Project Liberty Institute & BlockchainGov

The Blockchain Governance Toolkit

A Cookbook for a Resilient and Robust Ecosystem

May 2024

Project Liberty Institute

BLOCKCHAINGOV

Better web, better world

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Impressum

About Project Liberty Institute:
Project Liberty Institute, 501(c)(3) founded by Frank McCourt, is building a global alliance for responsible technology and bringing together technologists, academics, policymakers, civil society and citizens to build a safer, healthier tech ecosystem. The Institute has an international partner network that includes Georgetown University, Stanford University, Sciences Po, and other leading academic institutions and civic organizations; and is the steward of the Decentralized Social Networking Protocol (DSNP) which is available as a public utility to serve as the bedrock of a more equitable web and support a new era of innovation that empowers people over platforms and serves the common good.

https://www.projectliberty.io/institute

About BlockchainGov:
BlockchainGov is a 5-year project (2021-2026) funded by the European Research Council (ERC grant of €2M). The project is directed by Primavera De Filippi and hosted at the Centre National de Recherche Scientifique (France) and the European University Institute (Italy), with Principal Investigator and advisors from the Berkman Klein Center at Harvard University. As an interdisciplinary research team comprising legal scholars, social and political scientists, computer scientists, and blockchain engineers, BlockchainGov focuses on studying the impact of blockchain technology on governance and its consequences for legitimacy and trust.

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Disclaimer

This report has been developed with the help of the Governance Multistakeholder Council (MSH Council). The views expressed in this report do not reflect the views of the organizations with which Council members are affiliated. Any errors or omissions are those of the research team and not the MSH Council members. MSH Council members might not necessarily endorse all views presented in the research report.

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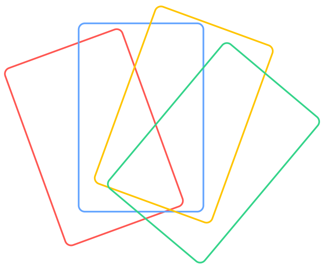
Executive Summary

The Cookbook in Five Steps

First Step:

‘Pick your flavors’ or identify the governance trade-offs and situate yourself in them



Some governance flavors cannot be simultaneously realized with the same intensity, requiring choices by blockchain governance designers among different trade-offs:

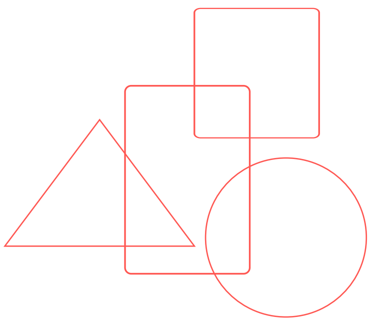
// Expediency favors fast and cost-effective decisions made by a select few, whereas participation favors governance decisions made by the most significant number of stakeholders, regardless of how fast or costly the decision-making process may be.

// Immutability advocates for permanent governance rules to ensure the system operates as expected, while adaptability argues for evolving rules that can respond to internal and external changes.

// Determinism calls for on-chain governance rules hard-coded into the blockchain, facilitating decision-making and actions without human intervention. Discretion emphasizes the importance of human judgment in the decision-making process, often involving off-chain discussions and interventions.

Second Step:

‘Pick your ingredients’ or identify the governance primitives to implement the preferred flavors



Governance primitives are crucial elements of governance frameworks that facilitate the implementation of desired governance designs.

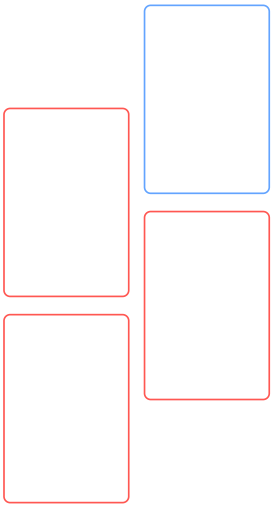
// From more expedient to more participatory, governance primitives include multi-signature councils, permissioned systems, consultative bodies, elected bodies, vote delegation, multiple-role delegation, token-weighted voting, multiple-track voting system, conviction voting, proof-of-personhood protocols, quadratic voting, and plural voting.

// From more immutable to more adaptable, primitives include exit-only or zero-voice systems, blockchain constitutions, protocol self-amendability, and improvement proposals.

// From more deterministic to more discretionary, primitives include fully self-executing systems, oracles, appeals, arbitration, on-chain voting, on-chain signaling, off-chain voting, off-chain signaling, and rough consensus.

Third Step:

‘Keep the strong flavors in check’ or implement safeguards to ensure the governance system is resilient and robust



Blockchain governance designers are encouraged to pick their preferred flavors (i.e., preference over governance trade-offs) and ingredients (i.e., governance primitives). Still, it is crucial to moderate strong preferences for systems to be resilient and robust. Safeguards are protective measures designed to offset the negative consequences of a system’s most potent governance features.

// Safeguards for heavily expedient systems include recall, slashing, and power checks.

// Safeguards for heavily participatory systems include whitelisting and decay functions.

// Safeguards for heavily immutable systems include exit, hard forking, and states of exception.

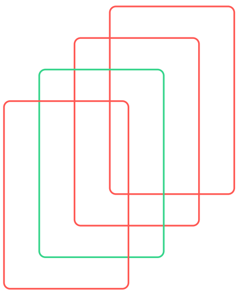
// Safeguards for heavily adaptable systems include blockchain formal constitutions.

// Safeguards for heavily deterministic systems include on-chain time-delay and smart contract kill switches.

// Safeguards for heavily discretionary systems include on-chain fund distributions.

Fourth Step:

‘Sample and continue refining your recipe’ or incorporate feedback loops.



// Feedback loops are critical mechanisms for evaluating and refining systems' governance, which build a bridge between endogenous and exogenous governance.

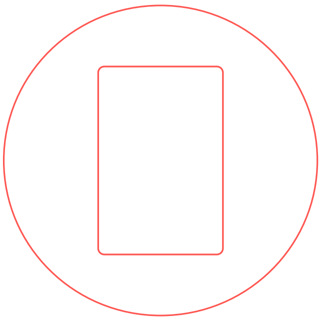
// Within blockchain systems, the absence of clear authority and the potential for opacity in decision-making processes can result in inefficient feedback loops, making it challenging to assess the outcomes of certain actions and effectively ‘steer’ the governance system.

// Feedback loops should leverage humans as sensors, especially in systems where technology and society mix in complex ways, such as blockchain governance systems.

// Feedback loops should adjust the control surface to account for the blockchain systems’ purpose, ensuring the system's internal will to change doesn’t skew the system towards excessive adaptability.

Fifth Step:

‘Choose the tableware and serve your dish’ or decide if and which legal entity you want to create



// Using one or more legal entities can help participants of a blockchain network to modulate ‘embeddedness’ or the freedom to engage with non-network participants, and ‘disembeddedness’ freedom from certain types of interference by external actors.

// Legal entities with separate legal personalities can enter into contracts in their name, own tangible and intangible assets, and sue and be sued separately from their founders or directors.

// Separate legal personality ensures ‘entity shielding,’ meaning that the legal entity’s assets are protected from the owners' creditors should the owners experience a rough patch.

// Limited liability is also a common feature of many legal entities, which ensures ‘owner shielding,’ meaning the protection of the personal assets of the corporate entity's owners from claims by the entity’s creditors.

Methodology

Why a "cookbook"?

After examining the governance dynamics of eleven leading blockchain networks, this cookbook translates our insights into actionable tools and recommendations.[1] We aim to help designers develop resilient and robust governance systems for their respective projects, considering their idiosyncratic preferences, goals, and contexts. Given that there is no one-size-fits-all governance system for blockchain networks, we opted to structure this document as a cookbook rather than a technical manual so that we can present multiple governance 'recipes,' each with their unique flavors.

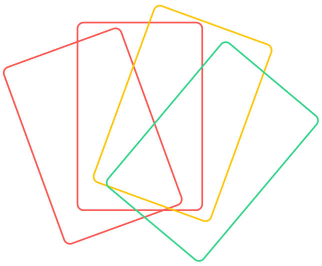
We begin by outlining trade-offs along three different sets of values (or 'flavors') to be considered in blockchain governance design. Next, we introduce different classes of governance primitives (or 'ingredients') that designers can combine to forge their preferred governance system. We also provide examples of how designers of different blockchain systems have chosen to adopt and combine these primitives. Subsequently, building on the notions of resilience and robustness, we argue for incorporating safeguards in the governance of blockchain systems against 'dominant flavors.' Next, we provide tools to help governance designers evaluate the impact of their chosen governance design by implementing a set of feedback loops and adaptability structures to align with the expectations of all relevant stakeholders. Finally, we examine how creating legal entities affects the embeddedness of a blockchain system, proposing that they should be seen as a distinct yet highly impactful component of blockchain governance frameworks.

While this cookbook is specifically focused on and tailor-made for blockchain networks, the methodology can be adapted for the governance design of other technologies as well.

1 Primavera De Filippi et al., "Report on Blockchain Governance Dynamics," a collaborative effort between Project Liberty Institute and BlockchainGov, May 2024.

First Step: 'Pick your flavors'

Identify the governance trade-offs and situate yourself in them



Summary in a nutshell

Some governance flavors cannot be simultaneously realized with the same intensity, requiring choices by blockchain governance designers among different trade-offs:

// Expediency favors fast and cost-effective decisions made by a select few, whereas participation favors governance decisions made by the most significant number of stakeholders, regardless of how fast or costly the decision-making process may be.

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// Determinism calls for on-chain governance rules hard-coded into the blockchain, facilitating decision-making and actions without human intervention. Discretion emphasizes the importance of human judgment in the decision-making process, often involving off-chain discussions and interventions.

Blockchain governance design involves attending to both endogenous (internal) and exogenous (external) elements of governance. **Endogenous governance** refers to the rules and processes internal to a specific blockchain system, controlled and influenced by its participants or 'insiders.'[2] The design process of endogenous governance involves a complex balancing act, as certain desirable features may conflict with each other. Therefore, designers must meticulously evaluate these trade-offs before prioritizing certain governance features. Below is a selection of some of the most critical trade-offs for blockchain governance designers to consider.

