Research Article

ICT, AI, and Web Coevolution are Explained and Predicted by Humanity's Increasingly Multidimensional Connectivity and Coordination

Daniel Siegfried[1]

1. ESCP Business School, Paris, France

The coevolutionary histories of information and communications technology ("ICT"), artificial / automation intelligence ("AI"), and the Web are explained *and predicted* based on four independent dimensions of human organization. Each iteration in core Web technology integrates a new organizational dimension of societal-scale connectivity and information content. The historical evolution of the Web from "read" connections (Web1) to "read/write" interactions (Web2) to "read/write/own" transactions (Web3) is a widely accepted paradigm amongst all Web3 thought leaders. It also implicitly identifies three of these four dimensions. However, what is not so well understood is how this stepwise evolution in connectivity and content technology leads to a similar multidimensional evolution in computation and coordination, commonly called AI. A metatheory lens of coordination is introduced to visualize, explain, and predict this coevolution of ICT, AI, and the Web. The exponentially increasing numbers of multidimensional connections and conflicts that need to be integrated at each evolutionary stage to achieve rationally coherent coordination are also quantified. As a result, it becomes exceedingly clear why societal-scale human coordination must coevolve via increasingly multidimensional AI-based coordination. Likewise, when viewed through this four-dimensional lens, the final "World Computer" stage of Web4 connectivity, coordination, and human organization becomes unexpectedly obvious: "read/write/control/own". To further support this predicted core Web4 feature of decentralized control, the persistently fatal flaws of Web3's existing decentralized autonomous organizations ("DAOs") are analyzed and directly traced to this major deficiency in coordination capability. Adding collective prioritization control over DAO resources would logically fix these flaws.

 doi.org/10.32388/569C2O

Correspondence: papers@team.qeios.com — Qeios will forward to the authors

1. Introduction: How and Why is the Web Evolving?

There are four independent dimensions of human organization to answer the four necessary questions required to coordinate: 1) people / perspectives (=Who?), 2) purpose(s) (=Why?), 3) preferences (=What?), and 4) property (=How?) [1]. These dimensions can also be denoted as the variables E, D, A, and R, respectively, which are short for the synonyms of effort/employees, directives, alternatives, and resources. No formal theory or metatheory of multidimensional coordination (as developed here) appears to be evident in the organization and management literature. However, what the literature does implicitly support is the assertion that these are the four independent dimensions required to coordinate [1][2][3][4]. In particular, Mary Parker Follett was arguably the first scholar to theorize deeply about organization itself being defined as an integrative process of four-dimensional coordination, with mathematically intensive "reciprocal relating" required [[4], pp. 297-305].

However, before individuals can coordinate effectively at increasingly higher levels of multidimensional complexity, this paper argues that ICT must first evolve exponentially to handle the prerequisite connectivity. For example, if N = 1,000 dimension members for each of three organization dimensions (like R, D, and E), this implies a web of connectivity that must increase multidimensionally from one thousand connections for 1:N ("1D"), to one million connections ($1{,}000^2$) for N:N ("2D"), and to one billion connections ($1{,}000^3$) for N:N:N ("3D"). Surprisingly, scaling such massive connectivity is the easy part. In fact, we have already accomplished all of this via Web1 for 1D connectivity, Web2 for 2D connectivity, and Web3 for 3D connectivity.

What is far more difficult and computationally intensive is scaling the integration of all those exponentially conflicting connections into a rationally coherent whole. Follett presciently argued one century ago, before ICT even existed, that this "integrative unity" is the ultimate purpose of all coordination and organization [see, e.g., [4], p. 192]. Siegfried [1] adds strong support to this argument. More important, such exponentially complex coordination at societal-scale cannot possibly be done without AI, which this example clearly illustrates. As a result, this paper implicitly argues that the ultimate purpose of all AI is to scale the integrative coordination of data, information, knowledge and decisions far beyond our human-only capabilities. Only after AI evolves to coordinate in increasingly

doi.org/10.32388/569C2O

multidimensional fashion across the four dimensions of organization can human coordination coevolve to do the same at societal-scale.

The purpose of this paper is therefore not only to explain the multidimensional evolution of the Web and human coordination via ICT and AI coevolution, but also to predict the future of both. This is done by exposing the coevolutionary process embedded in the history *and necessary future* of the Web via theoretical elaboration. The theoretical lens of "evolutionary intelligence" ("EI") introduced by Siegfried [1] will be applied to illuminate this generalized system of four-dimensional evolutionary coordination since the inception of commercialized ICT around 1960.

To help understand how this coevolutionary process works, one can break down ICT and AI capability into four basic innovation categories. These "4 Cs" are listed in Table 1 as follows: 1) connectivity (between computers / individuals), 2) content (the database layer), 3) computation (the processing power to facilitate societal-scale coordination), and 4) coordination (how to actually integrate connectivity and content across the four dimensions of organization). The first two categories of "connectivity" and "content" (i.e., communications and information) literally define core ICT functionality per its acronym. By contrast, the second two categories of "computation" and "coordination" intuitively define core AI functionality.

Each innovation in ICT and AI capability effectively facilitates the next, from #1 to #4 in the sequential list above. Also, both ICT and AI have critical attributes that coevolve over time in stepwise fashion across the same four dimensions of connectivity and coordination, as depicted in Table 1. In effect, the 4 Cs facilitate evolutionary scale, whereas the four dimensions describe evolutionary scope via the R:A:D:E network graph notation introduced by Siegfried [1] (where N= all societal-scale or Web-scale nodes of that dimension ID, n= all organization-scale or team-scale nodes, and 1= only one dictatorial node controlling that dimension).

doi.org/10.32388/569C2O

EI ID	ICT Stage Milestones	Multidimensional Evolution of Network (Web) Connectivity	DB Content Type (for non-static data)	Multidimensional Evolution of Data Content	Multidimensional Evolution of Computation	AI Evolution to Scale Coordination from n to N
		ICT Connectivity	ICT Content	ICT Content	AI Computation	AI Coordination
AI	Industrial Automation: 1793- ICT Automation: 1940- Chasm Crossing (Orgs.): 1960 Chasm Crossing (PCs):1984	**Mainframes, then Client-Server + PCs (Transact 1:1)**	Normalized Relational	1:1 Transaction-based Rows of Tabular Data	1:1 Centralized Processing of Transactional Data on a Global Scale for Global Organizations	HW: Industrial Robotics SW: 1:1 Expert Systems (scales to 1:1*N by bypassing 1:1 n-scale hierarchy limits)
BI	Internet Platform (TCP): 1977 Web1 ICT Platform: 1990- Chasm Crossing: 1994	**Web1 (Link & Publish 1:N)** (read-only)	Denormalized Relational Data Warehouse (ROLAP)	1:N HTTP Linking + 1:N Column-based Metadata Integrating All Data Rows and Tables	1:N Integration of Raw Structured "Big Data" to Create New Information	HW: 1: N Web & Data Servers SW: 1:N "cloud apps." + 1:N ML (incl. Predictive/Prescriptive Analytics as BI Agents)
CI	Web2 ICT Platforms: 2002- Chasm Crossing: 2004	**Web2 (Interact N:N)** (read/write)	Unstructured (Documents and Media)	N:N Index-based Page Ranking and Neural Network Linked Data	N:N (2D) Integration of Document and Media Data via GPUs to Synthesize Collective Knowledge	HW: GPU Clusters & IOT SW: N:N platforms, ecosystems, social networks + Gen. AI (CI Agents) via N:N Neural Networks
DI	Blockchain Technology: 2009 Web3 Blockchain Platform: 2014- DI Technology: N/A Chasm Crossing: N/A for both	**Web3 (Own or Control N:N:N)** (read/write/own w/o org. control or read/write/control but subordinate to org. owners)	Multidimensional (MOLAP or similar) + Distributed Ledgers	1:n:n:n Cell-based Data (for DI consensus) + N:1:N:N Blockchain Data (for token consensus)	3D Consensus Calcs. on Token Ownership (via Web Mining nodes) and on Org. Control (via separate HW)	HW: Self-Learning Androids SW: N:N:N DEXs, DAO Platforms, and DI Agents
EI	Web4 ICT Platform: N/A Chasm Crossing: N/A	**Web4 (Coordinate N:N:N:N)** (read/write/control/own at both individual and organizational levels, subordinate to no one)	Likely Blockchain-based "Smart Contracts", with Data Homomorphically Encrypted (details TBD)	N:N:N:N Blockchain-based Data for Any Dimensional Structure of Data	N:N:N:N Consensus over Ownership AND Control via (Quantum?) NPUs on Full Blockchain Tech Stack	HW: Internet as a "World Computer", Quantum-Computing SW: N:N:N:N Multiagent DAOs of Evolving EI Agents

