



REGENERATIVE TECHNOLOGY
PROJECT


REGENERATIVE TECHNOLOGY

Technological Innovation in Service to Life


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with Danielle Lanyard

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INTRODUCTION

Imagine a future where technology aligns with living systems, where we marvel at our tools for supporting a flourishing planet for all beings. A future in which the human technosphere is in harmony with the biosphere.

The tech industry is at a unique crossroads of awe-inspiring technological advancement and the grave urgency of compounding crises. Proliferating tools and algorithms, petabytes of data, billions of participants, and trillions of relationships are accelerated by an insatiable industrial economy that extracts more than it restores.





Technology acts as an enabler and accelerant in bringing forth the paradigm in which it's rooted. "Modern" technology structures haven't just become disconnected from living systems, many are synonymous with exploitation of people and the planet.

As the earth's resources are being depleted and social foundations erode, the dominant culture and structures in tech—relentless race to amass power, profits, and our attention—have already had profound systemic impacts: eroding public discourse, information integrity, our mental health, and our connections with life on earth, all while consuming exponentially more natural resources.

Recognizing that we shape technology, and technology shapes us and our whole story, is a crucial starting point for co-creating a better future. We propose a new technological era, in which we widen our aperture beyond "digital transformation" of obsolete models and instead use technology in service to the regeneration of life and a liveable future for all beings.

A regenerative approach to technological innovation recognizes our interconnectedness and is rooted in a whole systems view. Our tools are not just inert objects. They exist within a larger, living web of relationships; an ecology of technology.

This whitepaper invites the tech industry, and all of us co-creators, into a new technological era centered on regeneration and alignment with nature's wisdom. Regenerative Technology is an orientation and invitation to develop technologies in service to systemic health and resilience. This paper seeks to:

-  Define this concept, rooting design into the principles of living systems
-  Propose the key shifts regenerative technology supports
-  Introduce the "Regenerative Tech Stack"
-  Explore an Ecology of Technology

We invite folks from across tech, business, investors, builders, students, retirees, farmers, the Fortune 500— all of us "users"— to co-create this way forward, to reorient technological innovation through the lens of systemic health, and cultivate the "soil" for a regenerative technology ecosystem.



DEAR DISENCHANTED TECHIES,

Remember that spark of wonder when you first made a computer do something incredible? That feeling that you could change the world with a few lines of code? The web was magic and it was exhilarating to catch that fire.

That ember is still there, buried under layers of corporate jargon and KPIs. It's embedded into that nagging question, "what's all of this for?"

Tech can be brutal. We're caught in a whirlwind of constant change, expected to "innovate" at breakneck speeds while grappling with ruthless market pressures. Amidst all the sprints, the FOMO, the trade-offs, the burnout, the moving fast and breaking things, it's easy to lose sight of why we got into tech in the first place.

We have the power to reclaim and reignite that spark. To look deeply into our hearts and channel our skills into something bigger than the latest app or tech trend. What if we could be part of a global collaborative transition that shifts technology to be in service of a just and thriving future for all life on the planet?

We wrote this paper to invite you into a very big question.

What might be possible if we approached tech as though we actually belonged to the living world?

We are not offering answers, rather we are inviting the Tech sector to live this question.

Imagine using your data modeling skills to protect endangered species, improve soil health, or aid an ailing neighbor. Picture devising algorithms that help us learn from nature's genius and inspire new designs perhaps a whole new infrastructure. Envision building platforms that help distribute resources more equitably, or foster real-world relationships, or repurpose production waste into value.

This isn't a lofty, unattainable ideal. It was the north star that guided Tim Berners-Lee to invent the web to enable a global network to share more easily. In pockets all around the world, it's already happening. Techies just like you are (em)powering-up, choosing to wield their tech skills towards a greater wellbeing. They're asking hard questions about who their work serves and what their (and their children's) relationship with technology is. They make conscious choices to align their values with value creation.

No, you don't need to quit your job or become an activist overnight. Start local. Seek projects or opportunities in your current role that speak to you. Connect with like-minded colleagues. Inquire into a cause you care about. Bloom where planted.

The world needs your brilliance, your creativity, and your unique perspective. Not just to build the next shiny gadget, but to work on the real, messy, vital challenges facing our planet, our communities, and the next seven generations. You are a small and mighty node of energy with unlimited potential in a vast and giant interconnected web of life.

We can hack the operating system of tech itself, but it may require us to hack ourselves first.

Let's rekindle that spark. Let's code a better world together. Let's cultivate the soil to build a future where technology truly serves to restore ecosystems and enhance everyone's quality of life.



PART 1

DIGITALLY DISRUPTED THE CASE FOR REGENERATIVE TECHNOLOGY



TECHNOLOGY IS EVERYWHERE

We live in an era of immense technological development, adoption, and scale. In every corner of the planet, our increasingly prolific tools underlie so much: our economy, all industries and geopolitics, how we work, connect, plan, and much more.

“Digitalization” is transforming our energy grids, agriculture, finance, healthcare, education, and media. Today more than 17 billion devices create networks of information, sensors, and electricity that power everything from our lights, vehicles, and factories to our media, healthcare, and financial systems. [1] There isn’t a place on earth where technology isn’t present (thank you satellites), or where humans and the more-than-human world aren’t impacted by tech.

Chances are, you are using technology to read these very words on a digital screen at this very moment! From the minute we wake up in the morning, technology mediates our relationships. An alarm goes off. The kettle boils with anticipation. Open the refrigerator, prepare breakfast. Pick out clothes for the day, don’t forget a jacket. And your phone! The car starts, the train departs. The computer opens. The machines hum. Text the spouse to order dinner. Watch a movie with the kids. Streaming, meming, scrolling, scrolling, scrolling....

From smartphones that put the world’s knowledge at our fingertips to artificial intelligence systems that can diagnose diseases and create art, we are surrounded by technologies that, just a few decades ago, would have seemed like science fiction, even magic. These and more new waves of tech, from wearables to robotics, blockchain to synthetic biology, and countless others, are already influencing life today and shaping our assumptions about the future.

But our relationship to technology is far deeper and wider than today’s devices. It shapes our relationships with ourselves, one another, our organizations, our structures, and the world around us.



What do you think about
when you think about
your **relationship with
technology?**



What is Technology?

You might be wondering what we mean by technology. When we think of technology, our minds often jump to tangible objects like smartphones, washing machines, or even hammers. The conventional definition of technology is: “objects that humans use to apply knowledge to a specific area to solve problems” often using science and systems in a reproducible way. But this definition perpetuates the illusion that technology is separate from our intentions and from the natural world. If we question our preconceptions of what we think technology is, we may uncover and reconnect to its far more expansive and interconnected role. One that is essential to realigning ourselves and our tools with the living world we all share.



Technology is the structuring of materials, energy, and information to adapt and thrive.

Technologies can be understood as operating through the dynamic interplay of three key elements: materials, energy, and information. Like the interconnected systems within a living organism, all technologies are inherently in relationship across these dimensions. Just as a cell requires its physical structure (materials), metabolic processes (energy), and genetic code (information) to function, technologies similarly rely on the integration of these three elements to operate effectively.

This definition of technology spans far beyond digital, even beyond humans. Consider a washing machine; it is made of metals, plastics, glues, and other materials. It requires energy to spin and clean clothes. And it relies on a wealth of information, from the engineering knowledge used to design and manufacture it, to programming of the spin cycles, to the user manual few bother to read. Even something as seemingly “low tech” as a hammer or a beaver dam embodies these elements. Both are made of materials like steel or wood, require energy from bodies to function, and rely on knowledge (humans or beavers’) informing how to assemble or use them effectively.

While much of this paper focuses on digital tech, we offer this integrated definition of tech:



to help remind us of the
entangled relationships our
tech has with the world.



To ask what our relationship with technology is,
is to ask ourselves what kind of future we as a society
want to create.



DIGITAL TRANSFORMATION IN SERVICE OF WHAT?

The last two decades of “disruptive innovation” have been characterized by the digital revolution, where silicon, software, and “digital transformation” promised efficiency gains and increased profitability to businesses. Billions of dollars have flowed into technological infrastructure based on the truism that tech is a necessary evolution for companies to automate operations, remain competitive, reimagine products and services, and deliver value to customers.

While digital transformation promised to revolutionize industries, in many cases it has primarily served to harvest even higher profit margins for shareholders, and accelerate and amplify harmful business models and practices. Though commonly hailed as the great innovations of our time, today’s digital darlings have prioritized proprietary gains over the health of the ecosystems on which they rely.



Social media platforms have amplified division, undermined trust and discourse, and exacerbated the mental health crises (particularly among youth).



E-commerce platforms have accelerated the linear economy, increasing consumption and sending ever more stuff (including e-waste) into landfills.



Cloud platforms accelerate asymmetries: of data, information, AI, and power, creating unfair dynamics between the world’s most powerful corporations and workers, small businesses, marginalized communities, and their own users’ digital rights.

**Imagine digital platforms
that support bioregional
community resilience,
accelerate circular and
local economies, and
distribute the value and
digital rights across
billions of users.**

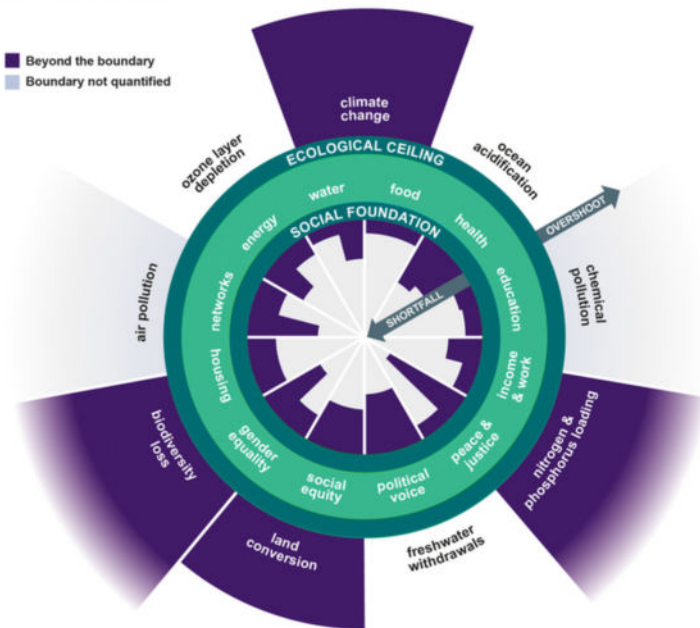


These examples demonstrate the profound potential for systemic impact that our technology has. It is undoubtedly true that our modern technologies have brought about amazing benefits. Even beyond convenience and economic value, technologies are facilitating a wide range of applications that address complex global challenges and improve the lives of people and other beings all over the planet. (See examples on the sidebar to the right)

Yet enterprise digital transformation has largely focused on amassing power and profits. Optimizing for narrow metrics has only distanced us from the impacts and interrelationships these companies have with the living world. While 89 percent of global corporations are investing in digital and AI transformation in 2024, [2] a mere five percent include nature in their business assessments. [3]

All this while the scientific evidence is unequivocal: six of nine planetary boundaries have already been crossed. [4] Others will likely be transgressed in the near future. Humanity will face even more severe environmental and social crises in the coming years and decades.

Figure 1: Overshooting Planetary Boundaries, as Social Foundations Erode



Source: The Doughnut of Social and Planetary Boundaries, Kate Raworth, 2017
Based on 9 planetary boundaries (Rockstrom et al, 2009)
Based on 12 dimensions of social foundation (Social Development Goals, 2015)

Instead of fostering truly innovative approaches that harness tech to address societal, environmental, and economic challenges, many organizations use digital transformation solely to optimize proprietary gains for shareholders. They deprioritize areas like interoperability and privacy, and ignore the needs of the ecosystem.

True digital transformation is in its embryonic state. Extractive economic structures are preventing businesses and humanity from addressing our greatest systemic challenges.

We're awash in new tech, but it's serving an old paradigm.

Tech can help us address global challenges

AI-powered crop management systems help address food security and promote more sustainable agriculture through data analytics which optimize irrigation, predict pest outbreaks, and improve crop yields while reducing water usage and pesticide application.

Blockchain for supply chain transparency helps track and verify ethical sourcing, product provenance, fair trade, and reduce environmental impacts.

Mobile banking and digital finance have increased financial inclusion in developing countries, allowing people without traditional bank accounts to access financial services, receive payments, and participate in the broader economy.

Crowdfunding platforms help democratize access to capital, particularly for projects addressing social and environmental issues that otherwise struggle to secure traditional funding by allowing entrepreneurs and social initiatives to raise funds directly from supporters.

Smart grid technologies play a critical role in transitioning to more sustainable energy systems by using IoT devices and AI to optimize energy distribution, integrate renewable energy sources, and reduce power waste.

Wildlife monitoring systems enable more efficient and proactive conservation efforts with minimal human intervention by using camera traps, drones, and satellites to collect and analyze data to identify animals, detect threats, prevent poaching, and provide real-time alerts.



NEW TECHNOLOGIES, SAME OLD PLAYBOOK

Prior to the industrial revolution, markets played a minor role in human affairs. Around the late 19th century, a new epistemology emerged: The mechanistic mindset, which understood nature, humans, markets as machines would come to alter humankind's economic relationships. This new industrial economic “machine” commodified human activity (as labor), nature (as land), and exchange (as money). The digitalization of this machine commodifies human activity, nature, and exchange into tradable data to be monetized. Digital has become an accelerating extension of extractive models that disconnect us from one another, and the biosphere on which we all rely.

For all of technology’s power and marvel, entrenched economic structures adhere our technological infrastructures to an old playbook, replicating outmoded logic and processes. Put simply, we’ve been using the same playbook in the digital economy as we have in the physical economy. The playbook goes like this:

Figure 2: Parallel Playbooks Accelerating Extraction in the Digital Age



Our physical (material) economy runs on a foundation of mining or extracting natural resources irrespective of its environmental destruction and pollution. The playbook takes from peoples and lands without asking, never mind compensating or accounting for such extraction. Millions of people, and billions of other creatures from soil to sky have been brutalized, enslaved, and dislocated in this relentless pursuit of material wealth.