More Expediency vs. More Participation

An essential consideration in designing a blockchain endogenous governance system is determining who should make governance decisions and how. This consideration requires weighing the trade-off between expediency and participation.

Expediency favors fast and cost-effective decisions made by a select few regarded as capable of achieving relevant governance outcomes. These select few, either appointed or elected, may consist of founders, the most tech-savvy (e.g., software developers), or the most financially invested parties (e.g., wealthy investors or token holders).

2 Primavera De Filippi et al., "Report on Blockchain Technology & Polycentric Governance," 2024.

Participation emphasizes that governance decisions should involve the widest possible range of stakeholders, regardless of the speed or cost of the decision-making process. Rather than focusing solely on achieving outcomes quickly, participation values a qualitative and quantitative broad spectrum of perspectives to influence governance decisions. In this case, decision-makers are not required to possess specific qualifications or attributes.[3]

Why a trade-off?

Participation and expediency represent a trade-off in blockchain endogenous governance: involving a wider range of views and expecting comprehensive commitments from participants generally slows decision-making. Conversely, the need for swift decisions can lead to reduced inclusivity and participation.

Participation and expediency exist on a continuum, with a resilient and robust blockchain governance system incorporating elements of both. Even highly participatory systems require some expediency to make timely decisions, especially in urgent situations or crises. For example, a highly participatory blockchain network lacking specific protocols for security breaches might experience slow decision-making during a hack, compromising the network's ability to resolve issues quickly. Implementing mechanisms for rapid decision-making in critical situations can help balance the need for widespread participation with operational efficiency.

Conversely, in systems designed for expediency, where decisions are predominantly made by a select group of experts, incorporating broader participation is crucial. This ensures decisions are well-informed and broadly accepted by the community. For instance, in a blockchain community governed by a few tech-savvy individuals, involving a wider group of stakeholders can enhance the understanding of decisions' impacts and lend more legitimacy. Gathering diverse insights improves the quality of decisions and ensures they are supported across the community, thus enhancing the effectiveness of the expedient process.

More Immutability vs. More Adaptability

A critical consideration in blockchain endogenous governance design is the permanence of governance rules, weighing the trade-off between immutability and adaptability.

Immutability promotes the idea that once governance rules are established, be it on-chain or off-chain, they should remain unchanged. This

3 The trade-off between expediency and participation in governance design has been long explored across different disciplines. For analysis of its implications in cooperatives and DAOs, see: Morshed Mannan and Simon Pek, "Platform Cooperatives and the Dilemmas of Platform Worker-member Participation," New Technology, Work and Employment, May 27, 2023, https://doi.org/10.1111/ntwe.12273; Morshed Mannan, "The Promise and Perils of Corporate Governance-by-Design in Blockchain-Based Collectives: The Case of dOrg," in Bristol University Press eBooks, 2023, 78–99, https://doi.org/10.51952/9781529226430.ch005. Kelsie Nabben et al., "DAO Vulnerabilities: A Map of Lido Governance Risks & Opportunities," BlockScience Medium, February 27, 2024, accessed May 7, 2024, https://medium.com/block-science/dao-vulnerabilities-a-map-of-lido-governance-risks-opportunities-92bc6384ff68.

principle ensures high confidence in the system's operation, as participants can trust that the rules will be consistently applied over time. With immutability, the focus is on designing a comprehensive set of rules and procedures at the beginning, guiding routine governance and decision-making.

Adaptability allows for governance rules, be it on-chain or off-chain, to evolve in response to changing conditions, both external and internal. This flexibility gives stakeholders more control over the governance system. However, it also means there is less certainty about how the system will function in the future, requiring greater trust in those with the authority to amend the governance rules. Adaptability shifts governance to a continuous, dynamic process that needs constant updating and evolution.[4]

Why a trade-off?

Immutability and adaptability are inherently a trade-off, as blockchain systems cannot fully embody both attributes equally. Embracing the same degree of immutability and adaptability in a blockchain system simultaneously presents inherent challenges because these principles fundamentally oppose each other regarding their core purpose and impact on the system.

In practice, resilient and robust blockchain governance designs usually exhibit a degree of both. A blockchain governance framework designed for high immutability often requires some level of adaptability to address unforeseen technological changes that might otherwise render it obsolete or vulnerable. This adaptability ensures the system remains resilient and relevant. Conversely, a highly adaptable blockchain system needs to maintain a certain level of immutability in core governance principles, such as block production rules or monetary policies. This stability is crucial: without it, frequent and unpredictable changes could erode trust in the blockchain governance system, making it unreliable for stakeholders.

More Determinism vs. More Discretion

Governance designers must also decide which 'force of regulation'[5] should dominate in the drafting, adoption, and enforcement of governance rules, choosing between greater determinism (e.g., blockchain code) or discretion (e.g., social norms).

Determinism prioritizes on-chain governance rules, meaning encoded directly into the blockchain protocol or smart contract, allowing decisions and actions to be executed automatically without human intervention. This approach entails clear, predefined rules that execute based on spe-

4 The trade-off between immutability and adaptability can also be framed in terms of trust and confidence. See: Primavera De Filippi et al., "Blockchain Technology, Trust & Confidence: Reinterpreting Trust in a Trustless System?," Social Science Research Network, January 1, 2022, https://doi.org/10.2139/ssrn.4300486.
5 Lawrence Lessig referred to architecture (including code), law, social norms, and market as the four forces of regulation. See: Lawrence Lessig, Code and Other Laws of Cyberspace (Basic Books, 1999), https://search.worldcat.org/title/43836713.

cific triggers or conditions. Determinism promotes a higher degree of confidence by ensuring transparency and predictability of governance rules, although it does not necessarily mean it has to be immutable. Governance designs prioritizing on-chain rules can also be amended on-chain.

Discretion advocates for human judgment in the decision-making process, relying more on off-chain discussions, agreements, and interventions to address governance issues that are not covered by or that go beyond the scope of automated rules embedded in blockchain code. Discretion empowers relevant stakeholders to intervene in endogenous blockchain governance affairs, although it does not necessarily mean the system has to be adaptable. A highly off-chain governance design can remain highly immutable if stakeholders decide so.[6]

Why a trade-off?

Determinism and discretion inherently represent a trade-off, as a blockchain governance system cannot fully integrate both simultaneously. Like in the case of immutability and adaptability, determinism and discretion fundamentally oppose each other in terms of their core purpose and impact on the system

Yet, no resilient and robust governance design operates exclusively on either determinism or discretion; a balance of both is typically necessary. A system predominantly based on determinism may still require discretion to handle complex scenarios requiring nuanced judgment, such as polarizing disagreements between stakeholders when there is no explicit precedent or rule set of reference. In this case, strict determinism without any degree of human input might lead to outcomes perceived as unfair or ethically questionable by the parties and the community. Conversely, a system that relies mainly on discretion could greatly benefit from incorporating determinism into processes that could benefit from greater consistency and impartiality, and that could be translated into on-chain code, such as treasury management policies. These also allow human resources to be allocated to areas where sophisticated judgment is essential.

6 Primavera De Filippi and Greg McMullen, "Governance of blockchain systems: Governance of and by Distributed Infrastructure," Blockchain Research Institute and COALA, (2018), https://hal.science/hal-02046787/document

Second Step: 'Pick your ingredients'

Identify the governance primitives to implement the preferred flavors

Summary in a nutshell

Governance primitives are crucial elements of governance frameworks that facilitate the implementation of desired governance designs.

// From more expedient to more participatory, governance primitives include multi-signature councils, permissioned systems, consultative bodies, elected bodies, vote delegation, multiple-role delegation, token-weighted voting, multiple-track voting system, conviction voting, proof-of-personhood protocols, quadratic voting, and plural voting.

// From more immutable to more adaptable, primitives include exit-only or zero-voice systems, blockchain constitutions, protocol self-amendability, and improvement proposals.

// From more deterministic to more discretionary, primitives include fully self-executing systems, oracles, appeals, arbitration, on-chain voting, on-chain signaling, off-chain voting, off-chain signaling, and rough consensus.

Once blockchain governance designers have decided on their trade-off positions, they must identify and select the governance primitives that will allow them to operationalize their preferences effectively.

What are Governance Primitives

Governance primitives are crucial elements of governance frameworks that facilitate the implementation of desired governance designs. Designers can leverage these primitives to manage entry and exit of in decision-makers, distribute decision-making power, define the decision-making processes, establish enforcement mechanisms, create incentives for participation, and set up procedures for resolving disagreements and disputes and amend existing rules when necessary.

- **Categorization:** While the same governance primitive can support different types of governance flavors, we categorize them here based on their most relevant flavor. For instance, rough consensus is primarily listed under the flavor of discretion, although, depending on its configuration, it could also support adaptability.
- **Scale:** Governance primitives can vary in scale. For example, on-chain voting is a broad primitive that includes more specific ones like conviction voting. When these sub-primitives are listed separately, it is to underline their unique contributions to achieving specific governance outcomes.

- **Composability:** Primitives operating at different scales but supporting similar governance flavors can be integrated to create more complex systems. For example, elected bodies might be combined with token-weighted voting to enhance participation. This composability allows for constructing layered and nuanced governance structures that cater to diverse needs and objectives.

Below, we provide a non-exhaustive list of governance primitives for blockchain governance design. While this cookbook primarily addresses the governance of blockchain networks, we also explore some primitives introduced by DAOs that are technically applicable to blockchain networks. Each governance primitive is accompanied by examples, many of which emerged from the empirical findings in our report on blockchain governance dynamics[7]

Insights

Notes from the Chef

Voting and signaling are primitives for stakeholders to manifest their preferences. While these terms are often used interchangeably, this cookbook distinguishes between the two. Voting outcomes are binding within the referenced blockchain community, whereas signaling outcomes are non-binding and may serve to gather sentiment before a final decision is made through voting.

