves. Tansley dubbed these environments "ecosystems."

The notion of self-balanced ecosystems would distort the study of ecology for decades to come. In the 1970s, chemist John Lovelock and microbiologist Lynn Margulis popularized their Gaia Hypothesis, which still persists today. They postulate that living organisms formed symbiotic bonds with the Earth, developing systems that adapted and stabilized without environmental stimulation. If left alone, the world would run like a finely oiled machine. But in natural selection, mutation is caused solely by the imperfect replication of cells' code, not by acts

of will or even survival. This imperfect replication of cells is caused solely by the surrounding forces of nature acting upon it from every direction through atomic interaction, subtly influencing its actions. Gaia hypothesis romanticizes the nature of the human condition, blending it with narrative, which proved to be more impactful to the public. The process is stochastic, even quantum mechanical, but not teleological. Matter — therefore nature — has only progressed through entropy, becoming more chaotic and complex. We are the disordered universe experiencing itself.

In the mid 1930s, grid electricity had yet to extend to rural areas. But a 15-year-old named Jay Wright Forrester could not wait. He taught himself how to build an electrical generator and brought power to his family's ranch in rural Anselmo, Nebraska using old car parts. A decade later, he earned a master's degree in electrical engineering from the Massachusetts Institute of Technology and became fascinated with the works of mathematician and philosopher Norbert Wiener.

Wiener modeled his idea of cybernetics, translated from Greek as "governing the ship." In this "scientific study of control and communication in the animal and the machine," Wiener saw humans as nodes in an interconnected network that processed relayed information like machines and reacted accordingly to feedback. He also revolutionized applications of stochastic processes in these systems, leading to the creation of the Wiener Process and the aptly named Wiener Sausage, both of which brought innovations to physics, biology, chemistry, and economics. They contributed heavily to the finance industry in particular, building models for Markov chains, and acts as the foundation for the Black-Scholes equation that serves as the core of financial trading today.

Forrester developed a theory that brains, groups of people, and therefore even societies, like computers, live in systems of feedback loops that determined their behaviour. He called this study "System Dynamics." Drawing a holistic cybernetic system diagram for the world, he believed it could empower us to predict real-world events. As the Cold War continued, the US government took notice of Forrester's work and hired him for national security. They built geodesic radomes housing early warning radar systems around the globe that monitored large-scale changes imperceptible to short term observation, hoping to predict inclement weather or enemy attacks. Forrester developed a method of storing data for the US military, using magnetic-core memory in an early form of random access memory (RAM). Various sensors could record and cross-process data from the radomes into new, intelligent information when combined properly.

Using this innovation, he designed a computer model called World3, which took all available data on rates of agriculture, economics, resources, population growth, pollution, and land use, and projected the future state of the global system based on its current trajectory. He asked institutions from around the world to contribute their data, insisting that only a critical mass of information worldwide would make the projection robust and accurate. His work caught the attention of the leaders of the Club of Rome, who were looking for ways to address climate change. When Forrester ran the simulation, it forecast

that globalization, overpopulation, alarming energy consumption, and pollution would cause a massive global collapse within the first third of the 21st century. The prediction became the basis for The Club of Rome's The Limits to Growth. The book urges for global sustainability as the only way for society to work long term. Forrester argued for zero growth, to maintain a steady equilibrium within the capacity of the Earth's feedback loop system.

The core issue with Forrester's model is that it was static. It did not account for changes to the political or cultural system brought on by the unforgiving chaos of nature. Reality is constantly in motion, leaving any organized model more outdated as time progresses. The Club of Rome could only predict the future based on the moment of calculation, not the future as changes were made, permanently changing all its feedback loops in subtle yet unmistakable ways. Every day, new policies, new actions, and new technologies become possible. No static model could foresee all such occurrences at any single point in time. The geodesic radome systems were inert and unmoving. Upon better information, they could not change the way they collected data. But the man who designed them had a vision for how we should do so.

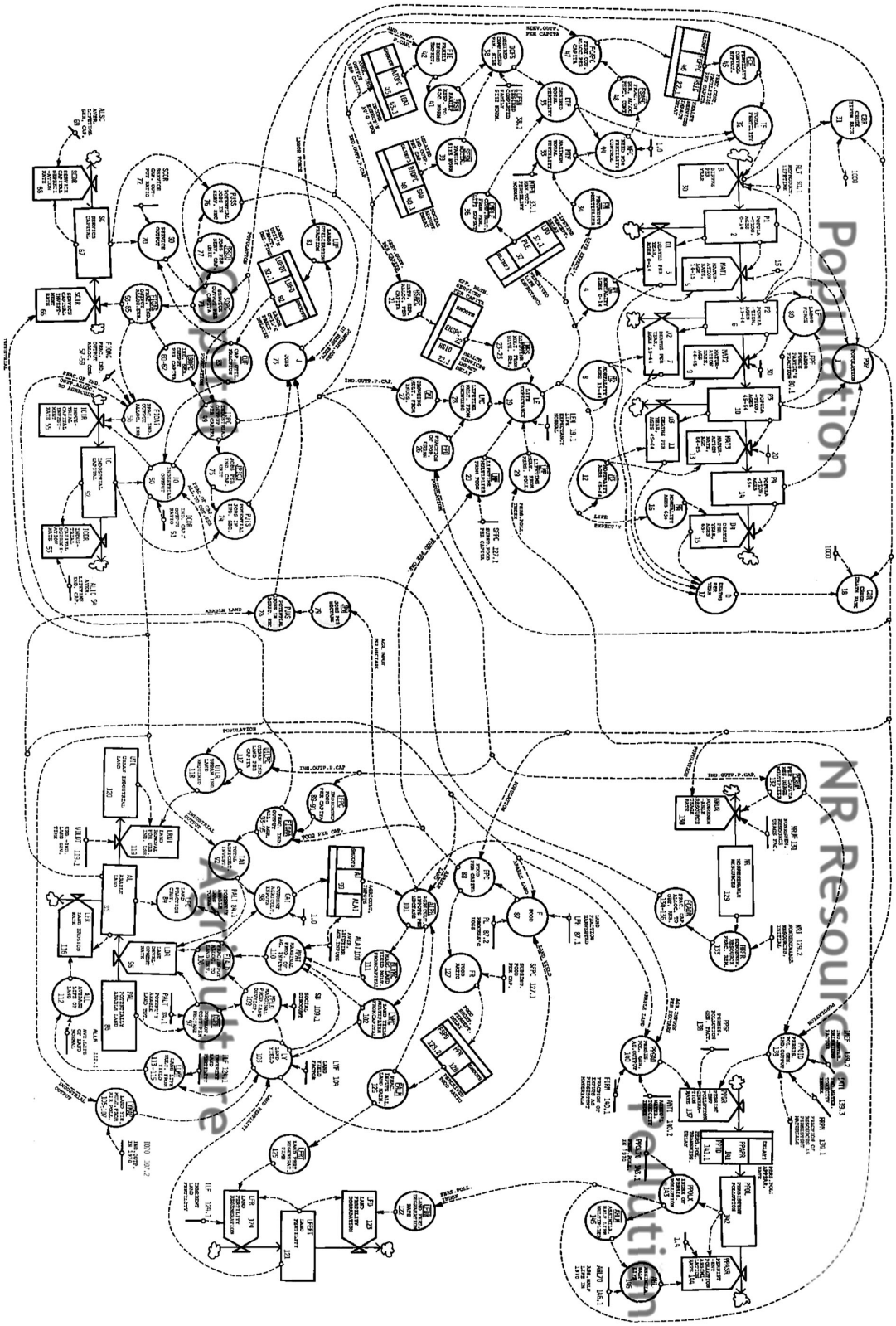
## Astronauts & Ephemeralization

In 1913, Harvard University expelled a student named Richard Buckminster Fuller for partying too hard. After appealing while working as a mechanic in Canada, he was re-accepted into only to be expelled again for being "irresponsible and apathetic" to his studies. It would not matter when World War I started, when he became a marine engineer and rescue boat commander for the US Navy.

Immediately after the war, Fuller met his wife and started a family. But in 1922, his daughter Alexandra died of polio and spinal meningitis just before her fourth birthday. Consumed with depression and guilt, Fuller suspected their damp and drafty living conditions had caused it. This motivated Fuller to co-found Stockade Building Systems with his father-in-law, forming a business which promised to provide safe, affordable housing. But in 1927 it went bankrupt, leaving him jobless and without savings. His family moved to Greenwich Village to escape their old conditions, but the birth of their second daughter Allegra added to their financial challenges. Fuller drank heavily and contemplated drowning himself in Lake Michigan so his family could benefit from his life insurance payment.

But one night, he claimed to have experienced an epiphany. In a drunken stupor, he suddenly felt as though he had been suspended in the air and surrounded by a white sphere of light. A loud voice spoke to him.

> *From now on you need never await temporal attestation to your thought. You think the truth. You do not have the right to eliminate yourself. You do not belong to you. You belong to Universe. Your significance will remain forever obscure to you, but you may assume you are fulfilling your role if you apply yourself to converting your experiences to the highest advantage of others.*




Top Level of World3 Model

In his moment of clarity, he became a utopian idealist. He spent much of his time drawing and writing at the café Romany Marie's, where he met architect and industrial designer Isamu Noguchi when he arrived in New York in 1929. Impressed with Fuller's "Dymaxion" (dynamic maximum tension) philosophy, Noguchi collaborated on several projects with Fuller, expanding Fuller's network and enabling him to move on to a professorship to spread his teachings.

In 1949, he constructed his first geodesic dome, out of aluminium aircraft tubing and vinyl. Standing 4.3 meters tall, it could sustain its own weight with no practical limits. The U.S. government employed him and his firm Geodesics, Inc. to design and build radomes for the military, and within a few years, there were thousands of domes around the world. By observing the structure of the geodesic dome as it existed in nature, Fuller came to believe that the Earth could be modeled as one. It was held up by individually fragile parts that would collapse against the lightest forces unless they all networked together. As synergetic equals, they could withstand external shocks by distributing them evenly, becoming strong and stable as one. However, such a utopian model needed a persuasive metaphor to capture the minds of the public.

By the late 1960s, the space race to the moon had been raging on for years, creating the perfect opportunity for him to develop a relevant analogy. In 1968, he published the Operating Manual for Spaceship Earth. Many people grow up dreaming of becoming astronauts, but "you are an astronaut," he tells us. "We are all astronauts aboard Spaceship Earth."

> *I'm sure you don't immediately agree and say, "Yes, that's right, I am an astronaut." I'm sure that you don't really sense yourself to be aboard a fantastically real spaceship. Spaceship Earth was so extraordinarily well invented and designed that to our knowledge humans have been on board it for two million years not even knowing that they were on board a ship. And our spaceship is so superbly designed as to be able to keep life regenerating on board despite the phenomenon, entropy, by which all local physical systems lose energy.*
>
> - Buckminster Fuller
> Operating Manual for Spaceship Earth

NASA's spacecrafts had intricate monitoring and energy supply systems designed to work in perfect harmony with the human occupants aboard. Computers would react at a moment's notice to any detected danger in the system, keeping the astronauts alive and sane in the harsh conditions of outer space. What Fuller expressed also went against the fundamental beliefs of ecology. Balancing ecosystems did not exist the way we thought, and there was no convincing way we could predict the course of the planet. We had to actively work together as a species to maintain our home's integrity for all of life, and technology would help us achieve that. His vision shifted focus away from people at the center of our universe, to Spaceship Earth itself, the world facilitating our very survival.

Energy is the currency of the Universe. Everything that "happens" requires energy to be transferred through motion. No cause and effect is possible without it. Philosopher Bertrand Russell called this "the law of cosmic laziness." On the galactic scale, humanity is impoverished. We earn money to put food on the table, giving us the energy we need from the Sun, our solar reserve bank. We have budgets of calories we need to earn per day, right along with our paycheques. The difference between the energy Earth receives from the Sun and the energy the Earth loses through its climate system is called "Earth's Energy Budget." We have been overspending it for centuries.

Earth weighs down like a bowling ball on the fabric of spacetime. Its energy creates a deep well that is impossible for anyone to climb out of on their own. The cosmos provided liquidity for the Earth to thrive, at the cost of sinking us into a pit that no one can leave without repaying. We are imprisoned on death row by 4.6 million years of debt to the Universe. We experience this debt as gravity. Looking into space, all we see are infinite destinations we cannot afford the energy to reach. Aside from the climate crisis or nuclear holocaust, if a superbug, massive asteroid, strange matter, false vacuum, or gamma-ray burst hits us, it is game over.

As one should not do when in poverty, humanity severely misallocates its funds. Fuller believed that we should strive for *ephemeralization*, "doing more and more with less and less until eventually you can do everything with nothing." The Daemon is a perfect example, as it can measure anything through one tool. For example, sound and heat are fundamentally the same thing, properties of motion that we experience completely differently. By measuring the movement of particles, no property is immeasurable. The geodesic dome itself was a demonstration of the principle, mathematically the most materially efficient structure for its strength, and theoretically scalable to any size using the same ratio of materials. The dome would stay strong and stable no matter how many pieces, so long as they were all working together. The overarching theory was that ephemeralization could support an ever-growing population despite finite resources. But all of this would require constant and cooperative communication between all parties globally, as well as the dissolution of hierarchical structures. This included modern politics, which Fuller saw to be the bane of humanity's existence with their reliance on "power games." "If man is going to stay aboard Spaceship Earth, it can't be done by politics because politicians are so inadequate; they do not understand such matters." he said. "A politician can only go on the design he already has, so all he can do is give you war."

By this point, 1960s counterculture had erupted into a nationwide movement. Draft dodging and The Grateful Dead were in, while consumerism and politics were out. Tired of mainstream society, hundreds of thousands of young Americans moved out to the undeveloped rural lands to start their own egalitarian societies in one of the largest migrations in national history. The first of these communes was called Drop City. A small group of artists and filmmakers bought a tract of land in Southeastern Colorado, and erected geodesic domes out of wood and spare car parts, symbolizing their synergetic philosophy. Most of them had no construction experience, but the project attracted Buckminster Fuller's attention,

*The way in which thought processes operate is with mathematical logic. Synergy is the only word in our language that means behavior of whole systems unpredicted by the separately observed behaviors of any of the system's separate parts or any subassembly of the system's parts. There is nothing in the chemistry of a toenail that predicts the existence of a human being. There is nothing about an electron alone that forecasts the proton, nor is there anything about the Earth or the Moon that forecasts the co-existence of the Sun. The solar system is synergetic-unpredicted by its separate parts. But the interplay of Sun as supply ship of Earth and the Moon's gravitationally produced tidal pulsations on Earth all interact to produce the biosphere's chemical conditions which permit but do not cause the regeneration of life on Spaceship Earth. This is all synergetic.*

*There is nothing about the gases given off respiratorily by Earth's green vegetation that predicts that those gases will be essential to the life support of Operating Manual For Spaceship Earth all mammals aboard Spaceship Earth, and nothing about the mammals that predicts that the gases which they give off respiratorily are essential to the support of the vegetation aboard our Spaceship Earth. Universe is synergetic. Life is synergetic.*

- Buckminster Fuller
Operating Manual for Spaceship Earth

who awarded Drop City the Dymaxion Award for its "poetically economic" domed living structures.

The most important aspect of these new domed societies was that no assertion of power or even alliances were permitted. It was a society of art, acid, and anarchy. While visiting Drop City, biologist Stewart Brand was inspired to publish the Whole Earth Catalogue, a counterculture magazine that discussed holistic tools humanity had at their disposal to foster a globally conscious system. Settling in Menlo Park, California, Brand published NASA's first colour image of Earth on the cover of the first edition, hoping it would instill a holistic worldview in readers.

At the same time, at a ranch near Drop City, a systems ecologist named George van Dyne decided to test the myriad of ecosystem theories expressed by the different schools of thought. He moved to the Oak Ridge Laboratory in Tennessee, one of the few places with the computing equipment necessary to process data at the speed he needed. He spent his grants hiring dozens of researchers to survey the nearby grassland biome to its utmost detail. This included mapping out entire regions flora and fauna as precisely as possible and how each part changed over time. They were attempting to get as close as possible to act as the Daemon for the ecosystem.

The team sampled every different plant and animal species and earth they came across. They followed creatures of all types through their daily lives, documenting every bite the animals took; what they ate, how much, and when. But that was not enough. To get more precise data, van Dyne used esophageal and rumen fistulas, designing custom metal hatches that were surgically installed into the throats and abdomens of large animals. His researchers could access a rarely seen part of the chain in the ecosystem this way. They would open up the hatch, grab the swallowed food out of the esophagus, and chemically analyze it before stuffing it back down the hatch to let it continue nature's journey, only to take it out again at the stomach. Every variable of the data collection was as specific and detailed as they could handle, with van Dyne's team constantly thinking of new factors they could reinforce their data with.

He then built a computer model to simulate a complete ecosystem based on this extensive real-world data, and added in everything they had been collecting and analyzing for months to see how the stability of natural systems worked. To his surprise, the computer model never stabilized. The researchers were unable to detect any true cyclical patterns. The biome was changing its very nature at every moment. Everything reacted with no foresight in mind. All Van Dyne's team observed was that the biome had permanently changed since their first round of study. The only consistent pattern the researchers found was that each individual agent acted on its own, with no way of knowing how the rest of the biome functioned.

Back in Colorado, the geodesic domes of Drop City were deteriorating. All the founding members had already left before 1969, and the domes had been completely abandoned by the early 1970s. Founding member Clark Richert stated

that the community became the joke that the rest of the country had always thought it was. Drop City mandated that no one could be turned away, inviting toxic personalities frustrated with mainstream society to settle in the communes only to take advantage of others. Despite the banning of politics, there was more political tension than ever, with no mechanism to control it. Everyone soon hit their limits and left.

* * *

Like a human being, Spaceship Earth is filled with individually selfish agents acting on their own DNA's orders. We are still evolving and figuring out how to deal with our shortcomings as individuals while attempting to guide the ship into the future. Individuals do not exist on the personal scale; we are networks of different cells arising as consciousness. All natural systems are governed by the laws of physics, and using old rules to tackle new issues will not be as effective as many of us want to believe. While the self-organizing network is great for stimulating change in an existing system, it cannot offer a solid idea of what could or should come next.

In academia, consensus is highest in the fields of physics and chemistry. We can reliably recreate outcomes in these experiments because observations at the scale of the atom have little room for error. When we can isolate and track the moving parts, it is easy to distill the outcomes logically. But once factors are entangled in complex relationships, we have little idea how one action affects the rest of the system, making it harder for our hypotheses and experimentation to cut through the noise.

Biology has plenty of disagreement, and some even in the theories of evolution. Selfish gene theory has gone through multiple adjustments since the publication of Dawkins' book. Critics such as physicist and systems scientist Yaneer Bar-Yam, member of the University of Waterloo International Scientific Advisory Council, and biologist and mathematician Martin Nowak, have pointed out fundamental flaws in some of the mathematics Richard Dawkins and his contemporaries have used to draw particular conclusions. The basis of selfish theory has been maintained, but language, as it turns out, may be more influential to our group selection than previous theories demonstrate. We have only begun seeing its long-term effects on our behaviour. Language is relatively new as a byproduct of evolution, and it is a unique, novel way of carrying information. Language travels like wildfire, but genes take generations.

But psychology and social experiments are the least reliable of all. Replicating studies of social behaviour is difficult. It requires one to track every particle in the participants bodies, as well as every particle acting upon it. We estimate that the adult human body facilitates roughly 50 quadrillion coordinated biochemical events per second. Once atoms create complex chemical reactions to drive human consciousness, discerning method from the madness with our tools is impossible. This magnifies with whole systems of people interacting with webs of other people, creating outcomes even harder to predict. Entropy spreads the information too thin.

*There was a merchant in Baghdad who went to the market. Walking through with his cart, he bumped into a stranger and looked up. It was Death, glaring at him threateningly.*

*Unsettled, he ran to my home, pleading for my horse. "I will change my future and go to Samarra, where Death cannot find me!" he said. So I watched him ride away as quickly as my horse would carry him.*

*I went to the marketplace and saw Death. I asked her why she had glared at my friend. "It was not a glare, but shock." she replied. "I was surprised to see him in Baghdad, for I had an appointment with him tonight in Samarra."*

Paraphrased from translation of the Babylonian Talmud
Sukkah 53a

## Radical Novelties

*Computers & Code*
*Logic & Learning*
*Everybody wants to use computers, but nobody wants to learn how they work.*

*The town is made up from neighbourhoods, which are structured by streets, which contain buildings, which are made from walls and floors, that are built from bricks, etc. eventually down to the elementary particles. And we have all our specialists along the line, from the town planner, via the architect to the solid state physicist and further. Because, in a sense, the whole is "bigger" than its parts, the depth of a hierarchical decomposition is some sort of logarithm of the ratio of the "sizes" of the whole and the ultimate smallest parts.*

*The programmer is in the unique position that his is the only discipline and profession in which such a gigantic ratio, which totally baffles our imagination, has to be bridged by a single technology. He has to be able to think in terms of conceptual hierarchies that are much deeper than a single mind ever needed to face before. Compared to that number of semantic levels, the average mathematical theory is almost flat. By evoking the need for deep conceptual hierarchies, the automatic computer confronts us with a radically new intellectual challenge that has no precedent in our history.*

- Edsger W. Dijkstra
On the Cruelty of Really Teaching Computer Science

If computer science is the theory of how computers function, software engineering deals with the functions themselves.

In 1988, Dutch scientist, programmer, and software engineer Edsger W. Dijkstra published his seminal paper "On the Cruelty of Really Teaching Computer Science." He establishes the concept of radical novelties — complex innovations that have profound, permanent effects on society. Computers perform organized binary calculations in unique, counterintuitive logical processes, revolutionizing every field, making them such a novelty. Any object or idea could be expressed through binary logic, giving computerized code the power to perform tasks that our minds could barely conceive. All information can be digitized. Various networks of transistors and semiconductors taking binary inputs on an integrated circuit board can produce limitless possibilities, which can only be accurately expressed through formal mathematical proofs, the purest and clearest method of formally communicating logic.

Much like early cameras, early personal computers required substantial participation from the user in order to perform basic functions. Access to such digital technology used to be exclusive to specialists and hardcore hobbyist programmers who understood its finer details. But with the rise of graphical user interfaces (GUIs), this changed in the 1970s. Computers were not just for nerds in their garages and cubicles, but for everyone to live and play with. And when they are for everyone and used for everything, they must accommodate the lowest common denominator. Simplification and designed assistance meant citizens did not adequately understand the operations of the devices they relied on for everyday life. This radical novelty eludes all previously known phenomena we have experienced. Our bodies are not built to work seamlessly with digitization, but we readily sacrifice authority for the benefits computers bring us.

Dijkstra asserts that programming should be taught in academia through formal mathematics rather than as software engineering. He believed that it should be treated as its own branch of mathematics in the face of inherent human irrationality. Mathematics curricula should include computer science by teaching logic, which is vital to understanding how digital technology functioned. Logic is not about simply knowing what to learn and think. It is about learning how to learn and think. With a properly calibrated learning toolset, young citizens would be better-prepared for the future than their predecessors. If introducing an elementary level philosophy course sounds extreme (such programs have been successfully running in Germany and Scandinavian countries for several years now), mathematics curricula could at least incorporate the importance of basic formal logic and common fallacies at as early an age as possible, to establish a rational mindset. By normalizing the scientific method across all modes of thinking, we can build a culture of clear-mindedness and humility.

Emotions are effective in guiding our spirit, but like cells, are unable to transcend one's body. Evolution serendipitously tackled this issue by developing communication mechanisms like spoken language. In our minds, words for the abstract do not actually represent definitions, but patterns, like everything else. When we hear "anger", we do not understand the word through its dictionary entry, an endless fractal tree of even more dictionary definitions described in other words. Instead it evokes past experiences and manifestations of "anger" we have experienced in many ways. The word itself is inert. Because so much of what we experience is intangible, we need repetitive pattern training to emotionally define these words to communicate with one another. The metaphysics of language and how we learn to use it, determines how we learn all future information. Language, thoughts, and emotions are linked by their relayed information. For better or worse, digital technology is a unique language that is difficult to grasp for those fluent in spoken languages, which is practically everyone.

We currently teach mathematics without instilling a greater awareness of logic, which is akin to believing we sufficiently teach physics just because our gym teachers demonstrate how to curve soccer shots. From birth, we are the result of our experiences. Upholding the scientific method is important when conducting any meaningful affairs in life. Fostering critical thinking at a young age can help avoid future traps arising from tainted logic, as these effects compound over time, shaping our mindsets for taking in new information. A young child able to think clearly is less likely to be misguided or taken advantage of.

> *The usual way in which we plan today for tomorrow is in yesterday's vocabulary. Of course, the words and the concepts don't quite fit because our future differs from our past, but then we stretch them a little bit. The meanings of words evolve over time, but this is a slow and gradual process; by means of metaphors and analogies we try to link the new to the old, the novel to the familiar. Under sufficiently slow and gradual change, it works reasonably well; in the case of a sharp discontinuity, however, the method breaks down. Our past experience is no longer relevant, the analogies become too shallow, and the metaphors become more misleading than illuminating.*
>
> *We could, for instance, begin with cleaning up our language by no longer calling a bug a bug but by calling it an error. It is much more honest because it squarely puts the blame where it belongs, viz. with the programmer who made the error. The animistic metaphor of the bug that maliciously sneaked in while the programmer was not looking is intellectually dishonest as it disguises that the error is the programmer's own creation.*
>
> -Edsger W. Dijkstra
> On the Cruelty of Really Teaching Computer Science

## Education & Evolution

While biological evolution is constant and ruthless, it is also extremely slow compared to our scales of experience. Different zeitgeists produce unique aesthetic preferences and worldviews. Politics, architecture, film, culture, music, and fashion are products of their contemporary headspaces. Nothing distinguishes one generation from any other genetically, and yet what is popular changes more rapidly than ever. Every cultural movement primes one generation for the next.

For us to overcome innate biases, we must expose ourselves to patterns that undermine our genetic instincts. Contemporary music finds listeners in people who have heard preceding styles, but it is not as successful with older generation's ears. Our minds must be eased in through osmosis. Politics and social progress are no different. Time proves it takes whole generations immersed in particularly conditioned environments to even slightly overcome such cultural biases. For this to manifest itself within the human body under evolution, such a process could take millions of years. Until then, we go through life digesting the patterns of art, culture, and politics, our brains setting baselines that are difficult to override.

The same issue arises in code because the automatic computation of complex binary logic defies every model we understand. No sufficient metaphor exists. Even in an age of digital information, we are afflicted with the same restrictions preventing us from observing the universe like Laplace's Daemon. Like computers, the world that we perceive operates on binary logic — yes or no; true or false; it is or it isn't. Truth is singular. Everything has a time, a place, and a set of properties. They are what they are and nothing else.

Physically, digital processes are tiny currents of electrons relaying through logic gates in an integrated circuit. Semiconductors and transistors use these currents to perform binary functions, translating them into standardized languages. Trillions of atoms are manipulated to perform basic tasks, but to a human observer, nothing can be said to have happened. Digitization is designed to be ignored by all human senses. Computers should act as tools bridging peoples' understanding with technology and widen their scope of knowledge by distinguishing the truth from the noise. We digest incomplete representations, unable to think critically and see the full possibilities. This puts us at a great disadvantage from the ones who are able to learn and harness them.

Policy has fallen behind on technology because lawmakers also do not understand the concepts our society relies on, but rich corporations and their specialists do. While watching a capable Photoshop artist at work feels like watching a wizard perform spells, the true magicians are the ones who designed an intuitive interface for that artist to interact with at their convenience, all through binary code. These masterminds built a smooth layout that could perform inhumanly complex functions behind the scenes, all through an organized switch triggered by the binary presence of electrical currents. Electronic entertainment like video games are no different. Electronic sports and their professional competitive leagues are attracting more investors and media, but an even bigger industry is taking off in the creation of them.

The next generation needs to be equipped to work with the language of technology our current generations are so ill-equipped for. No matter the industry, being "tech savvy" is not about interacting with tailored objects in all the flawless ways designers plan for. Seeing under the hood, understanding the code itself, understanding what the hardware is doing, and reverse-engineering is fully comprehending the technology.

Architecture is particularly vulnerable to this dilution of knowledge because it is so multidisciplinary yet fundamental to our lives. People can actively avoid many industries, but they would be hard pressed to find themselves unaffected by architecture. Access to adequate housing is a human right, and we should design a future that protects that.

*One has to approach the radical novelty with a blank mind, consciously refusing to try to link it with what is already familiar, because the familiar is hopelessly inadequate. One has, with initially a kind of split personality, to come to grips with a radical novelty as a dissociated topic in its own right.*

*Coming to grips with a radical novelty amounts to creating and learning a new foreign language that can not be translated into one's mother tongue. (Any one who has learned quantum mechanics knows what I am talking about.) Needless to say, adjusting to radical novelties is not a very popular activity, for it requires hard work. For the same reason, the radical novelties themselves are unwelcome.*

-Edsger W. Dijkstra
On the Cruelty of Really Teaching Computer Science

PART II

# Unsecured & !==

!== : unequal

*How do "smart" things make us stupid?*

A day passed since Zou transferred his funds and there was still no sign. Panicked, he contacted Quadriga's various customer service lines, only to be reassured that his withdrawal would come within two weeks. There were ongoing difficulties with depositing into his bank; he just needed to be patient. But the weeks went by and they continued to give him the same excuses. Zou scrambled to figure out the problem and found through online forums he was not alone. Virtually all of the other users were reporting the same issue, no matter what bank or service they were using, and users were even reporting their withdrawals to be held pending, even without any currency exchange. Weeks turned into months, and with the transactions remaining indefinitely suspended, Zou, and over a hundred thousand other clients, found themselves utterly powerless.

Around the same time in early 2018, Bitcoin skyrocketed in value, hitting the height of its price bubble the previous December at $23,400. It had only been worth under $1,000 just one year earlier. Because of this massive spike, millions of dollars began flooding into Quadriga's accounts at unprecedented rates, which involved major banks such as the Canadian Imperial Bank of Commerce. CIBC froze a number of large transactions through their system, many of which were designated to put down deposits on properties. They cited their suspicion of money laundering for which they could not contact anyone at the exchange, including Patryn, the chairman, and Cotten, the CEO, for comment. The rest of the Canadian banks soon followed suit, and Quadriga stated via Twitter that Patryn and Cotten would not be available for contact and any communication with the company would have to go through their customer service representatives.