Table 1. Multidimensional ICT and AI Coevolution. *Note that the Connectivity and Content columns (with an orange label) are associated with ICT evolution, whereas the Computation and Coordination columns (with a turquoise label) are associated with AI evolution.*

2. Methods

Theoretical elaboration and microhistory, as thoroughly described by Hargadon and Wadhwani [5], are the primary methods of theorizing applied in this paper. Indirectly, the interdisciplinary research method is also applied due to the integration of evolutionary theory. More specifically, the EI process narrative of multidimensional coordination within a single organization (as described per the EI framework of Figure 1 introduced by Siegfried [1]), is extended across a macrotemporal and macrospatial historical context. The increasingly multidimensional coevolution of ICT, AI, and the Web across modern history is then explained and predicted, beginning with the first commercialization of ICT in the mid-20th century. Figure 2 will be the visual roadmap for this theorizing to supplement the narrative roadmap of Table 1. Note in Figure 2 how the 4 Cs differentiate the row headers, and the four dimensions differentiate the column headers. In short, the theoretical elaboration and microhistory methods are applied to extend the microevolutionary EI processes within a single organization to the macroevolutions of ICT, AI and the Web to develop a *metatheory of coordination*.

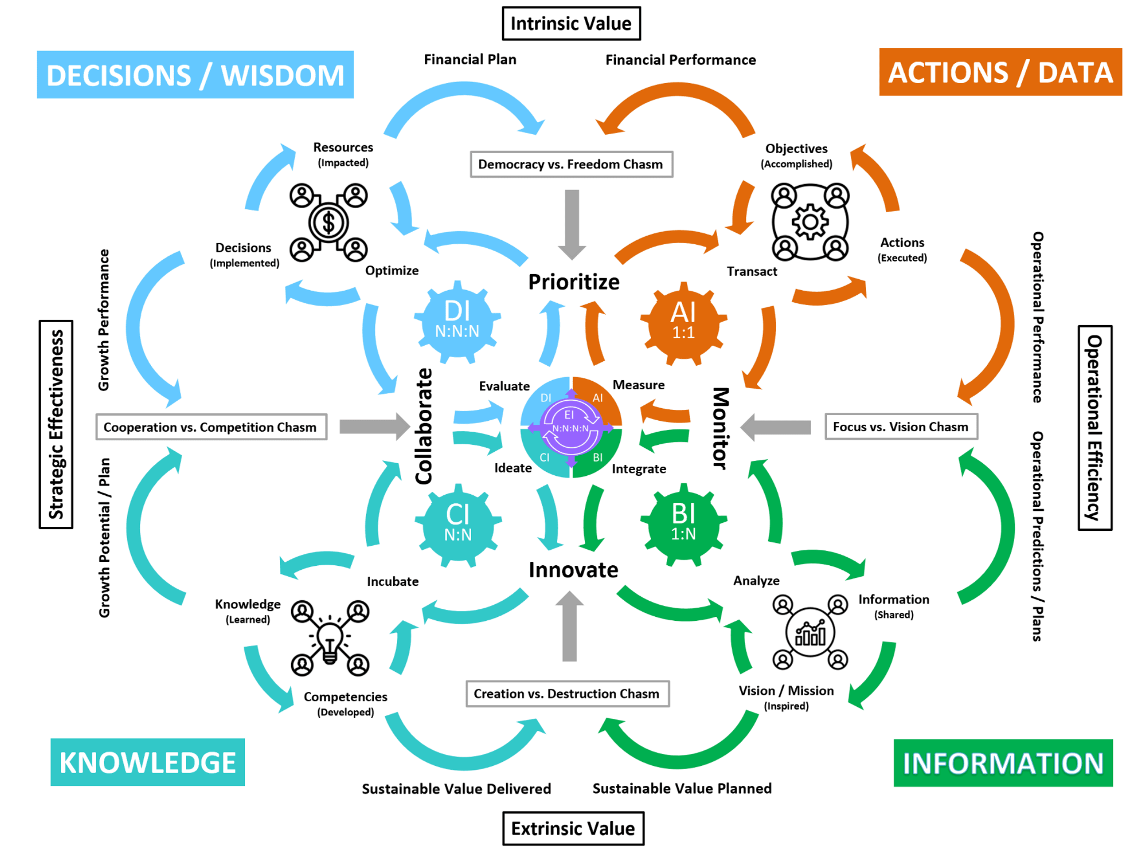

Figure 1. The EI Framework

doi.org/10.32388/569C2O

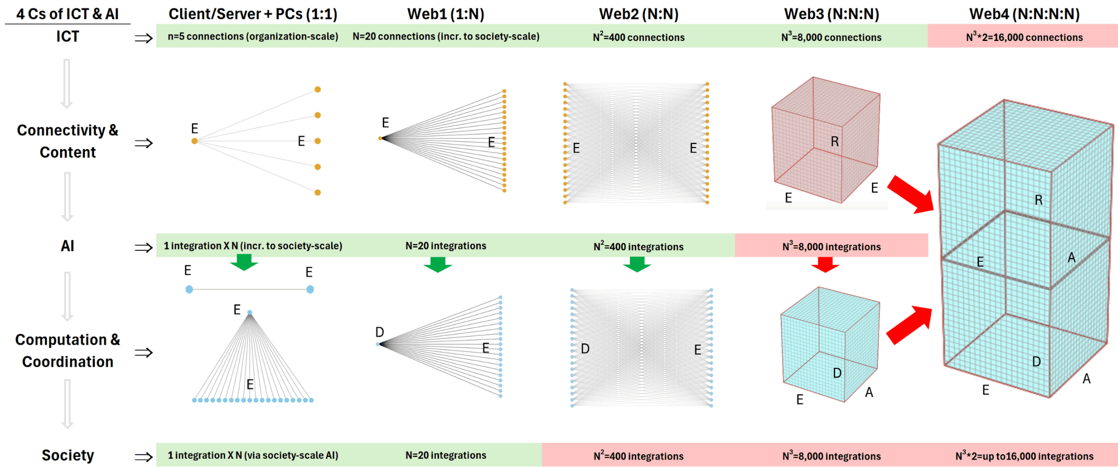

Figure 2. 4D Web and Society Coevolution via ICT and AI. *Note that Connectivity and Content (in orange) are associated with ICT coevolution, whereas Computation and Coordination (in turquoise) are associated with AI and Society coevolution. The 4 Cs (as row headers) facilitate evolutionary scale, whereas the four dimensions (as column headers) describe evolutionary scope via the R:A:D:E notation (where N= all nodes of a dimension, and 1= only one dictatorial node controlling that dimension). The nine coevolutionary stages with green labels have been achieved by humanity, whereas the six coevolutionary stages with red labels have not been. The latter are predictions of future societal-scale connectivity and coordination based on the four dimensions of organization. Technically, reflexive connections or integrations with oneself (in E) or one's profile of directives (in D) are done offline, but this is not significant at societal-scale.*

3. Results and Analysis

In the absence of sufficient multidimensional coordination technology, collectively rational organization becomes unachievable without dictatorial overrides, especially at scale. It is a classic bounded rationality problem [6] due to the requirement of an exponentially increasing network of interacting coordination nodes that no single individual can integrate. In short, multidimensional connectivity and content must logically precede multidimensional coordination. Also, substantive innovations in both hardware and algorithmic computation are intuitively required to scale that coordination beyond a single organization, or even beyond a single team. The multidimensional coevolution of ICT and AI via the Web is thus the necessary precursor to all stages of human coordination at societal-scale.