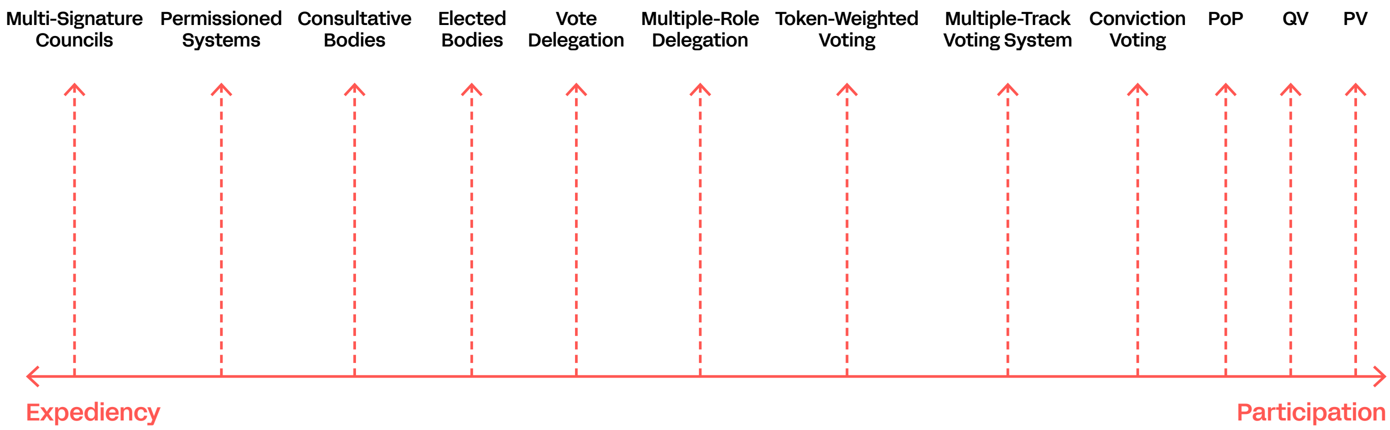
The implementation of voting and signaling can vary based on several factors:

- Whether they occur on-chain or off-chain (typically, voting is on-chain in blockchain systems, while signaling often happens off-chain).
- How the power to express preferences is distributed (e.g., based on resource ownership or equally among all stakeholders).
- The method through which preferences are expressed (e.g., directly or via delegation).
- The cost structure associated with expressing preferences (e.g., linear or quadratic costs).
- The duration preferences are registered (e.g., a single event or over a time-weighted period).

Depending on how they are implemented, these primitives can be instrumental in operationalizing distinct governance flavors.

7 De Filippi et al., "Report on Blockchain Governance Dynamics."

More Expediency vs. More Participation



The primitives outlined below show a progression from more expediency towards more adaptability. Blockchain governance designers can strategically use and combine them in different ways across governance areas. This customization facilitates a tailored governance design that adapts to varying priorities for decision-making speed and stakeholder inclusivity, helping achieve the blockchain system's specific goals.

- **Multi-Signature Councils**
  Multi-signature councils facilitate rapid decision-making by distributing authority among a predefined group of stakeholders, who must collectively approve or 'sign off' transactions or decisions. While this approach may limit widespread participation, it ensures that decisions are made swiftly by a select few, thereby enhancing the ability to respond promptly to critical issues.
  Examples: The Polygon's PIP-29 introduced the Protocol Council as a governance body responsible for performing regular and emergency upgrades to the system's smart contracts. To operate, the Council would rely on Safe, a multisig wallet implementation that requires multiple parties with unique private keys to approve a transaction before it can be executed.

- **Permissioned Systems**
  Permissioned systems, also called Role-Based Access Control (RBAC), regulate permissions, including access to and ownership of network resources, based on roles assigned to agents. These agents can be public addresses, multi-signature wallets, or a collection of smart contracts. Tokens held by the agents can represent roles. Permissions can range from 'pausing' certain aspects of a blockchain protocol to managing funds. While programmable permissions enable swift decision-making, this approach fosters broader participation among various agents.
  Example: Within the Cosmos ecosystem, Neutron DAO, which governs the Neutron chain, comprises a Security SubDAO with the power to 'pause' specific parts of the protocol but no other permissions. Authz allows communities to grant and revoke fine-grained permissions to act on behalf of a DAO or community.

- **Consultative Bodies**
  Consultative bodies typically consist of expert stakeholders offering rapid insights and recommendations on complex issues, facilitating quicker decision-making. These bodies usually include various perspectives and viewpoints, thereby promoting broader participation.
  Examples: The Zcash Community Advisory Panel (ZCAP) is a group of community members convened by the Zcash Foundation (ZF) to provide advisory feedback from the Zcash community. ZCAP members must have a proven record of meaningful contributions to Zcash software applications or have co-authored a Zcash Improvement Proposal (ZIP).

- **Elected Bodies**
  While elections may introduce some delay in decision-making, elected bodies provide a structured mechanism for selecting representatives who can make decisions on behalf of the community. Elected bodies ensure that decision-makers are accountable to the electorate, promoting participation by giving individuals a voice in selecting leaders who reflect their interests and values.
  Examples: The Synthetix protocol is governed by

a decentralized set of representative councils voted on by stakeholders. The Mangrove DAO conducts elections of Council members for six-month terms.

- **Vote Delegation**
  Vote delegation enables individuals who lack the time or expertise to participate in governance by transferring their voting rights to delegates. This method can enhance overall participation and ensure that the interests of community members are represented. However, it also tends to reduce the total number of active participants, which can lead to increased centralization under a small number of influential superdelegates.
  Examples: Among the governance entities introduced by Cardano's CIP-1694 are delegated representatives (DReps). ADA holders typically delegate their voting rights to these DReps. Additionally, ADA holders can become DReps themselves, further enabling them to delegate voting power to themselves.

- **Multiple-Role Delegation**
  Multiple-role delegation allows voters to assign their voting power to different delegates for various types of decisions within a governance system. With this mechanism, voters can delegate their influence differently across multiple decision-making tracks, choosing specific delegates for each decision category. This allows for greater customization and precision in representation, enhancing the granularity and flexibility of voter participation.
  Examples: Polkadot OpenGov introduced multiple-role delegation, allowing voters to assign a unique delegate for each class of referendum within the system. This feature enables delegation per track, allowing accounts to choose different delegates—or opt for no delegation at all—for each specific track.

- **Token-Weighted Voting**
  Token-weighted voting means the voting power of each participant is proportional to the number of tokens they hold. Token-weighted voting is designed to increase participation by reflecting the community's collective will directly, as each token directly translates into a vote in decision-making processes. However, the degree of participation heavily depends on the distribution of tokens. While it can promote voter eligibility and inclusivity—especially if tokens are easily accessible on exchanges or simple to mint—it has also been critiqued for potentially leading to centralized governance structures.
  Examples: In the Cosmos Hub, token holders have the capability to propose various actions, such as allocating funds from the community pool, altering core parameters, upgrading the blockchain, or updating IBC clients. Proposals are initially reviewed by the community off-chain. To proceed to an on-chain vote, a proposal must secure a 250 ATOM deposit within 14 days. For a vote to be valid, it requires a quorum of 40% of the voting power. Voting options include 'Yes,' 'No,' 'Abstain,' and 'NoWithVeto.' A proposal is passed with a simple majority of 'Yes' votes. However, if 33% of votes are 'NoWithVeto,' the proposal is rejected, and the deposit is forfeited.

- **Multiple-Track Voting System**
  A multiple-track system facilitates parallel voting processes, providing a broader range of participation options compared to simpler voting systems. This design accommodates various preferences and ensures all stakeholders can engage in governance activities.
  Examples: Polkadot OpenGov utilizes a multi-track voting system to oversee proposal submission, evaluation, and enactment. Proposals are sorted into one of fifteen tracks, depending on their specific characteristics and requirements. Each track is uniquely defined, influencing both the referendum's duration and the voting capacity.

- **Conviction Voting**
  Conviction voting enables decision-making by allowing participants to express the intensity of their preferences over time, facilitating the prioritization of proposals based on the strength of conviction. By incorporating the strength of preferences into decision-making, conviction voting ensures that proposals with strong support receive more significant consideration, encouraging active participation from those who feel strongly about specific issues.
  Examples: In Polkadot, voluntary locking or conviction voting allows token holders to boost their voting power by engaging in voluntary locking, where they commit their tokens for a specified period. This period determines their conviction multiplier, increasing the weight of their votes according to a predefined scale. The longer the lock period, the higher the multiplier, enhancing the voting strength per token. This system encourages long-term participation and decision-making in governance by linking the voting power to the commitment length.

Proof-of-Personhood Protocols

Unlike 'plutocratic' systems where decision-making power is based on the amount of resources one controls, such as tokens in proof-of-stake or computing power in proof-of-work, proof-of-personhood allocates decision-making power equally among all participants. This method adheres to a one-person/one-account-one-vote principle. Protocols and decentralized applications (dApps) utilizing this approach strive to uniquely associate each account with a single human user, ensuring fair participation without necessarily disclosing the individual's real-world identity. The academic paper that introduced the term 'proof-of-personhood' proposed it as the basis for a new cryptocurrency. While proof-of-personhood protocols aspire to increase inclusion and participation, it has been noted that these are vulnerable to 'oligopoly' and 'puppeteering,' and 'de facto Sybil attacks,' where a single entity pays participants to control their accounts for greater influence and economic rewards.[8]

Examples: Blockchain networks can technically implement proof-of-personhood if they decide to. Yet, the first practical application of this concept was on a dApp called Proof of Humanity (PoH). PoH is a registry of 'unique and singular' humans running on the Ethereum network.

- **Quadratic Voting**

  Quadratic voting allows participants to express the intensity of their preferences more accurately by allocating votes in a way that increases the cost of each additional vote quadratically. Allowing voters to show not just their preference but how strongly they feel about it can lead to outcomes that better reflect the community's collective will. This primitive mitigates the effects of 'the tyranny of the majority' by discouraging any single voter or a majority group from overpowering the decision-making process simply through sheer numbers, thus increasing participation.[9]

  Examples: The PoH DAO, entrusted with governing aspects of the PoH registry, adopted quadratic delegations through HIP-63. According to this, participants were free to delegate their votes, but delegations would be tallied quadratically. In principle, blockchain networks could also integrate quadratic voting as a governance primitive.