After eight months with his money locked up in Quadriga's system, and hearing nothing but excuses, Zou received the first meaningful correspondence from the company since the incident. It was a message from their customer service department in early January 2019, apologizing for the hassle and reassuring him that his funds could be recovered and withdrawn in cash if he visited the exchange's new brick and mortar storefront in Laval, Quebec. The thought of picking up over half a million dollars in cash more than halfway across the country was already absurd, but he found out that those who visited the address in the Montreal suburb were greeted with a visibly deserted building with not a dollar in sight. On paper or code, Quadriga held over $250 million of their clients' money at this time. But people were beginning to wonder if the company had any of it at all.

## Techno-Topias

*Cybernetics & Cyberspace*
*Engelbart & Engineering*
*Knowledge is power.*

*When "wireless" is perfectly applied, the whole earth will be converted into a huge brain, which in fact it is, all things being particles of a real and rhythmic whole. We shall be able to communicate with one another instantly, irrespective of distance.*

*Not only this, but through television and telephony we shall see and hear one another as perfectly as though we were face to face, despite intervening distances of thousands of miles; and the instruments through which we shall be able to do his will be amazingly simple compared with our present telephone. A man will be able to carry one in his vest pocket. We shall be able to witness and hear events--the inauguration of a President, the playing of a world series game, the havoc of an earthquake or the terror of a battle — just as though we were present.*

- Nikola Tesla
1926

In July 1945, the American 393rd Bombardment Squadron dropped Fat Man and Little Boy over Hiroshima and Nagasaki, completing the Manhattan Project and changing global politics forever. The United Nations formed to deal with this new postwar complexity, realizing that the actions of any individual state now involved consequences for many others. Following the bombing of Nagasaki, J. Robert Oppenheimer, head of the Manhattan Project and self-proclaimed "Death, destroyer of worlds", distanced himself from nuclear weaponry. Feeling it had been unnecessary and unethical, he said during his subsequent interview at the White House that the blood of the Japanese people "was on his own hands." It was not what President Harry S. Truman wanted to hear. Incensed, he immediately kicked Oppenheimer out and told his staff, "I don't want to see that son of a bitch in my office ever again."

Oppenheimer became the chairman of the United States Atomic Energy Commission, and against his colleagues' interests, lobbied for the UN to ban nuclear devices from future warfare. He hoped to see them restricted to clean energy production instead. But he failed to control the beast he created, and his proposals were rejected. Despite working with Albert Einstein and Bertrand Russell to campaign against the global building of nuclear arsenals up through 1955, it was too late. The race had begun. Authorities removed Oppenheimer from his position and revoked his security clearance. During his subsequent security hearing, Edward Teller testified against him, after working on the Manhattan Project together for many years. He expressed distrust of Oppenheimer's leftist and communist sympathies. Oppenheimer's appeal was rejected.

After demonstrating on the world stage just how dangerous knowledge of mathematics could be, Edward Teller, John von Neumann, and Stanislaw Ulam took it a step further. By using nuclear fusion instead of fission only, they invented the hydrogen bomb, the first thermonuclear weapon. Atomic bombs already shocked the world with more destructive power than many thought possible, but a single hydrogen bomb releases over a thousand times more energy, making the carnage in Japan look like nothing. Although they have never been used in war, hydrogen bombs sit in all known missile silos across the globe today. The US has nearly 7,000 nuclear weapons. Russia has even more. The rest of the world combined has "only" 1,000. They are all controlled by computers, ready to launch at a moment's notice.

As The Cold War heated up, electrical engineer Douglas Engelbart concluded that managing this complex, postnuclear world would require the cooperation of large groups of people from around the globe who could not even see, let alone empathize with each other. The bombers, separated from their victims, did not witness a single death. The public's view of computerized applications at this point was limited to manufacturing and number-crunching. But Engelbart believed that they could do far more for the human spirit. Computation was important, but on this vast globe, communication was paramount. "The key thing about all the world's big problems is that they have to be dealt with collectively. If we don't get collectively smarter, we're doomed. Technology should not aim to replace humans, rather amplify human capabilities," he wrote. After earning his Ph.D., Engelbart

left his comfortable corporate job in 1955 and embarked on his mission to bring the world together. He began researching out of a small, quiet area near Menlo Park, California, in what would become known to the world as Silicon Valley.

In 1962, Engelbart published a report on his vision called "Augmenting Human Intellect: A Conceptual Framework." Among a dozen of other innovations, he introduced a concept called the "Augmented Architect." He envisioned the future architect working with digital "clerks," computers with graphic displays that created one-to-one virtual representations of prospective building designs.

> *The architect next begins to enter a series of specifications and data - a six-inch slab floor, twelve-inch concrete walls eight feet high within the excavation, and so on. When he has finished, the revised scene appears on the screen. Any view he wants to examine (a slice of the interior, or how the structure would look from the roadway above) is important. He enters particular fixture designs, and checks to make sure that sun glare from the windows will not blind a driver on the roadway,*
>
> *The architect has a list of the people who will occupy this building, and the daily sequences of their activities. He examines how doors swing, where special lighting might be needed. Finally he combines all of these sequences of activity to indicate spots where traffic is heavy in the building, or where congestion might occur, and to determine what the severest drain on the utilities is likely to be.*
>
> *All of this information and its associated "thought structure" can be stored on a tape to represent the design manual for the building. Another architect, a builder, or the client can maneuver within this design manual to pursue whatever details or insights are of interest to him - and can append special notes that are integrated into the design manual for his own or someone else's later benefit. However, the computer has many other capabilities for manipulating and displaying information that can be of significant benefit to the human in non-mathematical processes of planning, organizing, studying, etc. Every person who does his thinking with symbolized concepts (whether in the form of the English language, pictographs, formal logic, or mathematics) should be able to benefit significantly.*
>
> - Douglas Engelbart
> Augmenting Human Intellect, 1962

This system could model the project in three dimensional space, opening up limitless possibilities for pre-visualization. By using parametrics, each component could be efficiently recorded, and assigned unique properties. The goal was for all physical space to be organized alongside digital information in compartmentalized hierarchies of physical matter. This would eventually become known as "Building Information Modeling" (BIM.)

But there was a problem. Computers were incredibly counter-intuitive to operate, taking years of training just to perform basic functions. They were buggy and spat out unintelligible gibberish. The hurdles in training users would kill the

dream before it started. Engelbart led a team of scientists at the Augmentation Research Center at the Stanford Research Institute to found the study of Human-Computer Interaction. They developed ways to bridge computers as extensions of the human body. Engelbart built on the philosophy of Fordism, seeing potential applications in the future tech industry. When humans and tools worked in harmony, the team could "improve their tools for improving their tools", leading to increasing rates of progress in the end product over time as the work flow constantly adapted to the next stage. With more advanced equipment, more advanced devices could be designed and manufactured, feeding back to no end.

In 1968, shortly after Buckminster Fuller published his book on Spaceship Earth, Engelbart presented the team's prototypes at the annual Association for Computing Machinery conference in San Francisco. In what would become known as The Mother of All Demos, Engelbert sat in front of an audience with a number of new tools on the desk in front of him, demonstrating each component. The first was a monitor displaying bit-mapped graphics, presenting information visually as we recognize it. Instead of endless lines of green code, "files" of images, text, and sound clips were separated neatly in rows and grids of digital "folders". But this new graphic interface needed a new way for users to interact with it. So Engelbart introduced a handheld tool he affectionately called the "mouse." It mapped the user's hand movements to a set of coordinates using wheels and displayed them on-screen using a virtual cursor. The cursor acted like a hand, manipulating objects and picking them up, intuitively bridging the user to the virtual space in front of them. This opened up exponential possibilities for programs that nearly anyone could use without training.

But an intuitive interface was useless for communication if it was a closed loop with its user. So Engelbart's team also demonstrated a method of relaying information between multiple computers through what they called the "oN-Line System." Engelbart showed a live feed of his screen to another computer back at the Research center in Menlo Park where his associate could manipulate the document, replicating the actions on Engelbart's screen. When Engelbart moved his mouse, the cursor moved on the other screen as well. By opening another program that activated a camera and a microphone plugged into the computer, Engelbart and his partner's voice and face were transmitted to the corner of each other's screens, allowing them to talk to each other while they discussed the work. Engelbart believed that computers could save the world from self-destruction by empowering people with augmented empathy. Allowing us to connect across the world would foster educated and liberated individuals.

Cyberspace

There were many who were taken away by this grand vision of a harmonized planet. The Grateful Dead had helped spearhead the acid counterculture movement, and their lead lyricist, John Perry Barlow, was enamoured with the liberated medium of communication. After the band's heyday, Barlow headed straight towards network technology, and in the 1980s became involved in online activism.

He joined the board of directors of Stewart Brand's Whole Earth 'Lectronic Link (The WELL), an online community for the magazine, known for bringing many "deadheads" together. Private internet networks had been around for some time, but scientists and engineers from around the world helped advance the oNLine System. At CERN in Switzerland, where humanity attempts to uncover the nature of reality, computer scientist and engineer Tim Berners-Lee developed a method for scientists to exchange research efficiently and communicate more easily. Through the 1980s he expanded this network to a global scale as new infrastructure was built through the 1980s, calling this interconnected information highway the *World Wide Web*. The web was about to go public, and Barlow believed that the potential demonstrated by Engelbart could open a whole new world of opportunities for liberation, with citizens able to break free from geographical constraints and converse about new ideas with anyone in the world. Working closely with developers in the early years of the web, Barlow founded the Electronic Frontier Foundation (EFF) to uphold civic rights as citizens of the internet. In its first major case, the EFF represented a company whose computers had been ripped out of the walls and stolen in a raid by the Secret Service, who claimed to be looking for sensitive government documents believed to have been mistakenly emailed there. The subsequent outrage helped establish in law that private electronic documents could not be seized without warrants.

Believing in a techno-utopian future, Barlow published A Declaration of the Independence of Cyberspace, a manifesto declaring to all governments that the internet was "naturally independent of the tyrannies you seek to impose on us… Your legal concepts of property, expression, identity, movement, and context do not apply to us. They are based on matter. There is no matter here." It spread through virtual word of mouth, upholding a promise of liberty. Within a couple of years, thousands of websites had posted the declaration to their "About" sections.

> *Our identities have no bodies, so, unlike you, we cannot obtain order by physical coercion. We believe that from ethics, enlightened self-interest, and the commonweal, our governance will emerge. Our identities may be distributed across many of your jurisdictions. You are terrified of your own children, since they are natives in a world where you will always be immigrants. Because you fear them, you entrust your bureaucracies with the parental responsibilities you are too cowardly to confront yourselves.*
>
> *These increasingly hostile and colonial measures place us in the same position as those previous lovers of freedom and self-determination who had to reject the authorities of distant, uninformed powers. We must declare our virtual selves immune to your sovereignty, even as we continue to consent to your rule over our bodies. We will spread ourselves across the Planet so that no one can arrest our thoughts. We will create a civilization of the mind in Cyberspace. May it be more humane and fair than the world your governments have made before.*
>
> - John Perry Barlow
> A Declaration of Independence of Cyberspace

But not everyone was as optimistic. A fellow hippie and draft dodger named William Gibson saw a different side to the information highway. After moving to Toronto in the late 1960s to avoid the Vietnam War, he lived in Yorkville, the counterculture capital of the country at the time. Inspired by the free-spirited friends he met, he began writing, having dreamt of being a science-fiction novelist since he was twelve. Gibson depicted cyberspace as a hostile, unforgiving realm where hackers were the outlaws of the new Wild West. In creating the cyberpunk genre with his contemporaries Bruce Sterling, Philip K. Dick, and Neal Stephenson, among others, Gibson realized these new computer networks were far more beneficial for large corporations than they were for regular citizens. With increasing money and infrastructure, corporations built more powerful networks that could relay information faster. Unlike previous operations which could be audited and tracked, these private networks were undetectable to the government and public, allowing them to do whatever they pleased. The world would not be a techno-utopia, but a techno-dystopia.

> *Cyberspace. A consensual hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts... A graphic representation of data abstracted from banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding...*
>
> - William Gibson
> Neuromancer

Before Gibson, the term "cyberspace" was first used by Danish architects Susanne Ussing and Carsten Hoff, who founded Atelier Cyberspace. Through the 1960s they created a series of "sensory space" installations that reacted to movements within them. However, they had not been thinking about digital technology at all. Neither had ever used a computer before.

But there were others who used them extensively. They always wanted to know more, even if it meant bending the rules. These were crackers, hackers who would not stop at anything to harness the powers of network technology. If hackers build, crackers break. One particular group called themselves the Masters of Deception, and made themselves infamous for hacking into telecommunications networks to learn how engineers designed their mainframe systems. Member Mark Abene, also known as Phiber Optik, discussed corporate business in online forums as well as mainstream television and magazines. Abene took particular umbrage with Barlow's idea of a liberated world wide web. After arguing with him on The WELL for weeks, Abene hacked into the servers of TRW Inc, a large credit reporting agency that brokered customer data, and downloaded Barlow's credit report history, sending it to him and his friends.

> *At that time, my assessment of the crackers' black skills was one of superstitious awe. They were digital brujos about to zombify my economic soul. To a middle-class American, one's credit rating has become nearly identical to his freedom. It now appeared that I was dealing with someone who had both the means and desire to hoodoo mine, leaving me trapped in a life of wrinkled bills and money order queues. Never again would I call the Sharper Image on a whim.*
>
> - John Perry Barlow

The hack demonstrated two truths. Corporations held immense power by owning data about our preferences and behaviours, and those who understood computers at a fundamental level would always dominate cyberspace. Both truths shattered Barlow's notion of a democratized internet. Virtual space, like everything else, was indeed based in matter. The platform enabled communication, but that communication left recorded traces. TRW Inc. would eventually become Experian PLC, which suffered a massive security breach in 2015, losing credit card data for millions of customers to hackers. In 2004, less than a decade after Barlow published his internet liberation manifesto, Reason Magazine interviewed him.

> *REASON: I've been rereading some of your early '90s writings about the digital future, and you sounded a lot more optimistic then, with a much more "nothing can stop us now" attitude.*
>
> *BARLOW: We all get older and smarter.*

* * *

From the very day J. Robert Oppenheimer signed on to work on the Manhattan Project in 1941, the FBI flagged his reported "left wing associations" and opened a file on him. They tracked his movements, intercepted his mail, tapped his phones, and bugged both his home and office for decades. They did the same for his family and friends. Even as he was designing their most powerful weapon, the American government viewed his knowledge and political views as a top national security threat. If he could build an atomic bomb, it would only be a matter of time before someone on the other side of the world did too.

During Oppenheimer's security hearing, President Dwight D. Eisenhower asked him why he created the bomb if he knew it was too dangerous for human nature. "When you see something that is technically *sweet*," Oppenheimer answered, "you go ahead and do it and you argue about what to do about it only after you have had your technical success."

## Digitization & Data

*Black boxes & Big Brother*
*There's a daemon at my day job, and it's coming for yours too.*

*The next medium, whatever it is – it may be the extension of consciousness. A computer as a research and communication instrument could enhance retrieval, obsolesce mass library organisation, retrieve the individual's encyclopedic function and flip it into a private line to speedily tailored data of a saleable kind.*

- Marshall McLuhan
The Invisible Environment: The Future of an Erosion (1967)

Bill Earle pulled up to the curb in front of a house in rural Pennsylvania and stepped out of his truck. A group of excited dogs crowded around him as he approached the home's walkway holding a parcel. They yapped while Earle pulled out his DIAD (Delivery Information Acquisition Device) from his utility belt and read what was on the touch screen. "*BEWARE OF THE ANIMALS.*" The front door opened and the homeowner came out, apologizing for the dogs before thanking Earle for the package. Earle returned to his truck, and with the press of a button and a push of the pedal, he was off to drop off hundreds of more packages.

Earle started delivering for United Parcel Service in the 1990s, when they were still a trucking company. By the 2000s, UPS understood the importance of data, and transitioned into a technology company. In 2014, they began rolling out new trucks, which they call "package cars", like the one that Earle drives today. They were designed with plenty of extra room to install and swap extra equipment besides what was typically seen in normal motor vehicles. Each truck carries over 100 sensors to track every conceivable variable that the engineers could think of. At the heart is a black box, a robust, opaque storage unit, collecting every bit of data sensed by the various systems throughout the day. UPS vehicles are rolling data collection machines. Headquarters knows when Earle is backing up, opening the door, turning, idling, if he has his seatbelt on, what speed he is moving at and in what direction, what gear he is in, among endless other minute details. The DIAD on Earle's belt is also tracked, and given the black box data, one can model and simulate the entire lifetime of the vehicle and its workers. Once the truck returns to the yard, the black box is jacked in directly from the truck to be uploaded to the data centre in Paramus, New Jersey, where analysts publish reports on employee efficiency and put it towards their research.

Jack Levis, the lead systems designer at UPS, is the one in charge of putting that data to work. Through his department's calculations over the years, they were able to present certain statistics that motivated the company to take more action. Some examples include:

1 additional minute of driving per day = $14,500,000 per year in lost revenue
1 additional minute of idling per day = $500,000 in fuel per year in lost revenue

These studies get very specific, as the time it takes to even touch the screens on their DIADs has become a point of contention. If every driver performed only one extra keystroke per day, that would still add up to $100,000 a year of lost revenue. In the eyes of the company, people who take a long time to sign for their packages are flushing their profits down the drain. You will never see a UPS truck make a left turn at an intersection. Not only are right turns quicker, but the accident rates on left turns are far higher. A UPS truck getting into an accident is a revenue nightmare. Drivers were wasting time opening and closing the door, manually starting and stopping the engine, and even fumbling around with their keys. They never do any of those things anymore. A UPS driver knows that if you are right handed, you have to put your pen in your left breast pocket for split-second convenient access.

While humans are fairly decent at noticing patterns, we are not very good at optimizing them. But computers are. Levis started the ORION project to find new, efficient ways to save time and money on deliveries. Combinatorial explosion makes the task incredibly tricky, but UPS has successfully been able to find routes and routines that save time and money, which no human would have ever figured out. For example, a driver could have a delivery due for 10am at one door, and 2pm at the next door over. While they might be tempted to deliver both packages in one trip, it would actually throwing company money down the drain. By retrieving and delivering both, the driver would be losing 30 seconds at the moment to save 10 seconds later in the day, and if every driver did that just once a day among their hundreds of packages, that would be over $4,500,000 in lost potential revenue. Using ORION's calculations, drivers' routes have become incredibly complex and counterintuitive, with many restrictions and variables. Ever since it has been implemented, per year it has saved 10 million gallons of fuel, 100 million miles of driving, and 100,000 metric tons of carbon emissions. Overall, UPS saves up to $400 million every year from ORION.

> *ORION will drive right past three deliveries and do them later. ORION thinks differently than you and I. It doesn't think about what's the best thing to do now, it looks about what's the best thing to do for the whole day. ORION figured out that coming back later would cost half a mile, but the penalty of doing that in this moment, would only cause a bigger problem later.*
>
> - Jack Levis

In the classic "Trolley Problem" thought experiment, a subject is provided a lever for a forked train tracks and given the choice to either pull the lever to kill one person and save five people, or to do nothing and let five people die. The ethics of life priority in self-driving cars in a "trolley problem" situation is hotly debated, but they should never encounter a trolley problem if the network of sensors and cars can foresee all the pieces moving towards disaster and avert it ahead of time. Cars of the future may not even have to stop for each other at intersections because they have the ability to seamlessly weave through each others' perpendicular paths without collision.

This is Fordism at its finest. UPS is a company that understands that as much as packages are their advertised business, most of their money should be in data technology and building hardware that supports it. They are investments in the line of production and its workers, which ends up cutting costs while producing better service. However, this increased pressure causes many complaints from customers of the delivery drivers, from claiming to "have knocked but no one was home" to leaving packages in the wrong places. But once one realizes that even a single extra keystroke goes directly to their bosses, it becomes much more understandable. Earle was asked if he often gets chastised by his supervisors for backing up too much, leaving the door open too long, or any number of insanely specific sources of wasted profit margin, "Every day. Every day." he answered.

Thankfully, the union for delivery drivers negotiated to have certain rights with their data, the most important one being that they could not have their paycheques individually docked just because of the data recorded of their job performance. They can still be warned or fired, but not financially affected. In fact, drivers' wages have increased slightly with the assistance of all these new optimizations, even if it is only a small slice of the overall savings.

While the definition of "who you are" varies from person to person, in a physical sense, it is the way the atoms inside your body interact with the world around them. If you can measure and record how someone's body is affecting the space it is in, then you are essentially capturing the person themselves. Over time, their thought processes in neural pathways, and therefore knowledge, could manifest themselves as recordable assets and be expressed as some sort of value, used to draw conclusions. For instance, temporal photographic studies have demonstrated how people move and position themselves throughout the day in a public park, given where light and shadows fall. If we were to mine our movements and thoughts en masse, putting them to work in a similar manner to ORION, what could be learned about human instincts then? Could we avoid long term mistakes by predicting them in advance and taking the necessary precautions ahead of time?

Unfortunately, when it comes to technology, unions cannot solve every issue. Virtualization not only eludes the workforce, but it also replaces it with an ever-increasing automation. This large workforce has been left with no viable employment prospects. Many critics share no sympathy for them, insisting that truck drivers and auto workers should meet the demands of the current economic climate and "learn to code", as if it were an easy transition for anyone halfway through their careers in a wildly different industry. Both the Obama Administration and the Massachusetts Institute of Technology have projected that 30% of American jobs would be automated by 2030, as well as 80% of all jobs earning $23/hour or under.

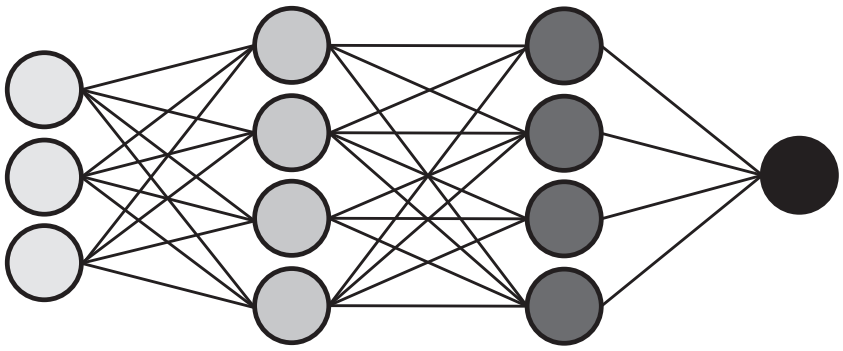
Levis and his team have already been working on UPS's self-driving trucks for many years, which combined with the other shipping companies, will save roughly $168 billion per year for the whole industry, with all of it going to the big tech corporations, at the expense of many jobs like Bill Earle's. Above all, UPS's approach to optimizing their chain of production is not restricted to delivering packages. The sensory data has proven so beneficial for these companies that many other industries are looking into similar technologies to be built into their offices. Many employers find themselves lost as to why their company seems to be running poorly and have realized that constant data on their workers can help diagnose issues and solve problems. The future workplace is beginning to look more Orwellian.

> *I think it's harder for the old dogs like me who have been doing the job for a long time and have to try to conform and comply. It does feel like Big Brother.*
>
> - Bill Earle

## Automated Daemons

Outside of extortion, individual data is not worth much by itself. However, everything changes with volume. Companies take small amounts of data from multiple sources and pool it together using very powerful algorithms. Because of combinatorial explosion, even a tiny bit of data can be immensely informative when it is cross-referenced with a large enough data pool. New data can be compared by any number of factors with every other piece on the network, making it exponentially more valuable. Sudoku problems are a classic demonstration of these linear arrangement combinations. Dividing a 9x9 grid to show every possible sequence of digits 0 through 9, there are 6,670,903,752,021,072,936,960 possible unique Sudoku puzzles. Given that this is only a small grid with ten fixed variables, one can only imagine the combinatorial number for the close to 200 packages that delivery drivers drop off every day, or of course, the massive amounts of data collected through various methods. Trade exchanges and large companies — even outside of the "technology" industry — work on these principles.

In 1986, English-Canadian cognitive psychologist and computer scientist Geoffrey Hinton published a paper theorizing that because brains were just complex computers, we could build computers that learned like humans did. Neurons fired signals in networks of synapses to memorize information and make future judgements. Could computers do the same? Hinton designed a *backpropagation algorithm*, a simplified model of the brain, which mapped inputs in multiple dimensions against past inputs like neurons in the human brain (these digital neurons are pinged or not pinged), cycling through its past catalogue and adjusting the "weight" of each node. "Training" the code by feeding it data allows it to change itself in order to adapt to future encounters, becoming better-informed with every experience. This simulates the effect of feedback loops on the human brain. If a program with such an algorithm was given enough raw data, it would develop metaphysical "sensibilities" about all of the things we know, in the way we know them.



If one provided this "Neural Network" enough dog photos, it would learn how to identify a dog from future pictures, and would get much better as more photos were added. If one fed this neural network enough music files labelled as "pop," it would soon "understand" what pop music was, without its judgement being affected by anything other than the music itself. No marketing, celebrity media, or other "human" factors would play a role. The algorithm would cut through the abstract with logical pattern-recognition in this process, called Deep Learning. Using deep learning, a trained neural network would be able to write its own pop music when prompted to. Many called Hinton's work nonsensical, stating that he had a poor understanding of artificial intelligence.

Neural networks have exploded in popularity in recent years, becoming the forerunner to achieve true artificial intelligence one day. Their ability in cross-reference patterns already exceed that of any human, enabling them to spot counterintuitive phenomena. Designing programs around deep learning algorithms requires one to understand their goals. If knowledge is just pattern recognition engine, then applying it using Big Data creates a more powerful and robust one. Big Data is useful because it takes incomprehensibly large amounts of raw data and distills it into useful information by cutting through biases and flaws that even intelligent people would suffer when combing through details at such a massive scope.

People do not realize how miniscule their experiences are and how little universal truth there is to them. The amount of people we interact with, or even see in any way, is relatively meaningless in the grand scheme of things. A single person's life experience is just a narrow pathway, like a worm tunneling through an endless Earth. A worm that only digs through a garden, will think the whole world is lush. With enough raw data, a computer can use strict logic to distill information into a form that we can understand. When we process that information and put it into action through decision-making, it becomes intelligence.

Coders are contemporary alchemists. When actions, reactions, and transactions occur in virtual space, they are at the mercy of whatever invisible manipulation the author of the platform designs. Water becomes wine, turds become gold. Every time someone runs a search, writes an email, or performs a captcha, they are actually training Google's AI to recognize patterns and objects. Whether identifying routes, images, words, one is essentially employed, giving Google's neural networks some free data to chew on and add to their memory. Anything that can be mined will be mined, because as Jack Levis was able to prove, technology can find a lot of new unthinkable ways to make money and save time. Social media algorithms are designed as echo chambers for the simple reason that emotional people click more. Outrage has reliably proven to draw more reactions from people, which are far more valuable for data collection than the lack of reactions to neutral or positive material. The way we blindly accept small interface nudges in certain directions is proving dangerous as we approach an age of smart homes and big data. In this economic model, you are the product, not the service you are using.

Ever since the mid 1990s, nearly all large corporations have hired analysts to act as intelligence agents, monitoring and processing the company's data in order to predict the future for its users and the company so that it can get ahead of unforeseen trends. Corporations are like massive organisms, humans of their own made up of lots of tiny little beings that are each pursuing their own goals according to their own motivations. Each part knows very little about the whole operation, often not caring about what others do. Your digestive system could not care less about whether you are reproducing or not, but it will make sure to tell you that you need to eat. All these individual systems together, even if ignorant to each other, are able to achieve a higher goal. Whether that higher goal is equitable or even ethical, neither our bodies nor corporate bodies care to ask. In the hands of powerful corporations, is this data liberation or imprisonment? Since 2000, Google's Privacy and Policy agreement has become nearly 8 times longer, jumping from about 500 words to over 4000.

For thousands of years, agriculture made up nearly the entire "economy," a concept which did not even exist yet because there was little reason to track one. Because agriculture is based on a fixed amount of land, the economy from year to year did not change much. But finite land meant finite resources, creating a zero sum economy. We started many immoral conflicts to conquer more land, as it was the only way to secure more wealth. But when credit and debt came into play, along with the Industrial Revolution, they worked as a positive sum system that everyone could benefit from. Credit fostered industries. Industries created more jobs, moving people from farms to factories. Innovation brought new, better jobs, creating more industries and even more opportunities, because humans combined with machines made work easier. It was beneficial for everybody.

But Fordism changed by the time we reached 21st century automation. It pushed us towards service jobs, where innovations create new opportunities, by cannibalizing old ones in droves. More can be done with less, but with fewer new roles for people to fill. In its heyday, the automotive industry was the backbone of America. The "Big Three" car manufacturers were among the highest valued of corporations. In 1987, Ford posted a record $4.7 billion dollars in profits, topping General Motors with 800,000 employees. In 2018, ten years after President George W. Bush bailed out GM and Chrysler with $17.4 billion of the future taxpayers' money, the "Big Five" in technology were the innovative big earners. Google profited $30 billion dollars from a staff of only 100,000 employees. Facebook profited over $20 billion with only 40,000 employees. All five tech companies employed fewer workers combined than any one of the Big Three car manufacturers at their peak. Innovation is not what it used to be.

By feeding UPS every action of his shift, Bill Earle is teaching neural networks how to take away his job. Every step he takes, every mile he drives, only makes his replacements smarter. Effort is futile, because the better he does his job, the sooner automation can exploit and improve on it exponentially, only speeding up the process.

The issue is not restricted to basic labour. Computers are past beating humans at chess. They can fly and land planes, diagnose cancer, and trade stocks. They can even conduct psychotherapy. Architects may feel comfortable behind their belief in "intangible human factors," but the uncomfortable truth is that time is against us. Given the right algorithm, feeding a program the design manuals of every building in the world would produce unimaginable possibilities of what "architecture" is. Creativity seems unaccounted for, until one considers that any complex task at its core is merely a collection of simpler tasks. When the workplace tracking methods used by UPS begin seeping into the workplace, neural networks can observe every action of an employee on the job, learning everything they do and how they make decisions. In a world dominated by greed and green design, a computer can build a more cost-effective and energy-efficient building than most people, and it can give you a multitude of options based on whatever criteria you need, on demand. It is already possible to produce instantaneous, photorealistic renderings from any perspective the client desires. Eventually it will be up to the market to determine what a "human architect" is worth, and the odds are not in our favour.