The playbook in the digital economy extends this logic, mining behavioral resources (data), taking from people and lands without asking, never mind compensating or accounting for doing so. Millions of people’s data have been utilized against them, manipulating their beliefs, behaviors, perceptions of self-worth, stealing their dignity and identities, and even to target political dissidents. **Self-sovereignty and agency over our data has been seized from us, just as land was stolen from indigenous and marginalized peoples.**



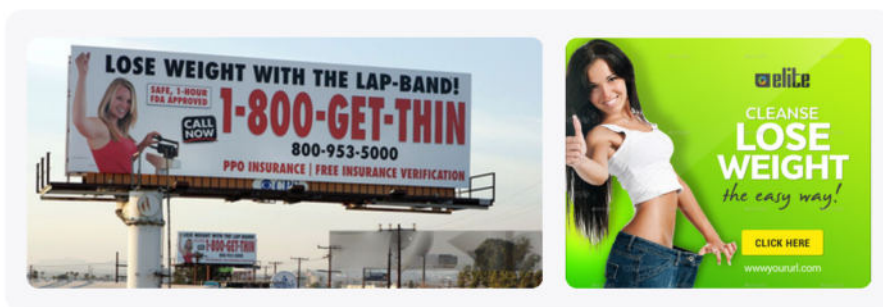
“Surveillance capitalism unilaterally claims human experience as free raw material for translation into behavioral data, declared as a proprietary behavioral surplus, fed into advanced manufacturing processes known as “machine intelligence,” and fabricated into prediction products that anticipate what you will do now, soon, and later.”

- Shoshanna Zuboff, in The Age of Surveillance Capitalism [5]

”

The physical economy uses machines and standardization to maximize efficiencies as a means of mass production and scale. Despite the harms to future generations. In the digital economy, algorithms are a means of mass production, and behavioral modification, putting humans into standard categories to maximize efficient “personalization at scale.” Despite the harms to future generations. Desires and fears are the fuel of consumption in both the physical and digital economies, using advertising tactics like scarcity and social comparison to reinforce notions of inadequacy and drive impulsive purchases.

Figure 3: Analogue and Digital Advertising



Source: Google Images

The physical economy is predominantly designed around linear economic models, in which supply chains are designed for low product longevity, even single-use, before going into the dumpster. Business models of “planned obsolescence” are integral to revenue strategies across many industries. The digital economy takes a page from the playbook here too. Tech continues to churn out new iterations of devices and software to fuel the desire for upgrades; while constantly advertising us to buy useless junk we don’t actually need.

“The fatuity of the products is matched by the profundity of the impacts. Rare materials, complex electronics, the energy needed for manufacture and transport are extracted, refined, and combined into compounds of utter pointlessness...”

We are screwing the planet to make solar-powered bath thermometers and desktop crazy golfers. People in eastern Congo are massacred to facilitate smart phone upgrades of ever diminishing marginal utility. Forests are felled to make “personalized heart-shaped wooden cheese board sets”. Rivers are poisoned to manufacture talking fish.”

- George Monbiot [6]

”

Extractive metaphors are everywhere in tech culture. Those close to the tech world will be all too familiar with terms like “landgrabs,” “goldrush,” “blitzscaling,” and infamous mottos like “move fast and break things” or **“when the product is free, you’re the product.”**

Recent digital economy scholars point out users aren’t even the product. The real product is created by the computational systems that turn the commodity (humans’ data) into expensive digital products, like hogs to sausage.

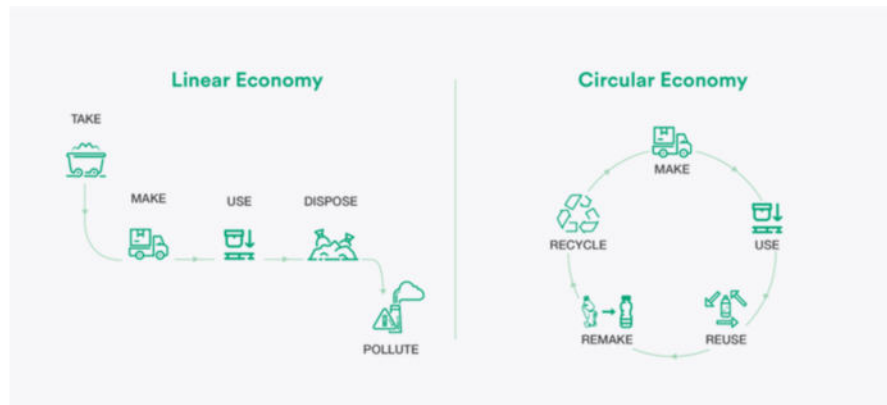
Who
does this
extractive
economy
serve?

From ads on our Instagram feeds to single-click purchases on Amazon, the digital economy has accelerated the extractive consumption economy with new methods of distribution.

Simultaneously, it has created an invisible network atop the physical economy that trades in computer-ready data.



Figure 4: Linear Economy versus Circular Economy



Source: Recycle Track System (RTS)

These linear models are not only accumulating hundreds of millions of tons of waste in landfills every year, they are causing record-breaking levels of pollution, forever chemicals, and contaminants in our air, soil, waterways, and oceans – the same water and soils we, other beings, and our food systems rely on. These models are the reason microplastics are now found everywhere from the deepest ocean trenches to glacial peaks in Antarctica, from human sperm and breastmilk, to insects, birds, and farm animals. [7]

Such models of unquestioned extraction and pollution are driving land degradation, from soil erosion to deforestation, and disrupting and displacing local communities' abilities to grow food, preserve their livelihoods and cultural heritage. These injustices largely befall communities across the Global South, yet they underpin the foundation of industrialized consumption and economic growth in the Global North.

Recognizing these old patterns gives new resonance to the commonly used descriptor of the digital age “the fourth industrial revolution.” [8]

The same top-down, colonialistic approach in the physical economy, in which powerful governments and corporations impose their models of material extraction onto low income and low tech countries, echoes in the digital world. Today, Tech giants dominate the digital landscape with their infrastructure, designs, data regimes, the English language, and more. This often reinforces dependencies, perpetuates inequalities, hampers local innovation and widens the digital divide.

Figure 5: Meta (Facebook) Uses Content Moderation Farms to Train AI

"You can't unsee it': content moderators take on Facebook

Contractors in Kenya review graphic content so users don't have to. Now, they are suing Meta for a fairer deal

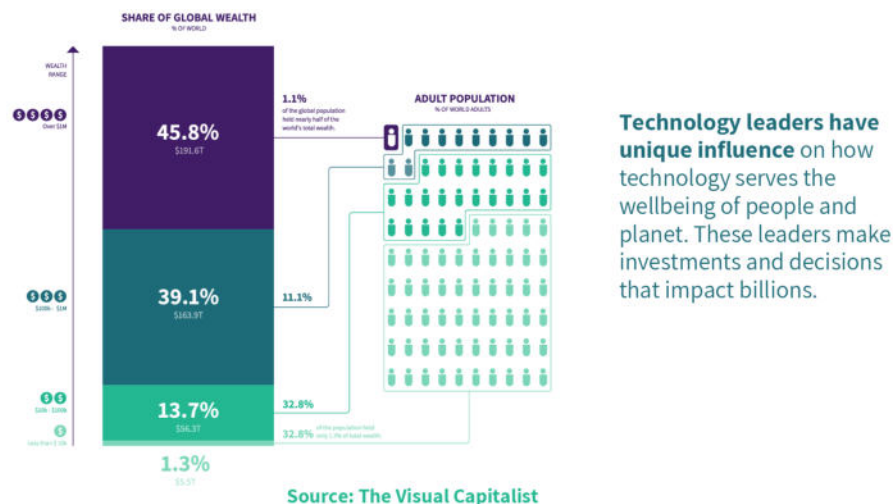
Source: Financial Times

Tech companies use AI to moderate most of their content, but outsource human moderation to other firms, often offshore such that workers do not appear on their annual reports. In 2020, Facebook paid a \$52m settlement covering 11,000 moderators who suffered from PTSD on the job. “Content moderation” is a euphemism to describe the painful work of sorting through horrific images and videos submitted on their platforms. [9]



Tech giants, like the oil and financial barons before them, enjoy massive power and information asymmetries. Consider just four companies control some 67% of the world's cloud infrastructure. [10] Just six tech corporations comprise 30% of the S&P 500 Index. [11] This dynamic is echoed in asymmetries in environmental degradation, where just 90 corporations are responsible for two-thirds of global industrial emissions. [12]

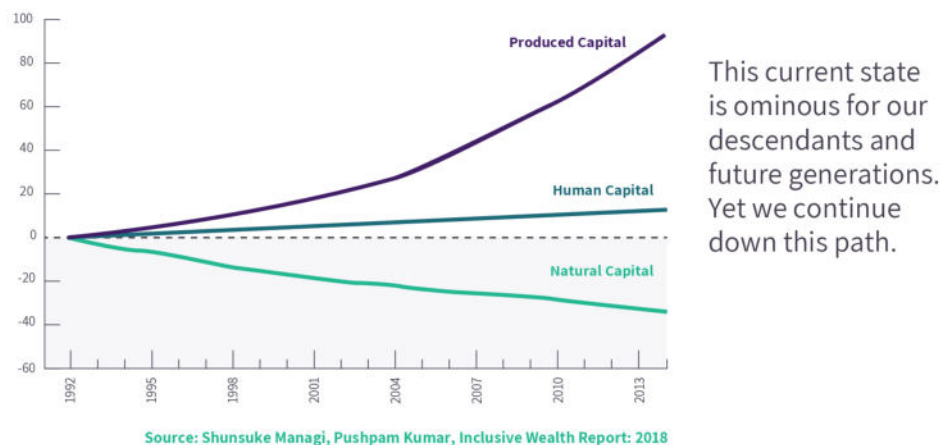
Figure 6: Global Wealth Distribution



Ignoring the human and ecological “costs” is part of the industrial playbook. We must, of course, acknowledge just how much the industrial age has improved the quality of life for many (albeit unevenly distributed). Poverty reduction, literacy rates, child mortality, life expectancy have all increased in the last 250 years. Yes, the material standard of living for the average person in the world is higher today than ever. But while focusing on material investments and outputs, we have overlooked investment in human, social, and natural capital.

The 2018 Inclusive Wealth Report tracked accounting values of produced capital, human capital, and natural capital across 140 countries and found that globally produced capital (i.e. material goods) per head doubled and human capital per head increased by about 13%, but the value of the stock of natural capital (i.e. environmental “services”) per head declined by nearly 40%. [13]

Figure 7: Wealth Gap, Tech Data Chart, Acceleration Chart



How might our digitized economy support a shift...

from extreme wealth and power asymmetries

to more just and equitable models that distribute agency and value across participants?



TECH'S TRAJECTORY IS POISED TO FURTHER ACCELERATE THE EXTRACTIVE PLAYBOOK

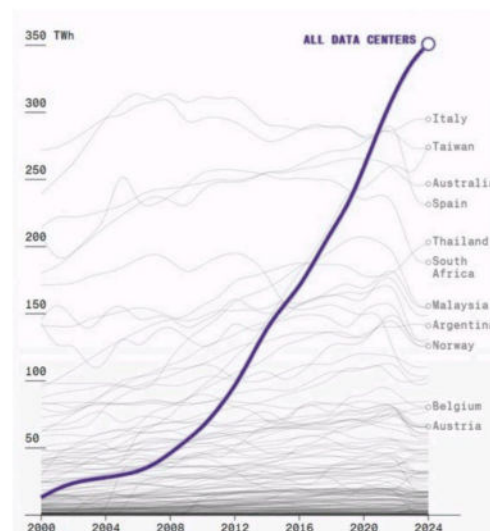
Many of today's most breakthrough "innovative" emerging technologies are poised to exacerbate the extractive trajectory of tech. If we take into account current projections around the growth of artificial intelligence, cloud computing, streaming, gaming, crypto transactions, blockchain, and virtual reality, the International Energy Agency and MIT forecast data centers will demand 21% of the world's electricity supply by 2030. [14] Emissions from end-user devices are estimated to increase at a CAGR of 12.8% per year. [15] Today we generate more than 50 million tons of e-waste per year, that number is expected to double by 2050, according to the United Nations. [16]

"Data is the new oil," often said as a rallying call to invest in tech, deaf to the environmental and societal inflictions this analogy invites. Yet there is an accuracy to this phrase. All of the above is, of course, powered by the energy economy, which uses mostly fossil fuels (and some renewables). The inverse is also coming true; nine out of ten oil companies are investing in AI.



Figure 8: Energy Demands of Artificial Intelligence are Growing Exponentially

Altogether, data centers use more electricity than most countries
Only 16 nations, including the US and China, consume more



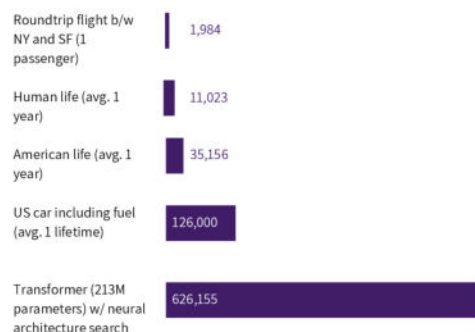
Sources: Bloomberg analysis of BloombergNEF and DC Byte data

Note: Data center energy consumption through Q1 2024. National energy consumption levels are actual through 2022 and projected for 2023 and 2024.

Data centers could demand 21% of the world's electricity supply by 2030,

an IEA/MIT forecast which, in addition to AI, incorporates cloud streaming, gaming, blockchain, and virtual reality. [14]

Common carbon footprint benchmarks in lbs of CO2 equivalent



Source: MIT Technology Review; Strubell et al. [20]

Instead of an extractive "data as the new oil," metaphor, what if asked how we might understand "data as the new soil" for innovation that supports the health of living systems?

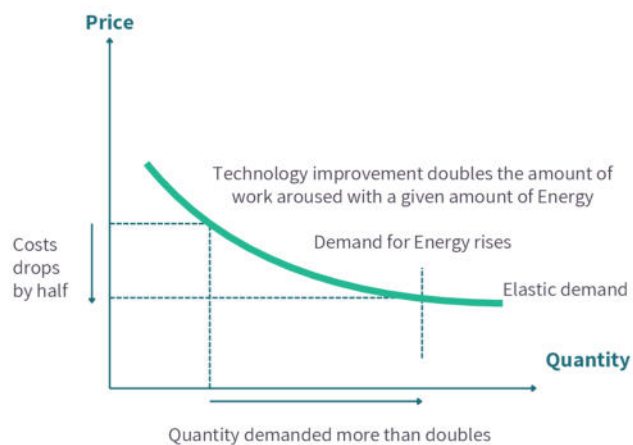
The tech industry's push to accelerate as rapidly as possible has compounded into a global race dynamic, which only accelerates the playbook. [18] Google and Microsoft, among others, are making huge investments in AI for their cloud services business and as the foundation for future revenues. In 2024, both companies reported substantial increases in greenhouse gas emissions (13% since 2023 and 30% since 2020 respectively, undermining earlier net zero pledges). [19] Both attest these increases are driven by the energy appetite of AI.