As a result, the evolution of the Web is itself explained by this same metatheory lens due to the same defining connectivity characteristics of each distinct era of Web technology. Moreover, this lens can credibly predict what the future of Web technology will look like based on the simple premise of four independent dimensions of organization. That is because the evolutionary history of ICT networks from client-servers through today's Web3 is fundamentally about an increasingly complex web of coordination facilitated first and foremost by multidimensional connectivity and content. Table 1 outlines this history.

In fact, the historical progression of the Web from "read" connections (Web1) to "read/write" interactions (Web2) to "read/write/own" transactions (Web3) is a widely accepted paradigm amongst all Web3 thought leaders. Chris Dixon [7] even made the latter the title of his book. However, what is not so well understood is what this progression means from a multidimensional coordination point of view. The theoretical lens of EI helps one to understand why each iteration in Web technology is not at all a new "version" of the Web. Each iteration continues to serve a uniquely valuable multidimensional integration purpose at different complexities of connectivity and coordination. Therefore, it is important to understand first how ICT connectivity and content have coevolved before exploring how this same stepwise multidimensional pattern is repeated with the subsequent coevolution of AI's computation and coordination capabilities. Figure 2 is the visual roadmap for presenting these results.

Once this metatheory of coordination is established via the theoretical lens of EI, the implications of the theory upon the predicted future of the Web are discussed. The persistently fatal flaws of Web3's existing decentralized autonomous organizations ("DAOs") are analyzed as the future's starting point. These flaws are directly traced to the missing fourth and final Web4 organizational coordination capability: collective preferences over strategic alternatives (i.e., competitively coordinating dimensions E, D, and A).

It is then assumed that Web4 will eventually be able to integrate this final societal-scale coordination capability to allow for the rationally coherent prioritization and optimization of organizational resource (R) allocations. If so, then it becomes quite clear why all existing DAO fatal flaws would no longer be applicable in a Web4 world. This is critically important, since Web4 DAOs could potentially be the sociotechnical foundation for a new economic system and society. They could finally allow organizational control to be completely independent of external financial ownership. This would break the stranglehold of shareholder primacy, since it would become obsolete by default due to the lack of any dictatorial overrides (by definition) within any of the four dimensions of coordination. That said, the scope of this paper is focused on the technical foundations of the Web to explain and extrapolate its evolution. Forthcoming papers expand more upon the related coevolution of human organization, including the threat from increasingly multidimensional AI.

3.1 ICT Coevolution

Even before the Web, the first ICT prototype appeared around 1940 with the "Complex Number Calculator" operating remotely. However, the first real ICT "chasm crossing" [the technology adoption concept popularized by [8]] occurred around 1960 for businesses. That was when the IBM 1401 mainframe was introduced, which was widely considered the "Model T" of computers after it comprised more than half of the world's computers by the mid-1960s [9][10]. Interaction with a mainframe was essentially transactional, implying 1:1 connectivity complexity.

Similarly, after the chasm crossing of PC and client-server technology roughly another 20 years later, ICT connectivity remained essentially 1:1 during this initial ICT era of Automation Intelligence ("AI"), which maps to the first microhistory stage and clockwise Actions / Data quadrant of Figure 1. "AI" here is a more generic concept per Siegfried [1] that fully embraces all past and future redefinitions of "artificial intelligence", since AI coordination capability naturally becomes increasingly multidimensional over time.

A distinctly new ICT intelligence era evolved only with the innovation of TCP for 1:N Internet connectivity in 1977, HTTP for 1:N content linking in 1989, and BI for 1:n structured data integration in the late 1980s (i.e., data warehousing and extract, transform & load "ETL" functionality at organization scale "n"). But the ultimate chasm crossing for this breakthrough 1:N Web1 era was, of course, the World Wide Web, accessed via the Netscape Navigator browser launched in 1994. This era maps to the second Information quadrant of Figure 1.

The key innovation defining the Web2 era, mapping to the third Knowledge quadrant of Figure 1, was the jump in connectivity from one-directional "read" (1:N) to globally interactive "read/write" (N:N). This was achieved primarily via social media and similar platforms that crossed the chasm to mainstream adoption around 2004 with the launch of Facebook. Societal-scale retailers like eBay, Amazon, and other N:N connectivity platforms followed soon thereafter.

Interestingly, the data and metadata structures are also fundamentally different in each era, but they follow the same multidimensional progression. Web2 (CI) data is organized based on N:N linkages, indices, and page-rankings between unstructured, text-based documents (i.e., web pages). This fundamentally differs from the transactional data organized in 1:1 normalized fashion via a hierarchy of primary keys, as commercialized in the client-server (AI) era. It also fundamentally differs from the set of metadata attribute tables organized in 1:n denormalized fashion around a single fact table (or "data mart"), as commercialized in the Web1 (BI) era.

So, starting from 1:1 hierarchical connectivity in the client-server era, connectivity and content (i.e., data) complexity jumped to 1:N with Web1, and then to N:N with Web2. Thus, there is a direct microhistorical correspondence between this multidimensional evolution of the Web and the increasing multidimensional coordination that is required within a single organization. This is seen in quadrants 1-3 of Figure 1, as 1:1 Actions transform into 1:N integrated Information, and then into N:N integrated Knowledge.

As we proceed to the Web3 era, only about half of the technology required for 3D connectivity, content, computation, and coordination currently exists. This is the blockchain component with its core 3D functionality of "read/write/own". Like in Web2, there is a 2D societal-scale network of individuals (E) interacting with each other's directives (D). However, there is also a third dimension of resources (R) added to the Web's dimensional complexity of connectivity and content via tokenized blockchain assets stored on distributed ledgers. This 3D Web3 capability maps to the fourth Decisions quadrant of Figure 1.

Eventually, the entire Web technology stack will likely become blockchain-based to decentralize it fully. A fully blockchain-based Web tech stack has been described as "third-generation blockchain" technology. Surprisingly, this too is already in existence, but not yet fully functional. Currently, only the Internet Computer has reached this evolutionary stage. They have the largest development team of cryptographers in the blockchain industry with well over 1,000 man-years of R&D on this third-generation technology. So, it is worth giving them a look to help imagine what our Web3 and Web4 future could look like after achieving "blockchain singularity", when all coordinated computation is available on-chain. This final 4D Web4 capability maps via microhistory to the completion of the fourth quadrant and the hub of Figure 1.

For the missing Web3 read/write/control functionality mapping to the fourth quadrant, this would almost certainly have to be based on a type of multidimensional cell-based database given the 3D connectivity and coordination that it requires. Similar "MOLAP" database technology for organizations has been around since 1975, but it has never been Web-scaled or applied beyond a single organization's collective evaluations (e.g., for planning and budgeting).

3.2. Why Blockchain Technology is Critical to Future ICT and AI Coevolution

Taking a step back, the first generation of blockchains in 2009 was just a cryptocurrency distributed ledger to hold Bitcoin tokens. However, it was still groundbreaking, since it represented the first ever fully autonomous storage of transactional value residing entirely on the Web. It requires no trusted custodians, intermediaries, organizational borders, or network firewalls. The only thing currently protecting and autonomously transacting over one trillion dollars in nakedly accessible Bitcoin assets is cryptographic math and a decentralized ownership consensus algorithm.

The second generation of blockchains, starting with Ethereum, introduced "programmable money" in 2014 by embedding customized software (called "smart contracts") into the distributed ledger to control the tokenized assets autonomously. However, this still amounts to little more than a distributed ledger table of roughly 10 columns replicated across the Web, despite its great potential for future decentralized finance ("DeFi") applications.

Only with third generation blockchains can the entire technology stack, from the browser to the database, be running fully encrypted with distributed transactional consensus on a blockchain. Data and Generative AI models can even be queried and manipulated within this technology while it remains "homomorphically encrypted" [11][12]. That basically means even a local database administrator with physical server access would be prevented from snooping on the data anywhere or, worse, editing it.

Although this technology may sound esoteric and out of place in a discussion about human coordination, it is not. We are evolving towards 4D societal-scale connectivity and coordination, where most of our private information, productive private property, and collectively governed public property would be tokenized and managed over the Web. If so, then it must be in a decentralized world without closed organization borders or firewalled network boundaries. Only a third generation or higher blockchain protocol can offer such platform technology.