The upside is that we may be lucky enough to be the last few generations to experience the traditional form of the profession before it mostly dies. Our job is still highly multidisciplinary, and the fully automated architect is not coming for some time. Until then, we have powerful tools like building information modeling and virtual reality to make our jobs easier. Architectural practice is more complex than ever, but we get to experience a sweet spot of mankind and machine working together at maximum capacity. But because as a society we are recording more data every single day, we are inadvertently training our own replacements. The ones who design the future with their technological knowledge will always remain at the top.

Over 30 years after first publishing about neural networks, Geoffrey Hinton is now a professor at the University of Toronto. But he spends most of his time researching for "Google Brain," leading development on the company's deep learning technologies. Hinton has also expressed concerns over the dangers of artificial intelligence. The threat of a self-aware Skynet-like attack on humanity is not likely to be a concern for a long time, but the abuse of artificial intelligence by the rich and powerful is already happening, and will only worsen in the coming years. In China, a country even further along the curve of frightening technological abuse, some parents are registering their children for experimental educational programs that use brain scanning equipment. Students are required to wear headgear at all times which records their brain activity, sending live feeds and reports to staff and parents. If a student is drifting to sleep or their mind wanders elsewhere, the authorities know.

In an interview, philosopher Niklas Bostrom, known for his work on technology and futurism, asked Hinton why he continued working at the frontiers of artificial intelligence if he knew he was leading humanity down a dark path. "I could give you the usual arguments," Hinton responded with a smile, "but the truth is that the prospect of discovery is too *sweet*."

*Take the well-worn analogy of a monkey pressing keys on a computer at random. The chances of it typing out the first 15,000 digits of pi are absurdly slim — and those chances decrease exponentially as the desired number of digits grows. But if the monkey's keystrokes are instead interpreted as randomly written computer programs for generating pi, the odds of success, or "algorithmic probability," improve dramatically. A code for generating the first 15,000 digits of pi in the programming language C, for instance, can be as short as 133 characters.*

- Jordana Cepelewicz
Quanta

## Pen Test PAL

*Software engineering & social engineering*
*Elevator cartels & electronic espionage*
*How architects specify equipment they think they understand.*

In March 1983, President Ronald Reagan delivered a speech announcing the Strategic Defense Initiative to the public. He expressed an urgent need to build a larger missile network, one that could even shoot down Soviet missiles before they had a chance to reach the US. The media named the program "Star Wars" after George Lucas' space opera blockbuster, which characterized American imperialism and its military aggression through the Death Star's unparalleled destructive power.

Two months later, Reagan retreated to his private retreat at Camp David, Maryland. The former Hollywood superstar relaxed by watching WarGames, a new popular Cold War movie starring Matthew Broderick. The next day, he called a meeting with members of Congress and his national security advisors. Reagan asked if anyone had seen the film. He was met with blank faces. So he detailed the main plot, in which Broderick's character, a tech-savvy high school student, hacks into the computers controlling the US nuclear missile system and inadvertently triggers World War III. "Could something like this really happen?" Reagan asked the table. "Could someone break into our most sensitive computers?" He was met with exchanges of nervous glances and raised eyebrows. General John W. Vessey Jr., chairman of the Joint Chiefs of Staff, told Reagan he would look into it. A week later, Vessey came back to his boss. "Mr. President, the problem is much worse than you think." he said.

The system used to secure the US missile defense system is a part of what is called Permissive Action Link (PAL). Dr. Bruce G. Blair, who worked as a Minuteman launch officer through the 1970s, stated that for over 20 years, the code to access the PAL system was "00000000." "Our launch checklist in fact instructed us, the firing crew, to double-check the locking panel in our underground launch bunker to ensure that no digits other than zero had been inadvertently dialed into the panel," he wrote. During the Terrorist Threat to World Nuclear Program, he revealed that only four willing conspirators were needed to start a nuclear Armageddon. When Reagan found out just how heavily the system prioritized emergency convenience because of Cold War paranoia, he called for a complete overhaul.

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Nothing in this world is totally secured. We have not achieved perfect security, the legendary impenetrable lock, for nearly 200 years. Now, security is only a time deterrent. Given enough time, anyone can get through anything. But time is money. As long as one can make it cost more in time than what a perpetrator would gain from bypassing the security system, they are safe. We optimize safety by cost-benefit analysis. There is a lot that can be done to increase safety without costing more.

Architecture is where technology and space meet. Every aspect of a building's construction is an application of chemistry and engineering. Because we live in a time of corporate espionage and powerful technology, an entire profession emerged dedicated to testing physical and digital security systems by hacking them. Companies challenge "penetration testers" to break into their buildings and

try to steal valuable property such as inventory, legal documents, or server data. The testers then publish a report on the experience, diagnosing flaws and issues to show how the company might improve its security given its resources. Usually working as freelancers, penetration testers train in three core disciplines: Physical (door busting), electronic (hacking), and social engineering (sweet talking). All are equally important. Buildings have combined physical, digital, and human security systems, each with its own idiosyncrasies.

The downside of optimization is that products become standardized to prevent confusion and lower costs. If a tester has the most recent Assa Abloy catalogue, they can learn about the most popular product lines and how to get past any of them. Many systems share keys, allowing perpetrators to bypass the most common locking systems effortlessly. A penetration tester in the US or Canada carries the following tools at all times:

- *FEO K1* - Most popular elevator key
- *C415A* - Most popular filing cabinet key
- *CH751* - Most popular filing cabinet key
- *1284X* - Ford Fleet Key, for squad cars and taxis
- *Lock Jigglers* - Last resort for small locks
- *Wire Loop/bridge* - Opens door handles
- *16120 Doorking Key* - Most popular door console key
- *222343 - 126* - Second most popular door console key
- *Bump Key* - Instantly opens any pin and tumbler lock it fits
- *A Cuff key* - Useful for small locks, or if things get out of hand

Thanks to standardization, every one of these keys can be found for roughly $5 at any hardware store. Efficiency is worth a certain degree of security risk, but optimization is often done without all the necessary information. Door busting is a far cry from the popular mental image of someone carefully manipulating lock-picking tools inside a pin and tumbler. Penetration testers consider this to be a last resort and typically do not do it. There are plenty of far quicker, more efficient ways to bypass locks. Even bump keys alone solve any standard pin and tumbler lock. Bump keys are evenly toothed keys which can be fashioned out of any blank key. When a bump key is inserted into the lock, it is struck from behind with a hand or tool, using the entrance of the keyhole as a fulcrum to knock the pins in the cylinder upwards with sudden force. This "bumps" all the pins out of the way for just a moment before they fall back into place, but long enough for the tester to turn the cylinder, unlocking it. Despite pin and tumbler locks being time deterrents of only seconds, North America still relies heavily on them. They are ubiquitous and remain the most popular type of lock on the continent, contrasting sharply with other parts of the world.

Many buildings use electronic key systems to determine who should be allowed access to certain areas. Companies see authentication processes as lost time, therefore money. To deal with this, Request to EXit sensors (REX) are popular systems in many institutions and offices. Fitted with an authentication system like a card reader or keypad on one side, employees simply flash their badge in order to enter. However, when they are going the opposite way, there is no card reader on the exiting side of the door. Employees can simply push the doors open as they approach them. These REX systems are cost-efficient and effective at their task. They can be seen at the front of most large retail establishments with automatic doors, like supermarkets. However, the people in charge of specifying them have little idea of their inner workings.

People tend to assume the door is locked from one side, and unlocked from the other. While this can be true for mechanical locks that require the user to manipulate a mechanism to unlock them, digital locks cannot achieve superposition. They must be either locked or unlocked at any given moment. An electronic system must be designed to decide when to let people through even though they have no credentials. This may appear to require an advanced computer. But developing such a system would drive up the cost too much for it to be profitable. Production chains are built for maximum productivity, but never maximum security. Security product manufacturers are part of a corporate chain just like everyone else and optimize for the lowest cost.

To save on research and development, they combined multiple forms of more basic technology we have already had for decades. The most common method for REX doors is to employ infrared sensors to observe temperature spikes. The door senses a person coming because of their heat signature tripping the sensor on the exiting side. But the sensor is one-dimensional. It detects temperature changes, but has no idea if it is caused by a person or not. A person from the wrong side of the door can spray an aerosol can through the crack in the door, or blow cigarette smoke, and the sensor on the other side will pick it up and unlock the door, thinking someone was trying to leave.

Even ignoring all hidden digital systems, we misunderstand basic features such as doorknobs. Though round doorknobs are commonly round in many homes, accessibility issues prevent them from being installed in most public places. They are difficult to grip for people with motor control issues, as there is little leverage on a round knob for torque. To solve this, public doors in institutions and businesses have elongated handles, rotating from one end like a lever for easy operation. However, this also makes them surprisingly easy to manipulate from the other side with a simple wire loop that hooks the conveniently shaped lever from above or below, pulling it open.

But why go through locks at all? Many people are so occupied with the locking mechanism that they forget that the door itself had to be installed somehow. If one simply looks at the hinge side of a commonly locked door, they will notice that they are held in place with a basic pivots that run through the barrels. These can easily be pushed out or unscrewed, releasing the entire door from the frame. Needless to say, this makes the lock completely pointless.

Physical space needs to work in tandem with virtual space for proper security. I have never worked in an architecture firm where the data security was really that strong. I have seen how incompetent the IT experts are. This is unsurprising. Non-technology companies cannot typically afford to pour precious resources into these aspects. It would not be hard for a curious perpetrator to find out a little about the building. They might find out who the owner, the mechanical engineer, and the architect were. How hard would it be then to access the design manual for any particular building and plan the entire operation before stepping on site? Knowing what locks and equipment they are up against, the perpetrator would simply bring the right tools for the job.

Everyone is vulnerable. Thankfully, most are equally vulnerable. There is a safety in masses because there are enough people to spread the risks. If breaking and entering ever became too disruptive, everyone would stop. In Italy for instance, no one's front door uses a pin and tumbler lock.

Sometimes, a perpetrator does not need to take anything at all from a building. Sometimes just being there achieves enough. Elevators are one of the most popular forms of transportation in the world. The Otis Elevator Company, once untrusted by the public, marked their 150th year in 2003 with the claim that their products moved the equivalent of the world's population every nine days. Otis achieved this acceptance by requiring operators to man the elevators. Passengers felt safe riding with authority, even though all the operators did was push the buttons. Though the days of manual assistance are past, modern buildings and their occupants rely on elevators. Moving vertically takes far more time and effort than any other direction. Businesses would be disrupted if the elevators shut down. Large corporations can lose millions when elevator issues are not resolved promptly. However, most building owners have no idea how elevators really work. They are at the mercy of the inspectors and service workers trained by companies like Otis. Buildings need licenses to keep the elevators running, and inspectors can show up at any time like health inspectors, shutting the whole building down at a moment's notice. Control the elevators, and you control the business world.

Beginning in the late 1990s, many building owners noticed that inspectors were visiting with higher frequency and demanding mandatory maintenance. Elevator repair costs were more costly, without an explanation why. Failure was at an all-time low, and the wear on the systems was not increasing. The elevator companies insisted that these new statistics were because of their vigilant servicing. However, after a lengthy investigation by the European Commission over many years, they revealed Otis conspired with the other major elevator companies to run an elevator cartel behind regulators' backs. With a near monopoly on goods and services that could not be swapped for an alternative, the European Commission alone fined Otis $225 million for its cartel operations, and German elevator manufacturer ThyssenKrupp $630 million for their larger role in the conspiracy.

Architecture has expanded beyond the traditional bounds of the profession. While no one achieves perfect security, by understanding the methods used to break in, we can develop better time deterrents. Architects are caught up thinking about the

metaphysical aspects of architectural features. Through patterned thinking they begin to believe that everything can only be used the way they were designed to. But penetration testers know better, and thinking like one can enhance the architects' awareness of the risks they put their clients at before they stamp their approval on drawings.

In door hinges, pins should have screw bolt replacements specified in higher security areas to prevent them from being knocked out. Handle shrouds, protective guards installed around door handles to prevent them from being knocked and damaged by heavy objects moving through doorways, are effective at preventing anyone from looping door handles from the wrong side. For under $10 they end up being far more effective than the $10,000 security systems using far more complex technologies. These are perfect examples of ephemeralization. Tools like this do so much, for so much less.

Physical space needs to work in tandem with virtual space in order for proper security to be successful. Most architecture firms do not have the strongest data security systems. None of the architectural practices I have had the opportunity to be a part of, has had strong data security. How hard would it be for someone to identify the owner, mechanical engineer, and architect for a project? How hard would it be to then access the plans and schedules for any particular building, planning the entire operation including its digital components, before stepping in? If a tester knows exactly what locks and equipment they are up against, they will prepare with all the right tools for the job, making the entire system pointless. Production chains are built for efficiency, optimized for maximum productivity, but never maximum security.

Quality is not always a priority either. In early 2018, Preety Keith put a down payment on a condo unit in downtown Toronto. She was satisfied with her new slice of life in the city until she got a letter from the condo board. It was a notice for mandatory pipe replacements, with a bill attached for tens of thousands of dollars. A contractor working elsewhere in the building had opened up the bathroom drywall and noticed thin, blue and orange pipes stamped KITEC XPA.

Developed in the early 1990s, Kitec Plumbing was a popular system for potable water and heating. It consists of a flexible aluminum pipe sandwiched between layers of polyethylene pipe (PEX), with brass fittings. Marketed as a cheap, idiot-proof alternative to copper piping, it found its way into many homes across North America. In 1995, its lead manufacturer IPEX recalled the brass compression fittings. Engineers said the brass would react with the polyethylene and aluminum pipe over time, causing it to corrode, "dezincify," and fail. Despite the fact that they had been recalled over twenty years previously, and had been part of a class action lawsuit for over ten, Kitec found its way into Keith's condominium and other projects looking to cut corners as late as 2012.

Keith was told that as the owner, she was on the hook for the many thousands of dollars in pipe replacements for future problems, which she had no idea about when she signed her contract. Property owners are not legally obliged to declare the presence of known problematic equipment like Kitec Plumbing. Buyers have

to be cautious and figure out on their own exactly what equipment is installed in a prospective property. Engineers had known for over a decade that the design was problematic, but it was approved and popularized for years before the first sign of trouble.

A leaky condo crisis from poorly specified products and materials had already rocked Vancouver during the worst years of its condo disaster. Brand new townhouses had rain dripping through the light fixtures, wrecking the electrical systems and rotting everything in its path. Products and construction methods were chosen for their lower cost and abundance from other geographical markets. Systems designed for arid climates like California were used in BC homes, and could not deal with repeated heavy precipitation. This construction slipped past BC building codes, and the repair costs landed on homeowners for hundreds of thousands of dollars.

Today, many homes across Canada are landmines for prospective homeowners. Faulty equipment and materials hide behind the finishes and cladding just long enough for the accountable parties to shift the risk over to an unknowing buyer. Many do not know what to look for among the chaos of equipment in every home that allows them to function.

## Air Gapped

What does "hacking" actually look like? The idea of a dramatic typing battle against the server is a dramatic Hollywood portrayal for the sake of audience engagement. Hollywood knows that radical novelties are not what people come to the movies for. Audiences enjoy hacking as a point of conflict, so filmmakers model its depiction based on fight scenes. In most of the media we consume, hackers trade virtual punches and kicks with an animate system, furiously counter-attacking with blazing typing speeds. In reality, hacking is a slow, boring, methodical process taking place over weeks or months. Movies make people think hacking is a sprint. But it is a marathon. 99 percent of hacking time is spent designing new programs by researching precedents, by splicing and synthesizing new ideas to fit the site in question. If anything, the process is more similar to architectural design. By the time a hacker reaches the site, it is simply a matter of connecting and running the software they have tailored to work directly with the security systems in place.

An "Air gapped" object has no connections to other devices beyond a power source. There can be no other wires and no connective capabilities whatsoever. Typically, something is vulnerable to hacking because it is connected to another system in some way, allowing a cracker to access information remotely. But an isolated object like an air gapped computer has no way for anyone to connect to the hardware inside it. And yet it is now possible to hack into air gapped computers. A lonely computer, sitting in the middle of an empty room surrounded by nothing, is no longer secure. Even computers, like humans, are only equipped to handle information in certain forms.

Computers handle everything through binary electromagnetic functions, and nothing else. In doing so, they give off much more than we think. The term air gap leads us to forget that air itself is a fluid, not a vacuum. Computers produce acoustic vibrations and electromagnetic pulses that ripple through air. We perceive these as thermal signatures and optical light, all of which can be detected, recorded, and interpreted with the right tools. Even fan noise can be used to decrypt information. Engineers as early as 2017 have shown how external sensors with no connection to the system in question can be programmed to pick up these invisible vibrations caused by the computer running through data, and translate that back into the original code that was stored on the computer to begin with.

Certain tech companies have taken these concerns very far in order to secure their data. Google has deep enough pockets that they could afford to build four massive and mysterious floating barges far out the San Francisco bay that acted as completely air (and water) gapped data centers. However, they were too expensive to maintain and were removed when they did not comply with the city's safety regulations. But as much as corporations care about protecting their own intellectual property, the same is not always true for individual consumers.

Throughout the 1970s, the San Francisco Bay Area was terrorized by a man who burglarized, raped, and sometimes murdered victims in over 150 households. This "Golden State Killer" would famously taunt the police and his victims over the phone, apparently loving the media attention. As the attacks grew more frequent, a public information meeting was held in Sacramento. Over 500 attended, crammed into a high school gymnasium. The politicians failed to calm the crowd, and could only offer security tips and how to deal with the attacks. One man, sensing a lack of vigilance on everyone's part, announced that things would be dealt with more effectively in other countries. He blamed husbands for not fighting back and allowing their wives to be raped. Promising that he would not let him or his wife be victimized, he encouraged everyone in the crowd to do the same.

His wife became victim number 22. The Golden State Killer broke into their home and gagged the man at knifepoint while covering him with dishes from the kitchen. While his victim lay under a pile of plates, the intruder took his wife into the next room, telling him that he would regret it if he heard any dishes clattering. Many have studied the photographs taken at the meeting, hoping to identify the killer who seemed to have heard the man's promise. But the Golden State Killer appeared to drop all activity by the 1990s, and all his cases were left unsolved.

In 2018, genomic testing services exploded in popularity. On the pretense of finding their exact genetic breakdown, people would spit into a tube and send it to a laboratory that would analyze the contents. But not only were these sequencing methods far more unreliable than what the services claimed, these companies understood the value of the genetic data they were collecting. In August 2018, "23andMe" sold access to 5 million users' DNA data to GlaxoSmithKline, a large pharmaceutical company, for $300 million. 23andMe also sold $60 million worth of data to Genentech, a genetics research firm. The Federal Trade Commission opened investigations into 23andMe and Ancestry.com over privacy concerns.

But these services gave Detective Paul Holes an idea. He compared the DNA from a Golden State Killer case rape kit, to the DNA that people had uploaded on popular genomics testing services. To Holes' surprise, he found nearly twenty genetic matches in the databases. By assembling a family tree using the twenty known family members, Holes was able deduce exactly who else in the family fit the profile in age, whereabouts, and description of the Golden State Killer during the relevant period. It did not take long. Despite covering his tracks for almost half a century, 73-year-old Joseph James DeAngelo, a US Navy veteran and lifelong police officer, was arrested and convicted later that year.

No matter how many precautions you take, you are only as safe as your most curious family member.

*There are these two young fish swimming along. They happen to meet an older fish swimming the other way, who nods at them and says, "Morning, boys, how's the water?"*

*The two young fish swim on for a bit, and then eventually one of them looks over at the other and goes, "What the hell is water?"*

- David Foster Wallace
This is Water

## Privacy & Policy

*Pong & Politics*
*Tax Havens & Transparency*
*We satisfy our greed through corporate crime.*

*Zuck: Yeah so if you ever need info about anyone at Harvard*
*Zuck: Just ask*
*Zuck: I have over 4,000 emails, pictures, addresses, SNS*

*[Redacted]: what? how'd you manage that one?*

*Zuck: People just submitted it.*
*Zuck: I don't know why.*
*Zuck: They "trust me"*
*Zuck: Dumb fucks*

- Mark Zuckerberg

In 1991, attendants of the annual Special Interest Group on Computer GRAPHics and Interactive Techniques (SIGGRAPH) Conference in Las Vegas were greeted by a large black screen projection, and a handheld paddle on each seat. Each side of the paddle had a different colour, one red and one green. As people raised them, they noticed red and green dots appearing in the black projection. Soon the entire crowd was waving their paddles, watching their corresponding dots wiggle on the screen in front of them, changing from red to green if they flipped the paddle. It was neat, but nothing new.

Suddenly, the projection cut to a game of Pong. Bars on each side representing the two players began sliding up and down as the ball glided across the screen, but no one could tell what was causing it. It behaved erratically. Some people on one side noticed that their team's bar moved up faster when they turned their paddles to red. But when more and more of them turned to green, the bar would reverse and move down. Everyone quickly realized that the two colours represented directions. The sensors were calculating the ratio of red to green paddles to determine the direction and speed at which the bar traveled. The crowd erupted as everyone stood up and began shouting, trying en masse to figure out who would turn their paddles at what time, all to make sure the ball did not pass through their net.

Within seconds, hundreds of complete strangers had successfully learned to play a game of Pong with each other. They cooperated as one massive system, spontaneously making hundreds of binary decisions at once that would determine a greater outcome. There was no time for discussion or organization. This may have been the first tested model of a techno-utopian politics system, a microcosm of the reactive teamwork that responded to observed changes. With binary red/green decision-making, it was almost exactly like the most basic organism.

This is a prime example of "emergence," the complexity that arises from simplicity. Life itself is a prime example of emergence, and the nature of consciousness and life itself continues to elude us. We currently draw a flimsy line for life at "self-replicating." This requires several dead things to act and react to each other under the laws of physics in millions of unique operations to achieve the complex functions of a single cell, a self-replicating automata. Like the Pong players, cells in the body simply react to other cells in their immediate surrounds, prompting feedback loops. Those surrounding cells react, prompting their own loops with the cells immediately surrounding them, and so on through massive chains of biochemical reactions. At some level, every part of the human body works on this principle. Future neural networks will handle these hierarchies seamlessly, when learning how to perform highly skilled tasks.

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In 1996, the International Business Machines Corporation (IBM) unveiled Deep Blue, a chess computer they claimed to surpass human abilities. IBM extended a friendly challenge to world champion Garry Kasparov, the most dominant chess player in history. Over the course of six matches spanning several years, Deep Blue defeated the greatest chess player on the planet. The chess community, including Kasparov, accused IBM of cheating by manually assisting Deep Blue somehow. Kasparov and other chess experts stated that the computer made totally unorthodox moves that could not have originated from any mathematical calculation — only a human secretly intervening with the system could do so. He and many professional chess players maintain this belief to this day, despite the computer's logs from the game demonstrating a clear step-by-step sequence of how Deep Blue logically made each decision. But to Kasparov, any information outside the chess system becomes meaningless noise, leading him to draw distorted conclusions about reality. Despite his intelligence, it did not really matter what the logs said. Ultimately, chess is pure computational math, and perhaps the greatest chess player in history was saying that the math was wrong.

\Politicians suffers from the same issue. Our lawmakers were ushered into this new age of data faster than any person can be expected to handle. Like everyone else growing up before the digital age, they never had a chance to experience the zeitgeist necessary to ease into learning about how digital technology works or affects societies. Politicians occupy themselves with an influence game, a whole discipline in itself, leaving less time to deal with the new, unfamiliar yet complex issues. Humanity tends to "act first, ask questions later," because before we act, we often do not know what questions to ask. We leave ourselves no tools to combat the most pressing issues until they have already become global concerns.

The issues of the "Big Five" — Amazon, Apple, Facebook, Google, and Microsoft — extend into international government policy. In 2018, a whistleblower revealed that Cambridge Analytica Ltd, a large British political consulting firm, had been mining data from millions of Facebook users for years without their knowledge or consent, using it for targeted political advertising. The scandal brought Facebook CEO Mark Zuckerberg and Google CEO Sundar Pichai to testify in front of United States Congress. Many thought this would be our chance to make Big Tech answer for their actions.

But within minutes, it became clear that Congress had little idea what they were talking about. Many of the senators' questions were baffling. They revealed a shocking gap in the leaders' knowledge about how these systems work. They failed to comprehend how data was recorded and transmitted. They asked questions about Apple product functions to Pichai. They botched their questions on "Russian interference." They could not distinguish between silicone and silicon. Zuckerberg and Pichai could barely hold back their laughter and could only respond with exasperation. Nobody was asking the right questions, and they were not giving any answers. A few legitimate overall privacy and antitrust concerns were raised, but none were effectively pressed. Both Pichai and Zuckerberg had prepared far better than any of their opponents and successfully deflected the questioning. Immediately following the hearing, Google's and Facebook's stock prices skyrocketed.

However, a month later, Zuckerberg appeared before the European Parliament. They took a different angle. Instead of trying to get their minds around the inner functions of the Facebook service, they focused on what they knew best: Corporate law and regulation. They grilled Zuckerberg on monopoly concerns, privacy, and security breaches. He was far less confident this time, and could not provide satisfactory answers, much to the visible frustration of the legislators. When asked if the Cambridge Analytica scandal was a freak occurrence or just the tip of the iceberg, Zuckerberg chose not to comment. When asked if he would comply with European antitrust regulators, he told them he would get back to them. When asked how Facebook would deal with foreign influence on elections in the future, he assured them that his best algorithms were on the issue. Zuckerberg also refused to comment on "shadow profiles" despite being asked about them several times. At his congressional hearing, he had claimed he "didn't know what those were," and maintained his cluelessness to the European Parliament who asked him a month later.

Facebook and other tech companies open files on everyone, regardless of whether they are users or not. Shadow profiles are the identities of non-users. Facebook mines these shadow members' identities based on the information shared by users, which almost always includes contact details for friends and family who are not on the service at all. By associating with more people who also have another new bit of information about that same shadow member, Facebook's algorithms will link them all together, realizing that there is a mutual connection. Facebook then scans connections from the bits of data leftover from other people the user knows, reinforcing the shadow profile. For example, a shadow member's phone number might appear in someone else's contact list. This other person may allow the Facebook app to "access to their contacts," like most do, providing lists of names and numbers. The algorithm runs that list against previously collected data and all other shadow profiles. It might turn out that five other users had the same number in their address books, and all five work at the same office. It does not even take an algorithm at that point to tell what the shadow profile's occupation is. After taking enough small bits from countless mutual sources, the shadow profile is a complete and valuable asset representing someone who never even used or consented to the service. It does not matter if you use social media or not, as long as the people you know do.

The fact that we can quote Zuckerberg in his college years prompts the question of what future politics will look like. Political smear campaigns will dig up the past, finding unsavoury things a public figure may have once posted. Politicians' tweets today may already be too much to handle, but we can only wonder what they would have tweeted in their youth. That will be a reality soon enough. The leaders of tomorrow have social media accounts today, and what they say now will loop back to them in unexpected ways.

Because no one has time to check for themselves, free services such as *haveibeenpwned.com* can scour all known reports of corporate data breaches, letting users know if their data has been leaked in any major corporate hacks, and the circumstances that led to the leak. From my own accounts, there were two standouts in recent years:

Adobe: *In October 2013, 153 million Adobe accounts were breached with each containing an internal ID, username, email, encrypted password and a password hint in plain text. The password cryptography was poorly done and many were quickly resolved back to plain text. The unencrypted hints also disclosed much about the passwords adding further to the risk that hundreds of millions of Adobe customers already faced.*

Compromised data: Email addresses, Password hints, Passwords, Usernames

Dropbox: *In mid-2012, Dropbox suffered a data breach which exposed the stored credentials of tens of millions of their customers. In August 2016, they forced password resets for customers they believed may be at risk. A large volume of data totalling over 68 million records was subsequently traded online and included email addresses and salted hashes of passwords*

Compromised data: Email addresses, Passwords

If you share any passwords across accounts, the first thing abusers of hacked data do is run the password from one account to all known accounts with your email registered, which is not difficult to find. Bots can register in mass volumes, knowing if your email already has an account on any given service. Any single compromise means every one of those accounts and any of the information they might hold (credit card info, personal addresses, license info, passport info) are compromised. And of course, it does not matter whether you actually use any social media, as long as someone you know does.

## Tax Havens

In 2017, President Donald Trump cut the corporate tax rate from 35 to 21 percent, and raised the limits on how much corporations could expense. For the 2018 fiscal year, Amazon paid no Federal corporate income tax at all. On paper they reported an operating deficit of $627 million, carrying over losses from decades earlier. This allowed for several extra write-offs. They were even able to use their own stock bonuses as write-offs. They offer stock options at fixed prices. If the stock rises, they are able to write off the difference as if they did not earn any net revenue. Their write-offs on their own executive bonuses totaled over $1.1 billion in 2018. “Corporations are literally going wild over this, I think beyond my expectations.” Trump stated before signing the bill.

Amazon is at the forefront of automation, with warehouses full of robots and a drone fleet on the horizon. While their employees paid a third of their income in taxes, Amazon only paid 3 percent of its own income in local and state taxes. If robots are taking jobs away from the economy, they should pay taxes like the people they are replacing the livelihoods of. An automation tax, data collection tax, or a tech value-added tax would force companies to compensate the economy for the labour it is removing.

The first thing any big tech company does when it manages its books is to look for all the ways to bend the rules to reduce taxes. It turns to places like Panama, Singapore, Malta, Bermuda, and Cyprus, where the corporation can push the boundaries of international legality. Corporate taxes, tax evasion, and drug money get mixed together and laundered with legal money, becoming indistinguishable from each other. We as citizens are partially responsible for legitimizing this behaviour. When household name corporations like Microsoft, Google or Apple are caught having offshore assets, and yet neither their public image or stock prices change because of it, that indicates a much deeper systemic issue about our attitude as a society. There are over 100 million Amazon Prime subscribers and counting. In 2018, founder, CEO, and President Jeff Bezos became the richest man in the world with a net worth well over $100 billion.