- **Plural Voting**

  Plural voting is an advancement of quadratic voting that relies on correlation discounts or bridging bonuses, correcting for quadratic voting's vulnerabilities such as Sybil attacks, over-coordination by groups (resulting from greater turnout), or intentional collusion.[10] If the goal of the blockchain governance design is to yield broadly beneficial outcomes beyond the systems 'insiders' (i.e., public goods), discounts/bonuses adjust the influence of both tyrannical majorities like quadratic voting does, but also hidden factions and colluding groups. Consequently, this primitive fosters a robust consensus that integrates diverse perspectives, including minority groups.[11] The concept of correlation discounts was first introduced in 2022, where authors presented a spectrum of public to private goods (i.e., networked goods) and proposed recognizing group memberships as non-transferable objects (i.e., soulbound tokens or SBTs or socially-administered verifiable credentials) to provision this spectrum without underprovisioning or capture.[12] Additionally, correlation discounts or bridging bonuses help overcome limitations of proof-of-personhood systems, in particular, the vulnerability to oligopoly, puppeteering, and de facto Sybil attacks.[13]

  Examples: In principle, blockchain networks can implement correlation discounts or bridging bonuses as well as plural voting for decision-making. Gitcoin Grants rely on "Cluster-Matching QF," a mechanism that combines quadratic funding with correlation discounts as an approach to address collusion.

8 The first mention of these risks associated with proof-of-personhood protocols appeared in: Puja Ohlhaver, E. Glen Weyl, and Vitalik Buterin, "Decentralized Society: Finding Web3's Soul," Social Science Research Network, January 1, 2022, https://doi.org/10.2139/ssrn.4105763. For a deeper dive into the topic, please check: Ohlhaver, Puja, E. Glen Weyl, and Vitalik Buterin. "Decentralized Society: Finding Web3's Soul." Social Science Research Network, January 1, 2022. https://doi.org/10.2139/ssrn.4105763

9 Steven P. Lalley and E. Glen Weyl, "Quadratic Vote Buying," Social Science Research Network, January 1, 2012, https://doi.org/10.2139/ssrn.2003531.

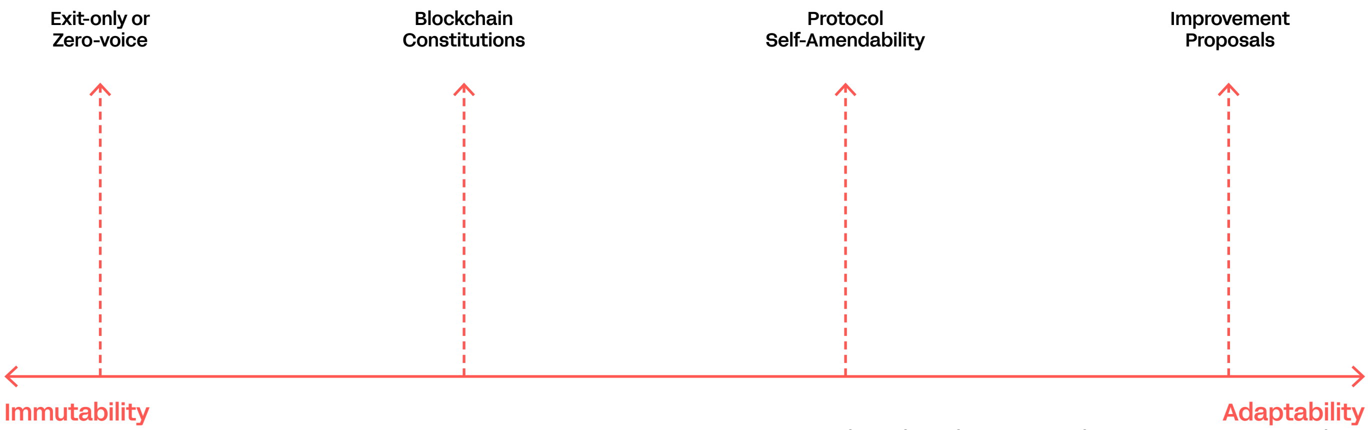
10 In 2022, RadicalXChange announced "a new chapter" and the reframing of its building blocks as "plural technologies." Quadratic voting was then replaced by plural voting. See: RadicalxChange, "A New Chapter for RadicalxChange," April 17, 2022, accessed May 7, 2024, https://www.radicalxchange.org/media/announcements/a-new-chapter-for-radicalxchange/.

11 When used for unlocking plural voting, correlation discounts or bridging bonuses work in the following way: Participants are clustered by shared memberships to groups, shared beliefs, or stated and demonstrated preferences. Quadratic votes are then discounted to the extent they are shared by other similarly clustered participants who historically have voted in the same way and/or share the same solidarities and financial interests, indicating shared bias. Conversely, voting power is augmented or given a 'bonus' for votes that bridge historical divides or adversarial relationships, encouraging broader consensus. The intuition is that if groups which have historically disagreed find agreement in a novel proposal, the proposal is more likely to be balanced across multiple interests in the public interest, as opposed to being captured by group interests, and therefore votes supporting the bridge should be given more weight.

12 Ohlhaver, Weyl, and Buterin, "Decentralized Society: Finding Web3's Soul."

13 Ohlhaver, Nikulin, and Berman, "Compressed to 0: The Silent Strings of Proof of Personhood."

More Immutability vs. More Adaptability



The primitives presented below show a progression from more immutability towards more adaptability, focusing on the scope of change inherently allowed by each primitive. Although some of these primitives are fundamentally incompatible and cannot be used together in the same governance area, others can be effectively combined. The selection of these primitives ultimately hinges on the blockchain governance designers' preference for balancing ledger integrity with the flexibility to make essential protocol adjustments.

- **Exit-only or Zero-Voice Systems**
  In exit-only or zero-voice blockchain systems, there are no predefined on-chain or off-chain rules, mechanisms, or tools for stakeholders to propose governance changes. Parties dissatisfied with the governance or operational direction of the blockchain system can only act by leaving the system or hard forking it. This primitive prioritizes immutability, placing a higher value on maintaining the status quo over accommodating changes based on the stakeholders' feedback.
  Examples: In July 2016, the Ethereum community voted on the preferred course of action following The DAO hack. After the majority voted to reverse the hacker's transactions to remediate the harm caused, the dissatisfied parties stayed on the original Ethereum ledger and formed what is now known as Ethereum Classic. While the original Ethereum community was not exit-only, Ethereum Classic does abide by the principles of governance immutability and 'code is law.'

- **Blockchain Constitutions**
  Blockchain constitutions comprise a set of fundamental principles, including 'rules on how to make rules' that govern how to create, amend, and revoke governance rules within a blockchain system. Principles and rules in blockchain constitutions are typically harder to modify or override than other standard governance rules. Blockchain constitutions can take various forms: on-chain, where rules are directly encoded into the blockchain protocol; off-chain written, which are formal and consolidated documents; and off-chain unwritten, encompassing informal governance practices. Blockchain constitutions combine adaptability by providing a process of amendability with immutability by 'entrenching' certain governance rules and making them more resistant to change[14]
  Examples: In 2022, the Optimism Collective adopted an off-chain formal or written Working Constitution. This document, intended to remain effective for four years from its adoption date, outlines the Collective's governance structure, the role of the Optimism Foundation, the rights of OP Citizens and OP Holders, and the guiding principles for interpreting the Constitution.

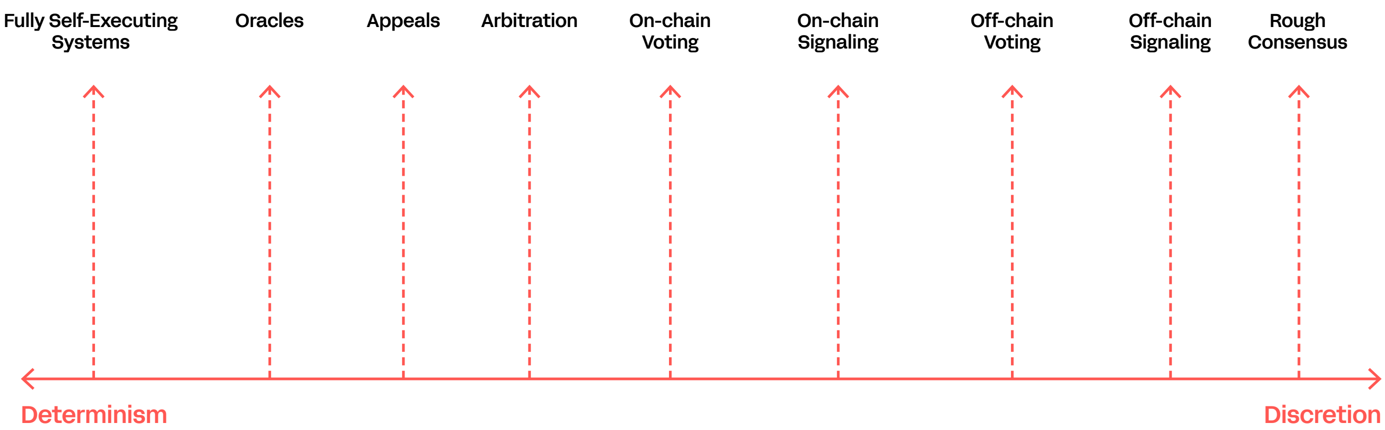
- **Protocol Self-amendability**
  Self-amendability is a governance mechanism that enables participants to propose, vote on, and automatically implement changes to a blockchain protocol directly on-chain. Once sufficient consensus is reached, these amendments are executed seamlessly. This feature integrates the immutability of formalized amendment parameters coded into the blockchain with the adaptability to evolve the protocol over time.
  Examples: Tezos showcases a sophisticated self-amending protocol with an on-chain voting process that unfolds over approximately 2.5

14 Morshed Mannan, Primavera De Filippi and Wessel Reijers, "Blockchain Constitutionalism," in Oxford Handbook of Digital Constitutionalism, ed. Giovanni de Gregorio, Oreste Pollicino and Peggy Valcke, (forthcoming).

months and spans five distinct phases. The outcomes of these votes are enforced automatically, with voting power tied to the holdings of XTZ tokens. The process is designed with adjustable quorum thresholds to maintain active participation and requires a supermajority to approve amendments. This structured approach ensures that new protocols are activated smoothly and efficiently upon successful adoption.