In fact, we already live in a world where the boundaries of organizations are becoming more porous due to increasing interdependencies and the growth of complex business ecosystems [13]. Outdated ICT firewalls are crumbling as fast as organizational walls due to growing pressures from coordination in an increasingly interconnected world of large, globalized corporations. As a result, cybersecurity risks, breaches, and costs have grown shockingly high. A startling 75% of U.S. executives ranked cyberattacks as their top business risk [14]. That is because the annual costs of cybercrime are expected to grow by nearly 70% from over $9 *trillion* in 2024 to nearly $16 *trillion* in 2029 [15].

doi.org/10.32388/569C2O

Also, cyber breaches are the rule, not the exception. For example, 69% of organizations have been successfully hit by at least one ransomware attack in a recent year, and 60% have been hit by four or more, while nearly 10% of phishing emails are clicked on by end users despite intensive corporate training against doing so [16]. The reliance on an outdated firewall of security between the naked data of an organization and the outside world is like still relying on castle walls for protection in an age of modern military power. The walled gardens of large, traditional organizations are becoming increasingly obsolete. They will likely have no place in a future rainforest of interconnected business ecosystems and independent individuals coordinating in natural evolutionary balance, where both firewalls and organizational walls no longer exist. In short, a blockchain-based Web4 is the worldwide manifestation of that digital rainforest.

3.3. AI Coevolution

As we have seen above and in Figure 2, there is a very consistent five-step progression in dimensional complexity at each stage of ICT coevolution: from 1:1 to 1:N to N:N to N:N:N to N:N:N:N. Web connectivity, database content structure, and even how data link together all follow the same incremental multidimensional coevolution pathway at each Web stage. The same applies to the AI capabilities of computation and coordination per the last two columns of Table 1. They facilitate the scaling of multidimensional coordination from mere team or organization levels (n) to societal or Web levels (N). Note in particular how, for each Web stage, there tends to be both a core hardware innovation and a core software innovation to make this AI scaling possible. Also, note in Figure 2 how the maximum integrations at any point in time increase exponentially with each new dimension of coordination added, thereby quantifying the progressive scale of AI complexity and computational intensity.

For example, robotics and hierarchical "expert systems", respectively, represent the core hardware and software automation innovations at the original 1:1 level of coordination. These allow a manufacturing operation to scale globally, either within a single multinational corporation or across an ICT/AI-enabled global supply chain. N-scaling AI in manufacturing is not about coordinating more human beings. It is about coordinating all the machines that have replaced human beings. As a result, the hierarchy of control can be completely flattened without going beyond direct 1:1 coordination. This can allow for a single global organization to scale enough to provide industry widget X to the entire world. That is because any number of machines can be "supervised" directly and interactively by a single computer in 1:1 fashion. This obviously requires significant scale in ICT, but it only requires minimal scale in AI. That is because machine supervision via an expert system is generally done independently and in parallel threads. No more than one thread of 1:1 integration is required per automation process at any point in time (i.e., 1:1 serial coordination).

If human beings were coordinating that global manufacturing instead, the 1:1 hierarchy would be many dozens of levels deep. That is due to the optimum number of direct reports per person being only about 5-9, per various estimates. Scaling that hierarchy would clearly not be feasible or sustainably competitive. Hence the need for AI to society-scale even 1:1 coordination.

In essence, the purpose of AI and its evolution in all multidimensional stages is to reduce, and ultimately to transcend, our bounded rationality constraints. Via AI, all data synthesis and coordination – from actions to information to knowledge to decisions – is able to scale from organization/team-scale n to Web-scale N. For example, just like the key output of 1:1 AI-based coordination is automation via the synthesis of actions, the key output of 1:N AI-based coordination is information or business intelligence ("BI") via the synthesis of raw data and existing information from all available sources.

With respect to the 1:N BI stage of AI evolution, the core hardware and software innovations are arguably 1:N Big Data farms and 1:N cloud applications facilitated by N-scale Web and data servers. They can all coordinate with each other via load balancing and dynamic fault-tolerance, along with predictive/prescriptive analytics based on 1:N Machine Learning ("ML") algorithms applied to Web-scale data sets. Moreover, the main purpose of BI is to integrate N disparate sources and fields of structured data into "one version of the truth" via a shared metadata dictionary, and then to publish that integrated data to its N (or n) end users. So 1:N applies with respect to both ICT connectivity and content, as well as to the AI-based coordination of metadata integration and information synthesis. Only via AI is this coordination able to Web-scale well beyond any pre-ICT organization's transactional boundaries.

For the CI stage, N:N Graphical Processing Unit ("GPU") clusters and "Internet of Things" ("IoT") represent the core hardware innovations automating coordination up to Web-scale. Likewise, N:N Deep Learning and Generative AI represent the core software innovations that can coordinate unstructured document and media data in N:N fashion at Web-scale. The latter is achieved via a sequential 2D layering of N:N neural networks [See [17], pp. 213-220 for an easy visual introduction to neural networks]. The key output of N:N AI-based coordination is integrated knowledge or collective intelligence ("CI") via the synthesis of new information and existing knowledge from all available sources.

doi.org/10.32388/569C2O

As the power of AI automation has continued to evolve stepwise beyond its original AI quadrant of EI [per [1]] and its original single-organization focus, the definition of "artificial intelligence" has fundamentally changed in likewise fashion over several decades. That is why the more generic and dynamic umbrella term of "automation intelligence" is the preferred way to define AI in this paper. Interestingly, others have come to the same conclusion that there have been three distinct eras (and thus definitions) of AI so far, which correspond exactly to these first three EI quadrants (AI, BI, and CI) of increasingly multidimensional coordination [18].

As for the future, self-learning androids and multiagent systems would be the likely hardware and software innovations coordinating across three dimensions (N:N:N) at a later Web3 DI stage. Decentralized financial exchanges ("DEXs", like Uniswap) and platforms to launch and manage DAOs (like FactoryDAO, DAOstack, and DAOhaus) already exist to facilitate 3D ownership coordination, but they cannot form meaningful organizations without 3D control consensus.

A recent case study on "the rise and fall of DAOstack" details this fundamental dysfunction in decentralized governance quite well, where the entire platform and all 92 of its active DAOs gradually descended into collapse over a seven-year period [19]. Other DAO platforms have also faced steep decline, if not already collapsed. Merk [20] provides a similar critique of this disappointingly consistent democratic dysfunction based on ethnographic research with 38 DAO contributors. The Discussion section below delves much deeper into why these dysfunctions persist in Web3 organizations, since DAOs arguably represent humanity's leading edge of connectivity and coordination.

At the fully evolved Web4 stage, the Internet Computer's goal of a decentralized "World Computer" probably best sums up the hardware vision. However, we would likely upgrade to dedicated Neural Processing Units ("NPUs") from GPUs for more AI-optimized computation, and then to quantum computing much later. The latter may be needed for permanent cryptographic impenetrability and for real-time coordination across a global 4D Web comprising quadrillions of human and multiagent connections that must be rationally coordinated together.

As for the software vision, the key Web4 component would likely be multiagent DAOs of evolving EI agents with N:N:N:N 4D coordination capability (i.e., "artificial intelligence" in the truest and fullest sense of the term). Alternatively, Follett's contemporary from a century ago, Nikola Tesla, may have poetically envisioned this Web4 future and Follett's "integrative unity" best of all: "When wireless is perfectly applied the whole earth will be converted into a huge brain, which in fact it is, all things being particles of a real and rhythmic whole" [21].

Ironically, to reach this Web4 future initially, very little hardware innovation may be required for 4D (vs. existing 3D blockchain) coordination. That is because Web3 transaction / ownership consensus is already coordinated between any two parties across a third decentralized Web dimension, which is the global array of blockchain mining nodes. Each node leverages 3D GPUs or NPUs with thousands of physical compute cores for massively parallel processing. Therefore, Web3's future control consensus for collective decision-making could theoretically rely on the same blockchain node hardware. Similar 3D AI-based coordination would likely be required to synthesize both collective evaluation data and blockchain's distributed ledger data. Avoiding a mass hardware upgrade across today's Web3 mining nodes would naturally expedite the transition to any Web4 AI capability.