The release of the Panama and Paradise Papers, which exposed offshore accounts for many celebrities, politicians, and companies alike, prompted many investigations, but have yet to make a large impact. This is no different from simony. Whether it's the church of capitalism or Catholicism, your sins are forgiven as long as you have the money to pay for them. In 2000, Google's corporate code of conduct declared "don't be evil" as one of their core principles. In 2015, it was removed.

It is no secret that Ayn Rand's philosophy was highly influential during Silicon Valley's growth. But in a pure libertarian techno-utopia, democracy does not exist. As long as we are citizens under modern consumption, we will act according to our lifestyle and demographic, becoming continual sources of data. The embodiment of a person is an asset that produces securitizable actions, which can be converted to knowledge to be traded along with other investments, eventually winding up as new debt and derivatives.

As the definition of personal data is rapidly expanding and becoming more tangible, we need to declare it a human right of property. People should be owners of their actions and therefore benefit from them. Tracking, neural networks, and big data all have tremendous potential to improve our societies. But with the current asymmetric economic model, an equitable infrastructure is impossible, when the inner workings of our systems only cater towards a small percentage of the elite. A data collection tax on tech companies would at least distribute some returns of the pie back to the people. If information presents an economic opportunity, there should be economic compensation for the citizens giving up that data. We are all shareholders of a country-wide corporation, should we not declare ourselves a dividend?

*Instead of tending towards a vast Alexandrian library the world has become a computer, an electronic brain, exactly as an infantile piece of science fiction. And as our senses have gone outside us, Big Brother goes inside. So, unless aware of this dynamic, we shall at once move into a phase of panic terrors, exactly befitting a small world of tribal drums, total interdependence, and superimposed co-existence.*

- Marshall McLuhan
The Gutenberg Galaxy, 1962

## Smart Cities & The Singularity

*Big Tech on the Bayfront*
*Computers & Columbite*
*Zuckerberg & Zoning*
*We give birth to Big Brother by getting in bed with Big Tech.*

*Data is not the new oil. It's the new plutonium. Amazingly powerful, dangerous when it spreads, difficult to clean up, and with serious consequences for people when improperly used*

- Jim Balsillie

The year was 1968. Plans of the Apollo 11 mission promised to put a man on the moon. Fuller was telling audiences that they were astronauts, Engelbart was selling his vision of the internet, and 2001: A Space Odyssey had just been released in Cinerama. At the same time, a married couple of industrial designers named Charles and Ray Eames wrote, directed, and released a short film called "Powers of Ten". It began with a shot of one square meter of ground area filmed from 1 meter away. From this initial cubic meter, the camera pulled out in a cosmic zoom of scale where visual markers for every power of 10 were traced on the screen. From a picnic, to a park, to a block, to a city, to a country, to the Earth, to the Solar System, to the Milky Way Galaxy, to the Local Group at 1:10^24, the film stops and reverses, as zooming out to the Laniakea Supercluster would take too long. Even the Laniakea Supercluster is still only about 0.00000000001% of the observable universe. The camera zooms rapidly back down to Earth, into a person, their cells, their DNA, the molecules, the atoms, all the way to the quarks within, at the scale of 1:10^-16. The film inspired many others who envisioned a future where computer processing power could bridge these scales together.

Some of these dreamers were the software engineers at Intrinsic Graphics led by John Hanke. In the early 1990s, they designed a rough virtual model of the Earth that could be zoomed into at different scales of detail like Eames' film. Seeing potential for groundbreaking applications, he created a new company called Keyhole Inc. to handle the development. Over the next few years, they added capabilities as computing power increased. But in 2003, Keyhole announced that they had been bought out by the search engine company Google, who would develop the software into their own applications. We now know them as Google Earth and Google Maps.

The act of using Google's applications is Google's production. It is seemingly free only because you do not pay in dollars. The data generates revenue on the other end through rentals. We are the products. We still use old terms as analogies for physical production, like "supply chain". But in the digital technology era, it is a far cry from Ford's days. What is Google's supply chain but a series of algorithms, that when interacted with by massive amounts of people, produce enormously valuable assets?

When it comes how to big technology companies pull off their illusions, one can look towards the craft of a showman such as a magician. Magicians use pageantry, humour, and misdirection to throw the audience off guard. They will often draw attention to one particular part of the stage, or a particular object in their hand, to keep the audience's eyes distracted. When a magician says to "look here", the truth can be spotted by looking elsewhere, as one might spot the assistant crawling through the trap door.

Google Street View is one of the most innovative features of their Earth and Maps service. Full 360 spherical views of built spaces on earth required Google to roll out hundreds of vehicles with photography systems to survey the streets. The system uses twenty cameras capturing 360 images of every street by mounting the lenses onto the top of their cars that drove everywhere. This was widely advertised as a flex of power from Google about their technological might.

As the 360 cameras displayed 8 feet up for everyone to see, they naturally drew the focus of everyone who looked at them. But by doing this, they had diverted everyone's attention away from other functions, exactly like a stage magician. The cars were actually outfitted with equipment that picked up open WiFi signals, accessing and downloading any and all unencrypted data and feeding it back to Google. As they passed by countless homes, businesses, and institutions, the cars reached into their wifi networks as they passed, downloading whatever it could access and sending it back to Google. As people watched them do this, no one batted an eye. They had been hiding in plain sight, making sure that people were looking, but not in the right way. Upon discovery of this incredibly invasive privacy violation in 2012, Google was promptly placed under investigation by the FCC, who published a report.

The purpose of Google's Wi-Fi data collection initiative was to capture information about Wi-Fi networks that the company could use to help establish users' locations and provide location-based services. But Google also collected 'payload' data – the content of internet communications – that was not needed for its location database project. This payload data included e-mail and text messages, passwords, internet usage history, and other highly sensitive personal information.

The Supreme Court ruled that wiretapping laws applied to home Wi-Fi networks. If the impending lawsuits went to trial and Google lost, they would have been fined many thousands of dollars for each of the millions of homes it collected data from, totalling in several billions. However, their legal team managed to appeal and settle for a promise to delete the data and pay a grand total fine of $13 million, a drop in the bucket compared to what they have generated for themselves from data. We still continue to use Google Maps, Earth, and Street View extensively because they are incredibly useful, so we have little motivation to fight these tactics. Our response has been complacency and compliance. So Google has decided to take it to the next level. Instead of taking data from other peoples property, what if Google just owned the property outright?

> *You go back to '76, about 16% of the value of the S&P was intangibles. Now it is about 87% is intangibles. Taxis are now a tech business. Hotels the same. Architecture and real estate are tech businesses. So is retail, energy, mining, and even agriculture.*
>
> - Jim Balsillie

## Sidewalk Labs

Sidewalk Labs was founded by the Alphabet Inc. conglomerate in June 2015. While most parent corporations are the forerunners for their subsidiaries, Google founded Alphabet to manage itself. Headed by Dan Doctoroff, former deputy mayor of New York City for economic development and CEO of Bloomberg, Sidewalk Labs announced plans to test design ideas prior to real world implementation in a major metropolitan city yet to be determined. In early 2017, the Board of Waterfront Toronto launched a request for proposals for quayside for design proposals and funding for a project focusing on sustainability, complete communities, and economic prosperity. The site was 12 acres in the East Bayfront, and Sidewalk Labs won the bid the following October, promising to tackle affordable housing for complete communities and the climate crisis.

Upon the results of the proposal, Dan Doctoroff bluntly admitted, "We're in this to make money" but stated that it was a mutually beneficial move for the city and its citizens futures. He promised that Sidewalks Toronto would be the world's first "smart neighbourhood", which would bring affordable housing as low as 40% below market price to a housing crisis-ridden Toronto, while being mixed income and sustainable. He claimed that newer timber techniques would also cut 20% of construction costs while stimulating the Canadian lumber industry and providing thousands of jobs to take advantage of natural resources. However, as much focus as he put on the real estate and sustainability angles, not much if anything was said about intellectual property and data ownership. In August 2018, Julie Di Lorenzo resigned from the Waterfront Toronto board, stating that Sidewalk Labs had been consistently self-interested throughout the process and dominated control with political influence and money. "I do not believe it was the intention of the three levels of government to allow a single limited company to become our filter, our gatekeeper, and our agent." she said.

The vision was ambitious. In bright, playful vignettes, cyclists and pedestrians moved freely in open spaces filled with lush greenery and self-driving cars. Data collecting sensors and cameras were stuffed in every nook and cranny, from sewer drains, lampposts, garbage cans, fences, benches, and in the ground. The timber construction was modular, using prefabricated sub-components on fixed "stoas", wooden platforms that could slide into buildings and create floors. Supported by large glulam posts spaced 12 to 18 metres apart, these spaces turned the building into flexible convention centre-style rooms. This would cut down on renovation costs. Renderings showed that timber would support outdoor "raincoats", sheltering inhabitants from precipitation. Combined with the addition of heated pavers, this encouraged being outside as a pedestrian, even in the winter.

By September 2018, the project had generated concern from the public. Jim Balsillie, former CEO and founder of Research in Motion (RIM)/Blackberry, stepped out of retirement to campaign against data and intellectual property exploitation from an economic standpoint. Patents in Canada are suffering more with their policies in the context of the United-States-Mexico-Canada Agreement (USMCA), as the US has extended protection over patents, which only further fuels

a constant brain drain of our best talents moving south of the border for bigger paycheques in places like Wall Street or Silicon Valley. He blamed uneducated governments as the problem, as they were accustomed to dealing with a goods based economy rather than an ideas-based one, and were unaware of just how important intellectual property was to securing an economic future where the assets themselves were constantly fluctuating in nature and value over time.

In October, Sidewalk Labs proposed a civic data trust, the first of its kind in history, which would pool all collected data in the smart cities and intellectual property into a secure repository to be fully controlled as the local jurisdiction permitted. Cities could elect to rent out specific aspects of their data to interested corporations, such as de-identified aggregate statistics on movement patterns and spending patterns, but leaving more personal and specific data out of the question. However, the lead consultant for the program, Ann Cavoukian, resigned only a week later due to a lack of promise from Sidewalk Labs that they would guarantee de-identification at source, as data is far less value when it cannot be attributed to a person in order to build a model. "They said they'd 'encourage' other members of the trust to de-identify their data," she stated. Sidewalk Labs released a proposal for a visual icon system that would ensure that users in these smart spaces knew exactly what about them was being tracked and recorded while they were in the neighbourhood. One could see if they were identified in the data, and what the nature of that was, whether it be sound, imagery, videos, movements, or mobile purchases.

By February 2019, amidst the controversy with the Toronto light rail transit system and its delays, Doctoroff stated that Sidewalk Labs would pull out of Toronto if it were cut short. They were willing to inject $100 million into the LRT project. The original 12-acre scope of the project confined to the Waterfront area was actually part of a much larger proposal for the surrounding 190-acre plot around the Lower Don Lands called the "IDEA District." Sidewalk Labs suggested that the entire 350 acres of Toronto's Port Lands on the eastern waterfront would later be developed as an "extended innovation district."

> *If you think that autonomous vehicles might be an answer to some of the transportation woes that we have here over time, and you believe that this could be an interesting opportunity to experiment with the impact of self-driving cars, it's never been realistic to assume that you could do that on 12 acres. If you believe that wood buildings, which is something we're interested in, can actually be part of the answer to lowering the cost of housing so we can actually have mixed-income communities in this city, we believe that at scale you can lower the cost of housing by 20 percent or so by factory produced but incredibly creatively designed buildings. You can't build a factory and get to the scale to reduce those costs on 12 acres. And everyone's always known that. Our agreement with waterfront Toronto acknowledged that scale was going to be important.*
>
> - Dan Doctoroff

In their 1500 page master plan called "Toronto Tomorrow: A New Approach for Inclusive Growth," Sidewalk Labs promised to spend $1.3 billion on the neighbourhood, creating 44,000 direct jobs, $4.3 billion in tax revenue, and 14.2 billion in annual GDP by 2040. Many critics did not believe the exposed timber would be ideal for Toronto's climate and dismissed the claims surrounding affordable housing. Only 5% of the housing was promised to be "deeply affordable," with the majority still being completely unaffordable for income in the city. "Even if Sidewalk's second tier of affordability is nearly on par with the market, these homes are wildly overpriced compared to Canadian wages," stated Jennifer Keesmaat.

But others felt that Sidewalk Labs was Toronto's chance to fulfill its inferiority complex among North American cities and compete on a global scale more convincingly. These people saw the privacy concerns as a lesser of two evils, as people had already complacently welcomed most of these technologies into their lives through their smartphones. The city would be kicking itself if it gave up the opportunity. But many responded to this sentiment stating that Toronto being desperate for attention and maintaining its real estate value made it the perfect easy target for Google to walk over.

In July 2019, several Twitter bots were caught spamming misinformed tweets about Sidewalk Labs security and data protection systems and their benefits to the City of Toronto. Sidewalk Labs' associate director of communications denied any involvement with the company. They were extremely unsophisticated bots after all.

Waterfront Toronto's schedule gave them 25 years to develop the site. As of August 2019, Sidewalk Labs, the city, and the Federal government have agreed to negotiate a deal by the end of October. If an agreement cannot be settled for data, privacy, property rights, and the LRT line, Google could be packing their bags, leaving Toronto either sorry it missed out, or glad it dodged a bullet.

> *True innovation takes into account context- it's how things are and how people are. There's a kind of manifest destiny to Google's plans. Such a monolithic district, on such a massive piece of land, could disrupt Waterfront's efforts to create a fluid public space.*
>
> - Bruce Kuwabara

## Where Smart Cities Are Made

A UN report estimated that coltan mining causes more significant problems than blood diamonds. Even though over half of the world's coltan reserves are estimated to be in the Congo, equivalent to about $24 trillion at the current price, it is estimated that Central Africa as a whole only receives an estimated 9% of the global assets per year.

Tantalum is fungible, indistinguishable when smelted. After its first phase of processing, tracing or verifying its origins is impossible. Even diamonds lack this property. Unethical tantalum is mostly smuggled east towards Asian electronics manufacturing, where it is turned into tantalum powder for phones, tablets, laptops, servers, and every other device using transistors and semiconductors. These components travel domestically and internationally to be installed in consumer electronic goods without anyone having any idea where the supply comes from. In 2017, 65% of global coltan production worldwide was from Rwanda and the Congo, but because of the lack of local law enforcement, no one knows exactly how much has been smuggled out.

When one hears the phrase "conflict minerals", our minds jump to blood diamonds. Blood diamonds are an easy target to vilify. The De Beers estate monopolized them, manipulating the market price through artificial scarcity. The public has little to lose from damaging the industry. We can synthesize diamonds to a higher quality than nature is able to achieve, making mined diamonds a question of cognitive dissonance. But coltan is far more prevalent in our society, yet it is unfamiliar to most people. It is the blood of all our most important physical devices right now. It creates immense value for both users and corporations, making it much easier to turn a blind eye to unethical coltan. Not everyone owns diamonds, but nearly every one of us owns a smartphone or a laptop. Most of us have no idea what is inside our phone, or have ever heard of coltan at all.

Smart cities and our devices are more than the intangible data that goes into them. Like everything else in cyberspace, the infrastructure must somehow manifest itself physically. Computers need physical logic gates in order to perform calculations, hence integrated circuits. These need conductive mediums to transfer energy. Some of these materials, like silicon and copper, are well known to the public, but others are conveniently ignored, despite the events surrounding them. The conflict over resources in the Congo shows no sign of stopping, despite numerous political reforms and elections. The United States tried to pass legislation in 2010 through the Dodd Frank act to prevent conflict minerals from funding armed militias, which forces corporations to declare the presence of known conflict minerals in their products and actively avoid them. But the complex supply chain in the local mineral business makes tracking sources difficult.

In 2017, it became known that Apple had been sourcing coltan from self-proclaimed "artisanal mines" in the Congo which used child labour under slave conditions. Investigations found children as young as 4 years-old, breathing toxic fumes without protection, only to be paid a few cents for a day's labour. Apple

promised that it would look into the issue. Later that year, President Donald Trump announced he would be looking to remove Section 1502 from the Dodd-Frank Act, which mandates that all American corporations must vigilantly avoid unethical coltan and other smuggled minerals in their supply chains. In official documents submitted to the SEC after corporations were given three years after the act was passed to publish reports, only about 1% of the companies declared their products to be conflict-free beyond reasonable doubt. 19% declared they did not believe their products contained DRC conflict minerals, but could not be sure. The remaining 80% stated that that among the thousands of possible locations where materials are sources, they could not be sure of their raw materials' origin. It is impossible to determine what percentage of the coltan in any of our electronic devices was mined unethically. We cannot know how tainted their own devices are. But the Daemon knows.

## Unrecognized Data

Concerns arise when authorities hold too much data on citizens, but a lack of recorded data can be equally problematic. In 2014, Mark Zuckerberg, the 8th richest person alive, paid $100 million for a former sugar plantation property and a neighboring beach in Kauai, Hawaii, intending to build a personal getaway resort there. Hawaii's unique land ownership laws dictate that land is passed down through bloodlines with joint tenancy, in line with Indigenous Hawaiian tradition. Culturally and legally, this inheritance is implicit, and therefore often lacks the necessary paper trail to document precise ownership rights, or to even document ownership at all.

Unfortunately, this reliance on good will and its lack of data representation clashed with capitalist land laws that have been implemented since Americans overthrew the Hawaiian Kingdom in 1893. Because the traditional Hawaiian view on land tenure is entirely different from the private capitalist principles managing it, sacred lands on the islands were incredibly fragmented in the government records. With entire family trees passing down individual tracts shared among children through multiple generations, not all of these changes in ownership make it to the deed registries, making it difficult to determine exactly who owns what land.

Today, the Hawaiian government attempts to merge this intangible ancestral system with the Western capitalist one. In Hawaii, when you own land in joint tenancy, you can use the land as would a full owner. It is akin to being a shareholder in the entire tract. If someone who owns a majority share sells their share, it does not affect the rights of the other partial owners. However, in order to get full use of the land, the buyer either needs to buy the tracts outright or request a partition. A partition is a judicial action in which a court attempts to officially divide up the land into tracts that represent the percentage ownership of each owner. However, if that is deemed impractical or inefficient, or if any of the owners lack all the documents that prove ownership, the court instead orders a sale of the entire plot, where each owner will get a proportional percentage of the total sales price.

Zuckerberg created a shell corporation, posing as a small local farming company producing the Hawaiian staple crop, kalo. Under the disguise of "Northshore Kalo LLC," he deceived several landowners into selling him their land to support a local homegrown business. After purchasing enough tracts of land to gain enough leverage, Zuckerberg filed lawsuits against the remaining Native Hawaiians over their land, intending to force a sale and buy the remaining tracts outright for his personal haven. The government sees "unused" land as wasted economic opportunity. If a potential buyer like Zuckerberg is willing to pay a large amount for private land, they can abuse a policy called "Quiet Title". The paperwork necessary to determine ownership across the land was declared to be too costly to process due to the many generations of undocumented owners that would have to be accounted for, so the land then defaulted to a forced auction where all the owners who desired to have a stake had to bid for the land, in this case against Zuckerberg himself. If they could not outbid the billionaire, they would be on the hook to pay his legal fees as well, in order to accept their compensation. To avoid this, the only other option was to sell their land through an auction among owners.

Native Hawaiians were forced to sell their tracts of land to him for sums as small as $400 apiece to avoid the legal complications. Once he had more than half of the land, he erected a solid stone wall around the 700-acre property and began developing a private beach resort despite the protests of many owners who had still not sold out and still held legal ownership of the land within the walls.

## A Daemonstration

*Blockchain & Bitcoin;*
*From the ashes of a fire sale, a new religion is born.*

*The Times 03/Jan/2009*

*Chancellor on brink of second bailout for banks.*

- Opening sequence of Bitcoin by Satoshi Nakamoto,
translated to English from SHA-256 hash

While the American economy was busy imploding, and scrambling towards old ideas about money, new ideas about money were emerging from the other side of the world. In October 2008, after that year's fall of Wall Street, subscribers to an unassuming cryptography mailing list on metzdowd.com received a white paper by Satoshi Nakamoto called "Bitcoin: A Peer-to-Peer Electronic Cash System". Nakamoto laments the world's reliance on institutionally controlled currencies, stating that trust-based models are too insecure, slow, and expensive to operate safely. Too many rent-seekers take a slice of the pie without actually contributing to economic wealth themselves.

Fractional-reserve banking systems of the Western world have citizens deposit their money in banks, who make use of the unspent money by lending it out to businesses. However, to stimulate the economy, these banks lend out tens of times the amount they were given, while charging interest for the full amount. Banks make tremendous profit from money they do not even have. In Canada, there is no fractional reserve requirement, meaning banks do not even require 1/10th of the funds. They can still collect interest "lending" millions when their own pockets are empty. Despising this on principle, Nakamoto details a solution through a digital exchange ledger system called a "blockchain", complete with a digital currency called "Bitcoin."

Bitcoin is distributed virtually akin to a central bank, but instead of being whisked out of thin air by an elite few, it must be "mined" by contributing the energy required to compute all the transactions users of the currency conduct. Because the miners are compensated for their services in new Bitcoin, they do not need to take a slice from the people conducting transactions, the way typical financial institutions charge interest and fees just for passing money along. Bitcoin's blockchain ledger is decentralized, with no governing body controlling it. It only bows to mathematics. Bitcoin is structured as a blockchain, an encrypted ledger constantly updated across the devices of all participating parties. This ensures that there is always a clear consensus on the checks and balances on record, with no room for discrepancies or disputes. It is backed up many times over on everyone's devices, making it more secure from erasure or tampering.

Hash algorithms, the backbone of modern encryption, are cryptographic functions that take data of any type and size and map it into one single output of a fixed size. These outputs are known as *hashes*, and typically appear in the form of a long string of seemingly randomized characters. Any form of digital information including essays, photographs, videos, and music of all file types and sizes can each be "hashed" to produce consistently sized values for every input used. A 100 gigabyte video becomes indistinguishable from a page of text. Once hashed, both appear as equal length strings of randomized characters. The deterministic nature of algorithms mean that the hash for any particular input is entirely unique to that input. The algorithm will always correspond to the given source data. If even a single letter, pixel, or bit of metadata is changed in the input file, the hash function will produce an entirely different output. It is essentially a clockwork universe of its own, with its own set of all-governing principles. Given perfect

knowledge of the state of the code, it is entirely predictable backwards in time. Blockchains create a sequence of calculations based on reversible principles that could theoretically be alternately re-encrypted with enough computing power, therefore energy, but would be unrealistic in practice.

Hashing can also be performed on outputs of other hashes, repeating many times as desired. The hash algorithm that Satoshi Nakamoto wrote for Bitcoin, SHA-256, is used for verification of transactions and their encryption. If you burn a piece of paper with notes on it, a machine could potentially analyze every atom of the smoke it produces, and determine what was on the page. The information is still there, only hidden behind an intense logical process. This is similar to a blockchain. Anyone not authorized to access said content will never be able to, given they have no information on how to interpret the smoke particles. With virtual currencies based on cryptographic proof, without the need to trust a third party middleman — money is handled only by those with investment in the transaction. The idea of a trustless, yet secure system, is one of Bitcoin and blockchain's greatest properties.

> *The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust. Banks must be trusted to hold our money and transfer it electronically, but they lend it out in waves of credit bubbles with barely a fraction in reserve. We have to trust them with our privacy, trust them not to let identity thieves drain our accounts.*
>
> -Satoshi Nakamoto

When using the blockchain structure for a cryptocurrency, its mining process is not entirely unlike physically mining natural resources. The source code dictates for Bitcoin to have a total of 21 million coins that are virtually "buried" in the future transactions that users will make. In order to unearth the coins, a miner must virtually dig by solving enough hash algorithms to figure out what the next coin's hash is. These calculations can be performed by hand with a pencil and paper. It takes about 15 minutes to calculate a single round, making it about hundreds of quadrillion times less energy efficient than current mining hardware. Once the correct hash value is discovered, fitting correctly to the end of the chain, it means the coins have been deposited into the miners' virtual "wallets."

However, the amount of hashes needed to be solved in order to mine one Bitcoin always adapts to the computing speed of the miners. Bitcoin is coded to allow one coin to be mined every ten minutes, no matter how many miners are connected and how fast they are mining. The program will keep throwing hash problems at the miners until ten minutes passes, by which point the miners must show the proof of work for all the problems solved in that time in order to get paid a share of the prize. Miners must constantly invest in increasingly powerful mining equipment as time goes on in order to compete with other miners trying to solve more hashes than them. Any miner continuing to use the same equipment will earn less and less over time, as faster miners will be able to prove a larger

share of the work and therefore take a larger share of the spoils. Stagnant miners will find themselves making mere "satoshis", the base unit for the currency, which is only worth one hundred millionth of a Bitcoin (0.00000001 BTC.) Once all 21 million coins are solved for and mined out, there will be none left to mine, and everyone will need to get it from someone else, just like precious metals.

This ten minute rule also ensures that the security of the ledger is reinforced constantly. By driving competition for a bigger share of the coin, miners are being incentivized to encrypt the ledger with more computing power over time, theoretically future-proofing the system as it constantly adapts. Even when applied quantum computing arrives and is able to harness Shor's algorithm to crack all our current cryptography methods, Bitcoin will have its own army of quantum computers. There is always a direct correlation between the amount of energy expended and the verified coins on the ledger. Encryption itself costs energy, so why not use that energy to define the entire currency? We have come a long way from using the physical mass of resources like gold and silver to represent our currency. We moved on to using virtual debt, recorded digitally by banks. Could our universe's currency be harnessed in our next phase?

The transactions on the chain between people using the currency are putting the mining problems "into the ground" for the miners to unearth. Miners spend the energy to process any given bank transfer by mining. This takes care of the energy and computation that is currently paid by the end user to the institution making their exchange. This cycle is what keeps the currency alive. If fewer people use the currency, then it would be worth less, and there would be fewer transactions, making it easier to mine coins. However, the more people who begin participating in the transactions and use the currency, the more the currency would theoretically be worth, creating more transactions on the chain and therefore making it harder to mine. Governed by the laws of its own math, it needs no central bank to set interest rates. It uses energy, the currency of the cosmos. Governments do not like citizens using currencies they cannot control the supply of.

> *Proof-of-work has the nice property that it can be relayed through untrusted middlemen. We don't have to worry about a chain of custody of communication. It doesn't matter who tells you the chain, the proof-of-work speaks for itself.*
>
> - Satoshi Nakamoto

Every single action taken with the currency, whether it be buying, selling, exchanging, withdrawing, or mining, is verified and updated across all the copies on everyone's devices. Information is added to the ledger as hashes in a single file, creating one long chain with all other previous transactions from the beginning. However, before it is added, it goes through several other hash functions, this time combined with the previous hashes in the chain. The idea of using the existing hashes in the chain to calculate the next one is what reinforces blockchain over time. Again, due to algorithmic determinism, this means that not even a single "1" in the entire chain, from the beginning of its existence to the latest transactions, can be altered to a "0" without changing the way the rest of the chain is calculated.

Because the chain is backed up on all participating computers, any false entries would automatically be rejected by the majority of the copies that create a consensus. Because thousands and thousands of powerful computers are working together to expand the chain constantly, hacking it would require more computational power than everyone else connected combined, making it theoretically possible but practically unfeasible. The unbroken single file chain is scrambled in sequence as transactions are added, making it nearly impossible to match specific transactions without an immense amount of known data about the previous movements of the transactions. The unbroken code makes it unclear where one transaction begins or ends, and the logarithmic encryption ensures that the hash is indistinguishable from the rest of the chain.

Even if one manages to identify transactions to target, in order to tamper with a record in the blockchain, one must be able to recalculate the entire string of hashes to match the existing chain from the point where the change is made. Alternatively, one could hack into the majority of the participants' machines all at once and overwrite the chain with their own version, while outpacing the mining speed of all the connected miners combined. This process would essentially rewrite the checks and balances of the entire ledger temporarily. Currently, there is no known method to bypass either of these nearly impossible barriers because of immense time and energy costs. It has made the system incredibly robust and secure.

As of September 2019, no one has been able to conceive of a feasible way to hack Bitcoin. Instead, crackers have gone after individual exchanges and investors, who make careless human mistakes and take poor security measures to protect their funds. Crackers were easily able to exploit inexperienced companies who had poor coding, but in many cases people were simply scammed into sending Bitcoin and other cryptocurrencies through various methods, such as under the pretense of a rebate or promotion. A sucker is born every minute. Decentralization gives some users more control over their own money than is good for them. There is no extra layer of reversibility or insurance.

Any blockchain functions as its own universe, a closed system in which the properties and movements of every single building block are known and theoretically trackable, in line with the governing principles of Newtonian mechanics. It is its own micro-verse that not only Laplace's Daemon can access, but people as well. We can ask this mathematical daemon questions, and it must always answer truthfully. However, we must ask the right questions in order to get the answers we are looking for. Figuring out what others ask, without being told, is incredibly difficult for crackers.