- **Improvement Proposals**
  Improvement proposals are formal suggestions made by stakeholders aimed at modifying or enhancing aspects of a blockchain governance system. These proposals undergo extensive off-chain review and discussion before being adopted and manually implemented. This mechanism leverages the immutability of a written, formalized amendment process while offering adaptability across various governance domains that may be subject to change.
  Examples: In the blockchain communities of Bitcoin, Ethereum, Zcash, and Filecoin, stakeholders submit improvement proposals (known as BIPs, EIPs, ZIPs, and FIPS, respectively) in governance forums. These forums serve as platforms for discussing and potentially adopting new governance rules. These proposals must adhere to specific formatting and procedural requirements to be considered. Improvement proposals cover a wide range of governance changes, from modifying the proposal adoption process to updating guidelines and information shared within the community, as well as technical adjustments, including changes to the blockchain protocol or standards that affect the interoperability of applications across the network.

More Determinism vs. More Discretion



The primitives presented below show a progression from more determinism towards more discretion, focusing on the degree of human intervention allowed in the governance design. While blockchain governance systems typically rely on the deterministic nature of smart contracts and consensus algorithms, certain primitives are designed to introduce discretionary elements. These allow for handling complex scenarios or subjective judgments that automated systems might not fully address. Many of the discussed primitives, often embedded in smart contracts, are more frequently utilized by DAOs than by blockchain networks at large. Nevertheless, integrating these elements into the governance frameworks of broader blockchain networks is feasible and can enhance their adaptability and responsiveness.

- **Fully Self-Executing Systems**
  A fully self-executing system is one where all governance decisions and operations are executed on-chain by predefined algorithms or smart contracts. These systems ensure the highest possible degree of determinism, eliminating all possibility of discretion.
  Examples: Bitcoin's mechanism for managing

its token issuance is fully self-executed. Bitcoin's issuance schedule is governed entirely by an on-chain algorithm that was defined at its inception. This algorithm controls the creation of new bitcoins through mining and the rate at which they are introduced to the market. Every 210,000 blocks, or approximately every four years, miners' reward for adding a new block to the blockchain is halved, an event known as 'halving.' This process is automatic and requires no human intervention or external decision-making. It is programmed to continue until around the year 2140 when the maximum supply of 21 million bitcoins is expected to be reached.

- **Oracles**
  Oracles provide external data to smart contracts, giving them access to real-world information. When integrating oracles, blockchain governance systems can incorporate a level of discretion by relying on external data sources such as data feed and sensors before proceeding with the automatic execution of conditions specified in the smart contracts. This degree of discretion is crucial for handling situations where decision-making based solely on on-chain data may be insufficient or inaccurate.
  Examples: In principle, blockchain networks relying on smart contracts for managing certain governance areas could incorporate oracles. For example, a blockchain network could update its token issuance based on external macroeconomic data. To date, oracles are mostly used by dApps. Chainlink is one of the Oracle providers used by many dApps running on various blockchain networks.

- **Appeals**
  Appeal mechanisms allow stakeholders to challenge or contest decisions made by the blockchain protocol. Through appeals, individuals can present additional information or arguments to be considered by the governance system, introducing a layer of human discretion to override or modify outcomes deemed unjust or incorrect.
  Examples: In Optimism Rollups, the fault-proof system (currently being tested) allows users to 'appeal' or challenge potentially fraudulent or incorrect transaction executions. Users who believe a transaction was processed incorrectly within the Optimism network can initiate an appeal. This process involves presenting evidence to support the claim that the transaction outcome was invalid. This primitive helps identify and mitigate any malicious or erroneous actions on the network by introducing some degree of human discretion, ensuring its integrity and reliability.

- **Arbitration**
  Arbitration mechanisms enable parties to resolve disagreements and disputes through a human-led process. Arbitrators, chosen by consensus or through established procedures, exercise discretion in interpreting contractual agreements, considering evidence, and reaching fair resolutions. This primitive introduces flexibility and subjectivity into governance decisions, especially in cases where deterministic rules may only partially capture the nuances of complex disputes.
  Examples: Blockchain networks relying on smart contracts to manage governance aspects can utilize protocols like Kleros Court to resolve disagreements or disputes. This protocol offers an arbitration process where involved parties submit their cases to a specific Kleros Courts. Jurors, who are participants staking PNK tokens, are randomly selected from the pool based on their token stakes. These jurors independently review the evidence and cast votes to decide the outcome. Decisions are reached through a majority consensus, with jurors who align with the majority receiving PNK tokens and a share of the arbitration fees, while those who dissent lose a portion of their staked tokens.

- **On-chain Voting**
  On-chain voting enables stakeholders to engage in governance decisions by casting their preferences, which are recorded on the blockchain. This process, including the issuance of preferences, the tallying of results, and often the execution of decisions, is deterministic and open for public audit. Additionally, decision outcomes can be executed automatically. Nonetheless, these mechanisms introduce a level of subjectivity, as stakeholders' varying priorities can lead to more diverse and subjective governance outcomes.
  Examples: Cosmos Hub, Cardano (after adopting CIP-1694), Optimism's Token House, Polkadot, and Tezos utilize different config-

urations of on-chain voting mechanisms, where token holders make binding governance decisions.

- **On-chain Signaling**
  On-chain signaling is a mechanism that records preferences directly on the blockchain, yet these results are non-binding. This approach contrasts with on-chain voting, where stakeholders might be technically or socially obliged to adhere to the expressed preferences. While on-chain signaling maintains a degree of predictability by relying on a publicly auditable record of preferences, it also offers a level of discretion by not automatically enforcing decisions.
  Examples: Although Bitcoin lacks an official voting system, several Bitcoin Improvement Proposals (BIPs) have implemented on-chain mechanisms for miners to signal their support or opposition. For instance, miners have used the block version field to signal. While these signals are not binding, they have played a crucial role in progressing Standards Track BIPs, particularly for the implementation of significant soft forks like Segregated Witness (BIP 0141) and Taproot (BIP 0341 and BIP 0342).

- **Off-chain Voting**
  Off-chain voting enables stakeholders to partake in governance decision-making directly and with minimal to no fees, offering a cost-effective alternative to the often expensive on-chain voting processes. However, it does not log these preferences on the blockchain or automate the issuance, tallying, or execution of these preferences. This approach means that while stakeholders may feel socially compelled to follow through on adopted decisions, thus contributing to a degree of determinism, they are not technically required to do so. This lack of technical enforcement provides greater discretion in the governance design.
  Example: The Optimism Collective has used the Snapshot platform to issue preferences off-chain, whose results are considered 'binding,' even if preferences are not recorded on the blockchain.

- **Off-chain Signaling**
  Off-chain signaling represents a highly discretionary method for expressing preferences, as it frees stakeholders from technical and social obligations to act according to the gathered sentiment. Since preferences are not recorded directly on the blockchain, this approach also offers greater discretion in interpreting the expressed preferences, allowing for more nuanced decision-making based on the sentiment collected
  Examples: In 2022, Polygon Labs announced they would use Snapshot to gather consensus in areas such as offboarding offline validators. Besides, many (if not most) projects in the blockchain ecosystem to date informally use Discord, Twitter, or Telegram polls for quick sentiment checks.

- **Rough Consensus**
  Rough consensus is an approach that enables off-chain discussions and debates among stakeholders to make governance decisions in the absence of significant opposition to a proposal. Unlike methods that quantitatively aggregate expressed preferences, rough consensus relies on a qualitative general sense of the group's opinion. This method introduces the highest degree of discretion, allowing stakeholders to collectively assess and interpret complex issues before making governance decisions. However, the inherent ambiguity in determining rough consensus can lead to extended, unresolved discussions or allow influential community members to manipulate public opinion.
  Examples: Several major blockchain networks, including Bitcoin, Ethereum, Filecoin, Polygon, and Zcash, make most governance decisions through rough consensus rather than formal voting or signaling mechanisms. Deliberations often occur online in dedicated governance forums, mainstream communication platforms, or in-person community events and conferences, allowing for a wide range of stakeholder input.

Third Step: 'Keep the strong flavors in check'

Implement safeguards to ensure the governance system is resilient and robust

Summary in a nutshell

Blockchain governance designers are encouraged to pick their preferred flavors (i.e., preference over governance trade-offs) and ingredients (i.e., governance primitives). Still, it is crucial to moderate strong preferences for systems to be resilient and robust. Safeguards are protective measures designed to offset the negative consequences of a system's most potent governance features.

// Safeguards for heavily expedient systems include recall, slashing, and power checks.

// Safeguards for heavily participatory systems include whitelisting and decay functions.

// Safeguards for heavily immutable systems include exit, hard forking and states of exception.

// Safeguards for heavily adaptable systems include blockchain formal constitutions.

// Safeguards for heavily deterministic systems include on-chain time-delay and smart contract kill switches.

// Safeguards for heavily discretionary systems include on-chain fund distributions.

Just as a chef must balance flavors to create a delectable dish, blockchain governance designers should select their preferred governance trade-offs and primitives while moderating strong preferences. Overly favoring certain approaches, such as creating excessively deterministic or discretionary systems, can lead to vulnerabilities and deterioration over time, eroding stakeholder support. It is crucial to keep intense flavors in check to ensure the governance design is theoretically sound and accounts for potential consequences for various stakeholders. The goal is not a perfectly balanced recipe but a viable one that can persist and function amid uncertain conditions.