Note that the worldwide array of mining nodes is the digital equivalent of the property (R) dimension of organization. In effect, potential conflicts in transaction finality and ownership, though rare, are all resolved automatically via this distributed consensus network of independent "miners" [See [22], pp. 229-236 for a technology intro.]. That means existing Web3 technology already leverages a form of 3D AI-based consensus. But once again, Web3's existing ownership consensus is incomplete without (still nonexistent) decentralized control consensus to complement it.

Moreover, for Web4 coordination involving both ownership and control consensus, the two 3D-compute processes to achieve 4D coordination would likely not need to run simultaneously. That is because collective control consensus across three dimensions (E, D, and A) would be coordinated first within the apex Prioritize process of Figure 1. By contrast, the allocation of available resources (R) would be coordinated separately in subsequent DI quadrant processes across three other dimensions (E, A, and R) as part of the existing blockchain ownership consensus. In other words, Web4 coordination should not require any 4D-compute process, but rather two successive 3D-compute processes integrated serially together. This is visualized via the two connected cubes in the last column of Figure 2. The software for 3D control consensus and 4D coordination are obviously the pieces that are still missing. Those will have to remain the subject of future AI research and innovation.

So now we can finally begin to see how 4D AI coordination maps directly to the 4D human coordination embedded in the four R:A:D:E dimensions of human organization. Web3 blockchain technology on its own essentially represents an N:1:N:N 3D level of connectivity and coordination complexity, with only the preferences / alternatives (A) dimension missing from Web-scale connectivity. However, in a DAO context, the counterparty being transacted with per the second N from the right (i.e., the "D" dimension) is actually equivalent to the alternatives (A) dimension from the previous 1:N:N:N 3D control consensus process covering the E, D, and A dimensions. Once investment or expense alternatives (A) are prioritized to receive allocations of resources (R), they would then become the beneficiaries of those allocations. In short, the prioritized alternatives (A) from the control consensus process would then become the directives (D, i.e., the "for whom?") in the subsequent ownership consensus process, per the last column of Figure 2.

At this point, it does not require any imagination or logical leap to see the final stage of ICT connectivity and AI coordination. That stage must simply incorporate the fourth organization dimension of preferences / alternatives (A) into existing Web3 technology to reach the N:N:N:N (4D) level of Web-scale coordination. However, before we can get to that ultimate point, we need to reach 3D connectivity and coordination incorporating this preferences (A) dimension (i.e., 1:N:N:N). That Prioritize process in Figure 1 does not yet exist. This is the second part of Web3 technology, which is required for the "read/write/control" functionality of fully collective decision-making, i.e., "organizational democracy" as defined by Siegfried [1]. Once it does exist, this 3D collective control consensus could easily be integrated into the already existing blockchain-based 3D ownership consensus (N:1:N:N), as shown in the last column of Figure 2. Only then would we enter the 4D N:N:N:N "read/write/control/own" world of Web4.

4. Discussion

4.1. The Urgency to Evolve Humanity's Multidimensional Coordination

As Figure 2 indicates, the distinctive features of 4D coordination arise from the merger of future 3D control consensus with already established 3D ownership consensus. Blockchain-based Web4 and its 4D coordination would be the foundation upon which we, as a society, can finally address the many grand coordination challenges and wicked problems that humanity is currently facing. Some of these problems are veritable existential threats, leading inexorably to catastrophic outcomes on a global scale if they cannot be solved soon [23][24]. But we first need the means to escape from the captivity of our organizational silos, which is what Web3 and Web4 are all about.

In particular, the seemingly inescapable nature of shareholder primacy is widely considered a wicked problem across many academic disciplines, including organization & management and Social Economy Science [25][26][27][28]. That is due to its persistent obstruction of sustainability initiatives, social equity, and an overall more "human" form of organization [29][30][31]. In effect, shareholder primacy is implicitly considered the root problem of many other wicked problems. However, when viewed through the metatheory lens of coordination, both its multidimensional cause and its theoretical resolution become fairly obvious. Without 4D coordination, organizational ownership and control cannot logically be separated. As a result, the singular shareholder role becomes the de facto dictator over all 3D (or lower) collective coordination. This is important, since all public resources (R) that need to be managed sustainably are currently in this fourth dimension outside of our organizational silos.

4.2. Forecasting the Future Starting from the Gaps in Web3 DAOs

Fully autonomous multidimensional coordination is not an easy concept to grasp, since it is like trying to imagine a four-dimensional world that does not yet exist. However, it can ironically become clearer by studying the 3D coordination that already exists in blockchain-based DAOs in order to understand why they still fall far short of the 4D coordination that is necessary. We can then infer how DAOs could change significantly after making the jump to 4D. By comparison, large organizations currently leverage, at most, 2D coordination at team-scale and 1:1 hierarchical or 1:N coordination above that scale, as discussed above. As a result, their leap to 4D would be greater and more difficult to imagine.

Surprisingly, nearly all DAOs rely on the second lowest evaluation granularity of binary (Y/N) approval voting for all on-chain decision-making [32][33]. Single-issue, independent proposals are considered and voted upon, one at a time, with a majority or supermajority required to pass them. Approval voting power is nearly always based on the number of tokens (analogous to shares) owned [in about 86% of DAOs per [34]], either directly or a square root thereof. The latter is called quadratic voting ("QV"), which is a blunt and arbitrary manipulation to increase voting diversity and to help avoid a hostile capture of the entire blockchain protocol (i.e., token economy) due to large ownership concentrations.

Other stopgap measures include "conviction voting" (to weight tokens by time owned to prevent temporarily increasing ownership before a vote), "holographic consensus" (to ensure a minimum quorum of X% voter participation before a voting outcome is validated), and "liquid democracy" (delegating one's tokenized votes to another trusted voter) [35]. A separate governance token pool might even be created to mimic the political one-person-one-vote method ("1p-1v"), which represents the remaining 14% of 36 DAOs with confirmed voting processes in the Peña-Calvin et al. [34] study cited above.

Unfortunately, so-called "capture resistance" via these methods without ID verification can be easily thwarted by a "sybil attack". This is when a token holder sets up multiple accounts as separate persons to diminish both the QV dilution impact and the perceived concentration of voting power. For example, a person with 10,000 tokens would normally only get 100 QV votes, but this could be artificially inflated to 1,000 votes by setting up 100 sybil accounts. An acceptable "proof-of-personhood" method that does not violate the nearly universal crypto industry requirement of anonymity has yet to be devised [36]. But more important, none of these pretentiously named voting variants can adequately disguise the same primitive voting method at their core. That method is always approval-based and lacks any multidimensional coordination capability whatsoever.

Even worse, the concentration of token ownership, and hence voting power, in DAOs is so extreme that it dwarfs both the wealth inequality of society and the stock market. Gini coefficients are nearly all on the cusp of the highest 1.0 level. Also, for the majority of DAOs in one study, three or less token addresses – some of which could be related or the same person – could "take full control of the governance system and pass any decision they want" [37]. Another study by Sedliačik and Ščerba [38] of 20 of the largest DAOs representing roughly 2/3 of all DAO market capitalization came to a very similar conclusion.

Unfortunately, however, concentration of power is even worse than these dire facts indicate. Ownership just happens to be concentrated most by the "blockchain conglomerates" (specialized VC investors/bankers) that invest in the blockchain "mining pools" [39]. These pools are essentially server farms of hardware mining nodes comprising the so-called "decentralized" ICT platform used to perform the calculation intensive mining tasks related to blockchain ownership consensus. So not only is the decentralized control consensus effectively a marketing mirage, so is the decentralized ownership consensus for almost all tokens beyond Bitcoin and perhaps Ethereum. For example, if a new block on a chain is added after consensus calculations are confirmed by a large number of mining nodes owned by the same blockchain conglomerate, then ownership is neither independently "confirmed" nor based on any real "consensus".