Artificial intelligence exemplifies one of several “exponential technologies,” characterized by their abilities to grow, disrupt, or converge with one another in ways that catalyze radical change. Robotics, renewables, genomics, 3D printing are all technologies poised to displace current infrastructure, and their material and energy demands.

Our trajectory of accelerating exponential technologies which promise greater efficiencies also confronts us with Jevons Paradox. This is the phenomenon where technological improvements in resource efficiency lead to increased consumption – not conservation – of that resource. In 1865, economist William Stanley Jevons noticed that as engineers made engines more efficient using less coal per unit of output, factories didn't just use less coal. Instead, they ran engines longer since it was cheaper to do so, and powered more machinery because the efficiency made it more economical. Oil refineries, cars, appliances, and industrial processes have all exemplified Jevons Paradox. Will our exponential technological efficiency gains lead to exponential increases in resource utilization?

Figure 9: Jevons Paradox



Underlying every efficiency-promising digital platform are orbits of hardware, software, storage, and AI, each of which can spell significant energy computation, heat, emissions, water, electronic waste, and land use.

This is not a reason to disband from technological development. Technology presents both unprecedented peril and transformative potential across many challenges we face, but navigating this complexity with an outdated extractive playbook is bound to produce the same extractive results.

”
Regenerative Technology is a profound provocation... to ask how we design and invest in technology to regenerate ourselves, our organizations, and our economies.

John Fullerton, Founder of the Capital Institute





To become regenerative, the digital has to be treated as more than a mere technology. It is a space, an ideology, and it's also a language. Like all languages, its distinct logic shapes its design, which shapes what can and can't be known, which interactions are allowed and not.

The digital is an explicit language, poorly equipped to understand and honor the subtleties and richness of the tacit ways of knowing that are so fundamental to humans and the whole of life. By overly relying on algorithmic ways of knowing, we create an impoverished understanding of the world around us.

Regenerative Tech is an approach to the digital that recognizes this need for balance.

- Helene Liu, PhD, Author of [Datafiction & Technology](#)



SHIFTING TOWARDS AN ECOLOGY OF TECHNOLOGY

"We shape our tools, and our tools thereafter shape us," as the famous saying goes. [23] To shift the paradigm of our technological age to one that serves life and systemic health, we must recognize this entangled relationship.

Throughout human history, technology has evolved alongside all other aspects of human society. They are in constant circular relationship with our values systems, our social systems, and the built world. (As a social system, our economic playbook part of this entangled web too.) These systems interact dynamically, with changes in one influencing the others, weaving the web that defines and shapes cultural, societal and technological evolution.

This web of influence isn't just a modern phenomenon. From stone tools to the plow, from the printing press to cars, buildings, televisions, or social media platforms, material creations are in dynamic relationship with us and everything else.

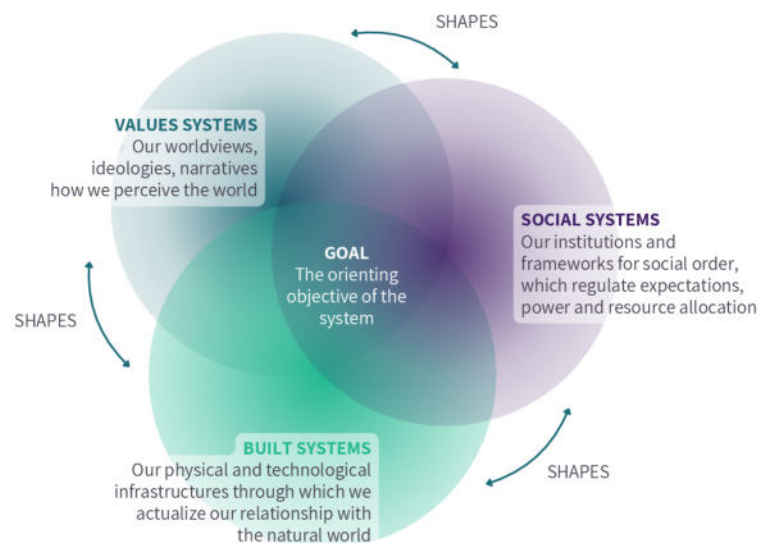
When we recognize technologies never live in isolation from the ideologies of their time, we see what's happening today is not unprecedented.

Recognizing that
technology shapes us,
and is inextricably part of
the ecology of our human
story, is a crucial starting
point for co-creating a
better future,
a better story.

"We shape our tools and
thereafter our tools shape us."

—Marshall McLuhan, Canadian media theorist

**Figure 10: A Complex Relationship:
Values Systems, Social Systems, Built Systems**



Our values, institutions, and technologies co-create each other. Consider the printing press, an incredible technological innovation whose invention and global spread was among the most influential events in the second millennium. Printing of thousands of books in vernacular languages allowed information and innovative ideas to spread widely, crossing borders and engaging the masses.

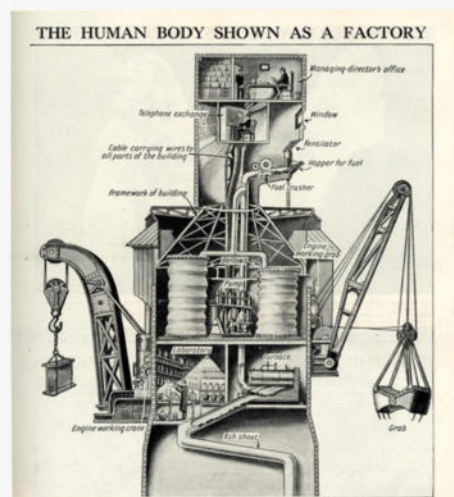
Soaring literacy rates contributed to a shift in power, challenging the authority of the educated elite's control over learning and empowering the growing middle class. A new social fabric emerged. Books printed in vernacular languages not only reduced Latin's dominance as a common tongue, but also helped develop a stronger sense of cultural identity, leading to early forms of nationalism.

Like the internet, a new substrate for mass communications emerged, underpinning the spread of Europe's dominance and the "enlightenment" period.



The predominant values system underlying the industrial and technological age is a mechanistic worldview. Prominent in Western, industrialized social structures, mechanistic ways of thinking and designing emphasize reductionism and linear causality, viewing any “thing” including natural and social phenomena, as made up of discrete parts with predictable interactions that can be controlled.

This metaphor informs how we build, invest in, and design technologies, how we separate problems into parts, industries (and people) into classifications, our businesses into functional silos, “success” into singular metrics, etc. Indeed, business is full of mechanistic metaphors, comparing organizations to “well-oiled machines,” employees to “cogs” and “resources to optimize performance and productivity”, creating “chains of command” in leadership. Seeking narrow outcomes, we’re trained to prioritize efficiency and short-term gains. We favor optimization of individuals and rivalrous dynamics, deprioritizing the health of the whole.



A 1933 Image portraying the human body as a factory. [24]

By focusing on isolated parts rather than whole systems, mechanistic approaches often take parts out of their contexts. We overlook and “externalize” inconvenient or seemingly unrelated relationship factors from the “part” in focus: “Maximize industrial output, ignoring environmental harms; globalize supply chains, ignoring community harms; take a pill, ignoring lifestyle or side effects; scale AI as fast as possible, ignoring energy costs and societal risks.”

Simultaneously, this mindset and approach has been, well, instrumental to countless scientific discoveries and technological infrastructure, from the atom to computer algorithms to assembly lines to the airplane. Mechanistic approaches to problem-solving have enabled the creation of standardized, efficient, and scalable solutions, and remarkable advancements not just in technology, but in fields like medicine, transportation, and communication.

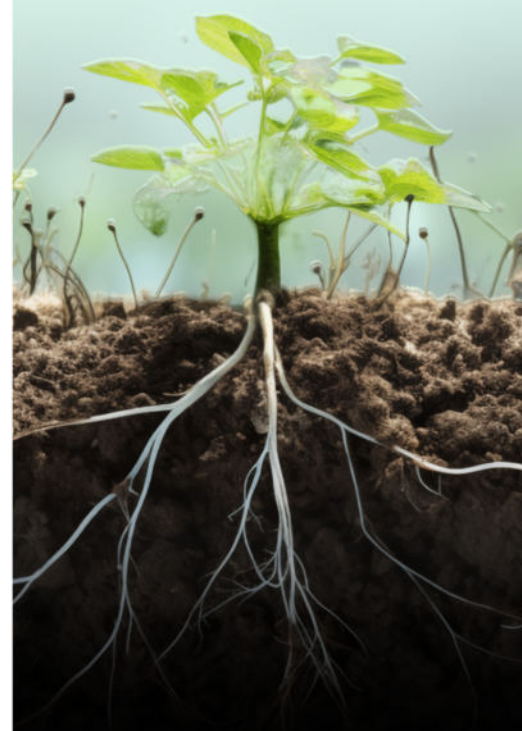
We spotlight this values system here not to condemn it. Our existing framework, while not inherently bad or wrong, is simply incomplete. It is inadequate to address the systemic complexity of our time, or for building resilience for changes to come.

The imperative to shift from a mechanistic to an ecological perspective on technological innovation is not a rejection of our current paradigm. It is an evolution towards a more holistic and adaptive one which creates technologies that recognize our interdependency and co-evolution with our values systems, our social systems, and our built infrastructures. A regenerative approach to technology it invites us to embrace the ecologies that inform its– and our– evolution.

We live in the “metacrisis” era,

defined as a complex web of multiple interconnected and compounding global challenges and uncertainties. [22] Environmental degradation, public health crises, political and financial system instabilities, geopolitical arms races, nuclear escalation, runaway AI and synthetic biology, social and wealth inequality, disinformation, diminishing mental health, and widespread erosion of trust... to name a few.

Today we address this tangled and interdependent knot by focusing on “silver bullet” approaches, single threads, technologies, and metrics.



Shifting from a mechanistic worldview to one that recognizes tech’s interrelationships –its ecology– with life itself, is a part of the co-evolution needed to steward technology that serves life.



SEEING THE ECOLOGY OF TECHNOLOGY

How can we see clearly the complex relationships– the ecology– within which our technologies are embedded?

Technologies are active participants shaping our world, our behaviors, our perceptions, our societies, our ecosystems, and the lives of trillions of beings. Just as biological organisms in a natural ecosystem interact and influence each other, so technologies take in resources (materials, energy, information), transform them, and generate interactions with the larger ecosystem.

Author and technologist, James Bridle underscores this urgency, writing in his book *Ways of Being*. “If we are to address the wholesale despoliation of the planet, and our growing helplessness in the face of vast computational power, then we must find ways to reconcile our technological prowess and sense of human uniqueness with an earthy sensibility and attentiveness to the interconnectedness of all things. We must learn to live with the world, rather than seek to dominate it. In short, **we must discover an ecology of technology.**” [25]

**An ecology of technology
embraces the interactions,
interrelationships, and interdependencies
between technologies, humanity’s
structures, and the living world.**

An ecology refers to the relationships and interactions among organisms and their environment; everything that surrounds the organism and allows it to be. Unlike other fields of science, ecology’s study of matrices of interrelationships offers an attitude or way of seeing that is applicable far beyond the field. Indeed an ecological approach is permeating health, psychology, economics, math, politics and more. Strangely, the technology field has struggled to embrace its ecology, even if tech as an industry is all about “early adoption!”



Ecologies of technology are everywhere, interwoven into just about everything. Yet they are almost never part of technology design. Uncovering these relationships starts with observing how we embed our values systems into our technologies. These assumptions, values, and biases directly inform the technological applications we design, and indirectly influence their materiality, energy consumption, interoperability, and all manner of relationships with the physical world and physical bodies. Then there are the infinite relational dynamics our technologies play across our social structures, culturally, politically, economically, psychologically, in business, and far beyond. Just about everywhere you look, our technology systems and our living systems are entangled with one another.

At the time of this writing, roughly 67% of the global population, some 5.44 billion human beings, are connected to the internet, with the average person worldwide spending nearly seven hours online every day. [26] With each like, post, swipe, stream, prompt, and share, the information economy is in relationship with all of life, bit by bit, byte by byte.

An ecology of technology recognizes the complexity that technology exists within.

Relationships with environment

Relationships with humans

Relationships with systems (cultural, economic, political, education, etc.)

Relationships with other living beings

Relationships with non-human cognition, and digital agents

Emergent properties, behaviors, capabilities

Interconnectedness and mutual evolution

Embracing this ecology can help us better design technologies that serve these relationships and interdependencies.



This is the complexity that our current technological paradigm ignores, or in business parlance, "externalizes." If we recognize our entanglement, how might we shift the paradigm from which we design, build, and interact with tech?



Ecologies of technologies are as wild, unpredictable, miraculous, and emergent as all other complex systems. Inherent risks and unintended consequences run through any initiative or innovation, and regenerative technologies are no exception.

”

“When you invent the ship, you also invent the shipwreck; when you invent the plane you also invent the plane crash; and when you invent electricity, you invent electrocution... Every technology carries its own negativity, which is invented at the same time as technical progress.”

- Paul Virilio, French cultural theorist and philosopher

In many ways, what we are calling for here is a return to (or re-embrace of) the origins of information theory, cybernetics, and the Internet itself. The imperative to embrace the trans-disciplinary and systemic complexity of information back to at least the 1940s and the Macy Conferences (1946-1953). [27] These conferences were a series of interdisciplinary meetings that were foundational in developing and disseminating cybernetic ideas, which essentially explore how information flows across systems, whether biological, mechanical, or social, and the communication processes that emerge to adapt, evolve, and maintain stability. This original embrace of complexity would later influence the conceptual and technical development of computer networks and the Internet.

That said, the applications of these fields in tech have largely focused on infrastructure communications, efficiencies, self-regulation, and other technical problems. These approaches often struggle with addressing complexity, dynamic environments, predicting unintended consequences of second/ “nth” order effects, balancing efficiency with resilience, and addressing ethical concerns, particularly in large-scale systems.

”

“When we try to pick out anything by itself, we find it hitched to everything else in the Universe.”

-John Muir, Scottish-American naturalist, written in his book *My First Summer in the Sierras*, 1911

Whether or not we weave our ecology of technology with strands that improve or imperil the web of life, is a choice. A new technological era internalizes these interdependencies and relationships into our designs.



Take a moment now and look around at everything in relationship with technology in your own life.



How does technology mediate your perception of news, politics, your sense of what's going on in the world?



What other countries' living beings, environments, and geopolitics, are involved in the semiconductors inside your smartphone?



Do you feel more or less connected when scrolling your mobile device?



How has technology changed how you experience shopping, advertising, surveillance, heartbreak, or love?



What impact has the internet had on your education, access to healthcare, your work, or retirement?