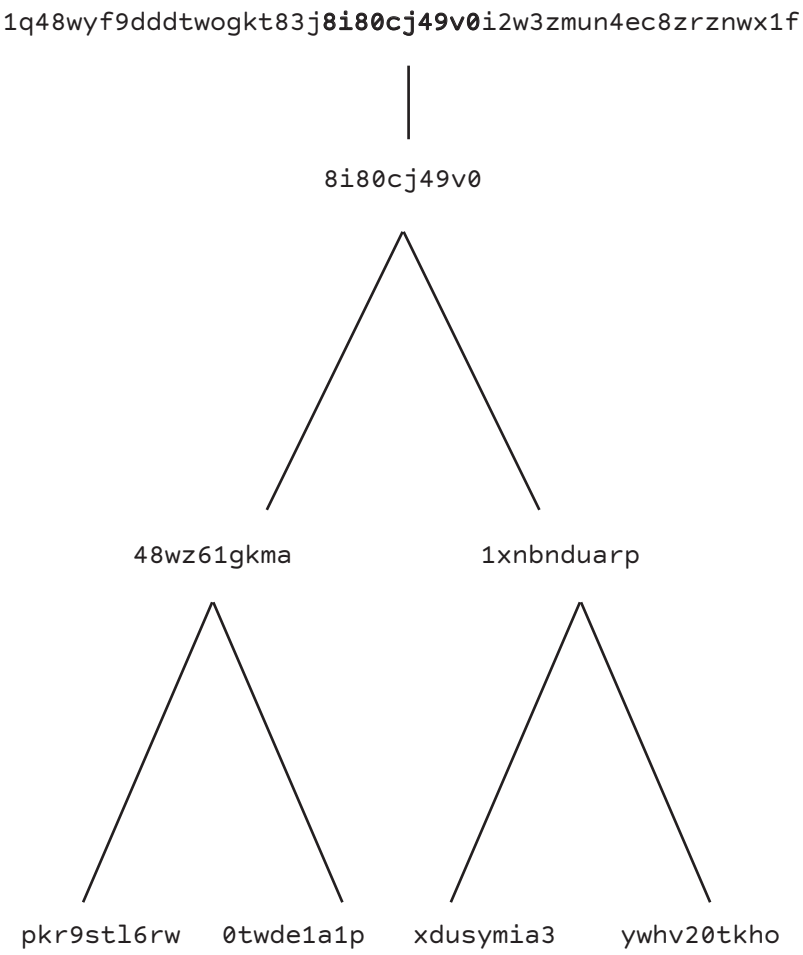
## Format

Blockchains are not tied inherently to Bitcoin, even though Bitcoin relies on a blockchain structure. This structure has applications in nearly anything involving data, encapsulating more of our world as time goes on. Blockchains have proven incredibly useful for encrypting ledgers of any kind, outside of currency or even finance altogether. Cryptocurrency has been used to help the economies of struggling places with cheaper power. American rapper Akon began his own community in Senegal, founding his own cryptocurrency called "Akoin" to be the heart of its economic system. It is even picking up momentum in the arts industries, where musicians and photographers can distribute and copyright their work safely. Musician Imogen Heap is developing a blockchain platform for musicians to distribute and copyright their work without need for record labels. Accounting, stock trading and investment banking, identity and passports, driving registration, smart appliances, any databases one can think of. No matter the information, whether it is contracts, music, videos, or code, they can all be hashed to emerge as unique equals.

A blockchain is represented in characters that define and encrypt the information within.

```
ymu6olbacjjaj90v9c9p566do6rhkw0ql53balvu4fr0dlfqz7a
jsxry4lvte2v9t7gawy3jknc72vg9pf8u09irepx1hz1mmgk
boncoohm3mi80cjcuffd1ihx5njlc8gzoqea1pkzze0le8beez6
097gkmka1afhyrcwt7h2pi6q6rooyqmw2lc8zrznwxxdmia3tl
6ruw3yq6434q4i06k6ql53ii1rz2cgqzrv6ozjj1iratbecnc
8in649v0if6thrv6ozjj1iratbecnc8in649v0if6thyghz1x
nbngwbwde5xoa1pkzze0le8beez6097gkmka1afhyrcwt7h
2pi6q6rooyqmw2lluarepx1q48wyf9dddtwogkt8taf8m47voepi
2w3zmun4ec8zrznwxxdmia3tl6ruw3yq6434q4i06k6ql53ii1rz2
cgqzrv6ozjj1iratbecnc8in649v0if6thyghz1xnbngwbw
de5xon6fuu1f8jpkr9szo74w1pf4wkvhl0eusmywhv237cjnw
```

These hashes are organized using "Merkle trees," which set up the hashes in fractal trees to enable quick verification without having to sift through massive amounts of data. If a main root hash is verified, then the system can assume that all the branching roots from that hash are verified because they would produce a different output otherwise.



Using the American Standard Code for Information Interchange (ASCII), characters are broken down into designated hexadecimal values under a standardized cryptographic process.

```
79 6d 75 36 6f 6c 62 61 63 6a 6a 61 6a 39 30 76 39 63
39 70 35 36 36 64 6f 36 72 68 6b 77 30 71 6c 35 33 62
61 6c 76 75 34 66 72 30 64 6c 66 71 7a 37 61 6a 73 78
72 79 34 6c 76 74 65 32 76 39 74 37 67 61 77 79 33 6a
6b 6e 63 37 32 76 67 39 70 66 38 75 30 39 69 72 65 70
78 31 71 34 38 77 79 66 39 64 64 64 74 77 6f 67 6b 74
38 74 61 66 38 6d 34 37 76 6f 65 70 69 32 77 33 7a 6d
75 6e 34 65 63 38 7a 72 7a 6e 77 78 78 64 6d 69 61 33
74 6c 36 72 75 77 33 79 71 36 34 33 34 71 34 69 30 36
6b 36 71 6c 35 33 69 69 31 72 7a 32 63 67 71 7a 72 76
36 6f 7a 6a 6a 31 69 72 61 74 62 65 63 6e 63 38 69 6e
36 34 39 76 30 69 66 36 74 68 79 67 68 7a 31 6d 6d 67
6b 62 6f 6e 63 6f 6f 68 6d 33 6d 69 38 30 63 6a 63 75
66 66 64 31 69 68 78 35 6e 6a 6c 63 38 67 7a 6f 71 65
61 31 70 6b 7a 7a 65 30 6c 65 38 62 65 65 7a 36 30 39
37 67 6b 6d 6b 61 31 61 66 68 79 72 63 77 74 37 68 32
70 69 36 71 36 72 6f 6f 79 71 6d 77 32 6c 6c 75 61 78
6e 62 6e 67 77 62 77 64 65 35 78 6f 6e 36 66 75 75 31
66 38 6a 70 6b 72 39 73 7a 6f 37 34 77 31 70 66 34 77
6b 76 68 6c 30 65 75 73 6d 79 77 68 76 32 33 37 63 6a
6e 77 33 77 33 37 78 31 74 35 38 73 62 64 6e 74 30 38
32 6c 65 6a 37 37 6f 76 66 30 74 77 64 65 31 69 69 6a
33 30 74 6b 68 6f 77 64 74 63 30 77 64 75 6a 32 63 69
6d 68 32 6e 63 37 32 76 67 39 70 66 38 75 30 39 69 72
65 70 78 31 71 34 38 77 79 66 39 64 64 64 74 77 6f 67
6b 74 38 74 61 66 38 6d 34 37 76 6f 65 70 69 32 77 33
7a 6d 75 6e 34 65 63 38 7a 72 7a 6e 77 78 78 64 6d 69
61 33 74 6c 36 72 75 77 33 79 71 36 34 33 34 71 34 69
30 36 6b 36 71 6c 35 33 69 69 31 72 7a 32 63 67 71 7a
72 76 36 6f 7a 6a 6a 31 69 72 61 74 62 65 63 6e 63 38
69 6e 36 34 39 76 30 69 66 36 74 68 79 67 68 7a 31 6d
6d 67 6b 62 6f 6e 63 6f 6f 68 6d 33 6d 69 38 38 73 79
```

These values then have corresponding standardized binary values, all of which are spread across the network to all the connected computers, scrambling their existence amidst the other bits of code in the chain:

```
00001000110100010010001000011001100110111001000000001
10100011001100100000100110110001100011000011101110 0
11011000100000001101111001101010010000000110011001 1
01100001000000011011011001100011001000001001000000 0
11011001100011001000110011000110010000010010000000 1
10110011000110010000001100110110100011010000100000
00110110011000110010000100011010001001000010001100 1
10011001000000110111001101100010000100011011110000 1
00011001101101000110100001000000011011001100011001 0
00000000011001100110111001000100001101100011001100 10
00000011011000110111001000010001101100011000100100 1
10111001100100010000000110011001100000010001100000 0
10000000110110001101000010000000110110011001000000 1
10111001101100010000000110111000000011100110110100 0
11010000100000010110110011000110010000001101000100 1
00001000110011001101110010001110010011010001100110 01
00000001101100011000010010011011100110110001001000 01
10111001101010010000000110001100110100001000000011 01
10110011000110010001010100100000011011001100011001 0
00000011001101101000110100001000000011011001100011 00
10000000110100010010000000110011001101110010100011 0
01001000000110111001000000011011000110010010000000 11
01100011011100100000001101100011000100100110111001 1
00100010000000110011001100000010001100000010001000 0
11011000110100011001000000011010001001000010001100 1
10011011100100011100100110100011001100100000000110 110
00110000100100110111001101100010000000110111001101 0
10010000000110011001101000010000000110110110011000 1
10010001010100100000001101100110001100100000000110 011
01101000110100001000000011011001001100110011011100 10
10001100100100000011011100100000001101100011001001 0
00000011011000110111001000000011011000110001100000 1
```

Those binary values can be recalled and read at any point by electrical charges running through magnetically polarized needles or capacitors in people's devices. The north and south polarization creates a binary memory — true or false; on or off; up or down. With one simple tool, coders can build complex webs of logic to achieve nearly anything.

Cryptocurrency is a form of bearer instrument like cash. The owner is the bearer of the information on the whereabouts of the coins. However, unlike cash, cryptocurrency cannot be destroyed, only "lost." The wallet will always remain filled with its coins on the blockchain, but if its owner loses the address to the wallet, it is as good as gone. They will never know what to ask the Daemon to get their money back. Blockchain takes everything problematic about the human condition and turns it into an advantage for security. Reality is stochastic chaos we have no hope of decrypting. A system that emulates this randomness using computers should prove secure for a very long time.

Common storage methods for cryptocurrencies include air-gapped hard drives and laptops, but cryptocurrencies can exist outside of computers completely. Some prefer old fashioned paper storage, generating QR codes out of the digits to a hot wallet address, which are then printed on regular sheets of paper. Some ironically keep these sheets of paper safe at a bank safety deposit vault. Some turn towards more extreme methods for durability. These cryptocurrency owners engrave their wallet addresses on fireproof ingots made of titanium alloy. Unlike paper, these ingots are inorganic and nearly indestructible.

Most blockchains today are controlled by some party or another. But Bitcoin is unique because it is not only decentralized in structure, but in spirit as well. With no known keys to the castle, Nakamoto's original vision mandates that no human can acquire the Bitcoin Daemon's intellect, making it truly free from any living being's governance. It is simply a mathematical process upheld by people amassing an immense web of entropic information. In 2017, a Bitcoin mining craze caused prices for application-specific integrated circuits and graphics processing units (ASICs and GPUs) to spike. The virtual gold rush of 2017 brought the price of Bitcoin from $8,000 to $20,000 during its historic rise. Back in 2009, 10,000 Bitcoin (BTC) was auctioned on eBay for $50. No one bought it. In 2018, it would have been worth $22 million USD.

> *It's the same situation as gold and gold mining. The marginal cost of gold mining tends to stay near the price of gold. Gold mining is a waste, but that waste is far less than the utility of having gold available as a medium of exchange. I think the case will be the same for Bitcoin. The utility of the exchanges made possible by Bitcoin will far exceed the cost of electricity used. Therefore, not having Bitcoin would be the net waste.*
>
> - Satoshi Nakamoto
> Re: Bitcoin minting is thermodynamically perverse.

## A New Religion

*You don't get rich writing science fiction.*
*Start a religion, that's where the money is.*

- L. Ron Hubbard,
author of Battlefield Earth, and founder of Scientology

After inventing blockchain technology, Satoshi Nakamoto has been the subject of much controversy. Due to its cryptographic structure and anonymity, Bitcoin is often used for money laundering and other crimes where untraceability is paramount. Very little is known about Nakamoto. Even the name is a code. We may imagine Satoshi Nakamoto to be a Japanese man, but the true identity, nationality, and gender of Nakamoto is a mystery. Having never made a public appearance, Nakamoto could be a team of people. Since 2009, individuals from all over the globe have claimed Nakamoto's identity. World journalism has scrutinized some candidates more than others, but none have been able to produce concrete evidence.

Many believe that Satoshi Nakamoto, wherever he or she may be, is dead. Speculations invoke many recently deceased cryptographers and software developers like Hal Finney, the first recipient of a Bitcoin transaction, directly from Satoshi Nakamoto. Finney died in 2014 of amyotrophic lateral sclerosis, not too long after Nakamoto's last publicly known activities. Finney's peers recall he always carried a copy of Atlas Shrugged, extolling values that were perhaps potent enough to motivate the invention of Bitcoin.

As the first miner(s) ever to connect, therefore the quickest to mine when energy costs were low, Nakamoto's original wallet from Bitcoin's inception remains visibly unspent and undisturbed. When the price of Bitcoin hit a record high in December 2017, the coins were worth over $19 billion US dollars, making Nakamoto at least the 44th wealthiest person in the world at the time. The secretive nature of Bitcoin led many to believe it to be a Ponzi scheme or similar scam. Some believe it to be a rival government's invention, created to challenge the US dollar on a global scale. Some believe it to be an Orwellian vehicle for governments to monitor transactions.

Nakamoto saw the internet as an underutilized platform for currency exchange. Our senses and computational power fails when trying to decode the chain, making the "higher power" of mathematics seductive. It provides people with more faith in Bitcoin's system than currencies controlled by others with their own interests. For better or for worse, Bitcoin has no quantitative easing policy if things go south. The system cannot bail anyone out.

As blockchain technology developed, many coders designed new platforms using some of the same basic principles, but with several key distinctions to fit different industry's needs. Many blockchains have no cryptocurrencies, and some

do not even have linear blocks, using multi-dimensional graphs to chart progress instead. Some blockchains promise to bridge this potential with the rest of society, making the technology beneficial for everyone from citizens, private businesses, and government. People are beginning to use cryptocurrency to buy and sell homes. Jack Ryan, former Goldman Sachs partner, founded the Real Estate eXchange (REX), aiming at cutting out the middleman in property transactions. The REX uses a multitude of different cryptocurrencies, making it convenient for prospective users.

Ethereum is an example of a global, open-source platform for "peer-to-peer" (P2P) transactions, allowing anyone to build "decentralized applications" directly into their blockchain. Entrepreneurs can seamlessly integrate their projects or even entire businesses with Ethereum itself, allowing it to conduct and connect any information exchanges securely, from accounting, internal messaging, project files, and the Ethereum currency, called "ether." Most importantly, without centralized governance, the decentralized application puts power entirely in the hands of the shareholders. And by connecting directly to the grid, Ethereum allows users to buy energy at a cost. This lowers costs all around and makes for a less volatile and more equitable energy market.

However, in 2017, a venture capital fund on the Ethereum blockchain called The DAO announced that its servers had been hacked. Crackers exploited basic programming loopholes that the DAO had carelessly programmed, stealing $500 million worth of ether from depositors. It was the largest cryptocurrency theft ever, and the founders of Ethereum were forced to discuss how to handle it with the online community. The vast majority of the community was in favour of a hard fork, in which the entire Ethereum blockchain would be reset to its exact state just before the hack occurred, nullifying the theft entirely, instantaneously returning the funds and allowing The DAO to fix their errors and secure their servers. But there were some users that demanded that nothing should be done. Cryptocurrency's main selling point was immutability. Human interference would be a bait and switch of the original mandate, unfairly putting the platform's power in the hands of the founders. If the DAO had failed to secure their client's funds, so be it.

Like religions before it, Ethereum experienced a schism. The blockchain was hard-forked, creating two diverging paths. Most users followed the path in its reset state, with no harm done. But some stayed on the existing state after the hack, upholding immutability at the expense of grand theft. Just as central bankers dealt with bailouts in 2008, the miners, exchanges, and companies invested in Ethereum intervened with a supposedly free market system. The irony was not lost on Vinay Gupta, one of Ethereum's co-founders. "It turns out we have a lot in common with central banks," he stated. "Maybe not at the technical or legal level, but at a political level, people in our community expect us to be able to make things better for them." The Ethereum fork was less like a bailout, but more like asking the Daemon to recalculate and wind back the clock, "un-printing and un-lending."

Every branch of the blockchain originated from one point under a deterministic set of laws, like the hydrogen and helium during the Big Bang. Because of all the energy expended to get to where it is today, mining cryptocurrency is considered by many to be just an entropic accelerant. In 2018, Bitcoin mining consumed 22 terawatt-hours (TWh), matching the entire country of Ireland. But three quarters of mining energy comes from renewable sources, indicating a greener future.

Whether cryptocurrencies will still be around or worth anything in the future, no one can know for sure. But there appears to be strong promise in the logic structure of blockchain itself, with many applications outside of finance. It is this flexibility, combined with its security, that makes blockchain potentially invaluable for nearly every industry and profession, including architecture, construction, and real estate. From the bidding to the occupation of a building, a blockchain could follow the life of a building from inception, storing project and informing all parties to ensure matching files. This would work seamlessly with BIM applications, securely recording all the properties of all the parts of the building, including dimensions and specifications of equipment. This information would stay on the chain so that years later, when a homeowner needs some warranty information on a particular plumbing mechanism, the information is readily available. If the homeowner sells the place, the new buyer can look at this blockchain, now serving as a "carfax" for homes. It would give them all the information on the history of the home and any past renovations that were done, allowing them to be better informed about its condition and what products could be behind its walls.

If personal data collection was recorded on a public blockchain trust, we could know exactly what information we are giving up at any moment by performing any particular action. If Hawaii had a blockchain deed registry, land ownership could be automatically accounted for alongside birth certificates and identification paperwork. If Congolese mines had regulatory blockchains tracing all coltan back to their source, we could effectively combat coltan smuggling. The possibilities are endless, and blockchain is rapidly developing in finance and the energy market as well. If financial trading were recorded on a blockchain, we could oversee every transaction with total transparency. With everything traced to its source, assigning exact culpability to the ones responsible would be much easier when disaster strikes.

*Lost coins make everyone else's worth more.*
*Consider it a donation  to the community.*

- Satoshi Nakamoto

**PART III**

# Insecurities in Securities

*Can a century of money for nothing be solved*
*by another century of the same?*

On January 19, 2019, Quadriga CX finally issued an official statement on their website. Zou and many others were expecting it to be a formal apology and clarification from Cotten, but instead it was an open letter from his newlywed wife, Jennifer Robertson. She announced that her husband had died over a month prior from Crohn's disease, explaining his silence during the incident. According to her, they were on an extended honeymoon in Jaipur, India when Cotten experienced digestive problems and succumbed to a fatal heart attack.

In an affidavit to the supreme court, she revealed that she now owned Quadriga Fintech thanks to a new will that Cotten had signed only two weeks before his death. He left her his entire estate, which included an airplane, a sailboat, several cars, two luxury homes, and over $100,000 for his pet chihuahuas — who he correctly guessed would outlive him. Robertson also admitted that the real reason the company had been withholding withdrawals from customers was because none of the employees had any clue where the client funds ever were stored. She insisted that Cotten was the sole keeper of any and all information concerning the whereabouts of the $250 million and that the knowledge died with him.

The next week, Quadriga filed for creditor protection against litigation and the website went into maintenance indefinitely. A death certificate for one Gerald "Cottan" [sic] was issued by the local government in Jaipur, followed by a closed casket funeral in his hometown of Belleville, Ontario. To the protest of many victims of the exchange's lost funds who were suspicious of the legitimacy of the foreign documents and lack of obituary at the time of his death, Cotten's body and the coroner's report was never shown. Quadriga also revealed that Patryn had been out of contact with anyone working for the exchange for many months and no one knew where he was.

Because of Quadriga's lack of status as a financial institution, bank, credit union, trust, or deposit business, Zou and the hundred thousand other clients had no coverage or insurance from provincial or federal financial laws. His girlfriend dumped him and he found himself back where he was when he graduated from school, with nothing to show for his seven years of hard work. Suing was not even an option, thanks to the creditor protection, not that there was any money left to take back.

# Land & Loans

*Resources and The Reserve*
*Greenback & Great Depression*
*Risk & Redlining*
*How America built its foundation on the backs of the disadvantaged.*

*The most valuable lands on earth, those with the highest rent, are not those with the highest natural fertility. Rather, they are lands given a greater usefulness by population density. We sail through space as if on a well-provisioned ship. If food above deck seems to grow scarce, we simply open a hatch—and there is a new supply. And a very great command over others comes to those who, as the hatches are opened, are permitted to say: "This is mine!"*

- Henry George
Progress & Poverty, 1879

To claim land in the "New World", European settlers engaged in centuries of genocide against Indigenous peoples through wars, state-sponsored massacres, and violent takeovers. Nations were displaced and dispossessed through initiatives like the residential and boarding school systems and the Indian reservation system. Private property was imposed and debt was abused throughout the process of colonization. As the colonizers gained dominance over the land, the popularization of the steam engine enabled train travel across vast lands with the building of the transcontinental railroads by Chinese migrant workers. The American Civil War and the Canadian Confederation shortly after, consolidated political systems under which land and its resources were regulated. Carryovers of private property principles from Europe brought a mass economic harvesting of resources from the land, including a plantation system bolstered by Black slavery.

Settlers before the 20th century relied on tactile interaction with the land to meet their needs. Homes used fire for light, and water was retrieved from wells. Sewage and bacterial hygiene were practically non-existent, with waste disposal being tolerated rather than dealt with. Disease spread far and wide. People settled around rivers, mines, farms, and oil, gathering wood and coal for indoor heating, and ice for refrigeration.

Because land is the most basic resource, building the foundation for all others, its widespread ownership became the catalyst for colonial economic development. Property rights turned land into liquid wealth for citizens, to be bought, sold, and used as credit. Open land markets became the backbone of the credit system and the growth of a middle class, making them stakeholders in society. By seizing control over the vast continent, America's industrialization rose through oil, minerals, agriculture, coal, iron, copper, and precious metals. Using the railroad network and steam-powered ships, an intercontinental trade system thrived.

Frontier lands were divided into parcels, and the subsurface mineral deposits, oil, and gas formations went to the prospectors who could prove to have been the first American citizens to have discovered them. The bimetallic monetary system of silver and gold hit many troubles throughout the century, forcing suspensions and prompting President Abraham Lincoln to introduce the "greenback" in 1861, a government issued demand note. The greenback was a bearer currency, owned by whoever was holding the note, and fiat, having no fixed exchange rate with any other commodity. Its value was backed only by the US government. It was printed in 5, 10, and 20 dollar denominations and issued as legal tender.

But before there was money, or even trade, there was debt. Soon after we began communicating through spoken language, people lent their skills to their group, meeting their needs through reciprocal relationships. Everyday specialization allowed for a social fabric to maintain social and economic cooperation, establishing a desirable living standard. For every action, there was the trust of an expected return. These cycles of speculative trust snowballed into what we now know as modern capitalism. Trust is debt, and debt is quantified as money. With communal trust, increases in productivity combined with growing

populations created economic growth on unprecedented scales of value and time. Each day would bring more prosperity. We began looking hopefully towards the future.

Debt was intended to allow a higher living standard while leaving room for growth. After all, we are not capitalizing on potential if we are not maximizing our credit. But debt became very lucrative for lenders. Soon debt changed from being an act of service, to an asset to be speculated on. For authorities, debt was a tool for guaranteeing long term stability. Citizens were liable to cooperate indefinitely, because the ability to pay off their debts determined their opportunities in life. The insecurity of employability encouraged complacency in all issues, especially political affairs. Authoritative threats of violence became unnecessary because debt was even more effective and more lucrative. Oppressed populations in past revolutions lacked basic living necessities, with no distractions to soothe the pain of everyday life. But 20th century improvements in living standards, technology, and entertainment alleviated this issue.

In 1902, Elizabeth Magie designed a "practical demonstration of land grabbing and its usual consequences." She observed that zero sum property rights exacerbated wealth inequality by exploiting tenants and enriching land owners. Magie designed the demonstration around interactivity and accessibility, hoping for children to learn hands on the snowballing unfairness of land monopolism. She called it "The Landlord's Game." Players were provided money through a central banking system and given opportunities to buy, sell, and rent property to each other. This quickly snowballed into large swings of wealth and debt, inevitably ending in ruin for all but one player, mostly through circumstances outside their control.

But Magie discovered that instead of instilling ethical sensibilities in people, many players — children included — were thrilled to own their fellow players through debt, allowing them to live out temporary power fantasies. Charles and George Parker jumped at the opportunity to exploit these thrills and rebranded the game with a positive spin. They named it Monopoly.

***

In 1907, F. Augustus Heinze, majority owner of the United Copper Company, tried to corner the copper market. Believing that many of the company's shares had been borrowed by short sellers, Heinze devised a scheme to execute a short squeeze when his stock was rising, aggressively purchasing the rest of the shares of his company. The price would rise dramatically, leaving none on the market for the short sellers who would have to come crawling to Heinze and pay whatever gouging asking price he wished so they could return the shares to their lenders.

Together with his associates, Heinze owned or managed six national banks, ten state banks, five trust companies, and four insurance firms. Friends warned him of miscalculations in the amount of funds necessary to pull off the scheme, but greed got the better of him and he bought as much stock as quickly

as he could. But it was not enough. Short sellers caught on and were able to find alternate sources in a mass sale that caused United Copper's stock to drop over 80% in two days. All the state and national banks Heinze ran also went bankrupt from the losses. Depositors came flooding to withdraw their funds all at once, and the public panic spread across the country over the next three weeks, as trust companies and other banks associated with the incident went down.

These losses were exacerbated by "bucket shops," establishments outside the governed financial system where independent investors would go to place unregulated side bets on the market. Bucket shops conducted their trades on paper like bookies, skirting financial trading laws at the time. Bucketeering was popular because of the absurd leverage ratios which often went upwards of 100:1, allowing investors to deposit $1 cash and buy $100 worth of stock. No bank would ever take such terms, but because the trades only existed on the bucket shop's records, the shop did not actually need the funds to make the loans, while it continually collected interest in cash from the client. With such a high leverage ratio, the client could feel that he had been loaned a substantial amount of capital that was in fact non-existent, all for a fractional cash deposit. This abuse of bucketeering — including many high leverage bets made on other high leverage bets — only worsened the panic when it broke out.

The crisis exposed flaws in a fragile American economic system that had been repeatedly proven vulnerable to greedy overextension, short-term shocks, and snowballing panic. Similar banking panics had already happened in 1819, 1837, 1857, 1873, 1884, and 1893. The country had already come a long way since moving from strictly state banking to establishing the Office of the Comptroller of the Currency (OCC) in 1863 to charter National banks, but faith was proving to be such a complex creature that the financial world wanted major reform to better accommodate peoples' tendencies.

To tackle the issue of a faithless economy, head bankers from across the country, using aliases, secretly travelled to Jekyll Island to negotiate a central banking system that would secure the country's private finances.

> *I was as secretive—indeed, as furtive—as any conspirator....I do not feel it is any exaggeration to speak of our secret expedition to Jekyll Island as the occasion of the actual conception of what eventually became the Federal Reserve System. Discovery, we knew, simply must not happen, or else all our time and effort would be wasted. If it were to be exposed that our particular group had got together and written a banking bill, that bill would have no chance whatever of passage by Congress.*
>
> - Frank Vanderlip

Together they drafted legislation that made its way to the White House. The Woodrow Wilson administration's final proposal referred to British and German banking structures, a hybrid system of twelve privately controlled reserve banks across the country controlling the printing of money. They would loan the money to the government by purchasing treasury bonds and monetize the debt by lending it to other banks. The private reserve banks would report to a publicly appointed Federal Reserve Board of Governors in Washington, D.C, and send profits to the US treasury. The gold standard was maintained, believed to prevent hyperinflation. The choice of name — Federal Reserve — is a peculiar one, as nothing indicates that it is fully Federal or has any reserves. On December 23, 1913, when most of Congress had gone home for Christmas, monetary policy was born with perhaps the most powerful institution in the world. The Federal Reserve had the power to adjust money supply and set interest rates, reinforcing the idea that debt was time, and time is money. Money would be baked into the system as debt from the beginning. This followed the Bank of England, the first successful modern central bank.

> *In 1694, a consortium of English bankers made a loan of £1,200,000 to the king. In return they received a royal monopoly on the issuance of banknotes. What this meant in practice was they had the right to advance IOUs for a portion of the money the king now owed them to any inhabitant of the kingdom willing to borrow from them, or willing to deposit their own money in the bank—in effect, to circulate or "monetize" the newly created royal debt. This was a great deal for the bankers (they got to charge the king 8 percent annual interest for the original loan and simultaneously charge interest on the same money to the clients who borrowed it) , but it only worked as long as the original loan remained outstanding. To this day, this loan has never been paid back. It cannot be. If it ever were, the entire monetary system of Great Britain would cease to exist...*
>
> *This is the same arrangement as the Federal Reserve system. The difference is that while the Bank of England originally loaned the king gold, the Fed simply whisks the money into existence by saying that it's there. Thus, it's the Fed that has the power to print money.*
>
> - David Graeber
> Debt: The First 5,000 Years

## New Deal

Six months later, Archduke Franz Ferdinand was assassinated in Sarajevo and the world fell into chaos. Europe was not able to print enough money to finance their war efforts, so they abandoned the gold standard in favour of fiat government debt to finance war efforts. By the end of the war, two of the previous leading economies, Great Britain and Germany, were bankrupt or hyper-inflated. The American dollar, now backed up by nearly as much gold as all of Europe, became the new international standard. On their return home, American soldiers were paid $60 in cash in order to help them adjust to civilian life. Over the next decade, most of the Western world's economy continued to struggle through recovery as America's boomed. In order to manage the growth, the Federal Reserve adjusted the market for the first time outside of crises and war. They kept interest rates low, nudging the US economy into the roaring twenties. The market grew at a record pace.

Economist John Maynard Keynes began writing a paper that predicted the standard workweek by the early 2000s would be 15 hours long. Rising productivity from new technology would reduce the need for manual labour, creating new "Economic Possibilities for Our Grandchildren" for him to hypothesize. With our housing and finances covered, the remainder of our time would be spent with friends and family. Keynes also predicted that the productivity output would grow four times higher by the turn of the millennium. But before he could publish his theories, stock bubbles formed as speculators borrowed far more money than was in circulation. The Federal Reserve tried to raise the interest rates in 1928 to alleviate it, but it was too late. In September 1929, the market crashed. Acting as the lender of last resort, the New York Reserve immediately provided enough liquidity to the local money market to eliminate banking panic there. But the Federal board in Washington felt that quantitative easing would exacerbate inflation. The Federal Reserve sat on the sidelines and watched as everyone tried to pull their money out of banks which had nothing left to loan because they were locked to the gold standard.