Insights

Notes from the Chef

Emerging from the field of cybernetics, **viability** depends on finding a balance between two additional components:

- **Resilience** is an organization's ability to recover from adverse conditions beyond its control, adapting effectively to environmental changes to continue fulfilling its purpose. This capacity for adaptation and recovery is closely linked to the concept of 'requisite variety,' which refers to the need for a system's governance to have a sufficiently broad array of behaviors to respond to a changing environment and ensure survival. In culinary terms, resilience is akin to a dish that can be easily modified to accommodate different dietary restrictions or ingredient availability without losing its essential character or flavor profile.
- **Robustness** is the capacity of a system to maintain its integrity and function despite facing threats or disturbances. In contrast and complementary to resilience, robustness does not depend on having enough capacity to adapt but rather on solidifying the scope of changes possible to minimize the governance attack surface. Drawing from the cooking analogy, robustness is like a well-crafted recipe that consistently produces a good meal, even when prepared by different chefs or in various kitchens, thanks to its carefully tested and refined ingredients and instructions.[15]

The Importance of Safeguards

Resilient and robust systems incorporate an appropriate number and type of safeguards. Contrary to 'regular' governance primitives that are meant to reflect governance preferences, safeguards are protective measures designed to offset the negative consequences of a system's most potent governance features. Consequently, safeguards may be triggered only in specific circumstances that could threaten the blockchain system's viability.

Below are some examples of safeguards that can help address heavily skewed governance designs by introducing a degree of the opposite flavor: participation into heavily expedient designs, expedience into heavily participatory designs; immutability into highly adaptable designs, adaptability into highly immutable designs; discretion into highly deterministic designs, and determinism into high discretionary designs.

15 Michael Zargham and Kelsie Nabben, "Aligning 'Decentralized Autonomous Organization' to Precedents in Cybernetics," Social Science Research Network, January 1, 2022, https://doi.org/10.2139/ssrn.4077358.

Safeguards for Heavily Expedient Governance Designs

- **Recall**
  Recall mechanisms enable the quick removal of decision-makers who fail to meet community expectations, allowing for prompt course correction. Empowering community members to recall decision-makers promotes accountability and ensures that highly expedient governance structures remain responsive to the broader community's desires.
  Examples: Within the Cosmos ecosystem, the Juno Network has put community multi-signature wallets under community administrators so that members may be removed or added or the treasury permissions recalled.

- **Slashing**
  Slashing is a punitive mechanism designed to deter dishonest or undesirable actions. As originally conceived in proof-of-stake consensus models, it penalizes actions such as double-signing, where a validator signs two or more conflicting transactions or blocks simultaneously, and downtime, which occurs when a validator is offline and fails to participate in the required consensus process. The consequences for such infractions typically involve the partial or total forfeiture of the stake that the validator has committed or locked up as collateral to participate in the consensus process. In highly expedient systems, slashing is a critical safeguard to discourage misconduct by introducing accountability into the governance process.
  Examples: Ethereum 2.0, Polkadot, Cosmos, and Tezos are some blockchain networks that use slashing to penalize harmful behavior.

- **Power Checks**
  Power checks refer to mechanisms, processes, or systems designed to prevent the abuse of power by distributing the power to veto or express dissent across various decision-making centers within a unified governance framework. Power checks are useful in heavily expedient systems to prevent any one party from exerting disproportionate influence, thus protecting against sudden and unilateral decisions that could overlook or harm broader community interests.
  Examples: In blockchain networks, certain stakeholders possess the credible ability to self-organize and counteract governance actions initiated by other groups. For example, miners and validators can resist changes to the blockchain protocol by opting not to upgrade their software. Conversely, non-mining or non-validating nodes may proceed with software updates without the explicit support of miners or validators. Beyond blockchain networks, an example of power checks includes the 2022 Lido DAO proposal of granting stETH holders veto power over proposals made by LDO holders. Although the proposal was not approved, this dual-governance arrangement would have enabled stakers of ETH (the protocol's users) to block any potentially harmful changes proposed by LDO holders (the protocol's token holders).

Safeguards for Heavily Participatory Governance Designs

- **Whitelisting**
  Whitelisting allows specific proposals to take priority over others or to be addressed more expeditiously. In heavily participatory blockchain systems, where open participation often leads to slower and more deliberative decision-making, whitelisting introduces a degree of expediency. This is typically achieved by establishing processes through which a select group of people can request that certain proposals be handled more quickly, cost-effectively, or be prioritized over other competing ones. By enabling expedited decision-making for particular issues, whitelisting helps to balance open participation with the need for timely and efficient governance, thus ensuring that critical or urgent matters receive the attention they need without getting bogged down in extensive deliberations.
  Examples: Under the new governance framework referred to as OpenGov, the Polkadot Technical Fellowship can decide to whitelist a proposal to have a shorter Lead-in, Confirmation, and Enactment period.

- **Decay Functions**
  The decay function, particularly time decay voting, acts as an effective safeguard in heavily participatory systems by adjusting the weight of votes based on the timing of their submission during the voting period. In such systems, earlier votes carry more weight than those made later. This approach introduces a strategic element of expediency to participatory governance designs, ensuring that decisions can be made swiftly. By encouraging stakeholders to vote early, time decay voting mitigates the potential for prolonged indecision and delays often encountered in systems with extensive participation, thus streamlining the decision-making process

while still honoring the principle of broad involvement.
Example: With EOSIO Dawn 4.0, the EOS blockchain introduced vote decay to combat voter apathy and the free rider problem. It reduces the power of each vote over time unless the voter continuously reasserts their choice, encouraging ongoing engagement and reassessment.

Safeguards for Heavily Immutable Governance Designs

- **Exit**
  The relatively low-cost exit is an inherent feature of blockchain networks, acting as a vital safeguard against overly immutable governance designs. Stakeholders can exit the system by selling their holdings, ceasing to make transactions, or stopping participation as network nodes. Thanks to network effects, where the value of a blockchain system increases with the number of participants, exit serves as a powerful corrective mechanism, incentivizing the blockchain system to remain attuned and responsive to the community's needs and demands.
  Examples: In all public and permissionless blockchain networks, the cost to exit is relatively low. Specifically within the context of DAOs, the 'rage quitting' concept exemplifies this exit strategy. MolochDAO, created to tackle coordination and funding challenges in the Ethereum ecosystem, was the first to implement this safeguard. The rage quit feature allows members to withdraw from the DAO and take their proportional share of the DAO's funds with them if they disagree with the outcome of a proposal, thus ensuring that governance remains flexible and aligned with member interests.

- **Hard Forking**
  Hard forking is a process in blockchain technology where the protocol undergoes significant changes or upgrades, resulting in a split that creates two divergent paths of the blockchain ledger. This method is employed when existing systems need to adapt to new technological advancements or evolving community needs that require changes incompatible with the existing blockchain rules. As a safeguard against highly immutable systems, hard forking allows communities to address issues or implement enhancements that the original system's design may not easily accommodate without abandoning the accrued value and history of the existing blockchain. It allows stakeholders to continue using the original chain or move to the new version with the updated features or rules.
  Example: Bitcoin and Ethereum have undergone a series of hard forks. For example, the Bitcoin Cash community originated from a hard fork of Bitcoin in August 2017 due to a long-standing debate within the Bitcoin community over scalability issues related to the blockchain's 1MB block size limit. While one faction advocated for keeping the block size small to maintain decentralization and proposed off-chain solutions like the Lightning Network, another faction pushed for increasing the block size to accommodate more transactions directly on the blockchain, aiming to reduce fees and speed up transaction times. The inability to reach a consensus led to the creation of Bitcoin Cash, which increased the block size to 8MB, offering a separate path forward with the stated goal of making it a more practical, everyday payment system.

- **States of Exception**
  States of exception typically refer to situations where ordinary governance procedures are suspended and replaced with temporary measures to address unforeseen challenges or crises. In blockchain systems, this mechanism allows for temporary deviations from strict immutability in exceptional circumstances, such as addressing critical security vulnerabilities or resolving systemic crises. By providing a degree of controlled flexibility within an otherwise immutable framework, the state of exception ensures that the blockchain can respond effectively to unforeseen challenges without compromising its fundamental integrity.
  Example: In 2021, Polygon faced a critical challenge when a severe vulnerability was identified in its PoS genesis contract by two whitehat hackers, who reported it through the blockchain security and bug bounty platform, Immunefi. This vulnerability put nearly the entire supply of MATIC at risk—approximately 9.27 billion out of 10 billion tokens. In response, Polygon Labs and Immunefi experts swiftly orchestrated an 'Emergency Bor Upgrade' to address the issue. They alerted validators and the full node community to update their software. Remarkably, about 80% of the network adopted the new client within 24 hours, effectively averting potential network disruptions. The resolution process

adhered to a 'silent patches' policy, meaning the bug fixes were disclosed several weeks after implementation. This approach deviated from the usual governance processes to address the unforeseen circumstances effectively and to minimize the risk of exploitation during the patching phase.

Safeguards for Heavily Adaptable Governance Designs

- **Minimal off-chain constitutions**
  Minimal off-chain constitutions are a type of blockchain formal (written) constitutions that lay out core values or principles of a blockchain system, instead of providing more specific 'rules on how to make rules' or rights and responsibilities of governing bodies and decision-makers. In highly adaptable systems, consolidating fundamental values or principles into a single document can introduce a degree of immutability to the governance design.
  Example: Beyond blockchain networks, an example of a minimal off-chain constitution is the one adopted by BrightDAO. This document focuses on presenting the DAO's vision, mission, and values.

Safeguards for Heavily Deterministic Governance Designs

- **On-chain time delay**
  On-chain time delays implement a mandatory waiting period before the finalization of certain actions within blockchain systems. The system allows network participants to review impending action by introducing a waiting period. This review process permits stakeholders to assess the appropriateness and safety of the actions and potentially veto or suggest modifications to them before they are executed irrevocably. This ability to intervene introduces a degree of human discretion, acting as a safeguard that tempers the rigidity of heavily deterministic systems.
  Example: The Tezos' self-amending process includes several phases, such as proposal, exploration, testing, and promotion periods, which are separated by mandatory time delays. These time delays serve multiple purposes: they provide ample time for discussion, testing, and validation of proposals by the community and ensure that changes to the protocol are made cautiously and with broad agreement.