PART 2

REGENERATIVE TECHNOLOGY A NEW TECHNOLOGICAL ERA



A NEW REGENERATIVE TECHNOLOGICAL ERA

It's time for a new paradigm for technological innovation. Our current technological revolution emerges during a time in which the viability of future generations relies on our capacity to reconnect to life.

While technology is by no means the only way to drive change towards systemic regeneration, our tools represent practical means for transformation. Indeed the internet is the mostly widely understood example of our networked interconnectedness! Inner work ("I") social work ("we") and systems work ("it") are all nested and necessary elements too. Each will be crucial if we are to evolve beyond the principal civilizational goal of financial growth, towards a goal of creating conditions for all life on earth to thrive. And as tech's past is fully interwoven in our co-evolution, so too are our futures.

Instead of perpetuating a system in which a tree is worth more dead than alive and where digital "users" are worth more when angry and addicted, where both environmental and digital plunder are synonymous with "business as usual," we have the opportunity to reorient technological and business innovation in service to restoring the health of the whole.

How can we harmonize our technosphere with our biosphere? How can we awaken to the ecologies surrounding our technologies, and design for cascading benefits with our technological relationships, investments, designs, business models, metrics, supply chains, cultural interplays? How can we design our technologies to be in service of life and systemic health? While these questions may sound daunting, the good news is we have 3.8 billion years of experience to learn from – that of the Earth itself, and the process of regeneration.

"We must ask ourselves: what kind of system do we want? One where we go beyond 'reducing harm' to creating an abundant, regenerative, life-affirming system that benefits all."

- Chad Frischmann, Founder & CEO of Regenerative Intelligence (RegenIntel)

WHAT IS REGENERATION?

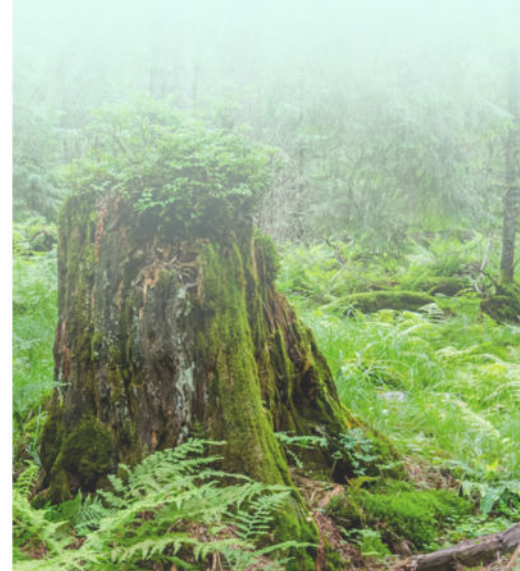
What does "regeneration" mean? The word 'regenerative' means "to produce new" or "to bring forth again," creating the conditions conducive for life to continuously renew itself, now and in the future.

Regeneration is a life-giving process that creates conditions for continuous renewal in various contexts. In nature, it is the process of restoration and regrowth that makes living systems resilient to disturbances. Regenerative design is an approach to creating structures, environments, and systems that go beyond sustainability to actively enhance and revitalize the surrounding ecosystems.

Across all these areas, regeneration emphasizes working in harmony with natural systems, recognizing interconnectedness, and actively contributing to the overall well-being of both people and the planet. This approach embraces how nature designs for flows rather than end states and never does just one thing at a time, inspiring holistic solutions in various fields that are designed to create cascading benefits.

Our own cells are constantly regenerating!

Forests are too, constantly exchanging nutrients and information through networks made up of mycelium fungi and forest ecology, (unironically coined the "Wood Wide Web"). [28]



Regenerative design is emerging across a wide field of disciplines, such as architecture, retail, tourism, medicine, finance, energy, business, and beyond. To date, however, the technology industry has been slow to embrace this new design paradigm.

Architects and urban planners design materials and buildings that generate more energy than they consume, improve air quality, sequester carbon, incorporate natural light for heating and cooling, and even share surplus energy locally.

Similar models are also coming into industrial and factory settings, such as the “Factory as a Forest” design, pioneered by carpet manufacturer, Interface.

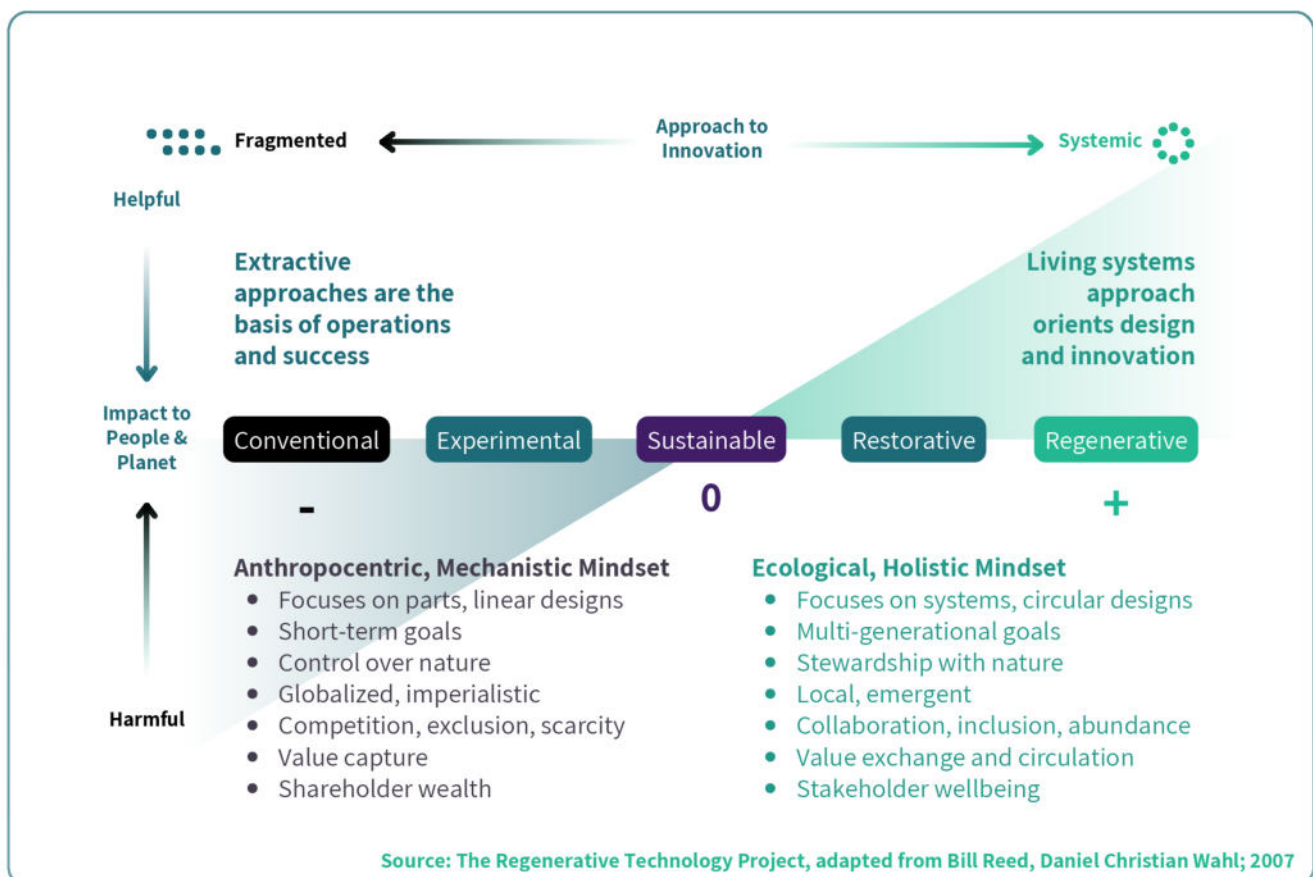
Figure 11: Rendering of a Regenerative Building



Image source: Omega Center for Sustainable Living (OCSL)

One simplified way of evaluating the difference between “regenerative” and “sustainable” or “conventional” designs is to consider the net impacts as positive, neutral/zero, or negative, respectively. For net negative businesses, “business as usual” relies on extraction of natural and human resources despite the costs to human, community, and environmental health. This is the model our current industrial playbook condones and forces through demands for endless growth. Sustainable designs aim for neutrality, aiming to do less harm, to off-set, to counter with incremental improvements. Regeneration focuses on actively improving and restoring ecosystems and resources, rather than just maintaining them at current levels.

Figure 12: The Regenerative Shift: A Living Systems Approach to Innovation



Yet understanding regeneration by simply framing it as “negative-zero-positive” overlooks a more essential foundation. Shifting from an extractive to regenerative models is contingent upon something far upstream: our mindsets. When we recognize that regeneration is the process of life on Earth, we see that it emerges from within. We are nature. Not dominant over, or separate from, but deeply embedded. Doing harm to any facet of this colossal ecosystem is doing harm to oneself.

While these concepts may feel foreign to technology, business, and economic orthodoxies of the 20th century, regeneration is not new. The interconnectedness of life and ecological knowledge are central to many indigenous and spiritual traditions, and to our survival story as a species. Nowadays, modern ecological and biological sciences are demonstrating how life supports itself, further reiterating and compounding our collective intelligence to adapt. It’s time we harness 3.8 billion years of nature’s R&D for regenerative innovation.

Cultures from around the world recognize humans are nature, and we must steward this interdependency as we would our own family.

Kaitiakitanga is a concept of the Māori people (New Zealand), which refers to guardianship and intrinsic intergenerational care and responsibility for the environment. [29]

The Cree people (Canada) are attributed with saying, “Only when the last tree has been cut down, the last fish been caught, and the last stream poisoned, will we realize we cannot eat money.” [30]

REGENERATIVE INNOVATION: A NEW PLAYBOOK

Innovation has become a Silicon Valley industry buzzword, hijacked by tech giants to hide the same industrial playbook behind the latest bright, shiny apps and gadgets. The core invitation of Regenerative Technology is to inspire a new playbook for innovation, and orient our technologies to do so.

Regenerative innovation puts life at the center of value creation. It is not only about reducing negative effects, but actively contributing to systemic health and the resilience of natural resources, social systems, and economic structures. It refers to the development and implementation of new ideas, products, or processes that aim to restore or revitalize whole systems, such as organizations, communities, or economies.

“Man does not weave the web, he is merely a strand in it. What he does to the web, he does to himself.”

— Chief Seattle



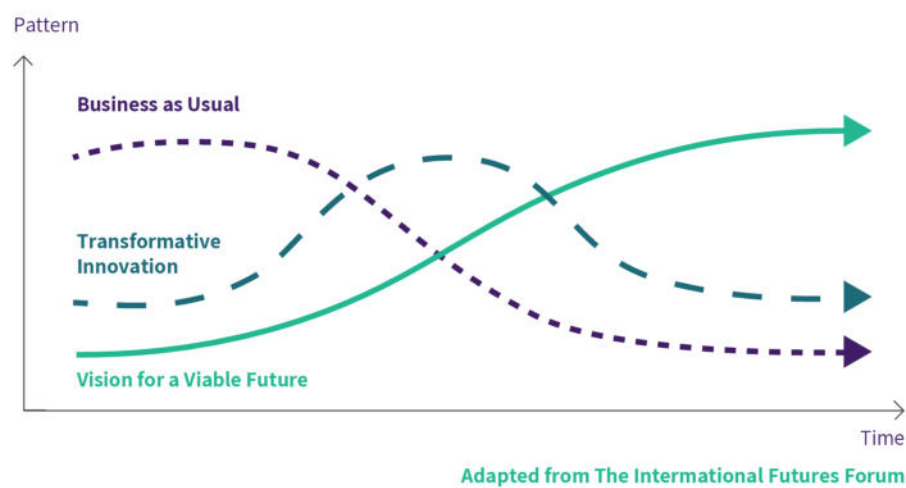
What if we applied a regenerative orientation to how we approach inspiration, investment, and implementation of technological innovation?



“We’re living between worlds” as Gil Friend, CEO of Natural Logic and Founder of Critical Path Capital puts it. We’re in a unique moment in which billions of people around the planet are awakening to the cruel inadequacy of the entrenched systems, and the imperative for better ones. The narratives, institutions, and governance of the last century are crumbling, yet the contours of the new paradigm remain unclear.

What we know is that our emerging new story is many stories. From food to education, energy to transportation, industry to agriculture, diverse solutions that honor place, and evolve with empowered participation, will all be part of the new models that render the old ones obsolete.

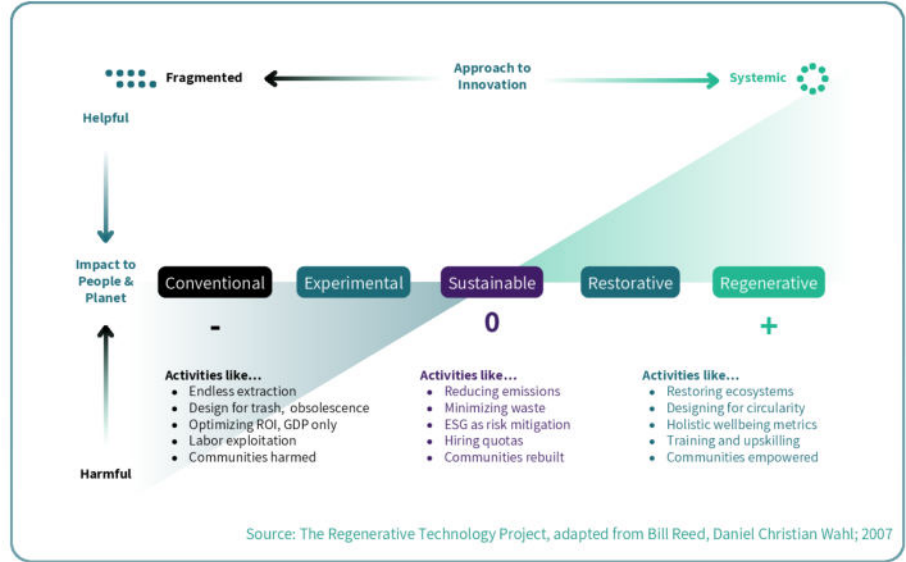
Figure 13: Three Horizons of Innovation



Imagine if we designed our technologies and businesses to create systems that restore more than they deplete, to produce more than they consume, to heal more than they damage.

Next, in the below framework, we suggest some activities that could support regenerative innovation. Now imagine we view these same opportunities as areas for technological enablement.

Figure 14: The Regenerative Shift: in Business Activities



Innovation leaders will be familiar with the 3 Horizons framework, a tool developed by Bill Sharpe to support strategic thinking around uncertain futures by connecting three horizons.