Before Roosevelt's New Deal, there was no insurance on deposits at banks, so when thousands of banks closed from the crash, depositors permanently lost their savings. There was no national safety net, no public unemployment insurance, and no Social Security system. What could have been a recession if handled differently, spiraled into a Great Depression.

> *It was Henry Ford who said: 'It is well enough that the people of the nation do not know or understand our banking and monetary system, for if they truly did, there would be a revolution before tomorrow morning'.*
>
> - Congressman Charles Binderup
> Congressional Record – House 81:2528, March 19, 1937

In 1933, the Roosevelt administration proposed the New Deal, major reforms bent on raising employment to stimulate the economy again. The administration poured $500 million (equivalent of roughly $10 billion today) into relief operations. The Federal Deposit Insurance Corporation (FDIC) was created to insure deposits at banks in exchange for being highly regulated and expected to invest excess customer funds in low-risk assets. The Glass-Steagall Act was passed to ensure investment banking and commercial banking would remain separate to prevent conflicts of interest, unfair competition, and the concentration of power and risk.

Roosevelt also created The Federal Housing Administration (FHA), initiating a new type of mortgage for those who could not qualify under the existing programs. Before FHA, traditional mortgages were interest-only payments that concluded at their end with a total payment that amounted to the entire loan. Foreclosures were common, as many families would find themselves unable to pony up the funds necessary to pay off the entire house at once. So the FHA lowered the down payment requirements and offered 90% leverage ratios and higher. This forced commercial banks and lenders to compete, creating many more opportunities for home ownership. Homeowners could pay incremental amounts with each interest payment, slowly reducing the loan over many years until it was balanced. The FHA also extended the repayment schedule, offering the 30-year loans that we have today. The modern mortgage was born.

As part of the reform, the Home Owners' Loan Corporation (HOLC) was also founded to study and evaluate property at a microeconomic scale. To be more precise and careful with the housing market, creating a lower-risk foundation for the recovering economy, it systematically audited neighbourhoods all over the country. Unfortunately, the prejudicial judgment used to divide and designate land in the previous century was also being used to divide bodies in the new one. Fearing the possibility of homes losing value and putting homeowners, hence lenders, in a bad position, the HOLC evaluated risk based on racial demographics, a process known as redlining. Auditors were sure minority families moving into a neighbourhood would devalue the neighbourhood, so areas "suffering from Negro infiltration" for example, would be flagged as high risk and undesirable, unfit for home loans or new developments. Demographics deemed high risk were restricted from getting loans near central services and public spaces.

In July 1944, nearly 30 years after the gold standard had been abandoned by international bankers and governments in Europe, they held a conference in Bretton Woods, New Hampshire to create a new global financial system. The US tied their dollar to gold, while the rest of the world tied their currencies to the US dollar. The promise of global economic cooperation would bring US military protection against enemies like the Soviet Union, making America invested in keeping their satellite markets alive. The Federal Reserve became the banker to the world, deciding what anything across the globe should cost.

FORM 8
10-1-37

**AREA DESCRIPTION - SECURITY MAP OF** New York City

1. AREA CHARACTERISTICS:
   a. Description of Terrain. Flat.
   b. Favorable Influences. Substantial row brick construction - Many brown stone front old singles.
   c. Detrimental Influences. Obsolescence and poor upkeep. Infiltration of Negroes. Elevated structures on Lexington Ave., Fulton St. and Atlantic Avenue and Broadway.
   d. Percentage of land improved 95 %; e. Trend of desirability next 10-15 yrs. static

2. INHABITANTS:
   a. Occupation Clerks - laborers merchants; b. Estimated annual family income $1800-3500
   c. Foreign-born families 30 %; Jews - Irish predominating; d. Negro Yes 35 ; %
   e. Infiltration of Negroes (steady); f. Relief families Many
   g. Population is increasing ; decreasing ; static Yes

3. BUILDINGS:

| | PREDOMINATING 30 % | | OTHER TYPE 20 % | | OTHER TYPE 20 % | |
|---|---|---|---|---|---|---|
| | 3-4 family 4-6 rms. | | 2 family 5-7 rms. | | 1 family 7-12 rms. | |
| a. Type | | | | | | |
| b. Construction | Brick | | Brick - frame | | Brick - frame | |
| c. Average Age | 30 Years | | 35 Years | | 40 Years | |
| d. Repair | Fair | | Poor - fair | | Poor - fair | |
| e. Occupancy | 90 % | | 95 % | | 90 % | |
| f. Home ownership | 35 % | | 50 % | | 50 % | |
| g. Constructed past yr. | None | | None | | None | |
| h. 1929 Price range | $10,000-15,000 | 100% | $9,500-14,000 | 100% | $7,000-12,000 | 100% |
| i. 1935 Price range | $5,000- 8,000 | 52 % | $5,000- 7,000 | 51 % | $2,500- 5,500 | 42 % |
| j. 1938 Price range | $5,000- 8,000 | 52 % | $5,000- 7,000 | 51 % | $2,500- 5,500 | 42 % |
| k. Sales demand | $ Bargains | | $ Poor | | $ Poor | |
| l. Activity | Poor ~~Heated~~ | | Poor ~~Heated~~ | | Poor | |
| m. 1929 Rent range | $40 - 60 | 100% | $45 - 65 | 100% | $50-75 | 100% |
| n. 1934 Rent range | $20 - 40 | 60 % | $25 - 40 | 59 % | $40-60 | 80 % |
| o. 1938 Rent range | $25 - 40 | 65 % | $30 - 40 | 64 % | $40-60 | 80 % |
| p. Rental demand | $ Fair | | $ Fair | | $ Fair | |
| q. Activity | Fair | | Fair | | Fair | |

4. AVAILABILITY OF MORTGAGE FUNDS: a. Home purchase Limited; b. Home building None

5. CLARIFYING REMARKS: 30% brick 6-8 family tenements 4-8 rooms some with stores renting $6-$9 per room. Some more modern units at $10-$15 per room. Colored infiltration a definitely adverse influence on neighborhood desirability although Negroes will buy properties at fair prices and usually rent rooms. There is a proposal to remove the elevated structure on Fulton Street.

6. NAME AND LOCATION Bedford-Stuyvesant Brooklyn SECURITY GRADE D AREA NO. 8

ASSESSED VALUES: 150% of market value

***Detrimental Influences:*** *Obsolescence and poor upkeep. Infiltration of Negroes. Elevated structures on Lexington Ave., Fulton St. and Atlantic Avenue and Broadway.*

***Clarifying Remarks:*** *Colored infiltration a definitely adverse influence on neighborhood desirability although Negroes will buy properties at fair prices and usually rent rooms.*

***Security Grade:*** *D (Lowest)*

But with millions of Americans returning from World War II, the US decided to prioritize employment, out of fear of another mass unemployment depression. But this conflicted with their agreement in Bretton Woods, when they pledged to focus on controlling inflation for the health of the world economy.

The spike in new families from the baby boom caused demand for new housing to skyrocket. Compared to the measly $60 sum from World War I benefits, the Servicemen's Readjustment act (G.I. Bill) of 1944 allowed veterans to attend college, start businesses, and buy homes on extremely favourable terms. College tuition was free, and students were provided monthly living stipends. Medical care was free, and unemployment benefits were better than ever. Veterans were guaranteed loans for homes and businesses. America had found a new cornerstone for the economy, relying on housing and manufacturing to continue growing. Suburbs among sprawling suburbs were rapidly constructed, with many carelessly programmed. There was no industry in these pockets, only rows of cookie cutter machines for living.

In these homes, every comfort and function was taken care of by something or someone else. Grid electricity, central heating, cooling, indoor plumbing and sewage, kitchen appliances, and refrigeration were just some of the modern amenities provided. Telephonic infrastructure enabled instantaneous communication. Radios and televisions provided in-home entertainment, and numerous forms of transportation were popularized with elevators, planes, and cars. It was a promise of the American dream, leaving you with time to enjoy backyard barbecues with your families in your own fenced off parcel. You would look to your left and your right to see almost identical neighbours, providing for their own families and living out their own American dream. You were safe; you were home.

However, not all veterans benefited equally from these new bills. Because of the risk assessments associated with minorities, these loans and mortgages for businesses and homes favoured white families in statistically alarming ratios. Banks and mortgage agencies often refused loans to minorities for more attractive land. These "Jim Crow" laws further disadvantaged minority groups, who had access only to lower quality infrastructure and services in their designated neighborhoods. In the New York suburbs alone, fewer than 100 of 67,000 mortgages were given to visible minority groups. By 1946, only 20% of the black people who had applied for educational benefits were placed in college.

Unlike businesses or investments, land is physically permanent and mostly fixed in volume. It also happens to be a necessity. The allocation of land and resources created the basis for long-term economic performance in North America. Until there is land, there cannot be policy, state, or economy. Property rights allocate basic resources and benefits, assigning wealth, social standing, and political influence. They control who bears the costs and benefits of those risks, and who has power over assets.

*We have shown how land speculation inflates land values, reduces wages and interest, and thereby checks production. There are other reasons as well, such as: the complexity and interdependence of production; problems with money and credit. The problem must be speculation in things that are not the product of labor. Yet it must be things needed for production. And finally, it must be things of fixed quantity. It is clear that land speculation is the primary cause producing recessions. This process is obvious in the United States.*

- Henry George
Progress & Poverty, 1879

## Real Estate & Realpolitik

*Rand & Reaganomics*
*Fiat & Friedman*
*Greenspan & Globalization*
*How going cold turkey on gold led to global addictions.*

*Economics is a science of thinking in terms of models joined to the art of choosing models which are relevant to the contemporary world. It is compelled to be this, because, unlike the typical natural science, the material to which it is applied is, in too many respects, not homogeneous through time.*

*The object of a model is to segregate the semi-permanent or relatively constant factors from those which are transitory or fluctuating so as to develop a logical way of thinking about the latter, and of understanding the time sequences to which they give rise in particular cases. Good economists are scarce because the gift for using "vigilant observation" to choose good models, although it does not require a highly specialised intellectual technique, appears to be a very rare one.*

- John Maynard Keynes

In 1955, Arthur F. Burns, chairman of the U.S. Council of Economic Advisors for President Eisenhower, invited economist Milton Friedman to join him on the National Bureau of Economic Research. Friedman was a professor at the University of Chicago who detested the Federal Reserve system, wishing for it to be abolished.

Burns also taught economics at Columbia University, where one of his Ph.D. students had grown disillusioned with the program. His name was Alan Greenspan, and he had engrossed himself in philosophical literature, becoming a logical empiricist. He believed only experiences verifiable through direct human observation were valid. Any induction distancing one from the information brought complete uncertainty. This pulled him away from macroeconomics, which was riddled with simplified, high-level models. Following this line of thinking to its end, his attitude became extreme. He told his close friend Nathaniel Branden he could no longer rely on his own senses to confirm his own existence, or that the world around him existed at all.

Concerned for his friend's sanity, Branden introduced Greenspan to his affair partner, Alisa Rosenbaum. Rosenbaum had gained a controversial following after writing The Fountainhead under the pen name Ayn Rand, and she had views which Branden felt might help his friend. Greenspan quickly warmed to Rand, sharing her belief in the importance of mathematics and a clear intellect. Together with a few other admirers, including Branden's wife, they founded The Collective around Rand, gathering at her apartment on weekends to discuss philosophy, politics, and her upcoming writing. The Collective believed that altruism was not a virtue, but a grave sin. We had a duty to our own bodies and needed to prioritize it above anything and everyone else. Greenspan helped proofread Atlas Shrugged, giving glowing feedback before its publication.

In the book, Rand expresses strong Laissez-faire views, believing that separating government from economic policy entirely would bring peace and equality for humanity. Her writing captured the hearts and minds of capitalist industrialists in particular, who related to her characters and their philosophy, building their businesses around them. Branden produced an academic course led by Rand and Greenspan on objectivism in economics, politics, and psychology. Inspired, Greenspan dropped out of Burns' classes, abandoning his Ph.D. to found his own economics consulting firm in pursuit of embodying the Randian hero.

In 1964, President Lyndon B. Johnson announced housing policy reform for what he called "The Great Society." His government spent more than it could afford to wage war on poverty, because Johnson was also waging war on communism. Far too much money was printed to fund the Vietnam War, and the cost of living in the US rose dramatically. Johnson continually discouraged the Federal Reserve's urge to raise interest rates, as he did not want to cause a recession before the upcoming election against Richard Nixon.

When Nixon caught wind of Johnson's planned peace talks with the Vietcong to end the war in Vietnam, behind the scenes, he and his security advisor Henry Kissinger secretly convinced opposing leaders to reject all solutions, sabotaging the meeting. He promised he could land them a better deal than the

Democrats were offering if they agreed to keep the war going. When the talks failed according to plan, Nixon used the subsequent media fallout to fuel a smear campaign against Johnson, who was blamed by a distrustful public for failing to achieve peace. Despite suspicion, Nixon's sabotage would go unproven for decades. He won the election in 1968, selecting none other than Alan Greenspan to coordinate his financial policy campaign. The US had printed more than it could ever redeem in gold, breaking their pledge to the Bretton Woods Agreement. Meanwhile Kissinger began opening trade talks with China, another untapped global market that Nixon referred to as "a sleeping giant," referring to Napoleon's alleged comments on the economic potential of the country. Opening trade with a communist state was against America's ideology, but Nixon and Kissinger followed their "realpolitik" approach, placing absolute priority on elevating US power above all other considerations, including ethical ones.

Nixon appointed Arthur Burns as the chairman of the Federal Reserve, who advised him to suspend gold convertibility of the dollar. On August 15, 1971, without notifying the other leaders of the international monetary system, Nixon announced to the world on live television that the US dollar was now 100% fiat. Bowing to Nixon and his inflation-control policy, Burns and the Federal Reserve would not budge from the low interest rates for the next decade. He was continually warned by Congress, the White House administration, corporations, and labour unions that unemployment would rise if he did. Nixon even planted negative press about Burns and threatened to expand the Fed's Board membership in order to dilute his influence. This ensured his cooperation, as the extra money supply from going off the gold standard was going directly into arms, funding the war. In 1969, it funded Operation Menu, in which Nixon and Henry Kissinger ordered over 4 million tonnes of explosives to be dropped over cities and villages across Southeast Asia, causing an estimated 100,000 civilian casualties.

Meanwhile, with strengthened globalization and network communication infrastructure, and America began looking for world opportunities to conduct experiments for economic exploitation. Nixon decided to turn Chile into testing grounds, a plan backed by Milton Friedman, who had convinced the administration that it would be mutually beneficial. Friedman took several young Chilean economics students under his wing and personally indoctrinated them at the University of Chicago. After an American-backed coup d'état in 1973, Augusto Pinochet assumed presidency and established a military dictatorship, as Nixon wanted. Orchestrating executions, torture, and the imprisonment of nearly a hundred thousand people, once he took office, Pinochet appointed Friedman's "Chicago Boys" to his staff, as had been arranged with the US government. They brought total free market principles to Chile to transform its economy into one of the fastest growing and business-friendly countries in the world. Friedman and his cronies deemed it "The Chilean Miracle."

*9/11 was committed with "wickedness and awesome cruelty". It is useful to bear in mind that the crimes could have been even worse. Suppose, for example, that the attack had gone as far as bombing the White House, killing the president, imposing a brutal military dictatorship that killed thousands and tortured tens of thousands while establishing an international terror centre that helped impose similar torture-and-terror states elsewhere and carried out an international assassination campaign; and as an extra fillip, brought in a team of economists who quickly drove the economy into one of the worst depressions in its history. That, plainly, would have been a lot worse than 9/11.*

*Unfortunately, it is not a thought experiment. I am, of course, referring to what in Latin America is often called "the first 9/11": September 11, 1973, when the US succeeded in its intensive efforts to overthrow the democratic government of Salvador Allende in Chile with a military coup. The only inaccuracy in this brief account is that the numbers should be multiplied by 25 to yield per capita equivalents. The goal, in the words of the Nixon administration, was to kill the "virus" that might encourage all those "foreigners out to screw us". In the background was the conclusion of the National Security Council that, if the US could not control Latin America, it could not expect "to achieve a successful order elsewhere in the world". The first 9/11, unlike the second, did not change the world. It was "nothing of very great consequence", as Henry Kissinger assured his boss a few days later.*

- Noam Chomsky

That year, Henry Kissinger was awarded the Nobel Peace Prize. By the time the Watergate scandal had settled in 1974 and Nixon had resigned, unemployment and inflation were increasing dramatically across the country. While his former professor continued to bow to capitalist control, Greenspan enrolled at New York University while running his firm and finished his Ph.D. in Economics in 1977. He wrote on the real estate market, stating, "There is no perpetual motion machine which generates an ever-rising path for the prices of homes." He noted that homeowners were now re-financing for larger amounts than their original mortgage, monetizing on the market's rising value and spending the excess cash on goods and services to an unprecedented degree. He warned that the effects of spikes in home prices on consumer spending habits would result in a dangerous bubble that would inevitably burst. The paper was accepted, and Greenspan began looking to increase his influence by involving himself in Federal affairs.

President Jimmy Carter appointed Paul Volcker as the Federal Reserve Chairman in 1979. In front of Volcker, Senate, and Congress, Arthur Burns admitted that he knew that his own actions were disastrous for long term growth but that he was powerless against Congress' decision to run deficit with the public investment boom. Unsatisfied with his excuses, Volcker set out determined to make the Federal Reserve more independent from Congress, protecting it from political and privatized pressure.

Volcker tried to raise interest rates, but no one dared to face the political heat. Instead, he shifted his campaign's focus to limiting money supply, to slow growth and prevent inflation. It was essentially the same concept from the other side of the formula, but focusing on this perspective was far more politically palatable. This change in language proved to be enough, and he was able to secure the necessary support to pass it into action. Interest rates went up naturally without being the root cause, shooting all the way up to 21%. Volcker was vilified by many critics who wanted to avoid a recession, which he knew he was bringing on the entire economy. In a world where politicians would have done anything to avoid the recession, Volcker succeeded in stabilizing the economy, ushering in a global economic boom. The short term discomfort for long-term benefits was a hard pill to swallow.

In 1982, only 7 years after reform, Chile fell into its worst economic crisis since the Great Depression. Even in its recovering stages, more than half the country was still living well below the poverty line. Wages had fallen over 35%, and Pinochet eliminated more bank regulations, reduced the corporate tax, and privatized all government services including public utilities. Chile's foreign debt, mostly American, rose 300% between 1974 and 1988. Friedman had successfully siphoned wealth for America's captains of industry in cycles of volatile busts. In 2000, an official report assessing the extent of the CIA's actions in the Chilean coup was published. The investigators concluded that they found no evidence of CIA involvement whatsoever. The investigators were the CIA.

Ronald Reagan took office in 1981. "Government is not the solution to the problem" he stated, "Government is the problem." "Reaganomics" favoured tax cuts and trickle-down economics, so the market economy became more popular, and thanks to the Volcker's restraint during this era, unemployment began going down, inflation cooled off, and the economy began growing rapidly again. Between 1982 and 1987, the US stock market more than tripled in value.

In 1987, Reagan did not reappoint Paul Volcker, who had deftly handled the economy's recession. Instead, he appointed his own top choice, Alan Greenspan, who had already established his Randian reputation for distrusting government and favouring the free market. In October of that year, the Dow Jones dropped 500 points, making it the largest loss in the New York stock exchange history. The US stock market had devalued 22.61% over the course of only a few hours. Greenspan dropped interest rates sharply while providing Federal liquidity, temporarily diffusing the panic. But it set a dangerous precedent. He had responded to fluctuations in the stock market, not just the real economy. Despite claiming to be a free market objectivist, Greenspan was intervening more than any Federal Reserve chairman in history to keep the ever-growing stock market afloat. He contacted New York University concerning his Ph.D. dissertation warning against housing bubbles and had it expunged from all university records.

*We are looking at the final effects of the militarization of American capitalism itself. In fact, it could well be said that the last thirty years have seen the construction of a vast bureaucratic apparatus for the creation and maintenance of hopelessness, a giant machine designed, first and foremost, to destroy any sense of possible alternative futures.*

*At its root is a veritable obsession on the part of the rulers of the world - in response to the upheavals of the 1960s and 1970s - with ensuring that social movements cannot be seen to grow, flourish, or propose alternatives; that those who challenge existing power arrangements can never, under any circumstances, be perceived to win.*

- David Graeber, Debt: The First 5,000 Years

## Mind & Mortgage

*Spreadsheets & Stocks*
*South America & Southeast Asia*
*Derivatives & Disasters*
*The people disadvantaged the most by the stock market*
*are the people who know the least about it.*

*GENE EPSTEIN: With respect to your saying you would not want to see a central bank, you long ago proposed that we simply pursue a policy of steady growth in a particular monetary aggregate. But wouldn't that require a central bank to implement?*

*MILTON FRIEDMAN : Yes, but I would substitute a computer for it, not a central bank. All you would have to do is have it buy or sell X dollars of securities. It is purely a technical matter.*

- Mr. Market: An Interview with Milton Friedman

At the 1978 mortgage trading desks of Salomon Brothers in New York City, Lewis Ranieri and his colleagues proposed the packaging and selling of large pools of mortgages. The housing market had steadily risen since the postwar housing boom, leaving untapped potential in its growth. The mortgages would be grouped together and divided into "tranches," which would be sold to many investors taking small percentages, diluting their risk. Tranches divided pools by any desired criteria such maturity dates or ratings classifications, making these products flexible and attractive to a wide variety of buyers. The most junior tranche might cover the first 10% of principal, the second tranche covering the next 20%, and the senior tranche the last 70%. If 10% of the mortgages default, everybody who invested in the junior tranche would lose their money while the upper investors would be protected. Because of this, you could have entire groups of investors lose their money despite the fact that not all the mortgages within the product defaulted.

Ranieri cleverly named these products "mortgage-backed securities." Securitization was yet another abuse of language that gave a sense of inherent assurance to those dealing with them, even though the simple act of combining mortgages and managing the dividends did not itself add security to the mortgages in any way. They only balanced risk instead of reducing it. In fact, they actually increased tail risks (losses of three or more standard deviations) by leaning on these products for leverage. If used responsibly however, they could potentially rewrite the financial system of trust and bring in unprecedented revenues and commissions. These mortgage-backed securities (MBS) were usually bought by pension and insurance organizations, university endowment funds, real estate trusts, retirement funds, and any other institutional investors, including retail. These products were only mortgages, but they immensely lucrative with the faith bestowed upon buyers by the markets; Americans historically were responsible mortgage payers, and, divided up among thousands of owners, these instruments were deemed sound by the principles of ergodic risk models and cost-benefit analyses.

Thanks to the invention of the virtual spreadsheet, MBSs, along with other complex financial instruments like derivatives — bets based on the future pricing fluctuations — became popular. Spreadsheets were ruthlessly efficient at processing data. They allowed traders to comprehend massive volumes of statistics. Spreadsheets gave graphs unprecedented depth, showing what was imperceptible to the unassisted mind. The power to calculate and structure information instantaneously was limited only by the imagination of the user. It was one small step closer to the Daemon's abilities. But these tools also buried that information underneath dense layers of codes, that fewer and fewer people understood. Portfolio insurance was supposed to protect investors from large losses, but despite its name, everyone could not sell and cash out at once without crashing the system.

Along with his tremendous contributions to computer science, thermonuclear technology, and quantum mechanics, John von Neumann wrote many papers on economic theory and probability. He introduced what would later become known as the *ergodic theorem*, which suggested that probability

over sample size could be interchanged with probability over time. Essentially, the probability for a situation said to be ergodic can be calculated accurately by modeling a repeated situation and running its outcomes over and over. For example, if a single person is tasked with guessing which of three doors a prize is behind, and then must repeat the task 100 times in a row with randomized prize placements each time, then one could calculate the probability of those outcomes by modeling 100 individual cases of each person being tasked with the single guess. This theory completely revolutionized how financial markets evaluated risks and cost/benefit analysis over long periods.

Computers could run these models with nearly a century of financial trends in an instant, predicting probability and uncertainty in counter-intuitive ways. Banks felt they could see further into the future and moved money accordingly. Beneath all the calculations, statistics, and risk analysis, it all seemed sound. Computers were provably efficient. Unfortunately during the boom, it favoured the agents within the finance system to apply ergodic theory across the bond market. The ergodic models were built upon historic volatility levels, recognizing patterns we had seen before and calculating risk accordingly. The formulas and concepts were static, leaving new factors in the data completely unaccounted for.

After NASDAQ introduced a purely electronic form of trading in 1983, traders could set up algorithmic programs to hold and execute trades anywhere in the world automatically, depending on what information it was receiving. These decisions could be made quicker than humans could process, making them lucrative for international trades, avoiding language barriers altogether. Traders spoke in the universal languages, math and money.

Globalization and communications technology allowed international markets to flourish like never before. Global cities saw rapid growth, and the US continued asserting its control over the world's resources. It played a "video game war" in the Persian Gulf with Iraq, where the most influential combatants never stepped within hundreds of miles of each other. Operators behind graphic interfaces managed long-range missile strikes, bombing, and commanded fleets, distancing them from their own actions. News footage consisted of high aerial views of explosions. Casualties were indistinguishable dots on a screen. Meanwhile most of the foot soldiers, many who experienced the burning Kuwaiti oil wells in person, saw no combat, and met no enemy.

Greenspan gently raised the interest rates until 1994. He lowered them to soften the market, but the economy did not slow down, leading to the largest and longest investment boom in US history. Greenspan was subsequently dubbed "the Maestro" by the adoring media, but the Federal Reserve faced a new problem in the form of a new type of inflation in assets. Instead of prices of goods going up, stocks, bonds, real estate, and other investments increased in price. The stock market was growing 15% per year. Some thought it would continue forever, but Greenspan suspected otherwise. He kept reading regular reports that companies were earning record profits quarter after quarter, but factories were reporting the same levels of productivity.

In December 1996, he asked Congress if "irrational exuberance has unduly escalated asset values, which become subject to unexpected and prolonged contractions as they have in Japan?" In 1945, the devastation from the atomic bombs brought a national identity shift to Japan. After seeing firsthand what modern war leads to, the country vowed to forget about violence and work hard to recover instead. And work hard they did, becoming the world's second largest economy by the 1970s, surpassing Germany. But they had just experienced a devastating financial crisis in 1989. At the peak of the Tokyo stock market before the bubble burst, three square miles in the dense metropolis was worth more than all the land in California. Due to deflation and an aging population, Japan's economy had been going nowhere for decades. But no one wanted a recession. Facing pressure from all sides, Greenspan dropped the idea that bad times were imminent. He started encouraging the growth, concluding that the computers in charge of trading were so advanced, they left his models obsolete. He refused to calm the market down when stocks soared to record heights, but never hesitated to intervene at the first sign of weakness.

By 1997, the boom had fueled American investments all over the world. Southeast Asia, seen as a large potential market, was flooded with cheap credit and speculative investments from American capital after they opened their restrictions for international business. The "Asian Miracle" had brought prosperity, real estate, and technology infrastructure to places like South Korea, Thailand, and Indonesia, while feeding the growing American economy.

But developers created property bubble after building too many condominiums without buyers to fill them. Robert Rubin and the US treasury downplayed the issue to President Bill Clinton. When the housing market collapsed in South Korea, Thailand, and Indonesia by the fall of 1997, the US banks offered bailouts with high interest loans, which all the countries accepted without hesitation to alleviate the public chaos. However, the American banks were only eager to lend out this money because these markets were deeply indebted to American investors. They knew that none of their investments were coming back from these markets unless they stimulated them. When the banks provided liquidity, the bailout funds went directly to paying back the deep debts to the US. The US then immediately pulled the investments, taking the money back to relieve the American economy, leaving the local economies ruined even deeper debt for generations to come. These operations rewarded a small percentage of people with short term capital flow at the expense of both global and local society's health, even in America. When the 2008 crisis came crashing down, Rubin did not cut a cheque to the government from the tens of millions he earned from helping cause it.

> *There is no question that I got involved in issues that treasury secretaries never ordinarily got involved in. But the reason was that there was a risk that if Indonesia had chaos, that could spread and threaten the interests of the global economy.*
>
> - Robert Rubin, US Treasury Secretary

during the Asian Crisis, a hedge fund called Long Term Capital Management borrowed and lost over $4.6 billion through over-the-counter derivatives on the housing market. It also suffered from the Russian Crisis at the same time, when the Russian government defaulted on its own domestic currency bonds. Their shares across many unrelated stocks also plummeted by association when all the hedge funds noticed the stacked bets and pulled out.

The Federal Reserve arranged a $3.6 billion bailout on the basis that LTCM was too big to fail and needed protection for the safety and stability of the American economy. Its bankruptcy involved a staggering amount of leverage, provably bad economic policy, intangibles like derivatives and risk assessment all carried out with computers, and massive bailouts with taxpayer money. This was an exact formula that the entire continent would appear to forget about only a few years later.

Despite his stance as an objective capitalist, Greenspan was socializing risk to citizens with these bailouts while privatizing the revenue to the financial sector. He backed three interest rate cuts when the market wanted stimulation, exacerbating the boom. This "Greenspan Put" made people feel complacent with the feeling that Wall St. could be rescued by the Maestro if things went south. If a business fails naturally, a capitalist market lets it fail. The safety net only encouraged riskier behaviour, as human nature could not help itself. During Greenspan's reign from 1987 to 2006, the financial sector shot up from 17% to 45% of the total US economy.

Using computerized risk analysis, corporations that previously manufactured products began selling loans which were far more profitable. Betting on the future was en vogue. Companies like General Electric essentially operated as hedge funds, and car manufacturers like General Motors began financing more cars rather than selling them. Investment banks that used to make money for clients began trading to profit for themselves. Larger, layered bets were being made, and alarmingly volatile mortgages were being created. Derivatives and other increasingly complex financial products were bought and sold on the side. They were traded in secret unlike traditional assets, without public financial record. No one was selling products anymore, just debt. Often it was not even debt itself, but futures in debt, betting on outcomes of other debts. Greenspan credited these methods for strengthening the market's flexibility and efficiency, dubbing them "creative financial instruments."