- **Smart contract kill switches**
  Smart contract kill switches, also called circuit breakers, allow developers or designated parties to disable or pause a smart contract in response to bugs, security breaches, or other critical issues. This capability is crucial in highly deterministic governance systems, as it allows for quick intervention to mitigate potential damage and prevent the further exploitation of vulnerabilities. By incorporating this feature, such systems introduce a necessary level of discretion, enabling human oversight in situations where automated processes might otherwise continue unchecked.
  Example: In principle, blockchain networks relying on smart contracts for governance processes can rely on this safeguard. For an example beyond blockchain networks, the MakerDAO governance system includes emergency shutdown features for its stablecoin, DAI. This mechanism is designed to protect users and the ecosystem in case of a critical failure, extreme market conditions, or attacks on the system. It allows the community or designated actors to trigger a shutdown, safely liquidating assets and ensuring users can redeem their DAI for the underlying collateral, preserving the system's integrity and user investments.

Safeguards for Heavily Discretionary Systems

- **On-chain fund distributions**
  On-chain fund distributions in blockchain systems automate the allocation of funds to stakeholders who meet specific predefined criteria and perform certain actions, such as engaging with the system, participating in decision-making processes, or promoting the adoption of the blockchain. These distributions ensure transparency and fairness in how rewards are handed out. Automating tasks like payments or reward distributions can be advantageous even in highly discretionary systems, where greater human oversight and flexibility are common. Such automation leverages the inherent transparency of on-chain operations, enhancing trust and efficiency without compromising the discretionary nature of the broader governance framework.
  Example: Zcash launched in 2016 with an on-chain distribution scheme where 20% of the mined ZEC was allocated as the 'founders reward.' This portion was taken from the block rewards, leaving the remaining 80% for the miners. Typically, miners received 80% of the block rewards plus transaction fees for mining blocks. The 20% allocated for the founders reward was further divided among several parties: 9.85% went to ECC founders, 2.2% to the Zcash Foundation, 5.75% to ECC itself, and 2.2% for ECC em-

ployee compensation. This distribution mechanism concluded in 2020 with the Canopy upgrade. After the upgrade, miners continue to receive 80% of the block rewards, while the remaining 20% is now distributed among the new Major Grants Fund (8%), ECC (7%), and the Zcash Foundation (5%).

Fourth Step: 'Sample and continue refining your recipe'

Incorporate feedback loops

Summary in a nutshell

// Feedback loops are critical mechanisms for evaluating and refining systems' governance, which build a bridge between endogenous and exogenous governance.

// Within blockchain systems, the absence of clear authority and the potential for opacity in decision-making processes can result in inefficient feedback loops, making it challenging to assess the outcomes of certain actions and effectively 'steer' the governance system.

// Feedback loops should leverage humans as sensors, especially in systems where technology and society mix in complex ways, such as blockchain governance systems.

// Feedback loops should adjust the control surface to account for the blockchain systems' purpose, ensuring the system's internal will to change doesn't skew the system towards excessive adaptability.

After blockchain governance designers have chosen their preferred flavors and ingredients and adopted the right number and type of safeguards to keep the strongest features in check, the resulting governance design should be monitored, evaluated, and adjusted. In other words, the governance design needs to integrate **feedback loops**. This step is akin to a chef tasting their dish and fine-tuning the seasoning to ensure harmonious flavors. However, this process requires accounting not only for the internal composition of the dish but also for exogenous factors, such as the dining environment, the preferences of the guests, and the availability of ingredients in the market.

Similarly, blockchain governance must consider **exogenous governance** or influences outside the blockchain system, such as legal and regulatory developments, socio-political factors, market dynamics, and technological advancements determined by 'outsiders.' While these external factors are beyond the direct control of the 'insiders,' they significantly impact the operations of the blockchain system, just as a chef must adapt their dish to comply with health regulations, accommodate changing customer tastes, and incorporate new cooking techniques or ingredients that become available. By carefully monitoring and responding to these exogenous factors, blockchain governance designers can ensure their system remains viable (i.e., resilient and robust) in the face of evolving external conditions.[16]

16 De Filippi et al., "Report on Blockchain Technology & Polycentric Governance".

Insights

Notes from the Chef

Feedback loops serve as a critical mechanism for evaluating and refining the governance of systems. This concept, also deeply rooted in the discipline of cybernetics, sees governance as 'steering' systems of information, where systems are not static but dynamic and complex structures.[17]

Feedback loop functions include:

- Controller: A process that makes decisions based on current beliefs to achieve a goal. The controller is restricted to changing variables within the control surface.
- Actuator: The mechanism executing the controller's decisions by manipulating variables on the control surface, translating decisions into concrete actions.
- Control Surface: The set of variables that the actuator can manipulate, essentially defining the scope of what can be adjusted to influence outcomes.
- Sensors: Interfaces that observe outcomes and convert them into measurements. These measurements provide data about the effectiveness and impact of the actions taken.
- Feedback Mechanism: The process where the measurements collected by the sensors are used to update the beliefs held by the controller. This updated information forms the basis for future decisions, creating a recursive or circular process essential to effective control.
- Outcome: The result of actions the actuator takes based on the controller's decisions. This outcome is crucial for sensors to evaluate and for adjusting subsequent actions.[18]

Feedback Loops in Blockchain Systems

In traditional centralized organizations, feedback loops often rely on well-defined hierarchies and clear lines of communication between stakeholders, management, and regulatory bodies. However, adding feedback loops to blockchain governance systems presents unique challenges. Blockchain systems are both 'architectural' and 'political' decentralized: they rely on blockchain networks where ledger data is stored across many nodes, and their governance cannot be controlled by any one person or entity.[19] The absence of clear authority and the potential for opacity in decision-making processes can result in inefficient feedback loops, making it challenging to assess the outcomes of certain actions and effectively 'steer' the system.[20]

17 Nancy G. Leveson et al., "Engineering Resilience Into Safety-Critical Systems," in CRC Press eBooks, 2017, 95–123, https://doi.org/10.1201/9781315605685-12.
18 Zargham and Nabben, "Aligning 'Decentralized Autonomous Organization' to Precedents in Cybernetics."
19 Vitalik Buterin, "The Meaning of Decentralization," Medium, July 24, 2018, accessed April 30, 2024, https://medium.com/@VitalikButerin/the-meaning-of-decentralization-a0c92b76a274.
20 Kelsie Nabben, "DAO Vulnerability Mapping: A Theoretical and Empirical Tool," Decentralized Autonomous Organizations by Kerckhoven, S.V. and Chohan, U.W. (Eds.), Routledge: London, ISBN: 9781003449607

Below, we propose two general recommendations for designing and integrating sound feedback loops into blockchain governance:

- **Leverage humans as sensors**
  Feedback loops don't always have to involve people directly. Still, they can—and often should—especially in systems where technology and society mix in complex ways, such as blockchain governance systems. Making feedback loops work effectively includes recognizing the role of humans as both observers and participants in the system, acting as sensors and conduits of information. By acknowledging and leveraging this human-system interaction, we can create more effective feedback mechanisms that capture valuable insights and drive meaningful improvements in complex, non-hierarchical systems like blockchain governance.[21]
  Example: Imagine a blockchain governance system designed to be quite deterministic with governance rules clearly defined on-chain for voter eligibility, ballot casting, and vote tallying, which can inadvertently lead to outcomes that might be perceived as unfair or problematic. This could include scenarios such as the exclusion of certain voter demographics or the potential for vote manipulation via unforeseen loopholes in the system's coding. The governance design integrates a feedback loop with human participants acting as sensors to address such issues. In this system, human users monitor and evaluate the outcomes of governance decisions and the voting process itself. These human sensors are crucial for identifying unintended consequences that the original code fails to anticipate. When they detect such issues, they can raise alerts within the community, initiating a review. This feedback prompts a community-driven discussion that can lead to the proposal and implementation of updates or amendments to the governance rules.

- **Adjust the control surface to account for the blockchain systems' purpose**
  While feedback loops are essential for adapting the blockchain governance system to changing circumstances, designers must ensure that the system's internal will to change doesn't undermine the blockchain system's foundational purpose and skew the system towards excessive adaptability. To avoid such undermining, it is crucial that the control surface—the parameters subject to change—be precisely defined and not overly broad, aligning closely with the organization's foundational purpose.
  Example: Imagine a blockchain governance design where the control parameters originally allowed for adjusting transaction fees and token issuance based on community votes. Over time, this flexibility leads to rapid and unpredictable changes in monetary policy, which confuses users and erodes trust in the blockchain system. Recognizing this, the blockchain governance design should be adjusted to restrict these changes to only occur under specific conditions, such as significant shifts in market dynamics or user base size, which more closely align with the system's long-term objectives of stability and user growth. This adjustment in the control surface helps maintain the systems' purpose while allowing for necessary adaptations.

21 Zargham and Nabben, "Aligning 'Decentralized Autonomous Organization' to Precedents in Cybernetics."

Fifth Step: 'Choose the tableware and serve your dish'

Decide if and which legal entity you want to create

Summary in a nutshell

// Using one or more legal entities can help participants of a blockchain network to modulate 'embeddedness' or the freedom to engage with non-network participants, and 'disembeddedness' or freedom from certain types of interference by external actors.

// Legal entities with separate legal personalities can enter into contracts in their name, own tangible and intangible assets, and sue and be sued separately from their founders or directors.

// Separate legal personality ensures 'entity shielding,' meaning that the legal entity's assets are protected from the owners' creditors should the owners experience a rough patch.

// Limited liability is also a common feature of many legal entities, which ensures 'owner shielding,' meaning the protection of the personal assets of the corporate entity's owners from claims by the entity's creditors.