H1

Horizon One:
The present, where businesses and institutions operate under the current dominant paradigm.

H2

Horizon Two:
The transition zone, where emerging innovations challenge and disrupt the existing systems.

H3

Horizon Three:
The desired future, where new practices and paradigms have replaced the old, leading to more sustainable and regenerative systems.



WHY DIGITAL TECH IS CRITICAL FOR A REGENERATIVE INNOVATION

Regenerative technology can help us envision, bridge, and innovate new designs for a viable future. This spans far beyond so-called Climate Tech or “Tech for Good.” What we are talking about here is a new paradigm for technological applications, business models, and innovation broadly.

This is a “blue ocean” opportunity to align humanity’s technosphere, in all its myriad expressions, with the health of the biosphere. **Our expanding toolkit has immense potential to regenerate social, economic, and ecological systems.**

Figure 15: Technological Potential Across a System of Solutions



Image Source: RegenIntel; Technology categories added by The Regenerative Technology Project

Today, millions of technologists, engineers, policymakers and financiers view technology as the solution. What if we understood our technologies as infrastructure underlying a **system of regenerative solutions**?

While it's undeniable that technology has contributed to environmental degradation, societal health issues, and economic disparities, digital technology in particular remains an indispensable tool in our pursuit of a future that regenerates and supports all life on earth. We know today's tech tools can foster local community and collaborative economies. We know they enable scale and accelerate network effects; we know of countless instruments that facilitate monitoring, traceability, accountability, and consensus. We know digital can represent new kinds of “assets” and economics. We can see how big data can help support decisioning, modeling, and see relationships in new ways. What follows several areas digital technologies already offer to regenerative innovation.



The nature of future innovation and innovation of the future of nature are interconnected”

— Leen Gorrissen



TODAY'S TECH ALREADY SHOWS DIVERSE POTENTIAL FOR REGENERATING SYSTEMS

Global Information Sharing and Innovation

The internet and open-source platforms serve as a global information layer. This is crucial for addressing complex, interconnected challenges which require efficient information and resource-sharing and collaboration across diverse, geographically disparate, and otherwise underrepresented parties.

Citizen Science

Digital tools empower individuals to actively participate in scientific research and data collection. Mobile apps and low-cost sensors allow citizens to contribute valuable environmental data, from air quality measurements to wildlife observations. This engagement not only enhances scientific datasets but also fosters a deeper connection between people and their environment, promoting stewardship and informed action.

“Glocalization” Global Scale and Local Accessibility

Digital tech uniquely enables both global scale and localization. For example, local apps support specific community needs or economic opportunities, while e-learning and telemedicine apps can adapt to unique participant needs in remote areas. This design flexibility is crucial to respond regeneratively based on context, rather than single “blanket solutions.” Services can be locally and bioregionally adapted (and governed), and offer the ability to interact with global platforms and markets.

Power Distribution and New Governance Models

Digital technologies enable new forms of decentralized decision-making and governance. Blockchain, online voting platforms, and digital town halls create opportunities for more direct democracy and transparent governance. These tools can help redistribute power, giving voice to previously marginalized groups and enabling more inclusive, responsive, and accountable systems of governance.

Global Coordination and Collaboration

Digital technologies allow geographically disparate, or otherwise untrusted parties to better coordinate around shared challenges and opportunities. For example, blockchain can enable more transparent and decentralized cooperation across parties, while crowdsourcing platforms allow groups to pool shared resources towards grassroots causes. In a time rife with global challenges that no single party can solve, these tools are essential for coordinating responses, adapting solutions, and fostering trust across parties.

Education and Awareness

Digital platforms revolutionize the dissemination of knowledge and raising of awareness on critical issues. For example, online courses, and interactive websites help expand global reach for educational initiatives, while augmented/mixed reality can be effective for illustrating interconnections, even building empathy. This widespread access to knowledge empowers individuals and communities to make informed decisions and take action towards regenerative practices.

Navigate Complexity

While no technology can manage complexity, advanced algorithms and AI can process vast amounts of data, helping humans better adapt and “dance” with complexity changing circumstances. For instance, machine learning can identify patterns and anomalies across more information than previously possible, while scenario development can help people imagine and co-create more holistic adaptations and interventions.

Monitoring Changes

Digital technologies monitor changes in human, societal, and environmental health over time. For example, satellite imaging can track deforestation, urbanization, and climate change impacts over time, while IoT sensors can monitor air, water, and soil. Monitoring, distinct from taking single metrics, allows us to more readily identify anomalies and effectiveness of interventions, in order to better adapt to changing circumstances.

Efficient Resource Management

Smart systems powered by digital technologies optimize the use and distribution of resources. From smart grids that balance energy supply and demand in real-time to precision agriculture that minimizes water and pesticide use, digital tools enable us to do more with less. This efficiency is crucial for minimizing waste, regenerating natural resources, and more circular systems across various sectors.

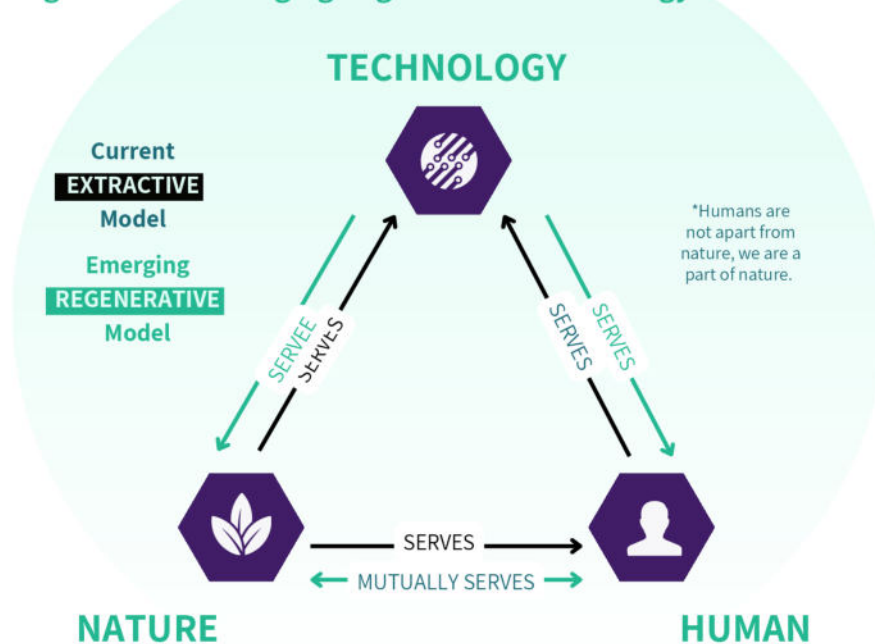


WHAT IS REGENERATIVE TECHNOLOGY?

Regenerative Technology helps realign humanity with healthy living systems. It reframes technological innovation as tooling to empower us— individuals, communities, institutions – to bridge from the current extractive economic paradigm into one with resilient and regenerative systems that create conditions for all to thrive.

IT IS TECHNOLOGY IN SERVICE TO LIFE.

Figure 15: An Emerging Regenerative Technology Model



Whereas today's technology is served by nature and humans, regenerative tech serves both people and planet, and enables mutual service between them.

Technology that serves health and living systems, relationships that ensure fairness, and overall care for the earth and community.

Source: The Regenerative Technology Project, adapted from Amanda Joy Ravenhill and RegenIntel

“

“Bridges are constructed by combining efforts from both sides of a divide. In this case, Regenerative Tech bridges the divide between two paradigms: the unstoppable force of technology...and the regenerative paradigm that seeks to embrace and sustain us.

... This force is reaching out to meet the regenerative paradigm, much like the telescope once drove the Copernican revolution.”

- Ernesto van Peborgh, founder of the SEVA Institute [31]



WHAT IS REGENERATIVE TECHNOLOGY?

ROOTED IN REGENERATIVE PRINCIPLES



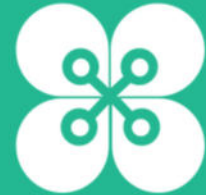
Regenerative design is based on the universal patterns and principles of living systems derived from both traditional ecological wisdom and current ecological, biological, and complexity scientific consensus. Thus regenerative tech adopts living systems principles as first principles.

A RE-MEMBERING OF TECH



Expanding the definition of tech, beyond digital, industrial, even beyond sapiens. Technologies are structuring the flows of materials, energy, and information to adapt and to thrive. Our technology is inextricable from our values and social systems. Regenerative tech exists in relationship.

TOOLS TO RECONNECT US



Humanity emerged in a period of high nature, and low technological facility. We find ourselves now in a period of "high tech" and "low nature," in that tech further separates us from the living world. Regenerative tech is a vision to re-align our "high tech" with "high nature," for thriving living systems.

A MATURATION OF "DIGITAL TRANSFORMATION"



Finally! As the "tech industry" pervades all sectors, influences all nations, and impacts all beings, it's time we aspire for more than efficiencies and revenues. Regenerative tech invites organizations to wield technologies towards new models that support the health of the whole.

AN OXYMORON?



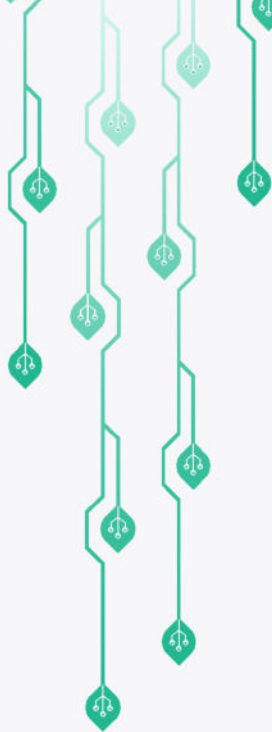
Can technology itself actually regenerate!? How could machines or silicon-based forms, engineered through reductionist logic, create conditions for more life. How could it help us integrate with the holism of ecological intelligence?

A BRIDGE FOR FUTURE GENERATIONS



An invitation to reframe technological innovation to empower us to bridge from the current extractive economic paradigm into one with resilient healthy systems that create conditions for all to thrive. Regenerative tech serves multiple generations.





Manifestations of technology are infinite. But the reorientation is simple, if profound:
design with, not against nature.



As regenerative design begins to permeate fields, sets of regenerative principles serve as the foundation. These “living systems principles” are derived from universal patterns of ecology, biology, and complexity science, and are echoed across the world’s ancient and indigenous wisdom traditions. Regenerative principles help us guide more holistic designs and decisions, while also allowing for emergence, systems learning, adaptation, and response-ability.

Though universal in essence, we see adaptations of these principles to context. [32] For example, regenerative principles applied to economics vary from principles of biomimicry used in product design.

Technology too presents unique complexities to the question of applying regenerative principles. Answers to these questions are part of the invitation to embrace the ecology of technology and co-create what’s next.



Can the material composition of technology itself be regenerative?



Or is this approach about designing the outcomes and use cases of the technology to be regenerative?



How would we re-design foundational technological infrastructure, such as in communications, energy, or economic systems to be regenerative?



Can investment in technology be regenerative? Can tech become regenerative without the finance sector doing the same?



How can we apply principles across the technology lifecycle?

[Have more questions? Strong opinions? \(held lightly\)...](#) Or want to participate in future versions of this whitepaper? Please reach out to us!



What we provide below are a set of living systems principles and sample areas that may be applied within tech

Figure 16: Living Systems Principles Applied to Technology

LIVING SYSTEMS PRINCIPLE	AS APPLIED TO TECHNOLOGY...
Patterns	Sample Manifestations
Interdependent, In Relationship All life is interconnected with its environment and other systems	<ul style="list-style-type: none"> • Design tech with a systems thinking approach, considering how components, users, society, environment interact • Incorporate holistic metrics in technology governance • Go beyond human-centered design, life-centered designs that balance diverse stakeholder needs and abilities.
Adaptive to Changing Conditions Life adjusts and evolves in response to environmental changes	<ul style="list-style-type: none"> • Ensure tech itself is adaptive and process-focused, through continuous design feedback, governance • Observe patterns over snapshots (monitoring rather than metrics optimization) • Deploy technology with response-ability and capacity for restraint, consequentiality, and an orientation towards social equity and justice
Circulatory Flows & Metabolism Life relies on continuous exchange of energy, materials, and information	<ul style="list-style-type: none"> • Facilitate distributive information and value flows, promote information symmetry and value-sharing across network • Design tech for circular economy (e.g. modularity, right to repair) • Consider materials, energy, information flows, waste, and upcycling
Resilience Through Diversity Variety in components and strategies enhances system stability and survival	<ul style="list-style-type: none"> • Prioritize representation in design, decision-making, data sets, algorithms, founders, investors, and projects invested • Employ diverse metrics, forms of value delivered • Design for interoperability and open standards to encourage broader innovation and collaboration • Configure systems for redundancy and multiple pathways to maintain functionality.
Place-Based Life happens in place, and is influenced by specific local conditions, contexts.	<ul style="list-style-type: none"> • Localize to community, cultural, bioregional contexts, avoiding top-down, globally imposed models that lack local context • Source / share resources based on what's around • Consider how the tech impacts local communities/economy
Self-Organizing, In Balance Life maintains stability through constant adjustments and feedback loops.	<ul style="list-style-type: none"> • Develop solutions that scale outwards (adapt to context; allow users to create their own workflows, autonomously coordinate) rather than scale-up (enforce replicate structures on users) • Help users maintain a healthy balance between digital engagement and real-world interactions, rather than optimizing for digital attention • Develop systems that can maintain equilibrium, adapt resources, balance risks in complex environments (e.g. smart grids, data centers, security)
Collaborative, Participatory Elements work together, often in mutually beneficial relationships	<ul style="list-style-type: none"> • Design for user agency, control over their data, digital identities • Facilitate participatory (multi-stakeholder, multigenerational) design and decision-making • Incorporate more holistic and transdisciplinary ways of knowing and asking, rather than ignoring uncertainties or the non-empirical. • Shift towards ecosystem-based business models to facilitate innovation, localization, less risk, and greater abundance




REGENERATIVE TECHNOLOGIES IN PRACTICE

It is early days for regenerative technology, but examples are emerging across sectors. Regenerative technologies align technological infrastructure with applications for systemic health, and are financed through a range of business models.

With regenerative principles as a guide, we design for applications that aim to restore rather than deplete the living world. Nature never does one thing at a time; how do we design technologies to support multiple forms of value at the same time?

What happens is relational and dynamic, not a checkbox or fixed state. There is no one single linear path, nor an absolute ‘if, then’ formula for regenerative practice. Regeneration is how nature stays resilient and adaptive to constant change.





There are key dynamics to shift in the technology ecosystem. Below are seven shifts towards a new technological epoch rooted in regeneration.