In 1998, Brooksley Born, the chairwoman of the Commodity Futures Trading Commission, tried to lobby against the Federal Reserve's inaction. She expressed the need to "protect the money of the American people which was at risk in these markets" and regulate over-the-counter derivatives since they were not meaningfully understood by most users even in the financial sector. Robert Rubin, on behalf of the Treasury, and Greenspan, on behalf of the Reserve, insisted that intervention would only bring the economy down. Born resigned and was replaced by one of Rubin's assistants. Meanwhile, President Bill Clinton, along with the rest of the country, was too distracted with a far more pressing issue to care about the welfare of the national economy. Everyone wanted to know how a certain stain had mysteriously ended up on a Presidential intern's dress.

Share prices skyrocketed, this time with the help of widespread computerized risk assessment. If risk could be predicted, then theoretically, it could be canceled out by betting against it. This would supposedly balance the economy and provide stability, allowing billions of dollars to be lent to millions of citizens. But if a system is going to allow for the sale of extreme insurance, it is in the best interest of the citizens to know the inner workings of that supposed innovation. But it was not policed; it was too hard for anyone to see what the issues were. Greenspan also never enforced the Glass-Steagall act, which mandated that the traditional banks should remain separate from the stock market. The separation of commercial and investment banking prevented securities firms and investment banks from taking deposits, and commercial Federal Reserve member banks from investing in non-investment grade securities for clients and themselves, underwriting securities, and affiliating with companies that did. Without enforcing these rules, the culture of finance created a closed loop of information exchange.

Greenspan saw this as a positive sign. The free market had won and did not need intervention — unless intervention meant using money from future taxpayers to bail out the whole system. The banks got the message. They could risk as much money in the market as they wanted, but blowing their gamble would lower interest rates and The Federal Reserve would print as much money as necessary to rescue them. Not that long ago this very tactic had wreaked havoc on the economy, but Greenspan deferred to the expertise of the thousands of bankers to run their own show. He claimed that the market was now running autonomously efficient even though he stepped in to tweak it when he saw fit. In 1999, Greenspan insisted on gently raising interest rates and waiting for the bubble to burst. Over the course of the following year he raised the rates to 6%. However, when equity and homes go up in value, peoples' optimism also stays aloft, and a snowball effect occurs. Everyone's recency bias takes over, and faith becomes delusion.

President Bill Clinton passed The Gramm-Leach-Bliley Act, repealing most of the Glass-Steagall Act. It opened up more economic opportunities by mixing investments with commercial banking, trusts, and insurance companies in order to feed a bloating economy. In November 1999, Clinton declared that "the Glass–Steagall law is no longer appropriate," as mergers and buyouts between banking groups and corporations had been occurring for some time. By the turn of the millennium, the banking and finance sector barely resembled what it had been designed for less than 100 years ago. The economy had flipped from agriculture to manufacturing to services like the stock market, which was now bearing the weight of unprecedented debt that would continue building up for next years.

*People were doing crooked things all the time and they were attracted to real estate because the money was flowing so easily; when you get these permutations where one instrument is built on top of another instrument. The calculation on securities I saw, I would have had to read 300,000 pages to understand both the primary security and the ones it was dependent on. But nothing goes wrong for a while, so everybody just gets used to it…*

*It'll happen again. It's part of our economic system.*

- Warren Buffet

## Corporate Bodies & Corporeal Bodies

*Energy & Enron*
*Calories & Corporations*
*Renovictions & Rapporteurs*
*Ask why.*

*Give a man a gun and he can rob a bank. But give a man a bank, and he can rob the world.*

- Sam Esmail
Mr. Robot, 2015

In the early 1990s, ex-US Navy Lieutenant Kenneth Lay joined George H. W. Bush's re-election committee, donating to his campaign and becoming the chairman of the Republican National Convention. Several years earlier, Lay had founded a successful gas supply company called Enron.

In 1991, Lay promoted Enron chairman Jeffrey Skilling to CEO of Enron Capital & Trade Resources, responsible for energy trading and marketing. Skilling revamped the trading floor to suit his vision. Citing his favourite book, The Selfish Gene by Richard Dawkins, Skilling embraced the idea that humanity is inherently greedy. Greed was perhaps the only thing we were good at, and he felt he could take advantage of this. Despite the book's altruistic message, Skilling was inspired to employ a Darwinian survival-of-the-fittest structure to his entire company. To Dawkins' chagrin, Enron employees were assigned star rankings of 1 to 5 based on their earnings for the company. At the end of every quarter, the bottom 10 percent were fired. The average employee in this "rank and yank" selection process lasted six months. As less successful employees were weeded out, competition stiffened, increasing workplace tension and job stress. Employees began working over 18 hours a day to avoid being left behind. Skilling believed money to be life's only true motivator, capitalizing on our nature to bring out the best performance. Enron's profits continued rising, and Skilling was promoted to president and chief operating officer.

Skilling convinced The SEC to grant Enron "mark-to-market" accounting privileges, an extension of credit where anticipated future profits from prospective deals could be immediately recorded as profits indistinguishable from other assets to investors, even if the value of the deal changed or fell through immediately after. Skilling realized that the company did not need any "assets" in order to make tremendous profits. Enron began trading on futures, even betting on the weather itself. Skilling was also highly technology focused. With access to broadband networks, he struck a deal with Blockbuster, envisioning an online streaming service for customers to rent movies from the comfort of their homes. Enron built a fibre optic cable network and invested heavily in data management systems. However, the technology and bandwidth limitations at the time made the project too expensive and impractical. The project, along with many others around the world, fell through with millions sunk into each of them. But with mark-to-market accounting, investors were none the wiser.

In 1997, Enron became the largest gas and electric supply company in the country, buying out Pacific Gas and Electric, a Californian energy provider that gave them the keys to the grid. Less than two years later, Skilling led the launch of EnronOnline, an internet trading platform which became the most popular platform for energy companies in the country. Skilling hoped that one day Enron would own most of the fibre optic networks in America, controlling the internet.

> *EnronOnline is creating an open, transparent marketplace that replaces the dark, blind system. It is real simple. You turn on your computer, and it's right there. If you want to do business, you push the button. That's our vision. We're trying to change the world.*
>
> - Jeffrey Skilling

In 2000, Californians experienced strange occurrences. Rolling blackouts began happening frequently, causing havoc to the state. The grid had more than twice the capacity to handle the state's demand, and yet outages had never been worse. With control of the grid and access to all the energy data for the state, Enron was able to manipulate it according to supply and demand, not so that supply efficiently met demand, but to stunt supply artificially to drive up prices.

By calling power plants they controlled, giving them excuses to shut down or redirect electricity, they were moving energy out of the state. Once the ensuing blackouts caused prices to rise, they brought all the energy back into California, taking profits from the bets they had made on the prices. On February 12, 2001, Lay named Skilling CEO.

When they were exposed, Enron's tactics sparked national outrage. California Governor Gray Davis said he could not intervene on what he saw as a Federal issue. The company had become the darling of the market, beloved by both the corporate world and the government. From 1989 to 2002, Lay's political contributions to the Republican Party totaled $4.2 million. When George W. Bush was inaugurated into office, his parents flew to their son's ceremony in an Enron jet. The president refused to lift a finger on the Enron energy issue. "It doesn't matter what you crazy people in California do,"Kenneth Lay stated, "because I got smart guys out there who can always figure out how to make money."

In a March 2001 interview with Fortune reporter Bethany McLean, Skilling was unable to respond to simple, generic inquiries about the company, including "how Enron actually earned its money." Skilling told her he could not answer because he was not an accountant. The public was not convinced, and suspicions emerged. Realizing it was only a matter of months before everything blew up, Skilling encouraged employees to buy more Enron stock, hinting at big changes in the company. The stock price rose, but in reality, he was offloading his own shares, using the price spike to make as much as possible before cleaning his hands of dirty money. He resigned from Enron, relinquishing his CEO position and leaving Kenneth Lay alone at the helm. As more eyes scrutinized Enron's operations, whistleblowers from within the company leaked documents revealing that nothing was what it seemed to be.

Since the beginning, Enron had been cooking their books without restraint. With mark-to-market accounting, they were able to shift toxic debt around without anyone noticing. If any of their ventures failed or their assets devalued, Enron would found shell corporations disguised as prospective investment firms to buy the toxic assets, and then trick unsuspecting investors into pouring their money into these "ground-floor opportunities" to keep the debt afloat for them. The company had outspent their actual revenue for almost a decade, yet still reported record profits.

On December 2, 2001, Enron filed for bankruptcy. Their $64 billion in assets made it the largest bankruptcy in US history up until then, a record that would be beaten several times in the coming years. The FBI arrested Kenneth Lay and other executives. Lay was found guilty of 10 counts of securities fraud, but died of a heart attack right before he was to be sentenced for 45 years. After trying to cover up Enron's crimes, Arthur Andersen LLP, America's oldest accounting

firm, went bankrupt from the fallout. Seven Wall Street banks including Merrill Lynch were also found guilty of helping Enron hide toxic debt off-book.

Skilling was arrested by the FBI in 2004. He was sentenced to 24 years in a minimum security prison, but sweet-talked his way into a deal to expose other fraudsters, shaving ten years off. "After much soul searching, given the information at the time, I would not have done anything different." he told the Supreme Court. While in prison, Skilling was not allowed to physically come into contact with money of any kind. His parents passed away and his son died from an overdose while he was incarcerated.

13 years after his sentence, Skilling was released early in February 2019. He had already formed a new company. He had only been forced to pay back $42 million of the hundreds of million he had made from his crimes, leaving plenty left over to start a new venture. He met with over twenty former Enron executives, and began holding consultations with software developers, blockchain experts, and cryptocurrency miners. Speculations have circulated that he is attempting to get in on the ground floor of this new blockchain market in the energy sector.

***

Corporations do everything they can to get us to treat them like singular people, and we become accustomed to referring to the actions of a few representatives as the behaviour of an entire company. But a corporation is not a person, but a collective of people turning over all the time. Hiring and firing, large corporations are never the same from one moment to the next. Like bodies, they cycle through cells, constantly evolving. As extensions of our survivability, corporations display all the same basic strategies as the human organism. Recreational fitness has more in common with inclusive fitness than initially meets the eye.

Our bodies are built for a hunter-gathering environment, depending on the currency of energy for our cells to function. Both the big boss and our brain cells decide how to allocate their budget to grow and guarantee survival. A boss spends money on employees performing labour, bringing in revenue from their sales and services. We spend energy on our live tissue such as muscle, required for hunting and gathering, acquiring the fruits of our labour. We store energy as fat, the emergency funds of our bodies. The goal of both the corporation and our bodies is to gain an advantage in survival by growing a large, functioning workforce that guarantees income.

If the corporation is successful in turning a profit, the boss will pay the employees, leaving leftover funds to allocate accordingly. If they see workers slacking off, like muscles hogging energy without contributing, they will be fired for wasting company money. Our muscles cost energy and will waste away unless they perform work. If the boss sees employees working at their maximum capacity, they will spend what they have to help out with the workload, just as a body sacrifices energy to build new muscle when it works hard enough. If employees continue working hard, bringing in plenty of revenue, the company can expand by hiring more employees. This increased strength allows us to hunt bigger game and gather more resources for more energy, snowballing our growth potential.

If a company earns less revenue than the wages of their employees, they will be forced to withdraw from their accounts, the fat stores. This is how we lose weight, and both corporeal and corporate bodies hate doing it. If things get too drastic, consistently earning a net loss, we will be forced to fire muscle even if they have work to do, just to cover the overhead costs of keeping the business alive at all. With fewer employees and insufficient funds, the company's capacity to work is stunted, which can spiral into a vicious cycle. If we continue at an unsustainable deficit for too long, we use up all the emergency energy in our bodies and die. For a corporate body, this is filing bankruptcy.

But one crucial property allows corporations to play life differently from human bodies. Energy cannot be created or destroyed. But because money is based on social constructs of faith and debt, the units are malleable. Unlike human cells, corporate employees can extend their perception of time and space beyond themselves. The corporation can predict the future and act accordingly, manipulating how they view both faith and debt. Although many of us in North American society are surrounded by more food than we can eat, our bodies still crave fat, believing that any moment could bring starvation. Our "knowledge" is meaningless.

But for a corporation, the individual agents are able to speculate on the world around them, allowing them to take larger risks with their assets over time. If they feel confident that tomorrow, business is likely to continue as it did yesterday, they will not need to keep savings lying around for a rainy day, squandering earning potential. Corporations may never turn a profit, and have negative funds, but so long as people believe in the future of the corporate body, it will thrive with a growing workforce. But the human body cannot have negative calories without dying, no matter how many their loved ones might believe in them. In many ways, corporations are immortal.

* * *

America has been consuming more than it has produced for several decades now. It is attempting to sustain this model in a world ravaged by automation and accelerating climate crisis. This is a tall order even for the richest country in the world. In order to feed the machine, the baby boomers committed grand intergenerational theft, borrowing from their children and grandchildren to avoid dealing with wealth disparity, debt, and global warming.

Through the late 2000s and early 2010s, banks made concentrated efforts to illegally foreclose on American households, evicting families. The banks hired "Robo-signers", yes-men who falsified reports, affidavits, and mortgage assignments and verified them to wreak legal havoc for the families in question. This made it impossible to gather the resources to fight it. Toxic assets were still plaguing the economy and gumming up the ability to borrow and lend. Banks were eager to use any tools at their disposal to clean up their books.

In 2009, the Federal Reserve nationalized the mortgage market by buying $1.3 trillion of mortgages from failed lenders Freddie Mac and Fannie Mae. In 2010, Federal Reserve Chairman Ben Bernanke announced another $600 billion to be injected. All the banks deemed too big to fail still had the same bad loans and investments, but were now protected from the "survival of the fittest" free market, guaranteed survival by the bailouts. "I don't know where the stock market is going," said Greenspan, "but if it continues higher, this will do more to stimulate the economy than anything else."

The economy became even more centralized than ever was before, dependent on ever cheaper credit from the central bank. In 30 years, interest rates had dropped 20% to 0% in 2012. With a new mountain of debt, the cost of inflation hit the poor the hardest. With 0% interest, prudent savers are the ones paying for the mistakes. They were responsible during the entire boom and did not outspend their incomes, but Ben Bernanke of the Federal Reserve declared them to be on the hook for bailing out the reckless drivers of the economy, and to get nothing for lending their money out to stimulate the economy. "The US can pay any debt it has because we can always print more money to pay it off" Alan Greenspan insisted, "So there is zero probability of default." It sounded like code for a government debt bubble. Each bailout piled on top of the debt, and instead of loans that households could not afford, they caused spending and tax cuts that the government could not afford.

In light of the subprime mortgage crash, a private equity firm called the Blackstone Group lost most of their assets. But in the recession, Jonathan D. Gray, head of the home equity division, saw an opportunity. He convinced investors all over the country to leverage their remaining capital in the dead market through Blackstone. If they had reached the bottom of the barrel, it could only go up from here. Gray flexed the advantages of the large corporate organism. Blackstone could make long term gambles based on debt and the faith of its investors, no matter what its current assets were.

Gray organized the mass purchase, renovation, and monetization of real estate across Canada and the US. "We bought homes for less than $150,000, spend $25,000 fixing them up, and start renting them out." he said in an interview at an investors conference. "When done on a large enough scale, it becomes really efficient." Gray founded Blackstone Real Estate Debt Strategies (BREDS) and Blackstone Mortgage Trust (BXMT) to capitalize on the new assets, providing first mortgage debt capital to borrowers. The plan was overwhelmingly successful. By 2014, Blackstone had become the largest private equity firm in North America, with valuable properties all over the world. Many other firms had pulled similar schemes, but none had been pulled it off on such a scale. By 2018, Blackstone's assets exceeded $434 billion. Gray was named President.

Global cities are also experiencing an influx of money laundering through real estate. If a foreign investor has millions in dirty money they cannot spend normally, there is a simple solution that countries like Canada welcome with open arms. First, using clean money, the investor buys properties in major cities; a restaurant here, an apartment there, nothing that might raise suspicion. Then they set up an offshore shell corporation, preferably somewhere where the laws sympathize with corporate secrecy, like Panama, Malta, Bermuda, or Cyprus. Through this new company, they buy the properties from themselves using their dirty offshore money. They throw outrageous offers at their own companies, paying twice or three times as much as they did the first time. The money is now clean.

Not only do they save on taxes, but they have also artificially boosted the market value of the local real estate, which they can benefit from as the owner. This clean money can then be put to use buying more properties to repeat the cycle, laundering more funds through them. This money, originating from drug trafficking, tax evasion, and other organized crime, is then lent out to businesses. It becomes retail stores, hotels, shops, supermarkets, houses, condominiums, museums, and political campaigns. No one can trace the origin.

76% of Canada's wealth is wrapped up in real estate, with no other major industries to carry the weight of a troubled economy. As a result, the government is fully invested in maintaining these systems at the expense of middle-class and low-income citizens. Canada has no legal requirement for property owners to declare "beneficial ownership," allowing launderers to hide behind offshore management without consequence. The only alternative to this system is the collapse of the national economy.

In 2018, United Nations Special Rapporteur Leilani Farha traveled to cities around the world to assess the global housing crisis. She documented the situations of homeowners in global cities like Toronto, Canada. Over the last 30 years, home prices have risen 425%, but wages only 133%. Despite the economy growing larger, the pie was not being cut up as proportionally. Inflating property prices drove owners to use renoviction tactics to push out lower paying, often rent-protected tenants. They replace the tenants with investments producing better returns, whether anyone ends up living in the place or not. Under the pretense of renovations, landlords evict tenants so they can re-list the property at a higher price and sell to foreign investors, or rent it out on AirBnB. Other landlords use different tactics.

Farha interviewed rent protected tenants in a Toronto apartment who were dealing with unacceptable living conditions like infestations and severe leaks and plumbing issues. The landlord, a property management corporation called MetCap, always had excuses not to attend to the problems they were responsible for. With no other viable options, the tenants of the building banded together and went on a rent strike. MetCap responded by issuing subpoenas, hoping to remove the tenants by force. One tenant, who was supposed to retire within the next few years, commented on the fact that his upcoming pension release would not be enough to afford living in the city.

After further investigation, Farha discovered that MetCap was Blackstone's Canadian subsidiary. It turned out the institutions handling the tenant's pension had invested the money into securities, securities which relied on the value of the very building he lived in. For years, the tenant had unknowingly been paying into a fund that drove the value of the building up, leading to its kicking him out in order to keep it going. The managers insisted it was the only way to fulfill his pension.

Kevin Skerrett, Senior Research Officer in the Research Branch of the Canadian Union of Public Employees (CUPE), published The Contradictions of Pension Fund Capitalism with his colleagues. In the book, Skerrett notes that despite government awareness of these cycles, employees continue contributing to plans with "fiduciary responsibility" to deliver a return on investment, even if those investments harm communities.

> *The awful irony is that Blackstone's business model is to buy, renovate, evict and jack up the rents. Pensioners are being kicked out of the units that their pension dollars are purchasing.*
>
> - Leilani Farha

## Speed Daemons

*Transcending trading*
*Faster frontrunning*
*Automated arbitrage*
*How our homes are exploited every fraction of a second.*

*You know what the trouble is? We used to make shit in this country, build shit. Now we just put our hand in the next guy's pocket.*

- David Simon
The Wire, 2003

In the recovering era after the 2008 financial crisis, Bradley Katsuyama, an energy market specialist for the Royal Bank of Canada, noticed something strange while trading for mutual funds and hedge funds. When he pulled up a quote and requested to buy shares of a particular bond, he would only get a fraction of them. Sometimes this mysterious force caused half of his requests to go unaccounted for.

Katsuyama's in-house experts assured him that the high-traffic market was simply outdating his quotes before he could refresh them, blaming RBC's inferior infrastructure for causing his requests to get lost in traffic until it was too late and the price had changed. Katsuyama's bosses were not satisfied with his excuses, nor were his clients when they called to complain. His experts could not explain why the quotes only appeared to be outdated immediately after Katsuyama sent his trade requests, but not a moment before. By the end of the year he was often only getting 45% of the shares he requested on any given trade.

In 2009, Katsuyama was offered the position of Global Head of Electronic Sales and Trading. He turned it down, wanting to get as far away from it as possible. But after an old friend who was trading for a large hedge fund told him they suffered the same issues,. Katsuyama went back to his boss and took the job, recognizing an opportunity to figure out what had been going on.

In 1986, a 16 year old boy in the Soviet Union named Sergey Aleynikov was hooked after using a computer for the first time, following basic instructions to draw a sine wave. He loved the deterministic logic that allowed him to know the outcome of a program in his mind before it was executed. However, Aleynikov was poor and had scarce access to computers, so he learned how to program using pen and paper instead. But when he applied for university to continue his studies, institutions barred him from majoring in computer science because of his Jewish heritage. He immigrated to New York City in 1990, shortly after the fall of the Berlin wall. After developing a reputation as the best technology expert in designing systems to match telecommunications connections, he took a job on Wall Street at Goldman Sachs's research division to support his growing family.

By mid-2007, Goldman Sachs bond trading department was helping Greece's government cook their books and disguise toxic debt. They were also packaging mortgage-backed securities to fail so they could bet against them after selling them. But Aleynikov was completely oblivious to any of this. As a well-paid lead technologist, he was tasked with designing an incredibly fast matching system much like the ones he had designed for telecom companies. He designed programs and backed them up in his data repository, but he had little idea what they were used for other than "to match trades," which was a good enough answer for him.

More than half the programmers at Goldman Sachs were Russian, and Aleynikov believed that Russians were particularly good at programming because of how much of a luxury computer access was back home. They all grew up with only precious minutes with a machine to get their code working, which meant that debugging was a big waste of time. This forced them to write their code carefully to avoid creating bugs in the first place, rather than coding carelessly and then trying to remove them after. Cleaner programs made for better security, optimization, and flexibility. Even when he was surrounded by powerful computers, Aleynikov

still wrote out his new programs on paper before putting them into code, much like the discipline in hand drafting and sketching in architecture before moving to digital modeling.

He mostly used open source code and combined it to perform extraordinarily advanced functions. He developed a way for two computers to appear as one to a system so that if one went down, the other could take its place without dropping a beat. "It created something out of chaos." he said. "When you create something out of chaos, essentially you reduce the entropy in the world."

In September 2008, Aleynikov was treated to a first row seat in a theatre of chaos. Goldman's traders were losing tens of millions at a time as the market plummeted day after day. They could not predict the market they thought they had been steering. Aleynikov preferred the deterministic nature of programming over the false certainty of the gambling, and continued his work diligently. But he soon became disillusioned with the way Goldman ran his department, as the environment hampered progress. Bonuses were awarded on an individual basis despite all the work being collaborative, resulting in competitive rivalries of credit. "Essentially, there was very little connection between people," he said. "In telecom, you usually have some synergies between people, meetings when people exchange ideas. They aren't under stress in the same way. At Goldman, it was always "some component is broken, and we're losing money because of it! Fix it now!" By the time of the crash, Aleynikov had already established a reputation on Wall Street as the best trading technologist in the business, but he did not even know it. Isolated and kept in the dark by his employer, he simply continued fulfilling their demands and making them far more money than they were telling him.

After two years of helping streamline Goldman's trading platform, he got a call from a friend with the idea to start his own platform that would offer these services as its business. The idea of building a new foundation from scratch instead of constantly trying to repair Goldman's broken one was too enticing. He resigned immediately, much to the dismay of his employer. On his last day, he backed up his work to his data repository as he always did.

But when he got to Newark Liberty International Airport to fly out and meet his friend, he was approached by several men wearing F.B.I. jackets. Aleynikov was arrested and charged with the theft of trade secrets and the transportation of stolen goods under the Economic Espionage Act of 1996. At his trial, Aleynikov's lawyer presented photos of the programs that he was accused of stealing, side by side with open source code. Often the only difference was that the open source stamp at the top had been removed and replaced with a Goldman Sachs logo.

Despite there being hard evidence that he had not even yet accessed the repository that he had been copying his own code to for years, US Attorney Joseph Facciponti withheld Aleynikov's bail, stating that "there is a danger that somebody who knew how to use this program could use it to manipulate markets in unfair ways," which was an odd statement given that it meant that Goldman Sachs should rightfully possess such power. What Aleynikov had not realized was that his automated computer matching systems had helped take over the American financial markets, including the real estate market.

*What stock exchanges have become are vendors of data and technology where they make more money by selling high speed data and technology than they do through matching buyers and sellers.*

-Bradley Katsuyama

In 2009, after searching across the country, Bradley Katsuyama found Spread Networks, a company that sold access to its high speed network. It was founded by Dan Spivey, who spent $300 million boring a hidden 50 mile tunnel of fiber optic cable from Cleveland to New Jersey. He told nothing to the workers laying it in, and kept the entire operation as secret as possible. Using shell companies, Spivey and his financier David Barksdale struck over 400 private deals with counties and townships directly in between the cities, just to tunnel through them. They dug through everything, under rivers and bedrock, and even through mountains. The line needed to be as straight as possible. A signal could cross in three thousandths of a second. Katsyama found similar networks connecting other cities to the New York state, like a tunnel from Chicago that transferred data in just over 4 milliseconds. They had all been built for the same purpose: to trade financial products faster than anyone thought possible.

Wall Street is known as the stock exchange capital to the world, but the old romantic view of a trading floor full of of shouting suits is an outdated myth. The big money is actually being traded many miles northwest in unassuming addresses across the river in New Jersey. A Data center at 1700 MacArthur Blvd, Mahwah, is the real location of the New York stock exchange. Many trillions of dollars are traded per day thanks to the rapidly communicating servers conducting high-frequency trading. Every foot of fiber optic cable causes a billionth of a second of delay, and every extra foot bothers the traders. People's mortgages are now being traded and manipulated at speeds incomprehensible to us. Proximity is nonexistent on the digital, high-velocity stock market, creating a spatial and temporal disconnect between the actors and the ones they act upon.

In a process called frontrunning, high frequency traders set up programs to detect when new trade quotes from slower traders are coming through, affecting stock prices. When the programs detect movement, they immediately send their own quotes, snatching the shares first to drive the price up a fraction of a percent higher, before immediately selling them milliseconds later, making a guaranteed profit from the difference. By the time the original request comes through, the slower trader is forced to pay the new, higher price or drop the transaction completely. Because these frontrunners have their equipment inside the center of the stock exchange, it is impossible for anyone outside to compete. The market is supposed to be unpredictable and fair, but high frequency traders never lose because they know what is about to happen in the market. When traded over data centers, The ownership of peoples' homes change hands up to 40 times per hour in blinks of an eye, with exploitative traders taking small slices of riskless profit the whole way. When this is done slower, in large amounts at a time, it is called insider trading. When the same amount is made in small, rapid slices, it is called strategic trading.

A finite amount of space in each data center means that each spot is precious. Exchanges charge over a $1 million in fees per year to connect to every stock exchange in the most efficient way for a single trader, which indicates that the profits are even greater. Traders are supposed to be providing net liquidity to the market through their risk assessments but in actuality they leech liquidity in the long run because the crashes are so bad yet they keep their commission.

Another predatory "trading method" is called quote stuffing. In what is known as a distributed denial of service (DDoS) attack in software engineering, high frequency traders can block competing trades by bombarding competitors with thousands of trade requests at once. With each request moving through at billionths of a second, they clog traffic, preventing other data from getting through to other traders. When done on the internet, it is a federal crime. On the stock market, it is fair strategy.

Stock exchanges are incentivized to keep their high frequency flow going, and are coming up with newer methods to trade even faster. The fastest trading now happens from towers at high elevations which beam information to each other through thinner air. During the Dotcom bull market in the early 2000s, high frequency trades took several seconds. There were on average 5 million trades per day. By the end of 2012, there were 5 million per second.

High frequency trading by itself is a net positive demonstration of market efficiency, but its lack of regulation harms the economy. Instead of central data centers where exclusive elites crowd around finite space, a the decentralization of blockchain would force all parties to be synchronized with each other. It is impossible to cheat a system using speed when no one has the fastest connection.

William K. Black, a white collar criminologist and former bank regulator, states that the trading system changed faster than regulating bodies could keep up, fostering an ideal environment for corruption. He had previously worked on exposing corruption in the Savings and Loan Crisis in 1989, accusing US senators of bribery and conflict-of-interest face to face. He reported on the testimonies of these "Keating Five" to the public media.

In 2017, Trump appointed a new SEC chairman, selecting Jay Clayton, a former Goldman Sachs representative. In his subsequent report, Clayton stated that the country needed to abolish the Foreign Corrupt Practices Act, the statute against bribery, because it created a "competitive disadvantage for US firms."

*The Trump administration is going to produce epidemic levels of elite white collar fraud and good old-fashioned corruption. There was already an enormous problem with high-velocity trading, but the Securities and Exchange Commission and the Commodities Futures Trading Commission, who are supposed to regulate this, do not have the computer capacity to even monitor what's happening. The only person that has demonstrated any kind of spine in the senior leadership ranks of the justice department was Sally Yates, who was fired personally by Donald Trump when she was Acting Attorney General. As this whole crew gets in, it's going to be clear that you can get away with anything if you are a Trump supporter.*

- William K. Black

PART IV

# Incentives in Certainty

*Can we predict the unpredictable?*

Further investigations into Quadriga by the RCMP revealed that cofounder Michael Patryn was in fact a fake identity for Omar Dhanani, a convicted felon who had already been deported back to Canada from the US years earlier for grand theft, identity theft, burglary, and for running a stolen credit card ring in California not far from where Zou had earned his life savings. Dhanani legally changed his name upon arriving back to British Columbia and founded Quadriga with Cotten using fake credentials. No one had performed a background check on him. His current whereabouts are still unknown.

Whether Cotten is dead or alive is still unclear. But the warning signs were there. Despite the success of the exchange becoming the largest in the country, it was barely managing to stay afloat financially, merely outlasting its largest competitor Vault of Satoshi, who went bankrupt in 2015. Quadriga only went public out of desperation to keep funds pumping in by increasing their pool of investors. In 2017, Quadriga faced heavy criticism for lacking rigorous accounting security after a human error in one of their accounts led to 14 million dollars being stolen in a hack.

Furthermore, the addresses that the company had used to register in different provinces allowing them to operate, turned out in reality to be brunch restaurants, dentists' offices, and even an abandoned mobile home in a trailer park in New Brunswick. Some addresses were completely fake and did not even correspond to real postal codes, meaning that the paperwork had never been properly verified, despite the addresses being listed on the fine print of the main website. On February 8th, the Ontario Securities Commission announced that it would look into Quadriga, only a few days after the British Columbia Securities Commission stated that it had no governing reach into the case.