Still worse, the majority of the mining pools are run on Web1 or Web2 cloud servers controlled by Amazon Web Services and a couple of other major providers. That is thus a third layer of extreme centralization on which DAOs are run.

Perhaps worst of all, voter participation rates in DAOs are notoriously abysmal. In a study of voter turnout rates across 50 DAOs and 4,936 voting activities, the mean voter turnout rate was only 1.77%, and the median (or typical number) was only 0.10% [40]. So not only is ownership heavily concentrated in "whale" investors, but it is also mostly only those whales doing all the voting.

doi.org/10.32388/569C2O

That said, even without 4D coordination capability, blockchain technology and DAOs can still add very significant value. For example, Bernhart [41] rightly extols the "algorithmic governance" potential of DAOs based on incorporating "a type of machine learning" for 1:N coordination (i.e., "deterministic" rules-based consensus), or "large language models" for N:N coordination (for more "dynamic consensus" rules). Similarly, Ibrahimy et al. [42] rightly see significant value in blockchain technology's ability "to combat corruption [by trusted third parties] and achieve transparency in the public sector". That benefit is about leveraging ownership consensus to extend 3D coordination beyond the boundary of a single organization, like at Haier [[43], pp. 143-152]. However, the biggest benefits of Web3 and Web4 would come with the integration of 3D control consensus and 3D ownership consensus.

So far, other than non-fungible tokens ("NFTs") designed to tokenize unique tangible or digital assets (mostly of a silly nature so far like "Bored Ape" cartoons), the core evangelists of Web3 technology have focused on decentralized finance ("DeFi") applications. This includes tokens like Bitcoin as an alternative to fiat currency. However, the DeFi use cases are mostly redundant vs. the utility that centralized banking and electronic payment systems already offer more efficiently [44]. Such a misplaced focus on DeFi is mainly because Web3 has no sustainable organization use case without 3D control consensus to complement its 3D ownership consensus.

Ownership consensus needs control consensus to have any significant impact on organizational control, and control consensus needs ownership consensus to have any significant assets to control collectively. Without this bi-directional integration, control consensus would at most be indirect and limited to the private assets of a single organization's owners, who would then still have ultimate approval control via ownership veto power (i.e., via the Board or its management agents). Shareholder primacy would thus remain technically intact, though clearly in heightened conflict with the multi-directive-based collective prioritizations of 3D control consensus.

Therefore, all that individuals can do with Web3 in the meantime is trade essentially useless coins with no productive value, one hype cycle after the next. Immutable token scarcity, combined with "the next new thing" frenzy and the addiction of casino culture momentum, lead to waves of tulipomania over and over again, just in a different century. To put this mania in perspective, there are over 17,000 active cryptocurrencies as of mid-2026, nearly double the number from only 2024 (per Statista.com), dwarfing the number of fiat currencies 1,000 to 1.

doi.org/10.32388/569C2O

There appears to be no credible scenario where Web3 has a viable mainstream home in a world without the decentralized organizational control of Web4. Until then, only crypto geeks, hoarders (aka “hodlers”), pariah states, and other global capitalism deviants will likely find a home for Web3 beyond some fringe NFT use cases. On the other hand, this is exactly what is so amazing about Web3 in the face of so much power arrayed against it. Just like Web1 and Web2, there is nothing in the world powerful enough to stop it. It truly is unstoppable.

To address this obvious coordination gap in DAOs, Gilson and Bouraga [45] have suggested that a “hybrid DAO model could incorporate different voting procedures, decision-making processes or consensus models as needed.” Unfortunately, however, 3D control coordination will not become possible just because it is done outside of a DAO smart contract. In fact, all coordination connected to DAOs – which is primarily related to strategic decisions about development project alternatives (A) and resource (R) allocations – is already done off-chain. Tiresome deliberation within a traditional consensus reaching process (“CRP”), both informal and formal, is the overwhelming coordination method by default for DAOs. This is done via basic Web2 social media platforms like Discord [46]. Therefore, relying on the blind faith that transitioning ultimate control to decentralized algorithmic DAO governance will save us from the oppression of corporate hierarchy is currently a recipe for disaster.

A deliberative CRP for collective prioritization is simply not scalable, especially since the ultimate DAO governance vote can only handle approval voting, not prioritization. Many well-intentioned protocol founders have found out the hard way that such blind faith leads to uncontrollable protocol exploits, and potentially to hostile capture of the entire blockchain [47][48]. Even worse, investors relying on the blind faith that such decentralized 3D control already exists just because it is called a “DAO” has led to an epidemic of “rug pulls” (i.e., exit scams), such as the major ones tracked by McGovern [49].

There has been a massive increase in actionable business information (BI) since the dawn of ICT, and there is proven business value in local and specialized knowledge (CI) [50]. Moreover, the importance of intrinsic motivation from “decision latitude” [51] (collective DI) has been well established and is now obvious. These are three critical performance amplifiers within the BI, CI, and DI quadrants, respectively, of EI per Siegfried [1], all of which make traditional top-down hierarchies obsolete. Therefore, it is an anachronistic delusion to advocate that the capitalist model of owner-controlled decision making should be continued, since that effectively discards the value of all three of those performance amplifiers. Yet that is exactly what DAOs have ironically been mimicking.

By contrast, only personally active participants in a token economy have the necessary information, knowledge, and legitimate right to decide how that economy's scarce resources (R) should be allocated. By extension, that right should be in direct proportion to their reputation, expertise, and active participation, both current and cumulative, to maximize collective welfare. That is how a humanity-centric economy should be run and naturally evolve based on the interactively shared knowledge and freely competitive human choices of those most qualified, respected, and personally invested in making an organization's decisions. Unfortunately, this will never be possible as long as all strategic decision-makers represent only one stakeholder role, the passive shareholder.

Moreover, shareholder agents (i.e., management) have no scalable means of 3D control coordination to represent all stakeholder roles even if they wanted to. That is why there must be both a complete separation of ownership and control *and* an AI innovation in multidimensional (3D) coordination. The AI innovation part is required to scale, and the separation part prevents ownership (the resources (R) dimension) from having default dictatorial control over both the directives (D) and alternatives (A) dimensions of organization. Combined together, this 4D coordination is logically the only way to allow asset allocations (via blockchain's 3D ownership consensus) and organizational control (via 3D control consensus) to become completely and independently decentralized.

4.3. Web4 DAOs Would Fix the Web3 Gaps by Adding 4D Coordination

After hypothetically integrating this full 3D coordination capability into the governance model of Web3 DAOs, it should now be logically obvious why the fatal flaws plaguing DAOs discussed above should automatically disappear, as summarized below. All of the root causes underlying these Web3 DAO flaws are simply not applicable in a hypothetical Web4 world:

1. Governance participation problems are due to passive ownership control.
2. Rug pulls are due to offline reliance on dictatorial strategic control.
3. Endless and ineffective strategic deliberations are due to non-scalable 3D coordination via primitive verbal interactions without AI.
4. The inevitable concentration of control, and thus the complete lack of any organizational wisdom (i.e., from diversity benefits and a decreasing error in the mean as N increases) is obviously due to ownership concentration [1].
5. Sybil attacks are due to unknown passive investors (without any established reputation) controlling decisions, as opposed to known active contributors doing so.

 doi.org/10.32388/569C2O

6. Poor strategic decisions are due to uninformed passive investors with no specialized knowledge of the business making major decisions.
7. And, most important, the lack of any scalable business use cases for DAOs is due to the total inability of DAOs to achieve the necessary 4D coordination to prioritize alternatives (A) fairly and to optimize the allocation of resources (R) to those alternatives (A) in a truly collective fashion.

This last point actually needs to be expanded upon further, since the allocation of resources (R) is not just about which business alternatives (A) to invest in. It is also about how to compensate both equity investors and labor investors in the business fairly based on their relative contributions. The same 3D collaboration, evaluation, prioritization, and optimization processes would be required for this, per the four process nodes of EI's DI quadrant in Figure 1. Due to the number of integrations required to achieve rationally collective coherence per Figure 2, no deliberation or low-granularity approval process like DAOs currently use could remotely achieve this necessary level of coordination. Also, prioritized evaluation data would be required rather than just approval data, and it would need to be cardinal rather than just ordinal to differentiate contributions accurately and to optimize resource (R) allocations fairly.