“The source of a project’s– or technology’s– regenerative potential does not lie within the project itself. It lies in the project’s relationship to the larger systems in which it is nested.”

-Regenesis Group

Figure 17: Key Shifts Towards a Regenerative Technological Paradigm

SHIFTING FROM INDUSTRIAL TECHNOLOGIES, WHICH...	TOWARDS REGENERATIVE TECHNOLOGIES, WHICH ...	EMERGING REGENERATIVE TECHNOLOGICAL APPROACHES
<div> Accelerate separatism: Embedded in extractive economics, our technologies accelerate separation from one another and the environment.</div> <div>“Social” platforms designed to maximize “time on-site”, algorithms driving isolation, rage, polarization; virtual metaverse economies disconnected from the natural world; automated customer service agents replacing human interaction; automating fast fashion.</div>	<div> Connect us to life and each other: Technologies that foster wellbeing, health of entire ecosystems and serve as platforms driving potential for deepening relationships to one another, our communities, and the planet.</div>	<div>Sensing and networking technologies supporting ecosystem remediation and biodiversity restoration.</div> <div>Biotechnologies developing circular and biobased materials to displace petrochemical-based plastics.</div> <div>Coordination technologies for participatory governance, care, crowdfunding, etc.</div>
<div> Accelerate competitive, unjust systems: Traditional economic systems often rely on scarcity and competition, leading to resource depletion and social inequality.</div> <div>Closed source, patent protected, technologies lead to monopolies and restricted innovation.</div>	<div> Support more collaborative, just systems: Systems where value increases with more participants, like open-source knowledge or community-owned resources, to help address issues of resource scarcity, inequality, and unsustainable competition.</div>	<div>Open-source technologies, distributed innovation networks, digital public goods.</div> <div>Collaborative networks that foster interoperability, data portability, and accessibility.</div>



SHIFTING FROM INDUSTRIAL TECHNOLOGIES, WHICH...	TOWARDS REGENERATIVE TECHNOLOGIES, WHICH ...	EMERGING REGENERATIVE TECHNOLOGICAL APPROACHES
<p> Take a limited view of value, impact: Current systems often ignore or externalize environmental and social costs, in myopic pursuit towards financial capital. Current technologies are often designed to maximize profits, scale, efficiency, often at the expense of social and environmental factors.</p>	<p> Account for holistic forms of value, impact: Systems that recognize multiple forms of value or capital (natural, social, human, etc.) and their interdependencies, and harness wider data, metrics, monitoring and traceability to substantiate and account for them.</p>	<p>Technologies developed with consideration of full lifecycle impacts across multiple capitals (natural, social, human, etc.) using comprehensive metrics.</p> <p>New digital asset classes representative of other capitals, such as “eco credits.”</p>
<p> Optimize for centralized control: Information and decision-making power is concentrated in the hands of few, leading to information / wealth asymmetry, security and privacy threats. It also harms capacity for group sense-making, fuels misinformation, and undermines local autonomy and economic mobility.</p>	<p> Promote high distribution/ sensemaking: Systems that distribute processing, access, resources. Fostering local empowerment, critical thinking, and accessible platforms for knowledge sharing and collaborative problem-solving.</p>	<p>Decentralized AI, federated learning, decentralized identity wallets, and personal data sovereignty, enabling widespread access to advanced analytical tools while preserving privacy.</p>
<p> Approach as complicated: Mechanistic, reductionist approaches treat people, business, planet as a machine, separating into disparate, decontextualized parts. Prioritization of high “industrialized” tech over “low” tech. Technologies organize the world into labels, hashtags, microsegments, etc. blind to the unquantifiable and to changing contexts.</p>	<p> Approach complexity holistically: Systems that help humanity approach issues holistically, consider other perspectives, ask more questions, expand context, hold wider boundary lenses, allow for emergence. Note regenerative tech includes low-tech and does not need to be a high tech solution to meet complexity.</p>	<p>Collaboration and coordination platforms to facilitate transdisciplinary sense-making and decision-making.</p> <p>Multimodal or multi agent AI architectures for expanding context in collective problem-solving.</p> <p>Accessible interfaces to enable participatory feedback and design.</p>
<p> Ignore limits, harms, and externalities: The business and technological development paradigm ignores nature’s resource constraints, harms of extraction on regions and communities. The unsustainable narrative of infinite growth on a finite planet goes unquestioned. Technologies are often designed for planned obsolescence, without consideration for material scarcity or energy limits, enabling unsustainable consumption.</p>	<p> Incorporate limits and design with responsibility: Systems that view limits and risks and opportunities for innovation. Technologies designed for longevity, energy and material efficiency, inspired by nature’s efficiency, designed for circular economy.</p>	<p>Modular, repurposable upgradeable designs, such as for smartphones;</p> <p>Platforms accelerating biomaterials, to design for circularity and account for risks of over extracting new materials.</p> <p>Aggregators of industrial waste into upcycled feedstock.</p>

TABLE: Key Shifts Towards a Regenerative Technological Paradigm





FAIRBNB

Fairbnb is a digital marketplace for short-term rentals. Like AirBNB, Fairbnb's sharing economy platform enables digital search, discovery, booking, host verification, and liability oversight for tourists, and has simple user interfaces and comparable pricing. Where Fairbnb diverges is in the design of its business, governance, and platform model.

It takes 50% of all platform fees and reinvests them back into local social and environmental organizations and projects in which the rental takes place. As a digital cooperative, collective ownership of the Fairbnb platform means it is owned by those who use it and are impacted by its use, such as hosts, guests, local business owners and neighbors. It is governed by citizens and works with "Local Nodes" to define rules to protect each neighborhood and keep profits within communities.

WHAT MAKES FAIRBNB REGENERATIVE

- **Promotes distribution and value localization:** Fairbnb reinvests and recirculates value within the communities it serves
- **Supports fair exchange:** between travelers, hosts, communities, and platform, in a scalable way
- **Fosters connection and coordination:** Cooperative model facilitates participatory governance, while also enabling coordination across stakeholders

MATERIOM

Materiom is a biotech platform that analyzes big data on nature's building blocks from abundant sources of natural biomass to accelerate commercialization of renewable feedstocks for bio-based materials. It tailors algorithms and recipes to specific product niches, customer requirements, circularity, and localization.

Using "green chemistry" (i.e. life-friendly) principles, Materiom screens materials to assess biodegradability, nutrient value, and sustainable sourcing practices. Through open data and AI, Materiom empowers scientists, material developers, and works with brands to collaborate on accelerating R&D in the shift from petrochemical-based products to biobased products.



WHAT MAKES MATERIOM REGENERATIVE?

- **Incorporates limits with responsibility:** Sourcing analytics are tuned ensure that new biopolymer recipes are designed to prevent over-extraction in any specific locality
- **Enables access and open source innovation:** By open-sourcing the latest peer-reviewed data and recipes across its community of over 5000 members, it helps accelerate materials development, while lowering barriers to entry around the world.
- **Supports :** By shifting from extractive methods towards those using regenerative abundant biomass





Check out 75 additional initiatives in the [Regenerative Technology Project Directory here](#). If you're part of a regenerative technology effort, [submit a listing here](#).



HOWGOOD

HowGood is a software-as-a-service (SaaS) platform that uses big data to help the food system account for and innovate around more holistic metrics. Hosting a database of over 33,000 materials, chemicals, and ingredients from 600 vetted data sources, it analyzes some 250 sustainability attributes to define “health” across eight core metrics. Consider the holistic forms of value across measuring Biodiversity, Greenhouse Gas Emissions, Blue Water Usage, Land Usage, Labor Usage, Soil Health, Animal Welfare, and Processing.

Its “Impact Spectrum” benchmarking tool helps companies across the food industry gain a more holistic perspective on impact data of their ingredients, supporting sourcing, manufacturing, and decision-making towards more regenerative outcomes.

WHAT MAKES HOWGOOD REGENERATIVE

- **Accounts for more holistic metrics:** Beyond agricultural productivity and efficiency, including soil, water, animal welfare, and more
- **Fosters more holistic decision-making:** Aggregates and tailors data to help food suppliers verify and assess decisions that account for more living systems health
- **Supports regenerative agriculture:** anchoring certifications and common metrics and creating marketplace incentives towards which competitors and collaborators can align



**New software,
no hassle!**

Adopting new software can be daunting. We're here to help. To accelerate your time to value you can perform your initial knowledge base setup and train your workers, and set up regular check-in adoption.



KIIREN AI

Kiiren is a no-code software-as-a-service (SaaS) application designed with regenerative intention to incorporate AI technology in right relationship with its human operators. The platform automatically tunes itself based on “knowledge bases” loaded into it, allowing non-technical people to adapt, curate, and collaborate around knowledge sets based on their unique operating context and place.

Its mission is to adapt LLM generative AI technologies into globally accessible “augmented regenerative intelligence” (ARI) in a way that is humane and living systems first, ethical, safe, useful, and serves as an impact multiplier and coherence builder in the regenerative movement. Kiiren’s “knowledge ecosystem” is currently supporting leaders and community building across intersections of regenerative economics, finance, spirituality, indigenous wisdom, and social transformation.

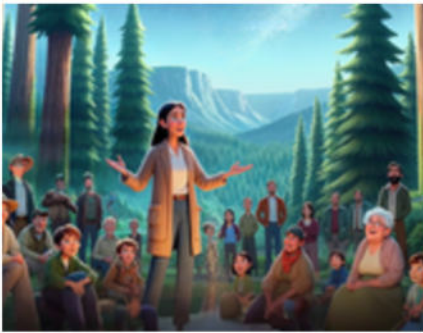
WHAT MAKES KIIREN REGENERATIVE?

- **Enables learning & knowledge sharing:** AI develops knowledge bases to support more regenerative decision-making
- **Enables access and participation:** Anyone can use Kiiren from any location at any time, which helps lower barriers to entry to its “knowledge ecosystem”





Check out 75 additional initiatives in the [Regenerative Technology Project Directory here](#). If you're part of a regenerative technology effort, [submit a listing here](#).



HYLO

Hylo is a community-led, prosocial coordination platform for purpose-driven groups. It is open-source, non-profit, and driven by participatory design with real-world groups at the forefront of regenerative agriculture, community resilience, peer learning, equity, inclusive capital, and place-based organizing. The platform has many unique aspects such as nested groups and cross-group posting, which lead to emergent cooperation between groups, generating broader coalitions with more power to address common goals. Hylo's community leaders and prosocial facilitators also help guide its member groups on best practices in community stewardship. The organization is committed to learning together alongside its ecosystem of friends and partners, and we know that successful coordination takes more than technology, it requires deep trust, strong relationships, and a lot of human care.

WHAT MAKES HYLO REGENERATIVE

- **Facilitates coordination:** Hylo enables coordination within community-led projects within specific bioregions, as well as collaboration and cooperation across them
- **Enables learning & knowledge sharing:** Supports communities by sharing best practices, and helping them better manage resources and decision-making that respect local ecological limits
- **Developed through participatory design:** Hylo works closely with partners and other active groups leading the regenerative movement to co-create the community tools they need to for bioregional organizing



Regenerative tech is an orientation. It is an invitation to co-create tools that serve the future we actually want. It's a vision for a future where humanity's ingenuity and the well-being of living systems are not at odds with each other, but are working in harmony.



WHAT REGENERATIVE TECHNOLOGY IS NOT

There is no panacea for systemic change. Silver bullet solutions or sweeping deterministic philosophies that any issue can be solved with technology, are fantasy; a hangover from the mechanistic worldview that we can fix and control single parts.

Regenerative Tech is not the solution. It is not a savior and it won't solve all our problems. Nor is this a new buzzword to be dropped at the next board meeting, like Web3 or GenAI. It is not Climate Tech, FoodTech, or AgTech, or other niche categorizations that sit in individual silos. It includes all these categories, and broader ones like tech for circularity or sustainable development, because it is oriented around systemic health in its diverse forms.

Our future does not solely depend on technological advancement. But it does depend on how we wield our tools to transition from our current systems towards a future in service to justice and life for future generations.

The question we now face is how to design technology for life?

Regenerative Technology is not about making technologies of the 20th century less bad.


It's about designing the technological infrastructure we need for the 21st century to be an era of systemic revitalization.



THE REGENERATIVE TECH STACK: A NEW MODEL FOR DESIGN

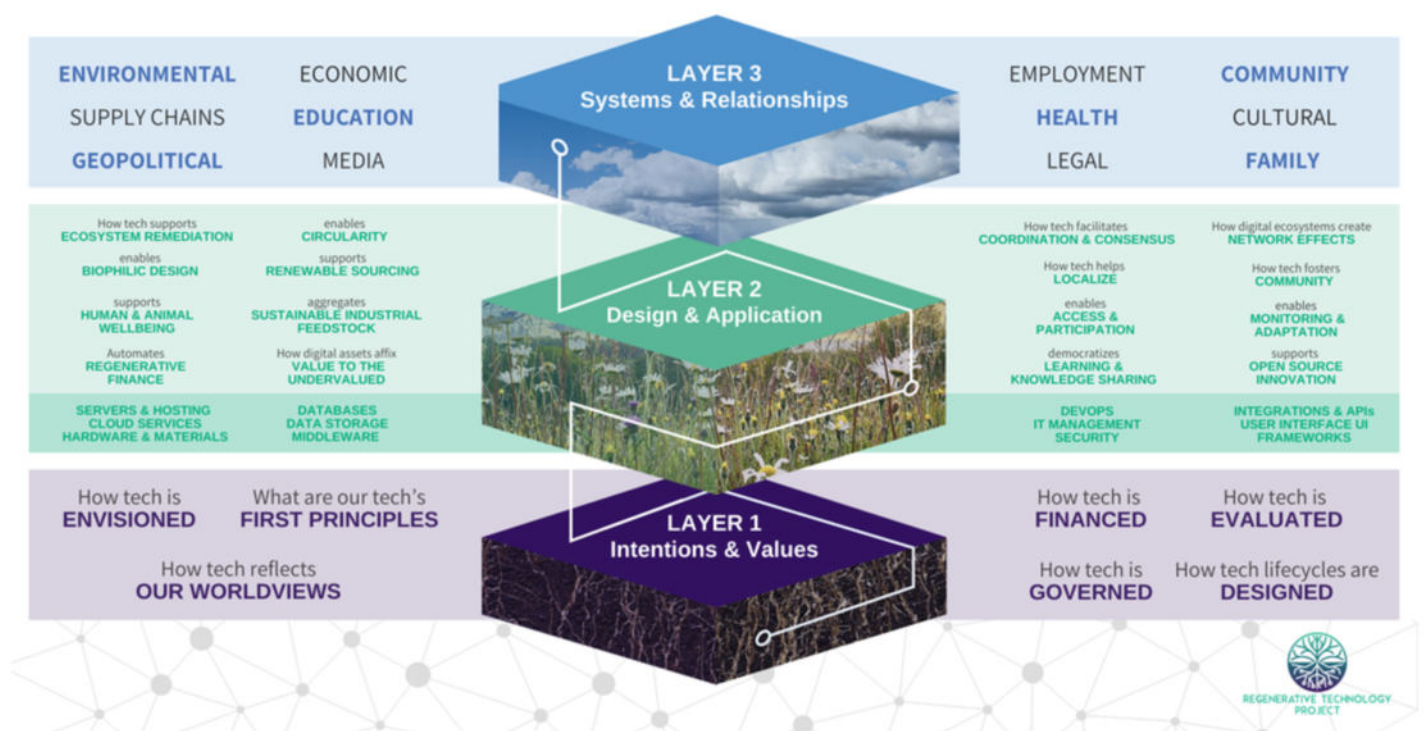
Technological designs are often understood by their infrastructure and applications. “Tech stacks” help people see the building blocks of a technological solution: which software, hardware, interoperability, and interfaces power the function or network. But conventional tech stacks are woefully inadequate. “User-centered design” focuses narrowly on people’s online experience. Even so-called “human-centered design” orients problem-solving around customer desires and behaviors, ignoring the ever-evolving contexts, stakeholders, and ecology in which the technology lands, lives, and relates.