When preparing to serve a meal, the choice of tableware is crucial—it enhances the dining experience, much like setting the tone and purpose of the gathering. In the context of blockchain governance, deciding whether to establish a **legal entity** (or entities) is akin to choosing the right tableware for your dish. Just as tableware can vary from simple everyday plates to more elaborate fine ones, legal entities can range in type and complexity, each suited to different scenarios and objectives.

Establishing a legal entity is not mandatory for all blockchain governance designs, but it can significantly enhance how the system interacts with external environments. This decision can be seen as a strategic move to increase the blockchain network's embeddedness or disembeddedness.

- **Increasing embeddedness** refers to blockchain networks' greater freedom to engage with non-network participants and institutions.
- **Increasing disembeddedness** refers to blockchain networks being increasingly free from interference by external actors.[22]

While the former seeks to embed blockchain networks, or at least their participants, in the context of institutions and social relations, the latter tries to decouple networks from said institutions and social relations.

22 Michael Zargham et al., "Disambiguating Autonomy," BlockScience Medium, December 6, 2023, accessed May 8, 2024, https://medium.com/block-science/disambiguating-autonomy-ca84ac87a0bf; Thomas Swann, Anarchist Cybernetics: Control and Communication in Radical Politics (Bristol: Bristol University Press, 2020), https://openlibrary.org/books/OL30176898M/Anarchist_Cybernetics; Mark Granovetter, "Economic Action and Social Structure: The Problem of Embeddedness," American Journal of Sociology 91, no. 3 (November 1, 1985): 481–510, https://doi.org/10.1086/228311.

Insights

Notes from the Chef

Blockchain networks are, by default, and to a limited extent, 'alegal' by design. Because they are distributed, autonomous, and transnational, they don't fit neatly into any country's legal system. These networks are tricky to pin down as strictly 'legal' or 'illegal,' which forces us to rethink these labels in some instances. They also present significant practical challenges in prohibiting their operations. Since no person or group can take over the whole network, efforts to close down blockchain nodes in one territory don't have much effect. The network will keep running, and whatever has been recorded on the blockchain stays put. For this reason, it is difficult to enforce laws or court decisions that may seek to reverse transactions or remove illicit content recorded on-chain.

Yet, this alegality is limited. There are ways for public authorities to coerce various network participants, such as crypto exchanges or software developers, which may indirectly affect the operation and governance of blockchain networks. For instance, laws and crackdowns might scare off exchanges from swapping crypto-assets for fiat currencies or make developers think twice before contributing to a blockchain network. So, blockchain networks are never fully embedded or disembedded within the context of institutions or social relations of a given territory. They are not fully autonomous or off-the-grid systems.[23]

Modulating Embeddedness and Disembeddedness

Blockchain networks may wish to be embedded or disembedded for various reasons, and legal entities can assist in this process. Depending on how they are designed and used the use and design of one or more legal entities can modulate how disembedded or embedded a blockchain network is, depending on how they are designed and used.

Ultimately, just as the choice of tableware can either complement or detract from a meal, the decision to create a legal entity should be carefully considered as it can influence the blockchain systems' ability to achieve its desired outcomes. Below, we list some of the affordances legal entities can bring to blockchain systems when included in the governance design.

- **Capacity to obtain and exercise legal personhood**
  Non-profit foundations or for-profit limited liability companies are examples of legal entities with a separate legal personality from the individuals and organizations that form them, direct them, benefit from them, or (in the case of corporate entities) own shares in them. That

23 Primavera De Filippi, Morshed Mannan, and Wessel Reijers, "The Alegality of Blockchain Technology," Policy & Society 41, no. 3 (February 16, 2022): 358–72, https://doi.org/10.1093/polsoc/puac006.

means these entities can enter into contracts in their name, own and hold tangible and intangible assets (e.g., intellectual property), sue, and be sued separately from their owners (including founder-owners), founders or directors. Notably, the separate legal personalities of these entities enable them to hold governance tokens in blockchain networks separately from their founders, potentially allowing them to serve a stewardship function in the long-term interests of that network's community. In other words, legal entities can help embed network participants within institutions and social relations beyond the network. Indeed, this can also enable the deliberate embedding of these legal entities among non-network participants if they so wish. Example: Several blockchain networks were initially developed and launched by a small team of founders. Some of them did it through a private company (e.g., Ava Labs Inc. for Avalanche; IOHK and EMURGO Group Pte Ltd. for Cardano) or a foundation (Ethereum Foundation for Ethereum; Web3 Foundation for Polkadot). Bitcoin is an exception to this trend, as it did not rely on closely-tied legal entities to promote its growth. Founded by Satoshi Nakamoto, it was steered by a diffuse community of volunteers and donors before attracting the support of corporate sponsors, research institutions, and non-governmental organizations for further development. Thus, while a legal entity is not a prerequisite for creating a blockchain network, it can be helpful in hiring developers, renting office space, and holding assets to disburse as grants.

- **Provision of 'entity shielding'**
  Separate legal personality can also help partition assets. Entities with legal personality benefit from 'entity shielding,' meaning that the legal entity's assets are protected from the creditors of the founders or directors, should the founders or directors experience a rough patch.[24] As mentioned above, a non-profit foundation or for-profit corporate entity can own a significant minority of tokens in a blockchain network as a separate patrimony from other token-holders, including the founders of the blockchain network. This means that in ordinary circumstances, the personal creditors of the founders or other token-holders will not be able to claim the assets of the foundation or corporate entity. Having a legal entity makes it easier to get funding because it becomes clear which assets can be provided to corporate creditors as security or claimed by creditors after a legal dispute if things go sideways. Without this setup, it will remain unclear which corporate assets can be given as collateral to corporate creditors and which cannot.
  Example: The governance and ownership of the Tezos network were structured through two entities, which allowed the project to leverage the benefits of entity shielding. The Tezos Foundation, on the one hand, was established as a non-profit entity designed to manage and promote the Tezos blockchain network. It held a significant amount of the network's tokens to fund the network's development. This arrangement shielded the Tezos foundation by keeping the foundation's assets—including the tokens it held—separate from the personal assets of the network's founders or any individual token-holders. Therefore, if the founders faced personal legal claims or bankruptcy,

24 Henry Hansmann and Reinier Kraakman, "Organizational Law as Asset Partitioning," European Economic Review 44, no. 4–6 (May 1, 2000): 807–17, https://doi.org/10.1016/s0014-2921(00)00046-5.

their creditors could not directly claim the tokens or assets held by the Tezos Foundation. On the other hand, Dynamic Ledger Solutions played a crucial role in keeping the intellectual property related to the Tezos blockchain technology. This setup ensured that the technological foundation of Tezos was protected under a separate legal entity, further isolating it from potential personal disputes concerning the project's creators or other stakeholders.

- **Provision of 'owner shielding'**

Limited liability is also a common feature of corporate entities, and this feature can ensure 'owner shielding' by protecting the personal assets of the owners (including founder-owners) of a corporate entity from claims by the entity's creditors.[25] This concept is essentially the inverse of entity shielding. Limited liability means that the financial responsibility of the owners of a corporate entity for the entity's debts and obligations is limited to the amount they have contributed to the entity. Therefore, if a corporate entity goes bankrupt or faces legal claims exceeding its assets, the owners' personal assets (such as their personal homes or savings) cannot generally be claimed by the entity's creditors to settle corporate debts. Owner shielding is less conceptually helpful in the case of non-profit foundations, as they do not have owners, but their directors and officers are still protected from personal liability due to the separate legal personality of such foundations.
Example: Say a corporate entity tied to a blockchain network needs to pay rent for its office space. The people it owes money to can't claim the personal assets of the owners should the corporate entity default on its payments. At most, the owners would lose the capital contributed to the entity.

- **Dual-shielding action keeps everyone's finances clear and separate**

Legal entities may not be established as stand-alone entities but as a group of corporate entities, with a 'parent' legal entity owning shares in one or more subsidiaries. Entity shielding and owner shielding will, in most (but not all) cases, separate the parent's assets from those of subsidiaries and vice-versa. This feature allows, for instance, the intellectual property of a blockchain network to be owned by a parent legal entity and subsidiaries to engage in other unrelated activities without being concerned that the risks incurred by the subsidiaries will imperil the parent. This dual-shielding action—protecting the entity's assets from the owners' debts and vice versa—helps keep everyone's finances clear and separate.

In sum, the use of one or more legal entities can help the participants of a blockchain network to modulate between the freedom to engage with non-network participants and institutions (i.e., be embedded) and freedom from certain types of interference by external actors (i.e., be disembedded), reinforcing their 'alegal' status.

25 ibid, 814.

Conclusion

Final Thoughts

In this cookbook, we presented a series of practical steps for governance designers to develop resilient and robust blockchain governance systems. While the culture, practices, and processes of governance design, implementation, and practice may vary among blockchain protocols and their communities, as well as according to the maturity of a particular blockchain protocol or project, this cookbook offers a pragmatic approach that can be adapted to the specific needs and desires of different blockchain communities.

The steps include:
1. 'Pick your flavors': Identify the governance trade-offs and situate yourself within them.
2. 'Pick your ingredients': Identify the governance primitives to implement the preferred flavors.
3. 'Keep the strong flavors in check': Implement safeguards to ensure the governance system is resilient and robust.
4. 'Sample and continue refining your recipe': Incorporate feedback loops to monitor, evaluate, and adjust the governance system.
5. 'Choose the tableware and serve your dish': Decide if and which legal entity you want to create to complement your governance system.

These factors are crucial for designing and maintaining effective blockchain networks. However, it is essential to acknowledge that this cookbook did not fully address the financial resources and expertise required to implement complex governance designs. This limitation may affect the feasibility of applying our proposed steps for organizations or communities with constrained budgets or limited access to technical specialists.

Nevertheless, the steps outlined in this cookbook provide a structured yet flexible framework for building governance systems that address the unique challenges and opportunities presented by blockchain technology while respecting the diverse values and goals of the communities they serve. Although this cookbook is not intended to be prescriptive, by following this approach, governance designers can foster environments where innovation flourishes, challenges are managed constructively, and the long-term sustainability of the blockchain network is achievable.

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