Even with 2D or 1D coordination in teams, peer and customer evaluations of contributors are considered a vital part of the coordination process [[43], pp. 92-96, [52][53], p. 262]. Typically, this is done via a rating system (e.g., 1-5) to approximate 3D coordination. However, averaging overall ratings is not precise enough to drive fair compensation levels due to some fundamental problems with this approach [54]. Parallel research on the obstacles to achieving 3D coordination will explore this particular topic further.

Assuming 3D coordination can be achieved algorithmically, it would then become a fairly trivial matter to link relative contribution values (as evaluated by the contributors) to relative compensation levels. It would also be a trivial matter to embed that link into a decentralized blockchain smart contract, which could then distribute (or reinvest) that compensation in a secure and trustless manner. The same allocation system would apply to all value-added contributors after adjusting for any contractual compensation or value that they have already received. This is where blockchain's tokenization of assets again comes into play to complete the separation of ownership from control. In the same way that a small proportion of DAOs already separate governance tokens from ownership tokens in order to facilitate their preferred 1p-1v voting process (i.e., completely disregarding how many tokens each person owns), it is a trivial matter to set this up for any DAO.

For example, workers who are paid a fair market contractual wage, or even customers who pay a fair market price for the organization's products, are all in some sense value-added contributors. They are investing significant labor, loyalty, and trust in the organization to add sustainable value. There are many forms of non-financial investment or contribution that could increase the organization's intrinsic value or society's extrinsic value significantly. Therefore, they should be proportionately rewarded too, especially when a contribution is exceptional.

The purpose of this process would be to make the other three dimensions of organization (A, D, and E) completely independent by disentangling them from the resources (R) dimension's overriding control. All strategic organizational decisions would then be under the collective and completely independent control of those most qualified and trusted to make each specific decision. As a result, shareholder primacy would no longer apply, let alone dominate.

In the end, organizations would no longer be captives of capital. Instead, capital would be fully commoditized so that it becomes just another contributor to be fairly compensated according to its relative value-added contribution. There would no longer be any owner entitlement to residual profits, since all profits naturally belong to the contributors in proportion to their contributions. After all, has it not always been devoted capitalists who have always asserted that entitlements are unjust and a counterproductive form of socialism? As they would no doubt agree if they were consistent in their philosophy, there should never be any privileged form of contribution. Instead of a "market" rigged for the benefit of only passive contributors, Web4 would lead to a radically free market of value-added competition amongst all contributors. The often glorified and self-proclaimed pro-competition ideal of capitalism would finally face its ultimate hypocrisy test.

5. Conclusion

Blockchain technology with its 3D connectivity and coordination capability gave us one key piece of the puzzle to get to a Web4 world from today's Web2-dominated world. But all Web3 can currently offer is decentralized ownership, which has no real-world coordination value without decentralized control. We already have a failing plutocratic system centered on ownership. It is called capitalism. Ironically, the "read/write/own" mantra of Web3 merely doubles down on capitalism's plutocracy instead of breaking free from it. We need a new system that can also commoditize ownership by decentralizing control and completely severing organizations from being captive agents of capital. That is why the overwhelming impact upon society from the two 3D consensus layers (i.e., for ownership and control) cannot materialize until Web4. That is when they could become fully integrated and finally be able to cross the sociotechnical chasm of mainstream adoption together.

A new Web version is never just about more bandwidth, new features, or new technology disconnected from our humanity. It has always been about adding a whole new dimension to global human connectivity and coordination that has no precedent in history. First came our 1:N digital connection to each other and our collective information via Web1. Then came our N:N interactive human knowledge via Web2. And finally came the direct, trustless, and permissionless N:1:N:N connection between our private assets via Web3. As each new Web dimension is added, we add one more dimension to the direct, human-to-human connectivity between us at societal-scale, without any intermediaries. In fact, each cell in Figure 2 effectively represents a doorway to a whole new world of connectivity or coordination for all of humanity. Yet we have only opened nine of these 15 doors. Six still remain.

The most recent societal-scale coordination door that humanity opened was 1:N business ecosystem platforms, to be discussed in forthcoming research. And the most recent AI coordination door opened was N:N generative AI, which almost everyone is now familiar with. We have also taken a peek behind the Web4 doors of the future, both via technical extrapolation and by imagining how persistently failing Web3 DAOs could actually become sustainably viable and scalable organizations under Web4. However, the societal implications and potential AI threats of opening these future doors will have to wait for future research, as will the related historical progression of human organization to get there.

But make no mistake – each of these future doors opens up a world of new hope. Via Web4, so much more would become attainable for humanity, including resolutions to some of our grandest challenges. Our preferences and purposes, manifested as choices, would finally be able to connect and competitively coordinate at societal-scale as an “integrative unity” and “rhythmic whole”, just as Follett and Tesla envisioned one century ago. The free market of competing choices would no longer be limited to just self-gratifying buying and selling. It would finally extend to all of our choices for our organizations, for our societies, for the world, and for all future generations. We can only hope that there is still enough time to cross the chasm to Web4 given the multiple existential crises that we currently face. But if we ever do cross it, there is one thing for certain: our newly-freed choices will be just as unstoppable as our choice to be free.

Statements and Declarations

Funding

No specific funding was received for this work.

Potential Competing Interests

No potential competing interests to declare.

Author Contributions

DS was the sole author and is responsible for all aspects of the manuscript.

Use of Generative AI

The author did not use AI-assisted technologies in the writing, editing, or data analysis of this manuscript.

References

1. [a, b, c, d, e, f, g, h, i, j, k] *Siegfried D (2026). "Effective Organization is a System of Four-Dimensional Evolutionary Coordination." doi:10.32388/LD2NPT.*
2. [^] *Battilana J, Fuerstein M, Lee M (2018). "New Prospects for Organizational Democracy? How the Joint Pursuit of Social and Financial Goals Challenges Traditional Organizational Designs." In: Rangan S, editor. Capitalism beyond mutuality? perspectives integrating philosophy and social science. Oxford: Oxford University Press. p. 256–288.*
3. [^] *Luyckx J, Schneider A, Kourula A (2020). "Learning from Alternatives: Analyzing Alternative Ways of Organizing as Starting Points for Improving the Corporation." In: Meyer RE, Leixnering S, Veldman J, editors. Research in the Sociology of Organizations. Emerald Publishing Limited. p. 209–231.*
4. [a, b, c] *Metcalf HC, Urwick LF, editors (1940). Dynamic administration: the collected papers of Mary Parker Follett. Harper & Row. https://books.google.com/books?id=s1-KvgAACAAJ.*
5. [^] *Hargadon AB, Wadhwani RD (2023). "Theorizing with Microhistory." Acad Manage Rev.* **48***:681–696.*
6. [^] *Simon HA (1987). "Bounded Rationality." In: Eatwell J, Milgate M, Newman P, editors. Utility and Probability. London: Palgrave Macmillan UK. p. 15–18.*