We propose a **Regenerative Tech Stack**, which enables stakeholders to hold foundational principles and patterns informing designs and applications, while also incorporating broader impacts and relationships that our tools have in the world. It is an attempt to expand the aperture of how we approach technological innovation.

 What are we accounting for when we design technology for systemic health?

The Regenerative Tech Stack is a framework for regenerative tech design, to help us envision how humanity can consider the ecologies of technology. A regenerative approach to technology calls on us to see the tech stack nested within the many complex systems in which all tech is embedded. Tech today focuses primarily on Layer 2, often undervaluing, overlooking, or altogether “externalizing” Layers 1 and 3. [33]

Figure 18: The Regenerative Tech Stack



Our values systems, social systems, and built systems all exist in entangled interconnectedness. Thus, the field of implementation for the regenerative tech stack transcends the technological infrastructure. The question of how to design technology for systemic health is not answered one simple solution, but through a holistic, participatory, learning approach.



LAYER

1

Assesses our values:

What is the intentionality, consciousness, and cultural worldview we bring into how we envision technological innovation? To progress? To success? To possibility? What are the principles we are designing around? Do we refer back to these as decisioning complexities around the technologies' lifecycle? How are these intentions, principles, values and other “underground” energies informing how the technology is financed? Its business model? How is it governed, and what trade-offs are made as it evolves and matures? These questions may seem outside of the realm of common Computer Science curricula, yet **they are the soil upon which any technology is created.** Ask any entrepreneur, and they can almost always point to stories and trade-offs in Layer 1 that inform how their technologies (and business ideas) evolve.



LAYER

2

Is all about the infrastructure capabilities:

the technological components and configuration, as well as the applications and use case designs. It is the “first order” quality of our technologies: how do they function and what are they used for? Our analysis of technologies supporting regeneration today finds a wide range of applications, from digital marketplaces supporting the circular economy, artificial intelligence for bioremediation and biofabrication, to sophisticated analytics in service to regenerative agriculture, and far beyond.

The “field” of regenerative tech is growing rapidly: to see real-world examples of Regenerative Technology, [click here](#). What is critical, however, is to recognize these application capabilities are not always the end of the story in terms of how technology interacts with, demands of, or influences the many systems in which they exist.



LAYER

3

Spotlights the tech’s cascading relationships,

the “ecology of tech.” The complex reality that our technologies are always embedded within countless societal systems, contexts, and relationships, and in turn are influencing and influenced by them. Rather than wave them away as externalities, or forget them, we hold them in the deep design. This may sound abstract, but we are all familiar with examples of Layer 3 interactions. How has the design of social media’s never-ending thread shaped our attention? Our purchases? What role do screens play in the lives of our children? When the interface of our job shifts from an office to a screen, how does the nature of our work change? **The “winds” of technology ever shift how we relate to each other and to the world.**

Intentions & Values

Design & Application

Systems & Relationships

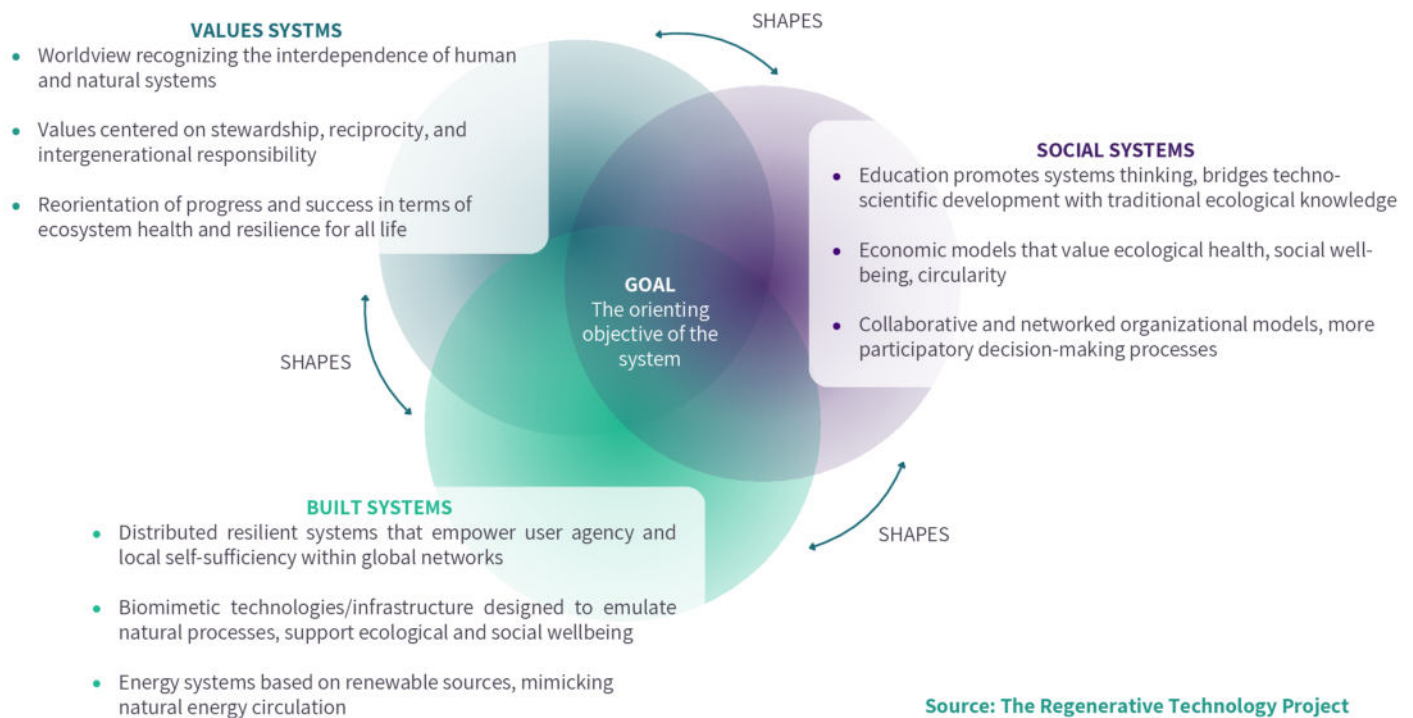


ENVISIONING A REGENERATIVE TECHNOLOGICAL ERA

Just as few in the early agrarian periods could have foreseen an industrial revolution, we too have little idea of how the coming technological era will manifest. We're immersed in conventional metaphors, tethered to old stories, haunted by the status quo. What might a new technological paradigm, which reflects our interconnectedness and systemic interdependency, look like?

New futures are woven with new stories, stories we co-create. We invite your ideas, and humbly imagine the following elements in a regenerative technological era.

Figure 19: Envisioning a Regenerative Technological Era



This shift would bring deep transformation in how we design, produce, consume, and govern, **guided by an orientating goal to create conditions conducive to life for all species**. It would aim to move beyond sustainability, to actively regenerating the planet's ecosystems and societal wellbeing.

In this era, our value systems embrace a holistic worldview that sees humans as part of, not separate from, the wider web of life. Social systems evolve to reflect the interconnected and cooperative nature of healthy ecosystems—biomimicry on a massive scale. The boundaries between human-made and natural systems would blur, with technology serving to enhance and restore ecological functions, rather than abstract away and replace them.

The ecologies of tech are woven into all of our lives. We weaved them so, and we, our collective humanity can now use the same tech tools to consciously co-create a new era. We choose, with each click, each post, each email, each light switch, which parts of the story we will weave.



PART 3

CULTIVATE THE SOIL FOR REGENERATIVE TECH



AN INVITATION TO CO-CREATE

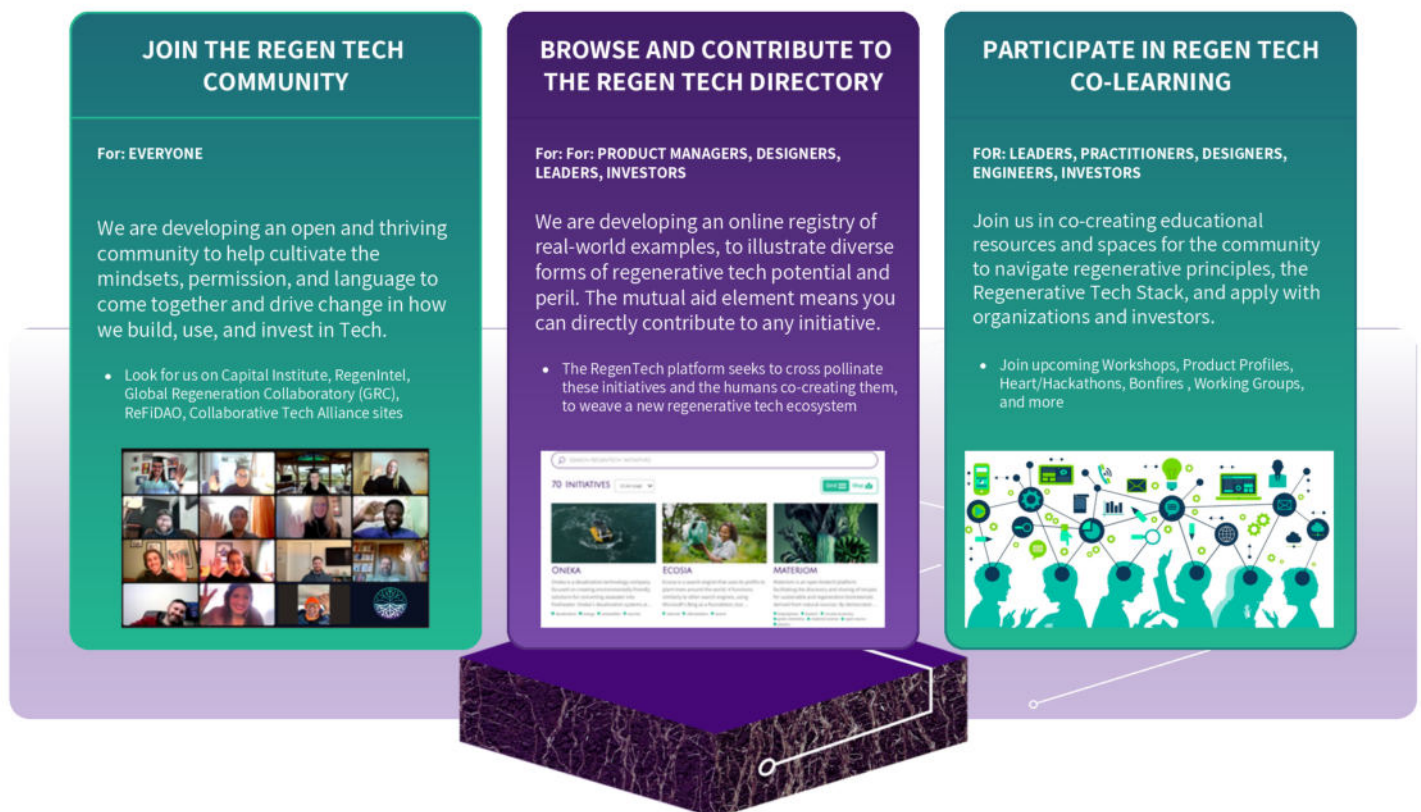
Regenerative technology is an invitation for investors, leaders, entrepreneurs, designers, builders, practitioners, youth leaders, engineers, and all of us to embrace a new playbook: one that harnesses our tools for the benefit of humanity and socio-economic-ecological alignment.

With this white paper, we hope to have planted a seed. The success of the seed's growth depends on the soil. Now we invite you to be part of the collective soil from which this radical new technological paradigm can take shape and emerge. The most powerful and immediate place to begin is in one's own "backyard." Start with your place in space, explore your relationship with technology, and with the world around you, your community, organization, your bioregion.

**Join us to cultivate
the soil for
Regenerative Technology!**

Join us at [Regentech.co](https://regentech.co) as we seek to contribute to the regenerative movement with a digital platform and community hub, and directory of initiatives, and related resources for regenerative technology.

Figure 20: The Regenerative Technology Invitation



Source: The Regenerative Technology Project

Join us to co-create these areas to help bring technology in service to life to the Tech industry, and across the countless sectors and realms of life it impacts. We're just getting started! Keep an eye out for our "innovation station" a constellation of regenerative technology initiatives and dreams.



For many millions working in Tech, and billions impacted by it: this new story for technological innovation is sprouting. Recent years have seen the tech community building more than new tools, instead planting seeds for a flourishing ecosystem: Communities, accelerators, open source designs, new institutions, programs, governance models and policies, all dedicated to technology stewardship in service of humanity, and to life itself. RegenTech is a validation of the growing movement of entrepreneurs, start-up “phoenixes” [34] investors, designers, and others who are already using technologies in service of this alignment.

While some still relegate these to “Tech for Good” or “Ethical Tech,” rather than technology for alignment, this overlooks the immense regenerative economic potential in these innovations. [35] Yes, we can do well by doing good; we can also thrive by getting in rhythm with life. If anything, perhaps

“data is the new soil.”

“The stone age was marked by our clever use of crude tools; the information age has, to date, been marked by our crude use of clever tools.

How can we enable the most regenerative use of our most clever tools?"