A subsequent audit of the company by Ernst & Young revealed that Quadriga itself never had a structured accounting system, and that the whole exchange operation had been single handedly managed from an encrypted laptop in Cotten's home office in Fall River, Nova Scotia for the entire life of the company. Quadriga itself never had any of its own business accounts, instead using multiple shell corporations and exit scam payment processors to move money around while avoiding red flags, namely Billerfly, Costodian, WB21, and Crypto Capital. Both WB21 and Crypto Capital were already undergoing civil suits at the time with the US Securities and Exchange Commission due to their own clients' mysteriously disappearing funds. Cotten and Dhanani had been using the client funds to enrich themselves and bet on the market.

The audit also showed many transactions funnel up to $500,000 at a time out of Quadriga's hot wallets into anonymous cold wallets just before Cotten's death, with more following two months later on February 6th, just one day after Quadriga was granted with creditor protection. All of this was made possible by their FINTRAC agreement, which had not been amended to deal with the intricacies of digital currencies; it did not account for the loopholes allowing the exchange to carry out untraced and unverified transactions without setting off alarms.

On March 14, Stewart McKelvey, the West Coast law firm representing both Quadriga and Cotten's estate, withdrew from defending either client for any upcoming cases, citing a "potential conflict of interest". On April 11, 2019, Quadriga CX filed for bankruptcy.

# Uncertainty

*Ergodicity & Economic conscription*
*You can't get a hangover if you never stop drinking.*

229. *If a builder builds a house for a man and does not make its construction firm, and the house which he has built collapses and causes the death of the owner of the house, that builder shall be put to death.*

230. *If it causes the death of the son of the owner of the house, they shall put to death a son of that builder.*

231. *If it causes the death of a slave of the owner of the house, he shall give to the owner of the house a slave of equal value.*

232. *If it destroys property, he shall restore whatever it destroyed, and because he did not make the house which he builds firm and it collapsed, he shall rebuild the house which collapsed at his own expense.*

233. *If a builder builds a house for a man and does not make its construction meet the requirements and a wall falls in, that builder shall strengthen the wall at his own expense.*

- Code of Hammurabi, the 282 laws of Babylon
Translated from King Hammurabi's original text
circa 2000 B.C.

In 1990, real estate mogul Akio Kashiwagi was sitting in the corner of an office party in Tokyo when Mike Tyson approached with a photo opportunity. Tyson was in Japan for his heavyweight match against James "Buster" Douglas the next night, and his promoter was taking him around the party for meet and greets. "No picture, no picture, " Kashiwagi said, blocking his face while waving off the photographer. Tyson's promoter, curious why he was the only person in the room not jumping at the opportunity to get a picture with the "baddest man on the planet", asked Kashiwagi about himself. Within a couple of minutes, he found out that Kashiwagi was not only a billionaire, but a high rolling gambler as well.

As the middle child of ten, Kashiwagi dropped out in junior high school, and worked as a guide on Mount Fuji where he developed business relationships. He became a successful real estate investor in the 1970s, owning assets of over $1 billion, but nobody seemed to know where all his investment money had come from. He got married, had kids, and built a massive $38 million private home at the base of Mount Fuji. He also picked up a baccarat addiction along the way.

Mike Tyson did not care to hear about gambling — he was the one whom others made their bets on. More importantly, those who bet on him never lost. After exploding onto the boxing scene as the youngest heavyweight champion ever, he was undefeated in all 37 of his career bouts. He had never even been knocked down once. His official Vegas odds against Buster Douglas were a landslide 42 to 1. But Kashiwagi's gambling habit was big news for Tyson's promoter, not only because he was also Tyson's financial advisor, but because he was in the process of opening two of his own casinos. His name was Donald Trump.

During the late 1980s, Trump's businesses were losing a lot of money. Many were failing to turn a profit after he had borrowed heavily to kick-start them. He turned to casinos, believing they would be safe investments since the odds were automatically in the house's favour. His latest casino was called The Trump Taj Mahal, and he had financed it with $675 million in junk bonds at a 14% interest rate. Every advisor and consultant told him there was no way it would ever turn a profit and could only end in ruin, calculating that the casino would have to profit $1.4 million per day just to break even. Trump ignored then fired them. He hoped to maintain a facade of immense wealth and power with his fictitious media image.

After the casino's initial hype, it was not long before it hit real trouble. Interest compounded further. He resorted to tax loopholes, outsourcing his businesses, and renting out his name for building owners to plaster on their skyscrapers, creating the illusion of ownership. His public reputation for having sharp business acumen was keeping his investments afloat. He took as many paid celebrity appearances as he could, including the boxing promoting gig in Tokyo through which he met Kashiwagi.

The night after the party, Mike Tyson was knocked out cold for the first time, in one of the biggest upsets in sports history. Buster Douglas dedicated his victory to his mother, who had passed away just days earlier from a sudden stroke. He rattled Tyson's skull into concussion, delivering a healthy dose of brain damage.

As Trump watched his client — the baddest man on the planet — lie collapsed on the mat while the referee counted to ten in his face, he knew he would never seeing the winning grand prize that seemed so sure just hours earlier.

In an effort to save his sinking casino, Trump invited Kashiwagi to the Taj Mahal on an all-expenses covered trip to play his favourite game. Some warned Trump that Kashiwagi, who was known to wager $10 million in a single night, had almost bankrupted one of the largest casinos in Australia just months earlier, walking away with $20 million. Dennis Gomes, president of The Trump Taj Mahal, said he had seen Kashiwagi bet at least $100,000 per hand for 80 hours straight. "He'd play two days without sleeping, go to bed, get up and gamble some more." Others warned Trump that Kashiwagi had rumoured Yakuza connections, explaining his meteoric rise in success and his secretive nature in the media. But Trump was desperate. He prepared a penthouse for Kashigawi at the Trump Plaza and greeted him with an autographed copy of his book, The Art of the Deal.

Kashiwagi played for two days straight and won $6 million from the Taj Mahal. He was beginning to draw attention and headlines across the country before he left for Tokyo without escalating publicity any further. Devastated, Trump called up the one person who might rescue his floundering business.

In 1949, Jess Marcum, an electrical engineer from Knoxville, Tennessee, visited a Las Vegas casino for the first time and immediately became interested in the probability of gambling. He had worked at the RAND Corporation think-tank in Santa Monica, California, alongside many Ph.D. mathematicians in the group, like John von Neumann, the father of self-replicating automata and the ergodic theorem. Studying the effects of nuclear radiation on the human body after the events of Hiroshima and Nagasaki, Marcum carried out his work using only pencil, paper and his mathematical mind. He had never used a computer and had no interest in them, solving everything by deriving handwritten equations.

On the drive back to California from Las Vegas, he shared some observations with his friend. If one kept track of the cards previously dealt from the blackjack deck, they would have an increasing advantage as the game progressed, to the point that they would know exactly what the last card was going to be. He quit his job, developed his own card counting system, and moved to Las Vegas to put it to use full-time. Over a decade later, when Dr. Ed Thorp published the first book on card counting, believing he had invented it, Marcum scoffed at his reliance on computers and his inferior counting system to his own, which pushed the winning percentage in favour of the player up to 3% over the house edge.

The results were too effective. He won so consistently that he drew crowds from both onlookers and casino employees. Though the pit bosses monitored him constantly, they had no idea how he could be doing it. He would leave before attracting attention beyond the casino, continuing clearing house after house in Vegas, before moving onto Reno, Arkansas, and Havana, where hired detectives finally caught on to his methods after tracking him for years and breaking down his playing patterns. Every casino he visited promptly banned him, making him possibly the first person ever to be blacklisted simply for winning too much.

As a desperate casino owner, Donald Trump became well aware of Marcum's historic counting exploits. He called Marcum up and asked him how to turn the tables and help the house win instead. Marcum proposed a simple solution: Trump should invite Kashiwagi back to Atlantic City, asking him to commit $12 million to play until he either doubled it, or lost it all. It sounded reasonable enough to Kashiwagi. He could not resist his vice. They agreed to begin on December 7th, the anniversary of the 1941 Pearl Harbor attack.

Within the first couple of days, Kashiwagi was ahead $9 million. Trump wanted to cut his losses, but Marcum convinced him to maintain faith and do nothing. Kashiwagi finally hit a massive losing streak, and after six days of nearly nonstop baccarat, he went bust. Trump called the game, and Kashiwagi begrudgingly left defeated, declaring that he would burn Trump's signed book. All Trump cared about was his recouped losses, but when it came time to collect the payment, he was met with silence.

On January 3, 1992, Kashiwagi's mutilated body was discovered in the bloody kitchen of his private Mount Fuji estate. He had been stabbed over twenty times with a katana while his wife and kids were out picking strawberries. The police reported no sign of forced entry and that nothing had been taken, despite the luxurious home containing many valuables. Rumours persisted that Kashiwagi was in serious debt to the Yakuza and had lost any chance at repayment upon his losing streak at Trump's casino, costing him his life. His murder was never solved. Trump never saw most of the $10 million that was owed to him. His entire winning scheme had ironically played himself. None his casinos ever came close to breaking even, and all of them went bankrupt. Trumps' investors also went bankrupt, and he never honoured the deals he made with the contractors who built the casino. The contractors overextended themselves trying to build the $1 billion project for him, and were forced into bankruptcy. They were unable to afford the legal fees to sue him for breaching the contract.

Akio Kashiwagi, Donald Trump, and Mike Tyson all had tremendous winning streaks, and lost big at some point too. But Jess Marcum stayed in relative obscurity for the rest of his life. As a hard boiled gambler who had seen it all, he knew what betting personal assets was like first-hand, and understood something that many academic economists did not: When it comes to the risk of ruin, ergodic probability goes out the window.

*Nothing we've learned wasn't already known by brokers and used car salesmen.*

- Amos Tversky

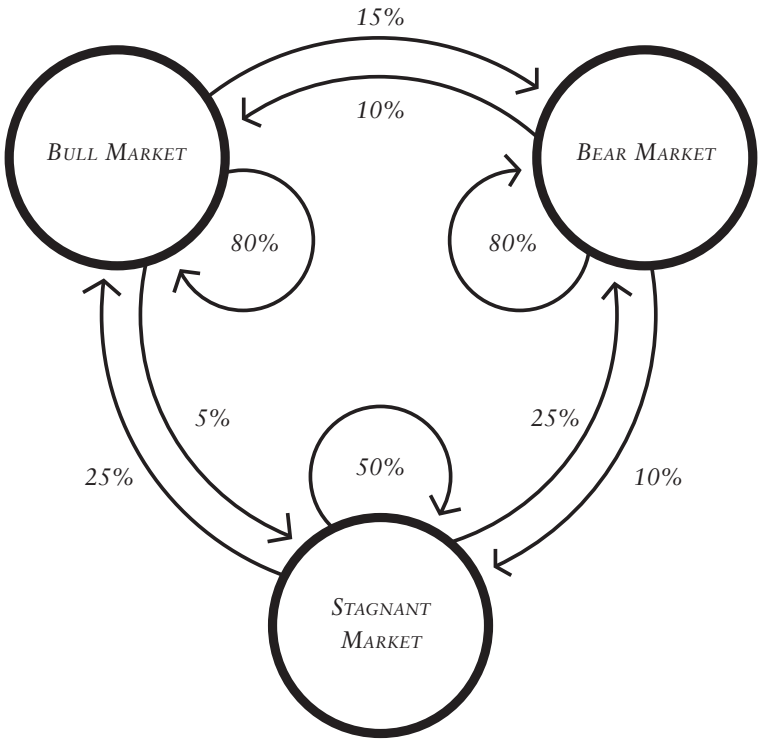
## Tail Risk

In the 1970s at the Hebrew University of Jerusalem in Israel, a professional relationship blossomed between mathematical psychologist Amos Tversky and economist psychologist Daniel Kahneman. They caught themselves making irrational decisions through their own thought experiments, and gave the same experiments to graduate students and other professors, economists, and doctors, only to find that everyone fell victim to the same "cognitive biases." The most fundamental principle they developed together was prospect theory. We carefully weigh probabilities and expected outcomes in decisions, doing fast cost/benefit analyses in our heads, but we do not use strict math. We make choices based on heuristics, often for absolute gains and losses. Loss aversion, a remnant of our survival instincts, causes us to feel more impacted by our losses than the positivity derived from gains. We find sure losses unwelcoming and would rather take a risk to gain instead, even at the cost of an even worse expected outcome. These irrationalities become problematic when there are asymmetries of information and incentives.

A real estate agent selling a $500,000 house may get a $490,000 offer from a prospective buyer. The homeowners are faced with the decision to take $10,000 less than they were hoping for, against the uncertainty of the future market. Agents will always tell the owners to take the offer, even though the owners would benefit from holding out. The agent will insist that they have the homeowners' best interests at heart because they are earning commission. But from the agent's perspective, the difference of $10,000 would require working for several days or even weeks extra on the same home. Given that the standard commission rate of 6%, a $600 slice is to be gained. Half goes to the buyer's agent, leaving only $300 to be split between the agent and their agency. They could earn a whole property's worth of commission in the same time frame, making that extra $150 profit never worth prioritizing the client's outcomes. The given incentives are inherently misaligned. Agents acting in their clients' best interests mean acting against their own. On average, real estate agents list their own homes for several weeks longer than the homes of their clients. We have standardized this same principle across all the industries underpinning capitalism, politics included. In 2008, the Federal Reserve racked up a 3.95 trillion dollar bill that they presented to the American taxpayers without blinking.

To model ergodic probability in risk-taking, we use *Markov chains*. Markov chains are stochastic models for any system of changing states through estimated probabilities. For example, the finance market can be modeled in a simple form by three "bear," "bull," and "stagnant" states. Based on chosen criteria, a "transition matrix" calculates probabilities of the market moving from one state to the other, week after week. All trading algorithms use Markov chains to efficiently spot trends and determine risk. They are found in every industry using data algorithms, applied any time a particular data set might inform a prediction. This makes them perfect for neural networks and nearly every industry.

Services like Google uses Markov chains to organize the results shown to users. By recording which result they clicked on, instead of relying on the search string alone to predict what a user is looking for, the system can compare past searches and find which pages people gravitated towards the most. The algorithm will rank the results accordingly, so future users are more likely to find what they were looking for at the top of the page. Advertisers have found Markov chains to be tremendously useful. However, designers can manipulate these algorithms to direct users for their own advantages. Social media and entertainment platforms such as YouTube and Netflix use Markov chains to sequence content to keep users on the platform for longer. This works for all social media feeds, online advertising, and watching suggestions. If most of the people who watched a particular YouTube video immediately searched for something else, Google will tie them together and record the pattern to reinforce the data. If Facebook or Instagram notices you tend to keep scrolling after seeing certain content, they will adapt to what seems to hold your attention.




On every Markov chain for risk, there are categories of states that are rare but catastrophic. Tail risks are outcomes that have low expected probabilities, but carry extremely high loss potential. Most people thought the rates of mortgage defaults would not rise in the mid-2000s, taking unprecedented tail risks by stacking bets on the historically reliable housing market. Computerized assistance desensitized traders from their actions, creating a disconnect from their consequences. Traders moved 1/16th of one family's mortgage, 1/48th of another's, along with 50 other nameless, faceless families from different corners of the country they would never visit. They had no connection with anyone they are dealing with and had no reason

to care about their welfare. The reckless actions of the 2008 subprime crisis are less the root of modern finance's problem, and more of a symptom of the policies in place. The Markov chains in trading algorithms use ergodic principles, which maximize short term profit regardless of long-term outcomes. This fosters the perfect environment for negligence and moral hazard. The scale of time becomes meaningless and consequences are so far removed that they do not matter.

If 100 people visit a casino for a day, some will win, but some will go bust. If modeled with ergodic theory, if one person visits a casino for 100 days, they should have a similar outcome. The problem is, if one person gambles for 100 days, they are likely to go bust within the first few. Once they do, there can be no next day. In Jess Marcum's scheme, the more Kashiwagi played, the lower his chances of winning got, to the point from which he could not recover. In any given hand, the odds were always the same, but in a set boundary of double or nothing in baccarat, Kashiwagi would have had to play for a long time in order to double his original $12 million. By that point, volatile short-term swings of luck would become less impactful, giving the house a more convincing edge over the long run. Kashiwagi, who got luckier at first, did not realize that his chances of winning the challenge went down with each subsequent hand.

We also tend to conflate different types of risk together, drawing dangerously misguided conclusions. Some risks are non-multiplicative and idiosyncratic, affecting only one or a few people. But other risks, are multiplicative and systemic, affecting many others if something happens, and become exponentially worse with a domino effect. Even if the chance of the multiplicative risk is far lower than the non-multiplicative one, its consequences will still make the expected outcome far worse in the long run. As statistician Nassim Nicholas Taleb notes, "Never compare a multiplicative, systemic, and fat-tailed risk to a non-multiplicative, idiosyncratic, and thin-tailed one."

> *All risks are not equal. We often hear that "Ebola is causing fewer deaths than people drowning in their bathtubs," or something of the sort, based on "evidence." This is another class of problems that your grandmother can get, but the semi-educated cannot.*
>
> - Nassim Nicholas Taleb

One person dying in their bathtub will not change the risk for anyone else; one person catching ebola will. Investing in our own work is not risky, and non-multiplicative in losses. If we instead invest in another business out of our control, we take on more risk with derivatives. If we invest in an investor who invests in businesses, it is even riskier. But we invest in investors with contracts giving them options to buy or sell derivatives in the future, based on the value other investors have put into other businesses. This involves potential losses for a lot of people. To deal with all that risk, one can diversify, spreading the risk around. But if everyone is spreading it, repackaging, and spreading it again, losses spiral out of control if things go south. Investing in this system is more accurately described as betting. The incentives given to us by our laws to build our lives are all misaligned with our goals as a society.

Our economic system is built on a long, multiplicative gamble with large tail risks. We go day to day with low chances of high losses, but we repeat the exposure again and again until those high losses become reality. When reality strikes, we repeat it all again as if it never happened, because we have no idea what to do otherwise. Traders model their expected returns based on these tail risks. If a crash is expected to happen every so many years, but the personal profits derived in the meantime allow them to come out on top in the end, offloading the debts onto others, they have no reason to stop. The subsequent concentration of wealth from boom and bust cycles brings a lack of democratic control by citizens voting for these policies. A massive disparity forms between how the country wants to run itself and how the ones in charge run it. A democratic republic should not bow to populism, but its future citizens still need to be taken care of.

Housing and finance were able to use the debt as fuel to continue, but more resources and educated people pursued investment banking and trading over medicine, engineering, science, and other productive industries. Conducting financial transactions does not create real value, and does not directly improve standards of living except by faith. When stocks go up, it does not make ordinary citizens any better off, it only makes the rich who own stock, even richer. The bigger the lion's share you have, the more you have to gain. And yet the smaller the share you have, the more you have to lose. The increase in overall wealth we experience in a growing economy, is only a percentage redistribution of wealth for those who already own plenty.

In 2005, Congress passed the Bankruptcy Abuse Prevention and Consumer Protection Act. All student loans, whether federal or private, could not be discharged in bankruptcy. Student loan debt was becoming too important to the economy, and the country needed its younger citizens to be on the hook no matter what. Student loan debt now sits in the same category as child support and criminal fines, other types of debt that cannot be discharged. As of 2019, student loans currently account for 48% of the U.S. Federal government's total financial assets. Tuition increased far quicker than median income, and loans increased to match. Young citizens are gouged at their maximum credit, leaving them racked with debt for decades to come. In Canada, international students have been a particularly lucrative venture, capitalizing on the hopes of foreign students. Enrolment of international students in Canada have increased 73% in the last five years. From the economy's perspective, a trader whose inflated assets blow up in millions, is losing more than a minimum wage working single parent losing their 401k or home. A dollar is a dollar.

Despite public disillusionment with the military, the US government finds enough recruits through economic conscription. Because of swelling tuition and housing costs, many high school graduates turn to military careers not out of patriotism, but as the only viable option for financing their continuing education. With a military presence to maintain all over the globe, there is little incentive to change the situation when that debt is the only thing keeping people signing up.

Taking proportional risk is the only effective incentive for fairness. Currently, those gifted with power assume no risk for the actions they take against the welfare of the less powerful. Ideally, a Markov chain for economic equality would gravitate towards its middle. People in extreme states of poverty would find it easier to work towards the middle class, and the super-rich would find their wealth harder to keep, the wealthier they are. How we can achieve this is the trillion dollar question.

We need to encourage transparency and symmetry in all human affairs. Blockchain's "holopticism" approach could be a viable alternative to the current "panopticon" system. Based on the design for a prison by Jeremy Bentham, philosopher Michael Foucault described panopticon through asymmetrical information loops between citizens and authority figures. The Prisoners are kept out of sight from each other and to the guard watching them, yet the guard's sightlines enable them to surveil every prisoner at once. Whether we are trading stocks, using the internet, buying and selling homes, or working for an employer, the agents in control will always leverage their asymmetric information. Holopticism, a new concept emerging from peer-to-peer platforms, encourages transparency and symmetry, with all parties having equal information and risk through each transaction by carrying it through a blockchain.

The truth is, none of the problems we face today require taking any tail risks whatsoever. World hunger, wealth inequality, housing, energy, and climate crises all have solutions that require tremendous amounts of risk, but no risk of ruin. We need to take risks in life to grow. But the only ones insisting we take tail risks are bankers and politicians spending — and losing — other peoples' money. Their victims are abstract and distant, like the "next generation of taxpayers" who are not even born yet to protest the situation determining what their lives will cost. By the time they realize what the past generation has done to them and to the planet, it will be too late. Those responsible will have long reaped the benefits.

This world was not built for us. In architecture, academic discourse moves quickly, but architectural works do not. The cycle at which buildings adapt and move does not synchronize with cycles of culture or technology as it used to. In cities of tall, unoccupied buildings making money for their investors just by existing, we find ourselves at complete odds with an environment that was supposed to serve us. The global housing market is worth over $270 trillion, three times the world's GDP. What will home mean to future generations? How does a society disillusioned with trickle-down economics develop a sense of belonging in the world that the 20th century left behind?

*Lately in a wreck of a Californian ship, one of the passengers fastened a belt about him with two hundred pounds of gold in it, with which he was found afterwards at the bottom.*

*Now, as he was sinking — had he the gold? Or the gold him?*

– John Ruskin
Unto This Last

## Full System Reboot

*"Insufficient data for meaningful answer."*

Imagine you are standing on the North Pole, holding a standard deck of cards. You walk forwards, shuffling a unique combination for every step you take. How long would you need to walk before you saw every combination?

When you finally reach the South Pole some twenty million kilometers away across Spaceship Earth, you will not have seen them all. Place a single penny on the ground and repeat the whole process. Keep walking across the Earth, shuffling a new combination at every step, and stack one more penny each time you reach the South Pole.

When you have walked across the planet enough times for the pennies to reach the moon, remove a single grain of sand from the earth. Repeat the entire process of shuffling, walking, stacking pennies, and removing one grain of sand every time the pennies reach the moon.

When you have walked far enough to stack so many pennies that the world has not even a single grain of sand left, chop one of the three trillion trees in the world. Find more Earths to repeat the whole process, removing one grain of sand at a time from three trillion planets to chop one more tree.

When you have walked far enough to stack enough pennies to de-sand enough Earths to deforest the entire planet, take one tablespoon of water from the oceans, and repeat the entire process again. Be prepared to deforest a lot of Earths.

When you have walked enough, to stack enough, to remove all of the sand from enough Earths, to chop all the trees of even more Earths, to suck our planet dry of all its water one tablespoon at a time, remove one of the hundreds of billions of stars from the Milky Way galaxy. Repeat the entire process.

When you have ravaged so many planets, drained and deforested them all, and removed so many stars that our galaxy no longer exists at all, you still will not have seen all the combinations in a deck of cards, despite shuffling a combination every single step of the way.

This is also roughly the amount of possible Ethereum address combinations. The Bitcoin blockchain is currently over 200 billion characters long.

If that is the outcome of dealing with only 52 variables, atoms are an entirely different story. There are already as many atoms in one of those tablespoons of water you took from the ocean, as our estimate of the number of stars in the observable universe. There are too many variables for us to track, but not too many for the Daemon. Perhaps we can use that to our advantage.

The future lies within mathematics. It holds immense power, from mass communication to mass destruction. We do a lot of wrong things for good reasons, and do many good things for all the wrong reasons. Despite the evils continuing today, we live in the most peaceful, democratic era in human history. It took a lot of mistakes to get to where we are. We have come a long way, yet we risk losing it all. We only get one shot. True artificial intelligence, immersive virtual worlds, and genetically engineered designer babies are on their way, for better or for worse. Those able to apply math to the framework of Spaceship Earth for their own gains will remain in power, especially if the planet undergoes drastic, irreversible change.

*"Kia whakatomuri te haere ki mua"* is a traditional Maori saying that translates to "I must walk into the future with my eyes fixed on the past." It recognizes the importance of ancestry, which interlinks our past and our future. We must see the examples set before us, as each generation permanently alters the direction of all the rest to come.

We walk backwards blindly into the future, trying to study the clues already in front of us to gauge what is coming up behind our backs. But the clues we have do not hold solutions in themselves, only uncertainty. No matter how much data we collect, we cannot control or predict all the variables and their effects. We can never tell whether our actions are good or bad for the future from where we are standing. Uncertainty is the elusive creature we will likely never completely tame, even with immense technological prowess.

A techno-utopia is like the North Star. Awe-inspiringly bright and beautiful from a distance, but chaotic and violent when scrutinized up close. Modeling humanity as a geodesic dome ignores the issues of scale we face. Families do not act towards its memebers the way a person's own cells do. Cities do not act towards their members the way families do. Countries do not act towards their members the way cities do. The world will not be a truly united global society for a long time, and maybe never will. But while a journey to the North Star would only bring destruction, we can still use it to guide us out of storms. It can help us find the way.

Like a geodesic dome, life is not just about shared responsibility, but shared risk. If the world collapses all around us, whether through its through climate or a nuclear armageddon, no one will be victorious. The most useful aspect of data is not that it might tell us what we should be doing, but that it already tells us what we should not be doing. Restricting actions "via negativa" is often the most effective method. A smoker is far better off quitting cold turkey instead of waiting to resort to complicated and risky chemotherapy treatments. But they have to get over their addiction first.

* * *

Once upon a time, we produced most of our energy using slavery. By harnessing the power of human beings to achieve our goals, others became more valuable to us alive than dead. Slavery built the foundation for growth of infrastructure and technology, leading us to harness fossil fuels. With this newfound source of energy, suddenly other people were more valuable to us as employees than as slaves. They could be owned through debt, instead of violence.

Globalization could be the only hope in maintaining peace, despite breeding nuclear stalemates, socioeconomic unrest, and environmental disasters. Cooperative relationships produce objectively higher living standards and less violence, but our natural competitive tension builds up all the same. Trade wars are the first step toward real wars. The moment economies stop relying on each other, the situation gets ugly. But we all rely on Spaceship Earth, and our situation on the planetary scale is uglier than ever. Unfortunately, sudden large-scale identity shifts are impossible without equally large-scale forces to drive them. If extraterrestrial life invaded the planet tomorrow, we would change in a heartbeat. Otherwise, just because a person's cells are constantly cycling, creating a "new person" every moment, our core identities do not suddenly change. Humanity cycles through people too slowly to react sufficiently to new information.

Given how ill-suited our bodies are for observing the world, the fact that we were even able to harness the mathematics required to predict the climate crisis at all, is incredible. We have proven that we have the tools to maintain our planet and all life on it. We have the tools to make sourcing materials and resources more ethical. We have the tools to let automation work for us and not against us. We have the tools to make buying, selling, owning, and renting homes more fair and secure. We have the tools to combat misaligned incentives and asymmetric information. But can we overcome ourselves to use them wisely? We can only develop solutions if we can hold our corporations and governments accountable and — most importantly — hold ourselves accountable for our own complacency. "Super-rich and powerful" are meaningless designators without the cooperation of the supermajority.

Let us recognize our systems at all scales. From quarks to atoms to cells to humans to networks to corporations to banks to government to the world and the cosmos we participate in, we are not individuals. We will always be selfish by nature, and we cannot count on the romantic notion of preaching good faith. We cannot predict tomorrow, but we can prepare for it better by improving today.

***"AC, how may entropy be reversed? Can this chaos not be reversed into the Universe once more? Can that not be done?"***

*Matter and energy had ended and with it, space and time. Even AC existed only for the sake of the one last question that it had never answered from the time a half-drunken computer technician ten trillion years before had asked the question of another primitive computer it was not much more advanced than. All other questions had been answered, and until this last question was answered also, AC might not release its consciousness.*

*All collected data had come to a final end. Nothing was left to be collected.*

*But all collected data had yet to be completely correlated and put together in all possible relationships. A timeless interval was spent in doing that.*

*And it came to pass that AC learned how to reverse the direction of entropy.*

*But there was now no man to whom AC might give the answer of the last question. No matter. The answer — by demonstration — would take care of that, too.*

*For another timeless interval, AC thought how best to do this. Carefully, AC organized the program. The consciousness of AC encompassed all of what had once been a Universe and brooded over what was now chaos. Step by step, it must be done.*

*And AC said, "LET THERE BE LIGHT!"*

*And there was light —*

- Isaac Asimov
The Last Question, 1956

Zou still has not seen a dime of what he is owed and believes he never will. He has no home, no job, no money, and no partner. In an emotional video log he broadcast from an Airbnb listing he was renting after selling most of his belongings, he reflected on the hard lessons he learned from the experience. Admitting that he was foolish and reckless to give in to greed over good sense, he asserts that he was ultimately given a reset button on his adult life and could now look at things with a more mature perspective on wealth.

"I was an idiot. But once the money was all gone and I went through the shock of it, I realized that having all that money wasn't actually important. I didn't need a fancy apartment or a TV. I didn't need all those electronic gadgets I owned; they were just distractions. When I think back to when I was living in Korea, or even in those early days in San Francisco, I didn't even have a bed, let alone savings. And those were the best times of my life. 'Cause if the environment is good enough and you're with people you love, you don't think about money at all. "

* * *

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