7. ^Dixon C (2024). *Read write own: building the next era of the Internet.* 1st ed. New York: Random House.
8. ^Moore GA (2014). *Crossing the chasm: marketing and selling disruptive products to mainstream customers.* 3rd ed. New York, NY: Harper Business.
9. ^Computer History Museum (2024). *"Timeline of Computing."* Computer History Museum. https://www.computerhistory.org/timeline/.
10. ^IBM (2024). *"The IBM 1401."* IBM. https://www.ibm.com/history/1401.
11. ^Goldberg M (2023). *"Cryptographers Devise an Approach for Total Search Privacy."* Quanta Magazine. https://www.quantamagazine.org/cryptographers-devise-an-approach-for-total-search-privacy-20231106/.
12. ^Lin WK, Mook E, Wichs D (2023). *"Doubly Efficient Private Information Retrieval and Fully Homomorphic RAM Computation from Ring LWE."* In: Proceedings of the 55th Annual ACM Symposium on Theory of Computing. Orlando FL USA: ACM. p. 595–608.
13. ^Jacobides MG, Cennamo C, Gawer A (2024). *"Externalities and complementarities in platforms and ecosystems: From structural solutions to endogenous failures."* Res Policy. **53**:104906.
14. ^PricewaterhouseCoopers (2024). *"PwC Pulse Survey: Executive takes on Election 2024."* PwC. https://www.pwc.com/us/en/library/pulse-survey/executive-insights-election-2024.html.
15. ^Petrosyan A (2024). *"Estimated cost of cybercrime worldwide 2018-2029."* Statista. https://www.statista.com/forecasts/1280009/cost-cybercrime-worldwide.
16. ^Proofpoint.com (2024). *"2024 State of the Phish."* Proofpoint.com.
17. ^Posner EA, Weyl EG, Buterin V (2019). *Radical markets: uprooting capitalism and democracy for a just society.* New paperback ed. Princeton; Oxford: Princeton University Press.
18. ^Delipetrev B, Tsinaraki C, Kostic U (2020). *"Historical Evolution of Artificial Intelligence."* Joint Research Centre. https://publications.jrc.ec.europa.eu/repository/handle/JRC120469.
19. ^Davó D, Arroyo J, Hassan S, et al (2025). *"The rise and fall of DAOstack: lessons for decentralized autonomous organizations."* PeerJ Comput Sci. **11**:e3320.
20. ^Merk T, Lotti L, Houde N, et al (2026). *"A workers' inquiry in Decentralised Autonomous Organisations: Insights and policies to align blockchain-based work with the solidarity economy."* Internet Policy Rev. **15**. doi:10.14763/2026.1.2053.
21. ^Kennedy JB (1926). *"When Woman Is Boss: An Interview With Nikola Tesla."* Collier's Magazine. p. 14–15, 78–79.

22. ^Antonopoulos AM (2017). Mastering Bitcoin: programming the open blockchain. 2nd ed. Sebastopol, CA: O'Reilly.

23. ^Cooperrider DL, Selian A, editors (2022). The business of building a better world: the leadership revolution that is changing everything. 1st ed. Oakland, CA: Berrett-Koehler Publishers, Inc.

24. ^Ferreras I, Battilana J, Méda D, editors (2022). Democratize work: the case for reorganizing the economy. Chicago London: The University of Chicago Press. doi:10.7208/chicago/9780226819631.001.0001.

25. ^Amis J, Barney J, Mahoney JT, et al (2020). "From the Editors—Why We Need a Theory of Stakeholder Governance—And Why This is a Hard Problem." Acad Manage Rev. **45**:499–503.

26. ^Amis J, Brickson S, Haack P, et al (2021). "Taking Inequality Seriously." Acad Manage Rev. **46**:431–439.

27. ^Battilana J, Obloj T, Pache AC, et al (2022). "Beyond Shareholder Value Maximization: Accounting for Financial/Social Trade-Offs in Dual-Purpose Companies." Acad Manage Rev. **47**:237–258.

28. ^Battilana J, Krol L, Sheppard-Jones K, et al (2022). "Beyond a niche approach: Could social business become the norm?" In: Social Economy Science: Transforming the Economy and Making Society More Resilient. Oxford University Press. p. 169–203.

29. ^Davis GF (2021). "Corporate Purpose Needs Democracy." J Manag Stud. **58**:902–913.

30. ^Davis GF, DeWitt T (2024). "Can Strategy Address the Climate Crisis Without Losing its Essence?" J Manag Stud. **58**:joms.13083.

31. ^Henderson R (2021). Reimagining capitalism in a world on fire. 1st trade paperback ed. New York: PublicAffairs.

32. ^O'Connor K (2022). "The Most Common Voting Mechanisms Used by DAOs." Peaka. https://www.peaka.com/blog/web3-dao-voting-mechanisms/.

33. ^Rikken O, Janssen M, Kwee Z (2023). "The ins and outs of decentralized autonomous organizations (DAOs) unraveling the definitions, characteristics, and emerging developments of DAOs." Blockchain Res Appl. **4**:100143.

34. a, bPeña-Calvin A, Saldivar J, Arroyo J, et al (2024). "A Categorization of Decentralized Autonomous Organizations: The Case of the Aragon Platform." IEEE Trans Comput Soc Syst. 1–0.

35. ^Bellavitis C, Fisch C, Momtaz PP (2023). "The rise of decentralized autonomous organizations (DAOs): a first empirical glimpse." Venture Cap. **25**:187–203.

36. ^Watson R (2023). "How blockchain can help solve proof of personhood." The Block. https://www.theblock.co/post/268446/how-blockchain-can-help-solve-proof-of-personhood.

37. ^Feichtinger R, Fritsch R, Vonlanthen Y, et al (2023). "The Hidden Shortcomings of (D) AOs -- An Empirical Study of On-Chain Governance." doi:10.1007/978-3-031-48806-1_11.

38. ^Sedliačik I, Ščerba K (2023). "Centralized Governance in Decentralized Autonomous Organizations." In: Tsounis N, Vlachvei A, editors. Applied Economic Research and Trends. Cham: Springer Nature Switzerland. p. 831–838.

39. ^Ferreira D, Li J, Nikolowa R (2023). "Corporate Capture of Blockchain Governance." Rev Financ Stud. **36**:1364–1407.

40. ^Liu X (2023). "The Illusion of Democracy— Why Voting in Decentralized Autonomous Organizations Is Doomed to Fail." SSRN Electron J. doi:10.2139/ssrn.4441178.

41. ^Bernhart S (2024). "Progressive Autonomy in DAOs." doi:10.13140/RG.2.2.25722.71361.

42. ^Ibrahimy MM, Norta A, Normak P (2023). "Blockchain-Based Governance Models Supporting Corruption-Transparency: A Systematic Literature Review." Blockchain Res Appl. 100186.

43. a, bMinnaar J, de Morree P, Van Der Lecq B (2022). Start-up Factory: Haier's RenDanHeYi Model and the End of Management as We Know it. CORPORATE REBELS NEDERLAND B.V. https://books.google.com/books?id=YsQ4zwEACAAJ.

44. ^Zachariadis M, Hileman G, Scott SV (2019). "Governance and control in distributed ledgers: Understanding the challenges facing blockchain technology in financial services." Inf Organ. **29**:105–117.

45. ^Gilson C, Bouraga S (2024). "Enhancing the democratic nature of voting processes within decentralized autonomous organizations." Digit Policy Regul Gov. **26**:169–187.

46. ^Hsieh YY, Vergne JP (2023). "The future of the web? The coordination and early-stage growth of decentralized platforms." Strateg Manag J. **44**:829–857.

47. ^Dhillon V, Metcalf D, Hooper M (2017). "The DAO Hacked." In: Blockchain Enabled Applications: Understand the Blockchain Ecosystem and How to Make it Work for You. Berkeley, CA: Apress. p. 113–128.

48. ^Thurman A (2020). "Dictators turn delegates: Former CEOs grapple with DAO governance." Cointelegraph Magazine. https://cointelegraph.com/magazine/dictators-turn-delegates-former-ceos-grapple-with-dao-governance/.

49. ^McGovern T (2025). "List of Crypto Exit Scams & Rug Pulls: History & Timeline 2026 - EarthWeb." EarthWeb. https://earthweb.com/crypto-exit-scams/.

50. ^Minnaar J, Morree P de (2019). Corporate rebels: make work more fun. Nederland: Corporate Rebels Nederland B.V.

51. ^*Karasek R, Theorell T (2009). Healthy work: stress, productivity, and the reconstruction of working life. 9th print. New York: Basic Books.*
52. ^*Davis GF, Sinha A (2021). "Varieties of Uberization: How technology and institutions change the organization (s) of late capitalism." Organ Theory.* ***2****:263178772199519.*
53. ^*Laloux F (2014). Reinventing organizations: a guide to creating organizations inspired by the next stage of human consciousness. 1st ed (revised). Brussels: Nelson Parker.*
54. ^*Buckingham M (2015). "Most HR data is bad data." Harv Bus Rev. https://www.tmbc.com/wp-content/uploads/2021/04/Most-HR-Data-Is-Bad-Data-HBR.pdf.*

Declarations

Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.

 doi.org/10.32388/569C2O