—unknown



LOOKING AHEAD: TECHNOLOGY FOR BIOPHILIA AND THE IN-FORMATION AGE

Regeneration begins with inner inquiry around what we're co-creating in the story of life, and what our relationships are to the world around us. Deeper still than recognition that we are part of nature, is the way of living in service to nature, in service to all of life. This is beyond accounting for the living world, even beyond imitating nature, also called biomimicry; it's about a love for life. That is Biophilia, the deep, inborn affinity or tendency to commune with nature, to love nature. And to love nature means to love oneself, for humans are nature, just one of over 8 million other species on earth. [36]

Our current technological epoch's orientation towards separation and dominance has relegated this concept to the dustbin of history, hippie fantasies, or simply obsolete. Anthropocentrism has become the north star, rugged individualism the means, with technology a key driver in accelerating this separation. Part of the regenerative technology inquiry is to ask what it might mean, and how might our technologies support us, if we loved ourselves and our environs, and lived as if they were gloriously entangled.

Behaving in ways that are systematically destructive to our ecosystem is a recipe for self-termination. If we want to survive and thrive as a species, perhaps our role as a "keystone" species evolves to help restore the greater ecosystem towards ecological balance— the true "natural order" of any ecosystem. Ecological balance is not a static state but a dynamic equilibrium, constantly adjusting to an ever changing ecosystem. This balance emerges from the interplay between order-creating processes (e.g., birth, growth, reproduction) and entropy-increasing processes (e.g., death, decomposition, energy dissipation). This process of seeking to establish homeostasis, the ecological balance, is the delicate symphony that all of earth's parts play with one another.

An Ecology of Technology invites us to do more than see the many systems and structures in which technologies are nested. It asks us how technological relationships might support health and healing for the whole. Humans will be at the heart of this transition. Re-memembering ourselves and our unique essence to a greater whole will be the first spark that ignites the transition to this new era. Ancient wisdom plus modern science, converging at the dawn of the information age.

Cosmologist, author, former business executive and co-founder of WholeWorld-View, Jude Currivan takes the question of the future of our information age yet further. Currivan proposes that our entire Universe is essentially living and holographically manifested, meaning that inherently all-pervasive and meaningful in-formation about the whole is encoded in every part. This echoes diverse wisdom traditions' core tenet of the fundamental interconnectedness and unity of all things in the Universe.

She posits that matter-energy and space-time are the appearance of its reality, not its underlying nature. Instead, that universal consciousness, articulated as meaningful in-formation is the most basic component of reality. The reality of universal "in-formation," manifests as the ongoing and evolutionary journey of our entire Universe as an ongoing process of coming into being. This means that this understanding of the divine wisdom, of the whole interconnected and interdependent Universe lies within each one of us and in every strand of the web of life.

In this way, there is an inherent tendency towards "intropy, as the increasing and emergent informational content of our Universe; its increasing complexity and consciousness, and in-formation patterns and processes repeating and holarchically nesting at different scales throughout the universe. Drawing on the latest in quantum physics, Unitive Science posits that the Universe itself is inherently conscious and that its consciousness permeates all of existence; every cell, organism, individual, society. In-formation complexity is thus a key factor in cosmic evolution, planetary evolution, biological evolution, and the development of human consciousness and culture. This sheds new light on the potential for the Internet, one of humanity's most powerful technological creations. What we do to the web, we do to ourselves.

 The implications of unitive science for technology and innovation are profound. Recognizing technology as a manifestation of universal and meaningful in-formation and sentience can guide its future development.

It can play a pivotal role in furthering a wholistic understanding of the essentially conscious reality and evolutionary potential of our Universe, and ourselves."

— Dr Jude Currivan





ABOUT US

The Regenerative Technology Project's mission is to reimagine technological innovation as a catalyst for thriving societies, ecologies, and economies. As ecosystem builders, our work is to co-create open resources, help people help each other, and guide entrepreneurs, investors, and organizations in regenerative technology and innovation.

The project was founded by Jessica Groopman, a technology industry analyst, author, and speaker, she studies the intersection of emerging technologies and regeneration, and advises forward-thinking leaders globally on disruptive "horizon 3" innovations. She was the lead author of this paper.

The project was co-founded by Danielle Lanyard, an environmentally focused entrepreneur and start-up leader and advisor, whose career has focused on sustainability, technology, and storytelling. Danielle was a co-author of this paper.




ACKNOWLEDGEMENTS

The Regenerative Technology Project would like to thank the countless supporters and contributors of this work, research, inspiration, and inquiry over many years. This whitepaper would not have been possible without the inspiration and critical provocations of Solène Lejosne, John Fullerton, Nora Bateson, Hunter Lovins, Jeremy Lent, Chad Frischmann, Tristan Harris, Ebru Kaya, Tanuja Prasad, Dr. Helene Liu, Ernesto van Peborgh, Daniel Christian Wahl, Kate Raworth, Grant Storry, Caroline Chubb Calderon, Lynelle P. Cameron, Raman Frey, Nicole Bastien, Marianne With, Dr. Danielle Rappaport, Roseann Stempinski, Jeremiah Owyang, Alan Booker, Jason Knoll, Wendy Moomaw, Ann Badillo, Christy Foulger, David Hodgson, Ethan Smith, Sarah Dubreil, Franco Amalfi, Gil Friend, and many more.

Particular gratitude to this paper's editors and contributors: Rebecca Lieb, Andrea Farias, Bea Addis, Maya Dentzel, and design contributions from Brooke Braddy and the design team at InfoBrandz.

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ENDNOTES

1. Duarte, Fabio. Number of IoT Devices 2024. Exploding Topics. 19, Feb. 2024. <https://explodingtopics.com/blog/number-of-iot-devices>
2. Kate Smaje and Rodney Zemmel "How Top Performing Companies Approach Digital Transformation" McKinsey Blog. 23, Mar. 2024. <https://www.mckinsey.com/featured-insights/themes/how-top-performing-companies-approach-digital-transformation>
3. Kaur, Dashveenjit. "95% of global corporations ignore nature in business assessments" Sustainability News. 21, Aug. 2024. <https://sustainability-news.net/climate-nature/95-of-global-corporations-ignore-nature-in-business-assessments/>
4. Planetary Boundaries. Stockholm Resilience Center. Accessed 22, Aug. 2024. <https://www.stockholmresilience.org/research/planetary-boundaries.html>
5. Zuboff, Shoshana. The Age of Surveillance Capitalism. Profile Books, 2019. P 8
6. Monbiot, George. "The Gift of Death" George Monbiot's Blog. 10, Dec. 2012. <https://www.monbiot.com/2012/12/10/the-gift-of-death/>
7. Microplastics are everywhere — we need to understand how they affect human health. Nat Med 30, 913 (2024). <https://doi.org/10.1038/s41591-024-02968-x>
8. The Fourth Industrial Revolution, or "Industry 4.0" is a neologism popularized by the World Economic Forum to describe how technologies such as artificial intelligence, robotics, and genomic editing will represent an "advancement" in industrial capitalism. The term's use of the term industrial also carries the assumption that technology will continue the logic of the industrial age." https://en.wikipedia.org/wiki/Fourth_Industrial_Revolution
9. David Pilling and Madhumita Murgia. "You can't unsee it: The content moderators taking on Facebook" Financial Times. 17 May, 2023. <https://www.ft.com/content/afeb56f2-9ba5-4103-890d-91291aea4caa>
10. Cohen, Jason. "Four companies own 67% of the world's cloud infrastructure" PC Magazine. 21 Dec. 2021. <https://www.pcmag.com/news/four-companies-control-67-of-the-worlds-cloud-infrastructure> via Statista <https://www.statista.com/chart/18819/worldwide-market-share-of-leading-cloud-infrastructure-service-providers/>
11. Jeran Wittenstein and Tom Cotiliano. "Nvidia and five tech giants now command 30% of the S&P 500 Index" Bloomberg. 30 May 2024. <https://news.bloomberglaw.com/artificial-intelligence/nvidia-and-five-tech-giants-now-command-30-of-the-s-p-500-index>
12. Starr, Douglass. "Just 90 Companies are to blame for most climate change, this 'carbon accountant' says" Science. June, 2016. <https://www.science.org/content/article/just-90-companies-are-blame-most-climate-change-carbon-accountant-says>
13. Shunsuke Managi and Pushpam Kumar. Inclusive Wealth Report 2018: Measuring Progress Towards Sustainability. 23 July, 2018. <https://doi.org/10.4324/9781351002080>
14. Foy, Kyle. "New tools are available to help reduce the energy that AI models devour" MIT News. 5 Oct. 2023. <https://news.mit.edu/2023/new-tools-available-reduce-energy-that-ai-models-devour-1005>; Data Centers and Transmissions Networks. International Energy Agency. Accessed 23 July, 2024. <https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks>
15. Gerrit Becker, Luca Bennici, et al. "The green IT revolution: A blueprint for CIOs to combat climate change" McKinsey. 15 Sept. 2022. <https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-green-it-revolution-a-blueprint-for-cios-to-combat-climate-change>
16. UN report: Time to seize opportunity, tackle challenge of e-waste. UN and Partnership for Accelerating the Circular Economy (PACE). 24 Jan. 2019. <https://www.unep.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste>
17. Bradstock, Felicity. Oil is breathing new life into Oil & Gas. OilPrice.com. 8, Aug. 2023. <https://oilprice.com/Energy/Crude-Oil/How-AI-Is-Breathing-New-Life-Into-Oil-And-Gas-Operations.html>
18. Roose, Kevin. "This AI Subculture's Motto: Go, Go, Go!" The New York Times. 10 Dec. 2023. <https://www.nytimes.com/2023/12/10/technology/ai-acceleration.html>
19. Connely, Caroline. "Microsoft and Google's GHG emissions gains call viability of net-zero targets into question" Computer Weekly. 9 July, 2024. <https://www.computerweekly.com/news/366592778/Microsoft-and-Google-GHG-emissions-gains-call-viability-of-net-zero-targets-into-question>
20. Emma Strubell, Ananya Ganesh et al. "Energy and Policy Considerations for Deep Learning in NLP." College of Information and Computer Sciences University of Massachusetts Amherst. 5 June 2019. <https://arxiv.org/pdf/1906.02243>; Hao, Karen. "Training a single AI model can emit as much carbon as five cars in their lifetimes." MIT Technology Review. 6 June 2019. <https://www.technologyreview.com/2019/06/06/239031/training-a-single-ai-model-can-emit-as-much-carbon-as-five-cars-in-their-lifetimes>



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TECHNOLOGY
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ENDNOTES

21. Giampetro, Mario and Kozo Mayumi. "Unraveling the Complexity of the Jevons Paradox: The Link Between Innovation, Efficiency, and Sustainability" *Frontiers Journal*. 3 Apr. 2022. <https://www.frontiersin.org/journals/energy-research/articles/10.3389/fenrg.2018.00026/full>
22. Dimiani, Jesse. "Explaining Polycrisis and Metacrisis" *Reality Studies*. 7 Nov. 2023. <https://www.realitystudies.co/p/explaining-polycrisis-and-metacrisis>
23. "We shape our tools and our tools thereafter shape us." This quote is famously attributed to Marshall McLuhan in his book *The Medium is the Message* (1967). This quote is often attributed to the Canadian media theorist Marshall McLuhan, though it is a derivative of Winston Churchill's quote "we shape our buildings; thereafter they shape us," delivered in a 1943 speech. *Quote Investigator*. 26 June 206. <https://quoteinvestigator.com/2016/06/26/shape/>
24. Poyner, Rick. *The Body as Factory: Anatomy of an Image*. *Design Observer*. 11 June, 2014. <https://designobserver.com/the-body-as-factory-anatomy-of-an-image/>
25. Bridle, James. *Ways of Being: Animals, Plants, Machines and the Search for Planetary Intelligence*. Farrar, Straus and Giroux. 21 June, 2022. <https://www.goodreads.com/book/show/58772732-ways-of-being>
26. *Facts and Figures 2023: Global offline population steadily declines to 2.6 billion people in 2023*. International Telecommunications Union. Accessed 20 Aug. 2024. "<https://www.itu.int/itu-d/reports/statistics/2023/10/10/ff23-internet-use/>
27. Summary of the Macy Conferences. American Society for Cybernetics. Accessed 21, Aug. 2024. <https://asc-cybernetics.org/foundations/history/MacySummary.htm>
28. Popkin, Gabriel. "'Wood wide web'—the underground network of microbes that connects trees—mapped for first time" *Science*. 19 June, 2019. <https://www.science.org/content/article/wood-wide-web-underground-network-microbes-connects-trees-mapped-first-time>
29. What is kaitiakitanga? *Environmental Guide*. Accessed 23, Aug. 2024. <https://www.environmentguide.org.nz/issues/marine/kaitiakitanga/what-is-kaitiakitanga/>
30. The saying "Only when the last tree has been cut down, the last fish been caught, and the last stream poisoned, will we realize we cannot eat money" is often attributed to the Cree people, though the earliest variation is cited in 1972 to a member of the Odenak Reserve. *Quote Investigator*. 20 Oct. 2011. <https://quoteinvestigator.com/2011/10/20/last-tree-cut/>
31. Van Pebourgh, Ernesto. *RegenTech: Embracing Bill Sharpe's Three Horizons Framework for a Sustainable Future*. Medium. 24 Apr. 2024. <https://ernesto-87727.medium.com/regentech-embracing-bill-sharpes-three-horizons-framework-for-a-sustainable-future-b4249199c733>
32. While the patterns of living systems are universal, humans use different sets of language to describe and apply these patterns to specific and variable contexts. Some examples include [Regenerative Principles for Economics](#), [Principles of Biomimicry for Product Design](#), [Regenerative Principles for Personal and Organizational Development](#), [Principles of Regenerative Leadership](#) and more.
33. In a business and economic context, "externalities" are unpriced components that are involved in either consumer or producer market transactions. Many of today's global digital platforms have not accounted for "external" costs such as political division or ecological harms caused by their platforms. <https://en.wikipedia.org/wiki/Externality>
34. "Of Unicorns and Zebras. Say Hello to the Phoenix" *Handprint*. 11 Aug. 2023. <https://handprint.tech/of-unicorns-and-zebras-say-hello-to-the-phoenix/>
35. Fullerton, John. *Regenerative Capitalism: How Universal Principles And Patterns Will Shape Our New Economy*. Capital Institute. April 2015. <https://capitalinstitute.org/wp-content/uploads/2015/04/2015-Regenerative-Capitalism-4-20-15-final.pdf>
36. "How many species on earth?" *California Academy of Sciences*. 24 Aug. 2011. <https://www.calacademy.org/explore-science/how-many-species-on-earth>



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